



EUROPEAN COMMISSION
Innovation and Networks Executive Agency

Director



GRANT AGREEMENT

NUMBER 814961 — SAFEMODE

This **Agreement** ('the Agreement') is **between** the following parties:

on the one part,

the **Innovation and Networks Executive Agency (INEA)** ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

represented for the purposes of signature of this Agreement by Head of Department, Innovation and Networks Executive Agency, H2020 Department for all technical projects and grant agreements, Alan HAIGH,

and

on the other part,

1. 'the coordinator':

DEEP BLUE SRL (DEEP BLUE), established in VIA ENNIO QUIRINO VISCONTI 8, ROMA 00193, Italy, VAT number: IT06458931000, represented for the purposes of signing the Agreement by Carla FRESIA

and the following other beneficiaries, if they sign their 'Accession Form' (see Annex 3 and Article 56):

2. **UNIVERSITY OF STRATHCLYDE (USTRAT)**, established in Richmond Street 16, GLASGOW G1 1XQ, United Kingdom, VAT number: GB261339762,

3. **EUROCONTROL - EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION (EUROCONTROL)**, established in Rue de la Fusée 96, BRUXELLES 1130, Belgium, VAT number: not applicable, as 'beneficiary not receiving EU funding' (see Article 9),

4. **STICHTING NATIONAAL LUCHT- EN RUIMTEVAARTLABORATORIUM (NLR)**, established in Anthony Fokkerweg 2, AMSTERDAM 1059CM, Netherlands, VAT number: NL002760551B01,

5. **HUNGAROCONTROL MAGYAR LEGIFORGALMISZOLGALAT ZARTKORUEN MUKODO RESZVENYTARSASAG (HUNGAROCONTROL)**, established in IGLO UTCA 33 35, BUDAPEST 1185, Hungary, VAT number: HU13851325,

6. **ECOLE NATIONALE DE L AVIATION CIVILE (ENAC)**, established in AVENUE EDOUARD BELIN 7, TOULOUSE 31400, France, VAT number: FR57193112562,

7. **UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA (UniSap)**, established in Piazzale Aldo Moro 5, ROMA 00185, Italy, VAT number: IT02133771002,
8. **ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (CERTH)**, established in CHARILAOU THERMI ROAD 6 KM, THERMI THESSALONIKI 57001, Greece, VAT number: EL099785242,
9. **CETENA S.p.A. Centro per gli Studi di Tecnica Navale (CETENA)**, established in via Ippolito D'Aste 5, Genova 16121, Italy,
10. **ISTANBUL TEKNİK UNIVERSİTESİ (ITU)**, established in AYAZAGA KAMPUSU, MASLAK ISTANBUL 34469, Turkey, VAT number: TR4810549377,
11. **CALMAC FERRIES LTD (CalMac)**, established in The Ferry Terminal, GOUROCK PA19 1QP, United Kingdom, VAT number: GB889051388,
12. **CHALMERS TEKNISKA HOEGSKOLA AB (CHALMERS)**, established in -, GOETEBORG 41296, Sweden, VAT number: SE556479559801,
13. **EMBRAER PORTUGAL SA (EMBPT)**, established in PARQUE DA INDUSTRIA AERONAUTICA DE EVORA - LOTE A- HERDADE DE PINHEIRO E CASA BRANCA, EVORA 7005 797, Portugal, VAT number: PT508607035,
14. **FEDERAL STATE UNITARY ENTERPRISE THE CENTRAL AEROHYDRODYNAMIC INSTITUTE NAMED AFTER PROF. N.E. ZHUKOVSKY (TsAGI)**, established in Zhukovsky str 1, ZHUKOVSKY 140180, Russian Federation, VAT number: RU5013009056, as ‘beneficiary not receiving EU funding’ (see Article 9),
15. **STATE RESEARCH INSTITUTE OF AVIATION SYSTEMS (GosNIIAS)**, established in victorenko, MOSCOW 125319, Russian Federation, VAT number: RU7714037739, as ‘beneficiary not receiving EU funding’ (see Article 9),
16. **STATE EDUCATIONAL INSTITUTION OF HIGHER PROFESSIONAL EDUCATION MOSCOW AVIATION INSTITUTE STATE TECHNICAL UNIVERSITY (MAI)**, established in Volokolamskoe Shosse 4, MOSKVA 125993, Russian Federation, as ‘beneficiary not receiving EU funding’ (see Article 9),
17. **KONSERN INNOVATIONNYYE TEKHNologii (Innoteh)**, established in CHKALOV STREET 44, BUILDING 4, ROOM 3, ZHUKOVSKY 140181, Russian Federation, VAT number: RU5040121113, as ‘beneficiary not receiving EU funding’ (see Article 9),
18. **MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY (STATE UNIVERSITY) (MIPT)**, established in KERCHENSKAYA STREET 1 A KOR 1, MOSCOW 117303, Russian Federation, VAT number: RU5008006211, as ‘beneficiary not receiving EU funding’ (see Article 9),
19. **DE MONTFORT UNIVERSITY (DMU)**, established in THE GATEWAY, LEICESTER LE1 9BH, United Kingdom, VAT number: GB806661135,
20. **NATIONAL TECHNICAL UNIVERSITY OF ATHENS - NTUA (NTUA)**, established in HEROON POLYTECHNIOU 9 ZOGRAPHOU CAMPUS, ATHINA 15780, Greece, VAT number: EL099793475,

21. **WORLD MARITIME UNIVERSITY (WMU)**, established in FISKHAMNSGATAN 1, MALMO 211 18, Sweden,
22. **AIRBUS OPERATIONS SAS (AIRBUS)**, established in ROUTE DE BAYONNE 316, TOULOUSE 31060, France, VAT number: FR13420916918,
23. **ANDREAS PAPADAKIS NAUTILIAKES KAI EMPORIKES EPICHEIRISEIS MONOPROSOPI ETAIREIA PERIORISMENHS EFTHINIS (APA)**, established in 3, XANTHOU STREET, BONA VISTA PLAZA, GLYFADA ATHENS 16674, Greece, VAT number: EL095736650,
24. **RYANAIR DESIGNATED ACTIVITY COMPANY (RYANAIR)**, established in RYANAIR DUBLIN OFFICE AIRSIDE BUSINESS PARK, SWORDS DUBLIN, Ireland, VAT number: IE4749148U,
25. **PANEPISTIMIO PATRON (UPATRAS)**, established in UNIVERSITY CAMPUS RIO PATRAS, RIO PATRAS 265 04, Greece, VAT number: EL998219694,
26. **RAIL SAFETY AND STANDARDS BOARD LIMITED (RSSB)**, established in THE HELICON 1 SOUTH PLACE, LONDON EC2M 2RB, United Kingdom, VAT number: GB899092068,
27. **UNIVERSITEIT VAN AMSTERDAM (UVA)**, established in SPUI 21, AMSTERDAM 1012WX, Netherlands, VAT number: NL003240782B01,
28. **WAERTSILA NETHERLANDS B.V. (Wartsila NL)**, established in Hanzelaan 95, Zwolle 8000GB, Netherlands, VAT number: NL001449679B01,
29. **ARCHIPELAGO PHILIPPINE FERRIES CORPORATION (APFC)**, established in 6TH FLOOR UNIOIL CENTER BUILDING COMMERCE AVENUE C ACACIA MADRIGAL BUSINESS PARK BRGY AYALA ALABANG, MUNTINLUPA 1781, Philippines, VAT number: PH223662279,
30. **INSTITUT TEKNOLOGI SEPULUH NOPEMBER (INSTITUTEKNO)**, established in KAMPUS ITS SUKOLILO KEPUTIH - SUKOLILO, SURABAYA 60111, Indonesia, VAT number: ID003438348606000,
31. **ROLLS-ROYCE MARINE AS (ROLLS-ROYCE MAR)**, established in BORGUNDSVEGEN 340, ALESUND 6009, Norway, VAT number: NO980371379MVA,
32. ***Wuhan University of Technology (WUT)**, established in Luoshi Road 122, Wuhan 430070, China (People's Republic of), VAT number: CN420111724685906, as ‘beneficiary not receiving EU funding’ (see Article 9),*
33. **TUI AIRWAYS LIMITED (TUI Airways ltd)**, established in WIGMORE HOUSE, WIGMORE LANE, LUTON LU2 9TN, United Kingdom, VAT number: GB490212079,
34. **DEMIRAL ALI (BeeBI)**, established in ALTE JAKOBSTRASSE 49, BERLIN 10179, Germany, VAT number: DE313122620,

Unless otherwise specified, references to ‘beneficiary’ or ‘beneficiaries’ include the coordinator.

The parties referred to above have agreed to enter into the Agreement under the terms and conditions below.

By signing the Agreement or the Accession Form, the beneficiaries accept the grant and agree to implement it under their own responsibility and in accordance with the Agreement, with all the obligations and conditions it sets out.

The Agreement is composed of:

Terms and Conditions

- | | |
|---------|---|
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| | 2a Additional information on the estimated budget |
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CHAPTER 1 GENERAL

ARTICLE 1 — SUBJECT OF THE AGREEMENT

This Agreement sets out the rights and obligations and the terms and conditions applicable to the grant awarded to the beneficiaries for implementing the action set out in Chapter 2.

CHAPTER 2 ACTION

ARTICLE 2 — ACTION TO BE IMPLEMENTED

The grant is awarded for the action entitled ‘**Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation**’ — ‘**SAFEMODE**’ (‘**action**’), as described in Annex 1.

ARTICLE 3 — DURATION AND STARTING DATE OF THE ACTION

The duration of the action will be **36 months** as of the first day of the month following the date the Agreement enters into force (see Article 58) (‘**starting date of the action**’).

ARTICLE 4 — ESTIMATED BUDGET AND BUDGET TRANSFERS

4.1 Estimated budget

The ‘**estimated budget**’ for the action is set out in Annex 2.

It contains the estimated eligible costs and the forms of costs, broken down by beneficiary and budget category (see Articles 5, 6). It also shows the estimated costs of the beneficiaries not receiving EU funding (see Article 9).

4.2 Budget transfers

The estimated budget breakdown indicated in Annex 2 may be adjusted — without an amendment (see Article 55) — by transfers of amounts between beneficiaries, budget categories and/or forms of costs set out in Annex 2, if the action is implemented as described in Annex 1.

However, the beneficiaries may not add costs relating to subcontracts not provided for in Annex 1, unless such additional subcontracts are approved by an amendment or in accordance with Article 13.

CHAPTER 3 GRANT

ARTICLE 5 — GRANT AMOUNT, FORM OF GRANT, REIMBURSEMENT RATES AND FORMS OF COSTS

5.1 Maximum grant amount

The ‘**maximum grant amount**’ is **EUR 6 988 469.31** (six million nine hundred and eighty eight thousand four hundred and sixty nine EURO and thirty one eurocents).

5.2 Form of grant, reimbursement rates and forms of costs

The grant reimburses **100% of the action's eligible costs** (see Article 6) (**‘reimbursement of eligible costs grant’**) (see Annex 2).

The estimated eligible costs of the action are EUR **6 988 500.81** (six million nine hundred and eighty eight thousand five hundred EURO and eighty one eurocents).

Eligible costs (see Article 6) must be declared under the following forms (**‘forms of costs’**):

(a) for **direct personnel costs**:

- as actually incurred costs (**‘actual costs’**) or
- on the basis of an amount per unit calculated by the beneficiary in accordance with its usual cost accounting practices (**‘unit costs’**).

Personnel **costs for SME owners or beneficiaries that are natural persons** not receiving a salary (see Article 6.2, Points A.4 and A.5) must be declared on the basis of the amount per unit set out in Annex 2a (**unit costs**);

(b) for **direct costs for subcontracting**: as actually incurred costs (**actual costs**);

(c) for **direct costs of providing financial support to third parties**: not applicable;

(d) for **other direct costs**:

- for costs of internally invoiced goods and services: on the basis of an amount per unit calculated by the beneficiary in accordance with its usual cost accounting practices (**‘unit costs’**);
- for all other costs: as actually incurred costs (**actual costs**);

(e) for **indirect costs**: on the basis of a flat-rate applied as set out in Article 6.2, Point E (**‘flat-rate costs’**);

(f) **specific cost category(ies)**: not applicable.

5.3 Final grant amount — Calculation

The **‘final grant amount’** depends on the actual extent to which the action is implemented in accordance with the Agreement’s terms and conditions.

This amount is calculated by the Agency — when the payment of the balance is made (see Article 21.4) — in the following steps:

Step 1 — Application of the reimbursement rates to the eligible costs

Step 2 — Limit to the maximum grant amount

Step 3 — Reduction due to the no-profit rule

Step 4 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations

5.3.1 Step 1 — Application of the reimbursement rates to the eligible costs

The reimbursement rate(s) (see Article 5.2) are applied to the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) declared by the beneficiaries (see Article 20) and approved by the Agency (see Article 21).

5.3.2 Step 2 — Limit to the maximum grant amount

If the amount obtained following Step 1 is higher than the maximum grant amount set out in Article 5.1, it will be limited to the latter.

5.3.3 Step 3 — Reduction due to the no-profit rule

The grant must not produce a profit.

‘**Profit**’ means the surplus of the amount obtained following Steps 1 and 2 plus the action’s total receipts, over the action’s total eligible costs.

The ‘**action’s total eligible costs**’ are the consolidated total eligible costs approved by the Agency.

The ‘**action’s total receipts**’ are the consolidated total receipts generated during its duration (see Article 3).

The following are considered **receipts**:

- (a) income generated by the action; if the income is generated from selling equipment or other assets purchased under the Agreement, the receipt is up to the amount declared as eligible under the Agreement;
- (b) financial contributions given by third parties to the beneficiary specifically to be used for the action, and
- (c) in-kind contributions provided by third parties free of charge and specifically to be used for the action, if they have been declared as eligible costs.

The following are however not considered receipts:

- (a) income generated by exploiting the action’s results (see Article 28);
- (b) financial contributions by third parties, if they may be used to cover costs other than the eligible costs (see Article 6);
- (c) financial contributions by third parties with no obligation to repay any amount unused at the end of the period set out in Article 3.

If there is a profit, it will be deducted from the amount obtained following Steps 1 and 2.

5.3.4 Step 4 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations — Reduced grant amount — Calculation

If the grant is reduced (see Article 43), the Agency will calculate the reduced grant amount by deducting the amount of the reduction (calculated in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations, in accordance with Article 43.2) from the maximum grant amount set out in Article 5.1.

The final grant amount will be the lower of the following two:

- the amount obtained following Steps 1 to 3 or
- the reduced grant amount following Step 4.

5.4 Revised final grant amount — Calculation

If — after the payment of the balance (in particular, after checks, reviews, audits or investigations; see Article 22) — the Agency rejects costs (see Article 42) or reduces the grant (see Article 43), it will calculate the ‘**revised final grant amount**’ for the beneficiary concerned by the findings.

This amount is calculated by the Agency on the basis of the findings, as follows:

- in case of **rejection of costs**: by applying the reimbursement rate to the revised eligible costs approved by the Agency for the beneficiary concerned;
- in case of **reduction of the grant**: by calculating the concerned beneficiary’s share in the grant amount reduced in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations (see Article 43.2).

In case of **rejection of costs and reduction of the grant**, the revised final grant amount for the beneficiary concerned will be the lower of the two amounts above.

ARTICLE 6 — ELIGIBLE AND INELIGIBLE COSTS

6.1 General conditions for costs to be eligible

‘**Eligible costs**’ are costs that meet the following criteria:

(a) for **actual costs**:

- (i) they must be actually incurred by the beneficiary;
- (ii) they must be incurred in the period set out in Article 3, with the exception of costs relating to the submission of the periodic report for the last reporting period and the final report (see Article 20);
- (iii) they must be indicated in the estimated budget set out in Annex 2;
- (iv) they must be incurred in connection with the action as described in Annex 1 and necessary for its implementation;
- (v) they must be identifiable and verifiable, in particular recorded in the beneficiary’s accounts in accordance with the accounting standards applicable in the country where the beneficiary is established and with the beneficiary’s usual cost accounting practices;

- (vi) they must comply with the applicable national law on taxes, labour and social security, and
- (vii) they must be reasonable, justified and must comply with the principle of sound financial management, in particular regarding economy and efficiency;

(b) for **unit costs**:

- (i) they must be calculated as follows:

{amounts per unit set out in Annex 2a or calculated by the beneficiary in accordance with its usual cost accounting practices (see Article 6.2, Point A and Article 6.2.D.5)}

multiplied by

the number of actual units};

- (ii) the number of actual units must comply with the following conditions:

- the units must be actually used or produced in the period set out in Article 3;
- the units must be necessary for implementing the action or produced by it, and
- the number of units must be identifiable and verifiable, in particular supported by records and documentation (see Article 18);

(c) for **flat-rate costs**:

- (i) they must be calculated by applying the flat-rate set out in Annex 2, and
- (ii) the costs (actual costs or unit costs) to which the flat-rate is applied must comply with the conditions for eligibility set out in this Article.

6.2 Specific conditions for costs to be eligible

Costs are eligible if they comply with the general conditions (see above) and the specific conditions set out below for each of the following budget categories:

- A. direct personnel costs;
- B. direct costs of subcontracting;
- C. not applicable;
- D. other direct costs;
- E. indirect costs;
- F. not applicable.

‘Direct costs’ are costs that are directly linked to the action implementation and can therefore be attributed to it directly. They must not include any indirect costs (see Point E below).

‘Indirect costs’ are costs that are not directly linked to the action implementation and therefore cannot be attributed directly to it.

A. Direct personnel costs

Types of eligible personnel costs

A.1 Personnel costs are eligible, if they are related to personnel working for the beneficiary under an employment contract (or equivalent appointing act) and assigned to the action (**‘costs for employees (or equivalent)’**). They must be limited to salaries (including during parental leave), social security contributions, taxes and other costs included in the **remuneration**, if they arise from national law or the employment contract (or equivalent appointing act).

Beneficiaries that are non-profit legal entities¹ may also declare as personnel costs **additional remuneration** for personnel assigned to the action (including payments on the basis of supplementary contracts regardless of their nature), if:

- (a) it is part of the beneficiary’s usual remuneration practices and is paid in a consistent manner whenever the same kind of work or expertise is required;
- (b) the criteria used to calculate the supplementary payments are objective and generally applied by the beneficiary, regardless of the source of funding used.

‘Additional remuneration’ means any part of the remuneration which exceeds what the person would be paid for time worked in projects funded by national schemes.

Additional remuneration for personnel assigned to the action is eligible up to the following amount:

- (a) if the person works full time and exclusively on the action during the full year: up to EUR 8 000;
- (b) if the person works exclusively on the action but not full-time or not for the full year: up to the corresponding pro-rata amount of EUR 8 000, or
- (c) if the person does not work exclusively on the action: up to a pro-rata amount calculated as follows:

$$\left\{ \begin{array}{l} \text{EUR 8 000} \\ \text{divided by} \\ \text{the number of annual productive hours (see below)}, \\ \text{multiplied by} \\ \text{the number of hours that the person has worked on the action during the year} \end{array} \right\}.$$

A.2 The **costs for natural persons working under a direct contract** with the beneficiary other than an employment contract are eligible personnel costs, if:

- (a) the person works under conditions similar to those of an employee (in particular regarding the way the work is organised, the tasks that are performed and the premises where they are performed);
- (b) the result of the work carried out belongs to the beneficiary (unless exceptionally agreed otherwise), and

¹ For the definition, see Article 2.1(14) of the Rules for Participation Regulation No 1290/2013: ‘**non-profit legal entity**’ means a legal entity which by its legal form is non-profit-making or which has a legal or statutory obligation not to distribute profits to its shareholders or individual members.

- (c) the costs are not significantly different from those for personnel performing similar tasks under an employment contract with the beneficiary.

A.3 The **costs of personnel seconded by a third party against payment** are eligible personnel costs, if the conditions in Article 11.1 are met.

A.4 **Costs of owners** of beneficiaries that are small and medium-sized enterprises (**'SME owners'**) who are working on the action and who do not receive a salary are eligible personnel costs, if they correspond to the amount per unit set out in Annex 2a multiplied by the number of actual hours worked on the action.

A.5 **Costs of 'beneficiaries that are natural persons'** not receiving a salary are eligible personnel costs, if they correspond to the amount per unit set out in Annex 2a multiplied by the number of actual hours worked on the action.

Calculation

Personnel costs must be calculated by the beneficiaries as follows:

{ {hourly rate
multiplied by
the number of actual hours worked on the action},
plus
for non-profit legal entities: additional remuneration to personnel assigned to the action under the
conditions set out above (Point A.1)}.

The number of actual hours declared for a person must be identifiable and verifiable (see Article 18).

The total number of hours declared in EU or Euratom grants, for a person for a year, cannot be higher than the annual productive hours used for the calculations of the hourly rate. Therefore, the maximum number of hours that can be declared for the grant are:

{number of annual productive hours for the year (see below)
minus
total number of hours declared by the beneficiary, for that person in that year, for other EU or Euratom
grants}.

The **'hourly rate'** is one of the following:

- (a) for personnel costs declared as **actual costs** (i.e. budget categories A.1, A.2, A.3): the hourly rate is calculated *per full financial year*, as follows:

{actual annual personnel costs (excluding additional remuneration) for the person
divided by
number of annual productive hours}.

using the personnel costs and the number of productive hours for each full financial year covered by the reporting period concerned. If a financial year is not closed at the end of the

reporting period, the beneficiaries must use the hourly rate of the last closed financial year available.

For the ‘number of annual productive hours’, the beneficiaries may choose one of the following:

- (i) ‘fixed number of hours’: 1 720 hours for persons working full time (or corresponding pro-rata for persons not working full time);
- (ii) ‘individual annual productive hours’: the total number of hours worked by the person in the year for the beneficiary, calculated as follows:

{annual workable hours of the person (according to the employment contract, applicable collective labour agreement or national law)

plus

overtime worked

minus

absences (such as sick leave and special leave)}.

‘Annual workable hours’ means the period during which the personnel must be working, at the employer’s disposal and carrying out his/her activity or duties under the employment contract, applicable collective labour agreement or national working time legislation.

If the contract (or applicable collective labour agreement or national working time legislation) does not allow to determine the annual workable hours, this option cannot be used;

- (iii) ‘standard annual productive hours’: the ‘standard number of annual hours’ generally applied by the beneficiary for its personnel in accordance with its usual cost accounting practices. This number must be at least 90% of the ‘standard annual workable hours’.

If there is no applicable reference for the standard annual workable hours, this option cannot be used.

For all options, the actual time spent on **parental leave** by a person assigned to the action may be deducted from the number of annual productive hours.

As an alternative, beneficiaries may calculate the hourly rate *per month*, as follows:

{actual monthly personnel cost (excluding additional remuneration) for the person

divided by

{number of annual productive hours / 12}}}

using the personnel costs for each month and (one twelfth of) the annual productive hours calculated according to either option (i) or (iii) above, i.e.:

- fixed number of hours or
- standard annual productive hours.

Time spent on **parental leave** may not be deducted when calculating the hourly rate per month. However, beneficiaries may declare personnel costs incurred in periods of parental leave in proportion to the time the person worked on the action in that financial year.

If parts of a basic remuneration are generated over a period longer than a month, the beneficiaries may include only the share which is generated in the month (irrespective of the amount actually paid for that month).

Each beneficiary must use only one option (per full financial year or per month) for each full financial year;

(b) for personnel costs declared on the basis of **unit costs** (i.e. budget categories A.1, A.2, A.4, A.5): the hourly rate is one of the following:

- (i) for SME owners or beneficiaries that are natural persons: the hourly rate set out in Annex 2a (see Points A.4 and A.5 above), or
- (ii) for personnel costs declared on the basis of the beneficiary's usual cost accounting practices: the hourly rate calculated by the beneficiary in accordance with its usual cost accounting practices, if:
 - the cost accounting practices used are applied in a consistent manner, based on objective criteria, regardless of the source of funding;
 - the hourly rate is calculated using the actual personnel costs recorded in the beneficiary's accounts, excluding any ineligible cost or costs included in other budget categories.

The actual personnel costs may be adjusted by the beneficiary on the basis of budgeted or estimated elements. Those elements must be relevant for calculating the personnel costs, reasonable and correspond to objective and verifiable information;

and

- the hourly rate is calculated using the number of annual productive hours (see above).

B. Direct costs of subcontracting (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible if the conditions in Article 13.1.1 are met.

C. Direct costs of providing financial support to third parties

Not applicable

D. Other direct costs

D.1 Travel costs and related subsistence allowances (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible if they are in line with the beneficiary's usual practices on travel.

D.2 The depreciation costs of equipment, infrastructure or other assets (new or second-hand) as recorded in the beneficiary's accounts are eligible, if they were purchased in accordance with

Article 10.1.1 and written off in accordance with international accounting standards and the beneficiary's usual accounting practices.

The **costs of renting or leasing** equipment, infrastructure or other assets (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are also eligible, if they do not exceed the depreciation costs of similar equipment, infrastructure or assets and do not include any financing fees.

The costs of equipment, infrastructure or other assets **contributed in-kind against payment** are eligible, if they do not exceed the depreciation costs of similar equipment, infrastructure or assets, do not include any financing fees and if the conditions in Article 11.1 are met.

The only portion of the costs that will be taken into account is that which corresponds to the duration of the action and rate of actual use for the purposes of the action.

D.3 Costs of other goods and services (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible, if they are:

- (a) purchased specifically for the action and in accordance with Article 10.1.1 or
- (b) contributed in kind against payment and in accordance with Article 11.1.

Such goods and services include, for instance, consumables and supplies, dissemination (including open access), protection of results, certificates on the financial statements (if they are required by the Agreement), certificates on the methodology, translations and publications.

D.4 Capitalised and operating costs of 'large research infrastructure'² directly used for the action are eligible, if:

- (a) the value of the large research infrastructure represents at least 75% of the total fixed assets (at historical value in its last closed balance sheet before the date of the signature of the Agreement or as determined on the basis of the rental and leasing costs of the research infrastructure³);
- (b) the beneficiary's methodology for declaring the costs for large research infrastructure has been positively assessed by the Commission ('**ex-ante assessment**');
- (c) the beneficiary declares as direct eligible costs only the portion which corresponds to the duration of the action and the rate of actual use for the purposes of the action, and
- (d) they comply with the conditions as further detailed in the annotations to the H2020 grant agreements.

² '**Large research infrastructure**' means research infrastructure of a total value of at least EUR 20 million, for a beneficiary, calculated as the sum of historical asset values of each individual research infrastructure of that beneficiary, as they appear in its last closed balance sheet before the date of the signature of the Agreement or as determined on the basis of the rental and leasing costs of the research infrastructure.

³ For the definition, see Article 2(6) of the H2020 Framework Programme Regulation No 1291/2013: '**Research infrastructure**' are facilities, resources and services that are used by the research communities to conduct research and foster innovation in their fields. Where relevant, they may be used beyond research, e.g. for education or public services. They include: major scientific equipment (or sets of instruments); knowledge-based resources such as collections, archives or scientific data; e-infrastructures such as data and computing systems and communication networks; and any other infrastructure of a unique nature essential to achieve excellence in research and innovation. Such infrastructures may be 'single-sited', 'virtual' or 'distributed'.

D.5 Costs of internally invoiced goods and services directly used for the action are eligible, if:

- (a) they are declared on the basis of a unit cost calculated in accordance with the beneficiary's usual cost accounting practices;
- (b) the cost accounting practices used are applied in a consistent manner, based on objective criteria, regardless of the source of funding;
- (c) the unit cost is calculated using the actual costs for the good or service recorded in the beneficiary's accounts, excluding any ineligible cost or costs included in other budget categories.

The actual costs may be adjusted by the beneficiary on the basis of budgeted or estimated elements. Those elements must be relevant for calculating the costs, reasonable and correspond to objective and verifiable information;

- (d) the unit cost excludes any costs of items which are not directly linked to the production of the invoiced goods or service.

'Internally invoiced goods and services' means goods or services which are provided by the beneficiary directly for the action and which the beneficiary values on the basis of its usual cost accounting practices.

E. Indirect costs

Indirect costs are eligible if they are declared on the basis of the flat-rate of 25% of the eligible direct costs (see Article 5.2 and Points A to D above), from which are excluded:

- (a) costs of subcontracting and
- (b) costs of in-kind contributions provided by third parties which are not used on the beneficiary's premises;
- (c) not applicable;
- (d) not applicable.

Beneficiaries receiving an operating grant⁴ financed by the EU or Euratom budget cannot declare indirect costs for the period covered by the operating grant, unless they can demonstrate that the operating grant does not cover any costs of the action.

F. Specific cost category(ies)

Not applicable

6.3 Conditions for costs of linked third parties to be eligible

⁴ For the definition, see Article 121(1)(b) of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002 ('**Financial Regulation No 966/2012**') (OJ L 218, 26.10.2012, p.1): '**operating grant**' means direct financial contribution, by way of donation, from the budget in order to finance the functioning of a body which pursues an aim of general EU interest or has an objective forming part of and supporting an EU policy.

Not applicable

6.4 Conditions for in-kind contributions provided by third parties free of charge to be eligible

In-kind contributions provided free of charge are eligible direct costs (for the beneficiary), if the costs incurred by the third party fulfil — *mutatis mutandis* — the general and specific conditions for eligibility set out in this Article (Article 6.1 and 6.2) and Article 12.1.

6.5 Ineligible costs

‘**Ineligible costs**’ are:

- (a) costs that do not comply with the conditions set out above (Article 6.1 to 6.4), in particular:
 - (i) costs related to return on capital;
 - (ii) debt and debt service charges;
 - (iii) provisions for future losses or debts;
 - (iv) interest owed;
 - (v) doubtful debts;
 - (vi) currency exchange losses;
 - (vii) bank costs charged by the beneficiary’s bank for transfers from the Agency;
 - (viii) excessive or reckless expenditure;
 - (ix) deductible VAT;
 - (x) costs incurred during suspension of the implementation of the action (see Article 49);
- (b) costs declared under another EU or Euratom grant (including grants awarded by a Member State and financed by the EU or Euratom budget and grants awarded by bodies other than the Agency for the purpose of implementing the EU or Euratom budget); in particular, indirect costs if the beneficiary is already receiving an operating grant financed by the EU or Euratom budget in the same period, unless it can demonstrate that the operating grant does not cover any costs of the action.

6.6 Consequences of declaration of ineligible costs

Declared costs that are ineligible will be rejected (see Article 42).

This may also lead to any of the other measures described in Chapter 6.

CHAPTER 4 RIGHTS AND OBLIGATIONS OF THE PARTIES

SECTION 1 RIGHTS AND OBLIGATIONS RELATED TO IMPLEMENTING THE ACTION

ARTICLE 7 — GENERAL OBLIGATION TO PROPERLY IMPLEMENT THE ACTION

7.1 General obligation to properly implement the action

The beneficiaries must implement the action as described in Annex 1 and in compliance with the provisions of the Agreement and all legal obligations under applicable EU, international and national law.

7.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 8 — RESOURCES TO IMPLEMENT THE ACTION — THIRD PARTIES INVOLVED IN THE ACTION

The beneficiaries must have the appropriate resources to implement the action.

If it is necessary to implement the action, the beneficiaries may:

- purchase goods, works and services (see Article 10);
- use in-kind contributions provided by third parties against payment (see Article 11);
- use in-kind contributions provided by third parties free of charge (see Article 12);
- call upon subcontractors to implement action tasks described in Annex 1 (see Article 13);
- call upon linked third parties to implement action tasks described in Annex 1 (see Article 14);
- call upon international partners to implement action tasks described in Annex 1 (see Article 14a).

In these cases, the beneficiaries retain sole responsibility towards the Agency and the other beneficiaries for implementing the action.

ARTICLE 9 — IMPLEMENTATION OF ACTION TASKS BY BENEFICIARIES NOT RECEIVING EU FUNDING

9.1 Rules for the implementation of action tasks by beneficiaries not receiving EU funding

Beneficiaries that are not eligible for EU funding (**‘beneficiaries not receiving EU funding’**) must implement the action tasks attributed to them in Annex 1 in accordance with Article 7.1.

Their costs are estimated in Annex 2 but:

- will not be reimbursed and

- will not be taken into account for the calculation of the grant (see Articles 5.2, 5.3 and 5.4, and 21).

Chapter 3, Articles 10 to 15, 18.1.2, 20.3(b), 20.4(b), 20.6, 21, 23a, 26.4, 27.2, 28.1, 28.2, 30.3, 31.5, 40, 42, 43, 44, 47 and 48 do not apply to these beneficiaries.

They will not be subject to financial checks, reviews and audits under Article 22.

Beneficiaries not receiving EU funding may provide in-kind contributions to another beneficiary. In this case, they will be considered as a third party for the purpose of Articles 11 and 12.

9.2 Consequences of non-compliance

If a beneficiary not receiving EU funding breaches any of its obligations under this Article, its participation in the Agreement may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6 that are applicable to it.

ARTICLE 10 — PURCHASE OF GOODS, WORKS OR SERVICES

10.1 Rules for purchasing goods, works or services

10.1.1 If necessary to implement the action, the beneficiaries may purchase goods, works or services.

The beneficiaries must make such purchases ensuring the best value for money or, if appropriate, the lowest price. In doing so, they must avoid any conflict of interests (see Article 35).

The beneficiaries must ensure that the Agency, the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards their contractors.

10.1.2 Beneficiaries that are ‘contracting authorities’ within the meaning of Directive 2004/18/EC⁵ (or 2014/24/EU⁶) or ‘contracting entities’ within the meaning of Directive 2004/17/EC⁷ (or 2014/25/EU⁸) must comply with the applicable national law on public procurement.

10.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Article 10.1.1, the costs related to the contract concerned will be ineligible (see Article 6) and will be rejected (see Article 42).

⁵ Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public work contracts, public supply contracts and public service contracts (OJ L 134, 30.04.2004, p. 114).

⁶ Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC. (OJ L 94, 28.03.2014, p. 65).

⁷ Directive 2004/17/EC of the European Parliament and of the Council of 31 March 2004 coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors (OJ L 134, 30.04.2004, p. 1)

⁸ Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC (OJ L 94, 28.03.2014, p. 243).

If a beneficiary breaches any of its obligations under Article 10.1.2, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 11 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES AGAINST PAYMENT

11.1 Rules for the use of in-kind contributions against payment

If necessary to implement the action, the beneficiaries may use in-kind contributions provided by third parties against payment.

The beneficiaries may declare costs related to the payment of in-kind contributions as eligible (see Article 6.1 and 6.2), up to the third parties' costs for the seconded persons, contributed equipment, infrastructure or other assets or other contributed goods and services.

The third parties and their contributions must be set out in Annex 1. The Agency may however approve in-kind contributions not set out in Annex 1 without amendment (see Article 55), if:

- they are specifically justified in the periodic technical report and
- their use does not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Agency, the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards the third parties.

11.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the costs related to the payment of the in-kind contribution will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 12 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES FREE OF CHARGE

12.1 Rules for the use of in-kind contributions free of charge

If necessary to implement the action, the beneficiaries may use in-kind contributions provided by third parties free of charge.

The beneficiaries may declare costs incurred by the third parties for the seconded persons, contributed equipment, infrastructure or other assets or other contributed goods and services as eligible in accordance with Article 6.4.

The third parties and their contributions must be set out in Annex 1. The Agency may however approve in-kind contributions not set out in Annex 1 without amendment (see Article 55), if:

- they are specifically justified in the periodic technical report and

- their use does not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Agency, the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards the third parties.

12.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the costs incurred by the third parties related to the in-kind contribution will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 13 — IMPLEMENTATION OF ACTION TASKS BY SUBCONTRACTORS

13.1 Rules for subcontracting action tasks

13.1.1 If necessary to implement the action, the beneficiaries may award subcontracts covering the implementation of certain action tasks described in Annex 1.

Subcontracting may cover only a limited part of the action.

The beneficiaries must award the subcontracts ensuring the best value for money or, if appropriate, the lowest price. In doing so, they must avoid any conflict of interests (see Article 35).

The tasks to be implemented and the estimated cost for each subcontract must be set out in Annex 1 and the total estimated costs of subcontracting per beneficiary must be set out in Annex 2. The Agency may however approve subcontracts not set out in Annex 1 and 2 without amendment (see Article 55), if:

- they are specifically justified in the periodic technical report and
- they do not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Agency, the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards their subcontractors.

13.1.2 The beneficiaries must ensure that their obligations under Articles 35, 36, 38 and 46 also apply to the subcontractors.

Beneficiaries that are ‘contracting authorities’ within the meaning of Directive 2004/18/EC (or 2014/24/EU) or ‘contracting entities’ within the meaning of Directive 2004/17/EC (or 2014/25/EU) must comply with the applicable national law on public procurement.

13.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Article 13.1.1, the costs related to the subcontract concerned will be ineligible (see Article 6) and will be rejected (see Article 42).

If a beneficiary breaches any of its obligations under Article 13.1.2, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 14 — IMPLEMENTATION OF ACTION TASKS BY LINKED THIRD PARTIES

Not applicable

ARTICLE 14a — IMPLEMENTATION OF ACTION TASKS BY INTERNATIONAL PARTNERS

Not applicable

ARTICLE 15 — FINANCIAL SUPPORT TO THIRD PARTIES

15.1 Rules for providing financial support to third parties

Not applicable

15.2 Financial support in the form of prizes

Not applicable

15.3 Consequences of non-compliance

Not applicable

ARTICLE 16 — PROVISION OF TRANS-NATIONAL OR VIRTUAL ACCESS TO RESEARCH INFRASTRUCTURE

16.1 Rules for providing trans-national access to research infrastructure

Not applicable

16.2 Rules for providing virtual access to research infrastructure

Not applicable

16.3 Consequences of non-compliance

Not applicable

SECTION 2 RIGHTS AND OBLIGATIONS RELATED TO THE GRANT ADMINISTRATION

ARTICLE 17 — GENERAL OBLIGATION TO INFORM

17.1 General obligation to provide information upon request

The beneficiaries must provide — during implementation of the action or afterwards and in accordance with Article 41.2 — any information requested in order to verify eligibility of the costs, proper implementation of the action and compliance with any other obligation under the Agreement.

17.2 Obligation to keep information up to date and to inform about events and circumstances likely to affect the Agreement

Each beneficiary must keep information stored in the Participant Portal Beneficiary Register (via the electronic exchange system; see Article 52) up to date, in particular, its name, address, legal representatives, legal form and organisation type.

Each beneficiary must immediately inform the coordinator — which must immediately inform the Agency and the other beneficiaries — of any of the following:

- (a) **events** which are likely to affect significantly or delay the implementation of the action or the EU's financial interests, in particular:
 - (i) changes in its legal, financial, technical, organisational or ownership situation
- (b) **circumstances** affecting:
 - (i) the decision to award the grant or
 - (ii) compliance with requirements under the Agreement.

17.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 18 — KEEPING RECORDS — SUPPORTING DOCUMENTATION

18.1 Obligation to keep records and other supporting documentation

The beneficiaries must — for a period of five years after the payment of the balance — keep records and other supporting documentation in order to prove the proper implementation of the action and the costs they declare as eligible.

They must make them available upon request (see Article 17) or in the context of checks, reviews, audits or investigations (see Article 22).

If there are on-going checks, reviews, audits, investigations, litigation or other pursuits of claims under the Agreement (including the extension of findings; see Article 22), the beneficiaries must keep the records and other supporting documentation until the end of these procedures.

The beneficiaries must keep the original documents. Digital and digitalised documents are considered originals if they are authorised by the applicable national law. The Agency may accept non-original documents if it considers that they offer a comparable level of assurance.

18.1.1 Records and other supporting documentation on the scientific and technical implementation

The beneficiaries must keep records and other supporting documentation on scientific and technical implementation of the action in line with the accepted standards in the respective field.

18.1.2 Records and other documentation to support the costs declared

The beneficiaries must keep the records and documentation supporting the costs declared, in particular the following:

- (a) for **actual costs**: adequate records and other supporting documentation to prove the costs declared, such as contracts, subcontracts, invoices and accounting records. In addition, the beneficiaries' usual cost accounting practices and internal control procedures must enable direct reconciliation between the amounts declared, the amounts recorded in their accounts and the amounts stated in the supporting documentation;
- (b) for **unit costs**: adequate records and other supporting documentation to prove the number of units declared. Beneficiaries do not need to identify the actual eligible costs covered or to keep or provide supporting documentation (such as accounting statements) to prove the amount per unit.

In addition, for **unit costs calculated in accordance with the beneficiary's usual cost accounting practices**, the beneficiaries must keep adequate records and documentation to prove that the cost accounting practices used comply with the conditions set out in Article 6.2.

The beneficiaries may submit to the Commission, for approval, a certificate (drawn up in accordance with Annex 6) stating that their usual cost accounting practices comply with these conditions (**'certificate on the methodology'**). If the certificate is approved, costs declared in line with this methodology will not be challenged subsequently, unless the beneficiaries have concealed information for the purpose of the approval.

- (c) for **flat-rate costs**: adequate records and other supporting documentation to prove the eligibility of the costs to which the flat-rate is applied. The beneficiaries do not need to identify the costs covered or provide supporting documentation (such as accounting statements) to prove the amount declared at a flat-rate.

In addition, for **personnel costs** (declared as actual costs or on the basis of unit costs), the beneficiaries must keep **time records** for the number of hours declared. The time records must be in writing and approved by the persons working on the action and their supervisors, at least monthly. In the absence of reliable time records of the hours worked on the action, the Agency may accept alternative evidence supporting the number of hours declared, if it considers that it offers an adequate level of assurance.

As an exception, for **persons working exclusively on the action**, there is no need to keep time records, if the beneficiary signs a **declaration** confirming that the persons concerned have worked exclusively on the action.

18.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, costs insufficiently substantiated

will be ineligible (see Article 6) and will be rejected (see Article 42), and the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 19 — SUBMISSION OF DELIVERABLES

19.1 Obligation to submit deliverables

The coordinator must submit the ‘**deliverables**’ identified in Annex 1, in accordance with the timing and conditions set out in it.

19.2 Consequences of non-compliance

If the coordinator breaches any of its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

ARTICLE 20 — REPORTING — PAYMENT REQUESTS

20.1 Obligation to submit reports

The coordinator must submit to the Agency (see Article 52) the technical and financial reports set out in this Article. These reports include requests for payment and must be drawn up using the forms and templates provided in the electronic exchange system (see Article 52).

20.2 Reporting periods

The action is divided into the following ‘**reporting periods**’:

- RP1: from month 1 to month 18
- RP2: from month 19 to month 36

20.3 Periodic reports — Requests for interim payments

The coordinator must submit a periodic report within 60 days following the end of each reporting period.

The **periodic report** must include the following:

(a) a ‘**periodic technical report**’ containing:

- (i) an **explanation of the work carried out** by the beneficiaries;
- (ii) an **overview of the progress** towards the objectives of the action, including milestones and deliverables identified in Annex 1.

This report must include explanations justifying the differences between work expected to be carried out in accordance with Annex 1 and that actually carried out.

The report must detail the exploitation and dissemination of the results and — if required in Annex 1 — an updated ‘**plan for the exploitation and dissemination of the results**’.

The report must indicate the communication activities;

- (iii) a **summary** for publication by the Agency;
 - (iv) the answers to the ‘**questionnaire**’, covering issues related to the action implementation and the economic and societal impact, notably in the context of the Horizon 2020 key performance indicators and the Horizon 2020 monitoring requirements;
- (b) a ‘**periodic financial report**’ containing:
- (i) an ‘**individual financial statement**’ (see Annex 4) from each beneficiary, for the reporting period concerned.

The individual financial statement must detail the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) for each budget category (see Annex 2).

The beneficiaries must declare all eligible costs, even if — for actual costs, unit costs and flat-rate costs — they exceed the amounts indicated in the estimated budget (see Annex 2). Amounts which are not declared in the individual financial statement will not be taken into account by the Agency.

If an individual financial statement is not submitted for a reporting period, it may be included in the periodic financial report for the next reporting period.

The individual financial statements of the last reporting period must also detail the **receipts of the action** (see Article 5.3.3).

Each beneficiary must **certify** that:

- the information provided is full, reliable and true;
 - the costs declared are eligible (see Article 6);
 - the costs can be substantiated by adequate records and supporting documentation (see Article 18) that will be produced upon request (see Article 17) or in the context of checks, reviews, audits and investigations (see Article 22), and
 - for the last reporting period: that all the receipts have been declared (see Article 5.3.3);
- (ii) an **explanation of the use of resources** and the information on subcontracting (see Article 13) and in-kind contributions provided by third parties (see Articles 11 and 12) from each beneficiary, for the reporting period concerned;
 - (iii) not applicable;
 - (iv) a ‘**periodic summary financial statement**’, created automatically by the electronic exchange system, consolidating the individual financial statements for the reporting period concerned and including — except for the last reporting period — the **request for interim payment**.

20.4 Final report — Request for payment of the balance

In addition to the periodic report for the last reporting period, the coordinator must submit the final report within 60 days following the end of the last reporting period.

The **final report** must include the following:

- (a) a '**final technical report**' with a **summary** for publication containing:
 - (i) an overview of the results and their exploitation and dissemination;
 - (ii) the conclusions on the action, and
 - (iii) the socio-economic impact of the action;
- (b) a '**final financial report**' containing:
 - (i) a '**final summary financial statement**', created automatically by the electronic exchange system, consolidating the individual financial statements for all reporting periods and including the **request for payment of the balance** and
 - (ii) a '**certificate on the financial statements**' (drawn up in accordance with Annex 5) for each beneficiary, if it requests a total contribution of EUR 325 000 or more, as reimbursement of actual costs and unit costs calculated on the basis of its usual cost accounting practices (see Article 5.2 and Article 6.2).

20.5 Information on cumulative expenditure incurred

Not applicable

20.6 Currency for financial statements and conversion into euro

Financial statements must be drafted in euro.

Beneficiaries with accounting established in a currency other than the euro must convert the costs recorded in their accounts into euro, at the average of the daily exchange rates published in the C series of the *Official Journal of the European Union*, calculated over the corresponding reporting period.

If no daily euro exchange rate is published in the *Official Journal of the European Union* for the currency in question, they must be converted at the average of the monthly accounting rates published on the Commission's website, calculated over the corresponding reporting period.

Beneficiaries with accounting established in euro must convert costs incurred in another currency into euro according to their usual accounting practices.

20.7 Language of reports

All reports (technical and financial reports, including financial statements) must be submitted in the language of the Agreement.

20.8 Consequences of non-compliance

If the reports submitted do not comply with this Article, the Agency may suspend the payment deadline (see Article 47) and apply any of the other measures described in Chapter 6.

If the coordinator breaches its obligation to submit the reports and if it fails to comply with this obligation within 30 days following a written reminder, the Agency may terminate the Agreement (see Article 50) or apply any of the other measures described in Chapter 6.

ARTICLE 21 — PAYMENTS AND PAYMENT ARRANGEMENTS

21.1 Payments to be made

The following payments will be made to the coordinator:

- one **pre-financing payment**;
- one or more **interim payments**, on the basis of the request(s) for interim payment (see Article 20), and
- one **payment of the balance**, on the basis of the request for payment of the balance (see Article 20).

21.2 Pre-financing payment — Amount — Amount retained for the Guarantee Fund

The aim of the pre-financing is to provide the beneficiaries with a float.

It remains the property of the EU until the payment of the balance.

The amount of the pre-financing payment will be EUR **5 590 775.45** (five million five hundred and ninety thousand seven hundred and seventy five EURO and forty five eurocents).

The Agency will — except if Article 48 applies — make the pre-financing payment to the coordinator within 30 days, either from the entry into force of the Agreement (see Article 58) or from 10 days before the starting date of the action (see Article 3), whichever is the latest.

An amount of EUR **349 423.47** (three hundred and forty nine thousand four hundred and twenty three EURO and forty seven eurocents), corresponding to 5% of the maximum grant amount (see Article 5.1), is retained by the Agency from the pre-financing payment and transferred into the ‘**Guarantee Fund**’.

21.3 Interim payments — Amount — Calculation

Interim payments reimburse the eligible costs incurred for the implementation of the action during the corresponding reporting periods.

The Agency will pay to the coordinator the amount due as interim payment within 90 days from receiving the periodic report (see Article 20.3), except if Articles 47 or 48 apply.

Payment is subject to the approval of the periodic report. Its approval does not imply recognition of the compliance, authenticity, completeness or correctness of its content.

The **amount due as interim payment** is calculated by the Agency in the following steps:

Step 1 — Application of the reimbursement rates

Step 2 — Limit to 90% of the maximum grant amount

21.3.1 Step 1 — Application of the reimbursement rates

The reimbursement rate(s) (see Article 5.2) are applied to the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) declared by the beneficiaries (see Article 20) and approved by the Agency (see above) for the concerned reporting period.

21.3.2 Step 2 — Limit to 90% of the maximum grant amount

The total amount of pre-financing and interim payments must not exceed 90% of the maximum grant amount set out in Article 5.1. The maximum amount for the interim payment will be calculated as follows:

$$\begin{aligned} & \{90\% \text{ of the maximum grant amount (see Article 5.1)} \\ & \text{minus} \\ & \{\text{pre-financing and previous interim payments}\} \}. \end{aligned}$$

21.4 Payment of the balance — Amount — Calculation — Release of the amount retained for the Guarantee Fund

The payment of the balance reimburses the remaining part of the eligible costs incurred by the beneficiaries for the implementation of the action.

If the total amount of earlier payments is greater than the final grant amount (see Article 5.3), the payment of the balance takes the form of a recovery (see Article 44).

If the total amount of earlier payments is lower than the final grant amount, the Agency will pay the balance within 90 days from receiving the final report (see Article 20.4), except if Articles 47 or 48 apply.

Payment is subject to the approval of the final report. Its approval does not imply recognition of the compliance, authenticity, completeness or correctness of its content.

The **amount due as the balance** is calculated by the Agency by deducting the total amount of pre-financing and interim payments (if any) already made, from the final grant amount determined in accordance with Article 5.3:

$$\begin{aligned} & \{\text{final grant amount (see Article 5.3)} \\ & \text{minus} \\ & \{\text{pre-financing and interim payments (if any) made}\} \}. \end{aligned}$$

At the payment of the balance, the amount retained for the Guarantee Fund (see above) will be released and:

- if the balance is positive: the amount released will be paid in full to the coordinator together with the amount due as the balance;
- if the balance is negative (payment of the balance taking the form of recovery): it will be deducted from the amount released (see Article 44.1.2). If the resulting amount:
 - is positive, it will be paid to the coordinator

- is negative, it will be recovered.

The amount to be paid may however be offset — without the beneficiaries' consent — against any other amount owed by a beneficiary to the Agency, the Commission or another executive agency (under the EU or Euratom budget), up to the maximum EU contribution indicated, for that beneficiary, in the estimated budget (see Annex 2).

21.5 Notification of amounts due

When making payments, the Agency will formally notify to the coordinator the amount due, specifying whether it concerns an interim payment or the payment of the balance.

For the payment of the balance, the notification will also specify the final grant amount.

In the case of reduction of the grant or recovery of undue amounts, the notification will be preceded by the contradictory procedure set out in Articles 43 and 44.

21.6 Currency for payments

The Agency will make all payments in euro.

21.7 Payments to the coordinator — Distribution to the beneficiaries

Payments will be made to the coordinator.

Payments to the coordinator will discharge the Agency from its payment obligation.

The coordinator must distribute the payments between the beneficiaries without unjustified delay.

Pre-financing may however be distributed only:

- (a) if the minimum number of beneficiaries set out in the call for proposals has acceded to the Agreement (see Article 56) and
- (b) to beneficiaries that have acceded to the Agreement (see Article 56).

21.8 Bank account for payments

All payments will be made to the following bank account:

Name of bank: INTESA SANPAOLO SPA
Full name of the account holder: DEEP BLUE
IBAN code: IT41I0306905048100000007792

21.9 Costs of payment transfers

The cost of the payment transfers is borne as follows:

- the Agency bears the cost of transfers charged by its bank;
- the beneficiary bears the cost of transfers charged by its bank;

- the party causing a repetition of a transfer bears all costs of the repeated transfer.

21.10 Date of payment

Payments by the Agency are considered to have been carried out on the date when they are debited to its account.

21.11 Consequences of non-compliance

21.11.1 If the Agency does not pay within the payment deadlines (see above), the beneficiaries are entitled to **late-payment interest** at the rate applied by the European Central Bank (ECB) for its main refinancing operations in euros ('reference rate'), plus three and a half points. The reference rate is the rate in force on the first day of the month in which the payment deadline expires, as published in the C series of the *Official Journal of the European Union*.

If the late-payment interest is lower than or equal to EUR 200, it will be paid to the coordinator only upon request submitted within two months of receiving the late payment.

Late-payment interest is not due if all beneficiaries are EU Member States (including regional and local government authorities or other public bodies acting on behalf of a Member State for the purpose of this Agreement).

Suspension of the payment deadline or payments (see Articles 47 and 48) will not be considered as late payment.

Late-payment interest covers the period running from the day following the due date for payment (see above), up to and including the date of payment.

Late-payment interest is not considered for the purposes of calculating the final grant amount.

21.11.2 If the coordinator breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or the participation of the coordinator may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 22 — CHECKS, REVIEWS, AUDITS AND INVESTIGATIONS — EXTENSION OF FINDINGS

22.1 Checks, reviews and audits by the Agency and the Commission

22.1.1 Right to carry out checks

The Agency or the Commission will — during the implementation of the action or afterwards — check the proper implementation of the action and compliance with the obligations under the Agreement, including assessing deliverables and reports.

For this purpose the Agency or the Commission may be assisted by external persons or bodies.

The Agency or the Commission may also request additional information in accordance with Article 17. The Agency or the Commission may request beneficiaries to provide such information to it directly.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

22.1.2 Right to carry out reviews

The Agency or the Commission may — during the implementation of the action or afterwards — carry out reviews on the proper implementation of the action (including assessment of deliverables and reports), compliance with the obligations under the Agreement and continued scientific or technological relevance of the action.

Reviews may be started up to two years after the payment of the balance. They will be formally notified to the coordinator or beneficiary concerned and will be considered to have started on the date of the formal notification.

If the review is carried out on a third party (see Articles 10 to 16), the beneficiary concerned must inform the third party.

The Agency or the Commission may carry out reviews directly (using its own staff) or indirectly (using external persons or bodies appointed to do so). It will inform the coordinator or beneficiary concerned of the identity of the external persons or bodies. They have the right to object to the appointment on grounds of commercial confidentiality.

The coordinator or beneficiary concerned must provide — within the deadline requested — any information and data in addition to deliverables and reports already submitted (including information on the use of resources). The Agency or the Commission may request beneficiaries to provide such information to it directly.

The coordinator or beneficiary concerned may be requested to participate in meetings, including with external experts.

For **on-the-spot** reviews, the beneficiaries must allow access to their sites and premises, including to external persons or bodies, and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the review findings, a '**review report**' will be drawn up.

The Agency or the Commission will formally notify the review report to the coordinator or beneficiary concerned, which has 30 days to formally notify observations ('**contradictory review procedure**').

Reviews (including review reports) are in the language of the Agreement.

22.1.3 Right to carry out audits

The Agency or the Commission may — during the implementation of the action or afterwards — carry out audits on the proper implementation of the action and compliance with the obligations under the Agreement.

Audits may be started up to two years after the payment of the balance. They will be formally notified to the coordinator or beneficiary concerned and will be considered to have started on the date of the formal notification.

If the audit is carried out on a third party (see Articles 10 to 16), the beneficiary concerned must inform the third party.

The Agency or the Commission may carry out audits directly (using its own staff) or indirectly (using external persons or bodies appointed to do so). It will inform the coordinator or beneficiary concerned of the identity of the external persons or bodies. They have the right to object to the appointment on grounds of commercial confidentiality.

The coordinator or beneficiary concerned must provide — within the deadline requested — any information (including complete accounts, individual salary statements or other personal data) to verify compliance with the Agreement. The Agency or the Commission may request beneficiaries to provide such information to it directly.

For **on-the-spot** audits, the beneficiaries must allow access to their sites and premises, including to external persons or bodies, and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the audit findings, a ‘**draft audit report**’ will be drawn up.

The Agency or the Commission will formally notify the draft audit report to the coordinator or beneficiary concerned, which has 30 days to formally notify observations (‘**contradictory audit procedure**’). This period may be extended by the Agency or the Commission in justified cases.

The ‘**final audit report**’ will take into account observations by the coordinator or beneficiary concerned. The report will be formally notified to it.

Audits (including audit reports) are in the language of the Agreement.

The Agency or the Commission may also access the beneficiaries’ statutory records for the periodical assessment of unit costs or flat-rate amounts.

22.2 Investigations by the European Anti-Fraud Office (OLAF)

Under Regulations No 883/2013¹⁶ and No 2185/96¹⁷ (and in accordance with their provisions and procedures), the European Anti-Fraud Office (OLAF) may — at any moment during implementation of the action or afterwards — carry out investigations, including on-the-spot checks and inspections, to establish whether there has been fraud, corruption or any other illegal activity affecting the financial interests of the EU.

22.3 Checks and audits by the European Court of Auditors (ECA)

Under Article 287 of the Treaty on the Functioning of the European Union (TFEU) and Article 161

¹⁶ Regulation (EU, Euratom) No 883/2013 of the European Parliament and of the Council of 11 September 2013 concerning investigations conducted by the European Anti-Fraud Office (OLAF) and repealing Regulation (EC) No 1073/1999 of the European Parliament and of the Council and Council Regulation (Euratom) No 1074/1999 (OJ L 248, 18.09.2013, p. 1).

¹⁷ Council Regulation (Euratom, EC) No 2185/1996 of 11 November 1996 concerning on-the-spot checks and inspections carried out by the Commission in order to protect the European Communities’ financial interests against fraud and other irregularities (OJ L 292, 15.11.1996, p. 2).

of the Financial Regulation No 966/2012¹⁸, the European Court of Auditors (ECA) may — at any moment during implementation of the action or afterwards — carry out audits.

The ECA has the right of access for the purpose of checks and audits.

22.4 Checks, reviews, audits and investigations for international organisations

In conformity with its financial regulations, the European Union, including the European Anti-Fraud Office (OLAF) and the European Court of Auditors (ECA), may undertake, including on the spot, checks, reviews, audits and investigations.

This Article will be applied in accordance with any specific agreement concluded in this respect by the international organisation and the European Union.

22.5 Consequences of findings in checks, reviews, audits and investigations — Extension of findings

22.5.1 Findings in this grant

Findings in checks, reviews, audits or investigations carried out in the context of this grant may lead to the rejection of ineligible costs (see Article 42), reduction of the grant (see Article 43), recovery of undue amounts (see Article 44) or to any of the other measures described in Chapter 6.

Rejection of costs or reduction of the grant after the payment of the balance will lead to a revised final grant amount (see Article 5.4).

Findings in checks, reviews, audits or investigations may lead to a request for amendment for the modification of Annex 1 (see Article 55).

Checks, reviews, audits or investigations that find systemic or recurrent errors, irregularities, fraud or breach of obligations may also lead to consequences in other EU or Euratom grants awarded under similar conditions (**‘extension of findings from this grant to other grants’**).

Moreover, findings arising from an OLAF investigation may lead to criminal prosecution under national law.

22.5.2 Findings in other grants

The Agency or the Commission may extend findings from other grants to this grant (**‘extension of findings from other grants to this grant’**), if:

- (a) the beneficiary concerned is found, in other EU or Euratom grants awarded under similar conditions, to have committed systemic or recurrent errors, irregularities, fraud or breach of obligations that have a material impact on this grant and
- (b) those findings are formally notified to the beneficiary concerned — together with the list of grants affected by the findings — no later than two years after the payment of the balance of this grant.

¹⁸ Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002 (OJ L 298, 26.10.2012, p. 1).

The extension of findings may lead to the rejection of costs (see Article 42), reduction of the grant (see Article 43), recovery of undue amounts (see Article 44), suspension of payments (see Article 48), suspension of the action implementation (see Article 49) or termination (see Article 50).

22.5.3 Procedure

The Agency or the Commission will formally notify the beneficiary concerned the systemic or recurrent errors and its intention to extend these audit findings, together with the list of grants affected.

22.5.3.1 If the findings concern **eligibility of costs**: the formal notification will include:

- (a) an invitation to submit observations on the list of grants affected by the findings;
- (b) the request to submit **revised financial statements** for all grants affected;
- (c) the **correction rate for extrapolation** established by the Agency or the Commission on the basis of the systemic or recurrent errors, to calculate the amounts to be rejected if the beneficiary concerned:
 - (i) considers that the submission of revised financial statements is not possible or practicable or
 - (ii) does not submit revised financial statements.

The beneficiary concerned has 90 days from receiving notification to submit observations, revised financial statements or to propose a duly substantiated **alternative correction method**. This period may be extended by the Agency or the Commission in justified cases.

The Agency or the Commission may then start a rejection procedure in accordance with Article 42, on the basis of:

- the revised financial statements, if approved;
 - the proposed alternative correction method, if accepted
- or
- the initially notified correction rate for extrapolation, if it does not receive any observations or revised financial statements, does not accept the observations or the proposed alternative correction method or does not approve the revised financial statements.

22.5.3.2 If the findings concern **substantial errors, irregularities or fraud or serious breach of obligations**: the formal notification will include:

- (a) an invitation to submit observations on the list of grants affected by the findings and
- (b) the flat-rate the Agency or the Commission intends to apply according to the principle of proportionality.

The beneficiary concerned has 90 days from receiving notification to submit observations or to propose a duly substantiated alternative flat-rate.

The Agency or the Commission may then start a reduction procedure in accordance with Article 43, on the basis of:

- the proposed alternative flat-rate, if accepted

or

- the initially notified flat-rate, if it does not receive any observations or does not accept the observations or the proposed alternative flat-rate.

22.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, any insufficiently substantiated costs will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 23 — EVALUATION OF THE IMPACT OF THE ACTION

23.1 Right to evaluate the impact of the action

The Agency or the Commission may carry out interim and final evaluations of the impact of the action measured against the objective of the EU programme.

Evaluations may be started during implementation of the action and up to five years after the payment of the balance. The evaluation is considered to start on the date of the formal notification to the coordinator or beneficiaries.

The Agency or the Commission may make these evaluations directly (using its own staff) or indirectly (using external bodies or persons it has authorised to do so).

The coordinator or beneficiaries must provide any information relevant to evaluate the impact of the action, including information in electronic format.

23.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the Agency may apply the measures described in Chapter 6.

SECTION 3 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND AND RESULTS

SUBSECTION 1 GENERAL

ARTICLE 23a — MANAGEMENT OF INTELLECTUAL PROPERTY

23a.1 Obligation to take measures to implement the Commission Recommendation on the management of intellectual property in knowledge transfer activities

Beneficiaries that are universities or other public research organisations must take measures to

implement the principles set out in Points 1 and 2 of the Code of Practice annexed to the Commission Recommendation on the management of intellectual property in knowledge transfer activities¹⁹.

This does not change the obligations set out in Subsections 2 and 3 of this Section.

The beneficiaries must ensure that researchers and third parties involved in the action are aware of them.

23a.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

SUBSECTION 2 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND

ARTICLE 24 — AGREEMENT ON BACKGROUND

24.1 Agreement on background

The beneficiaries must identify and agree (in writing) on the background for the action (**‘agreement on background’**).

‘Background’ means any data, know-how or information — whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights — that:

- (a) is held by the beneficiaries before they acceded to the Agreement, and
- (b) is needed to implement the action or exploit the results.

24.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 25 — ACCESS RIGHTS TO BACKGROUND

25.1 Exercise of access rights — Waiving of access rights — No sub-licensing

To exercise access rights, this must first be requested in writing (**‘request for access’**).

‘Access rights’ means rights to use results or background under the terms and conditions laid down in this Agreement.

Waivers of access rights are not valid unless in writing.

Unless agreed otherwise, access rights do not include the right to sub-license.

¹⁹ Commission Recommendation C(2008) 1329 of 10.4.2008 on the management of intellectual property in knowledge transfer activities and the Code of Practice for universities and other public research institutions attached to this recommendation.

25.2 Access rights for other beneficiaries, for implementing their own tasks under the action

The beneficiaries must give each other access — on a royalty-free basis — to background needed to implement their own tasks under the action, unless the beneficiary that holds the background has — before acceding to the Agreement —:

- (a) informed the other beneficiaries that access to its background is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel), or
- (b) agreed with the other beneficiaries that access would not be on a royalty-free basis.

25.3 Access rights for other beneficiaries, for exploiting their own results

The beneficiaries must give each other access — under fair and reasonable conditions — to background needed for exploiting their own results, unless the beneficiary that holds the background has — before acceding to the Agreement — informed the other beneficiaries that access to its background is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel).

‘**Fair and reasonable conditions**’ means appropriate conditions, including possible financial terms or royalty-free conditions, taking into account the specific circumstances of the request for access, for example the actual or potential value of the results or background to which access is requested and/or the scope, duration or other characteristics of the exploitation envisaged.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

25.4 Access rights for affiliated entities

Unless otherwise agreed in the consortium agreement, access to background must also be given — under fair and reasonable conditions (see above; Article 25.3) and unless it is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel) — to affiliated entities²⁰ established in an EU Member State or ‘**associated country**’²¹, if this is needed to exploit the results generated by the beneficiaries to which they are affiliated.

²⁰ For the definition see Article 2.1(2) Rules for Participation Regulation No 1290/2013: ‘**affiliated entity**’ means any legal entity that is:

- under the direct or indirect control of a participant, or
- under the same direct or indirect control as the participant, or
- directly or indirectly controlling a participant.

‘Control’ may take any of the following forms:

- (a) the direct or indirect holding of more than 50% of the nominal value of the issued share capital in the legal entity concerned, or of a majority of the voting rights of the shareholders or associates of that entity;
- (b) the direct or indirect holding, in fact or in law, of decision-making powers in the legal entity concerned.

However the following relationships between legal entities shall not in themselves be deemed to constitute controlling relationships:

- (a) the same public investment corporation, institutional investor or venture-capital company has a direct or indirect holding of more than 50% of the nominal value of the issued share capital or a majority of voting rights of the shareholders or associates;
- (b) the legal entities concerned are owned or supervised by the same public body.

²¹ For the definition, see Article 2.1(3) of the Rules for Participation Regulation No 1290/2013: ‘**associated country**’ means a third country which is party to an international agreement with the Union, as identified in Article 7 of Horizon 2020 Framework Programme Regulation No 1291/2013. Article 7 sets out the conditions for association of non-EU countries to Horizon 2020.

Unless agreed otherwise (see above; Article 25.1), the affiliated entity concerned must make the request directly to the beneficiary that holds the background.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

25.5 Access rights for third parties

Not applicable

25.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

SUBSECTION 3 RIGHTS AND OBLIGATIONS RELATED TO RESULTS

ARTICLE 26 — OWNERSHIP OF RESULTS

26.1 Ownership by the beneficiary that generates the results

Results are owned by the beneficiary that generates them.

‘**Results**’ means any (tangible or intangible) output of the action such as data, knowledge or information — whatever its form or nature, whether it can be protected or not — that is generated in the action, as well as any rights attached to it, including intellectual property rights.

26.2 Joint ownership by several beneficiaries

Two or more beneficiaries own results jointly if:

- (a) they have jointly generated them and
- (b) it is not possible to:
 - (i) establish the respective contribution of each beneficiary, or
 - (ii) separate them for the purpose of applying for, obtaining or maintaining their protection (see Article 27).

The joint owners must agree (in writing) on the allocation and terms of exercise of their joint ownership (**‘joint ownership agreement’**), to ensure compliance with their obligations under this Agreement.

Unless otherwise agreed in the joint ownership agreement, each joint owner may grant non-exclusive licences to third parties to exploit jointly-owned results (without any right to sub-license), if the other joint owners are given:

- (a) at least 45 days advance notice and
- (b) fair and reasonable compensation.

Once the results have been generated, joint owners may agree (in writing) to apply another regime than joint ownership (such as, for instance, transfer to a single owner (see Article 30) with access rights for the others).

26.3 Rights of third parties (including personnel)

If third parties (including personnel) may claim rights to the results, the beneficiary concerned must ensure that it complies with its obligations under the Agreement.

If a third party generates results, the beneficiary concerned must obtain all necessary rights (transfer, licences or other) from the third party, in order to be able to respect its obligations as if those results were generated by the beneficiary itself.

If obtaining the rights is impossible, the beneficiary must refrain from using the third party to generate the results.

26.4 Agency ownership, to protect results

26.4.1 The Agency may — with the consent of the beneficiary concerned — assume ownership of results to protect them, if a beneficiary intends — up to four years after the period set out in Article 3 — to disseminate its results without protecting them, except in any of the following cases:

- (a) the lack of protection is because protecting the results is not possible, reasonable or justified (given the circumstances);
- (b) the lack of protection is because there is a lack of potential for commercial or industrial exploitation, or
- (c) the beneficiary intends to transfer the results to another beneficiary or third party established in an EU Member State or associated country, which will protect them.

Before the results are disseminated and unless any of the cases above under Points (a), (b) or (c) applies, the beneficiary must formally notify the Agency and at the same time inform it of any reasons for refusing consent. The beneficiary may refuse consent only if it can show that its legitimate interests would suffer significant harm.

If the Agency decides to assume ownership, it will formally notify the beneficiary concerned within 45 days of receiving notification.

No dissemination relating to these results may take place before the end of this period or, if the Agency takes a positive decision, until it has taken the necessary steps to protect the results.

26.4.2 The Agency may — with the consent of the beneficiary concerned — assume ownership of results to protect them, if a beneficiary intends — up to four years after the period set out in Article 3 — to stop protecting them or not to seek an extension of protection, except in any of the following cases:

- (a) the protection is stopped because of a lack of potential for commercial or industrial exploitation;
- (b) an extension would not be justified given the circumstances.

A beneficiary that intends to stop protecting results or not seek an extension must — unless any of the cases above under Points (a) or (b) applies — formally notify the Agency at least 60 days before the

protection lapses or its extension is no longer possible and at the same time inform it of any reasons for refusing consent. The beneficiary may refuse consent only if it can show that its legitimate interests would suffer significant harm.

If the Agency decides to assume ownership, it will formally notify the beneficiary concerned within 45 days of receiving notification.

26.5 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to the any of the other measures described in Chapter 6.

ARTICLE 27 — PROTECTION OF RESULTS — VISIBILITY OF EU FUNDING

27.1 Obligation to protect the results

Each beneficiary must examine the possibility of protecting its results and must adequately protect them — for an appropriate period and with appropriate territorial coverage — if:

- (a) the results can reasonably be expected to be commercially or industrially exploited and
- (b) protecting them is possible, reasonable and justified (given the circumstances).

When deciding on protection, the beneficiary must consider its own legitimate interests and the legitimate interests (especially commercial) of the other beneficiaries.

27.2 Agency ownership, to protect the results

If a beneficiary intends not to protect its results, to stop protecting them or not seek an extension of protection, the Agency may — under certain conditions (see Article 26.4) — assume ownership to ensure their (continued) protection.

27.3 Information on EU funding

Applications for protection of results (including patent applications) filed by or on behalf of a beneficiary must — unless the Agency requests or agrees otherwise or unless it is impossible — include the following:

“The project leading to this application has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 814961”.

27.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 28 — EXPLOITATION OF RESULTS

28.1 Obligation to exploit the results

Each beneficiary must — up to four years after the period set out in Article 3 — take measures aiming to ensure ‘**exploitation**’ of its results (either directly or indirectly, in particular through transfer or licensing; see Article 30) by:

- (a) using them in further research activities (outside the action);
- (b) developing, creating or marketing a product or process;
- (c) creating and providing a service, or
- (d) using them in standardisation activities.

This does not change the security obligations in Article 37, which still apply.

28.2 Results that could contribute to European or international standards — Information on EU funding

If results are incorporated in a standard, the beneficiary concerned must — unless the Agency requests or agrees otherwise or unless it is impossible — ask the standardisation body to include the following statement in (information related to) the standard:

“Results incorporated in this standard received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 814961”.

28.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced in accordance with Article 43.

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 29 — DISSEMINATION OF RESULTS — OPEN ACCESS — VISIBILITY OF EU FUNDING

29.1 Obligation to disseminate results

Unless it goes against their legitimate interests, each beneficiary must — as soon as possible — ‘**disseminate**’ its results by disclosing them to the public by appropriate means (other than those resulting from protecting or exploiting the results), including in scientific publications (in any medium).

This does not change the obligation to protect results in Article 27, the confidentiality obligations in Article 36, the security obligations in Article 37 or the obligations to protect personal data in Article 39, all of which still apply.

A beneficiary that intends to disseminate its results must give advance notice to the other beneficiaries of — unless agreed otherwise — at least 45 days, together with sufficient information on the results it will disseminate.

Any other beneficiary may object within — unless agreed otherwise — 30 days of receiving

notification, if it can show that its legitimate interests in relation to the results or background would be significantly harmed. In such cases, the dissemination may not take place unless appropriate steps are taken to safeguard these legitimate interests.

If a beneficiary intends not to protect its results, it may — under certain conditions (see Article 26.4.1) — need to formally notify the Agency before dissemination takes place.

29.2 Open access to scientific publications

Each beneficiary must ensure open access (free of charge online access for any user) to all peer-reviewed scientific publications relating to its results.

In particular, it must:

- (a) as soon as possible and at the latest on publication, deposit a machine-readable electronic copy of the published version or final peer-reviewed manuscript accepted for publication in a repository for scientific publications;

Moreover, the beneficiary must aim to deposit at the same time the research data needed to validate the results presented in the deposited scientific publications.

- (b) ensure open access to the deposited publication — via the repository — at the latest:
 - (i) on publication, if an electronic version is available for free via the publisher, or
 - (ii) within six months of publication (twelve months for publications in the social sciences and humanities) in any other case.
- (c) ensure open access — via the repository — to the bibliographic metadata that identify the deposited publication.

The bibliographic metadata must be in a standard format and must include all of the following:

- the terms “European Union (EU)” and “Horizon 2020”;
- the name of the action, acronym and grant number;
- the publication date, and length of embargo period if applicable, and
- a persistent identifier.

29.3 Open access to research data

Regarding the digital research data generated in the action (**‘data’**), the beneficiaries must:

- (a) deposit in a research data repository and take measures to make it possible for third parties to access, mine, exploit, reproduce and disseminate — free of charge for any user — the following:
 - (i) the data, including associated metadata, needed to validate the results presented in scientific publications, as soon as possible;
 - (ii) not applicable;

- (iii) other data, including associated metadata, as specified and within the deadlines laid down in the ‘data management plan’ (see Annex 1);
- (b) provide information — via the repository — about tools and instruments at the disposal of the beneficiaries and necessary for validating the results (and — where possible — provide the tools and instruments themselves).

This does not change the obligation to protect results in Article 27, the confidentiality obligations in Article 36, the security obligations in Article 37 or the obligations to protect personal data in Article 39, all of which still apply.

As an exception, the beneficiaries do not have to ensure open access to specific parts of their research data under Point (a)(i) and (iii), if the achievement of the action's main objective (as described in Annex 1) would be jeopardised by making those specific parts of the research data openly accessible. In this case, the data management plan must contain the reasons for not giving access.

29.4 Information on EU funding — Obligation and right to use the EU emblem

Unless the Agency requests or agrees otherwise or unless it is impossible, any dissemination of results (in any form, including electronic) must:

- (a) display the EU emblem and
- (b) include the following text:

“This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 814961”.

When displayed together with another logo, the EU emblem must have appropriate prominence.

For the purposes of their obligations under this Article, the beneficiaries may use the EU emblem without first obtaining approval from the Agency.

This does not however give them the right to exclusive use.

Moreover, they may not appropriate the EU emblem or any similar trademark or logo, either by registration or by any other means.

29.5 Disclaimer excluding Agency responsibility

Any dissemination of results must indicate that it reflects only the author's view and that the Agency is not responsible for any use that may be made of the information it contains.

29.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 30 — TRANSFER AND LICENSING OF RESULTS

30.1 Transfer of ownership

Each beneficiary may transfer ownership of its results.

It must however ensure that its obligations under Articles 26.2, 26.4, 27, 28, 29, 30 and 31 also apply to the new owner and that this owner has the obligation to pass them on in any subsequent transfer.

This does not change the security obligations in Article 37, which still apply.

Unless agreed otherwise (in writing) for specifically-identified third parties or unless impossible under applicable EU and national laws on mergers and acquisitions, a beneficiary that intends to transfer ownership of results must give at least 45 days advance notice (or less if agreed in writing) to the other beneficiaries that still have (or still may request) access rights to the results. This notification must include sufficient information on the new owner to enable any beneficiary concerned to assess the effects on its access rights.

Unless agreed otherwise (in writing) for specifically-identified third parties, any other beneficiary may object within 30 days of receiving notification (or less if agreed in writing), if it can show that the transfer would adversely affect its access rights. In this case, the transfer may not take place until agreement has been reached between the beneficiaries concerned.

30.2 Granting licenses

Each beneficiary may grant licences to its results (or otherwise give the right to exploit them), if:

- (a) this does not impede the access rights under Article 31 and
- (b) not applicable.

In addition to Points (a) and (b), exclusive licences for results may be granted only if all the other beneficiaries concerned have waived their access rights (see Article 31.1).

This does not change the dissemination obligations in Article 29 or security obligations in Article 37, which still apply.

30.3 Agency right to object to transfers or licensing

Not applicable

30.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 31 — ACCESS RIGHTS TO RESULTS

31.1 Exercise of access rights — Waiving of access rights — No sub-licensing

The conditions set out in Article 25.1 apply.

The obligations set out in this Article do not change the security obligations in Article 37, which still apply.

31.2 Access rights for other beneficiaries, for implementing their own tasks under the action

The beneficiaries must give each other access — on a royalty-free basis — to results needed for implementing their own tasks under the action.

31.3 Access rights for other beneficiaries, for exploiting their own results

The beneficiaries must give each other — under fair and reasonable conditions (see Article 25.3) — access to results needed for exploiting their own results.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

31.4 Access rights of affiliated entities

Unless agreed otherwise in the consortium agreement, access to results must also be given — under fair and reasonable conditions (Article 25.3) — to affiliated entities established in an EU Member State or associated country, if this is needed for those entities to exploit the results generated by the beneficiaries to which they are affiliated.

Unless agreed otherwise (see above; Article 31.1), the affiliated entity concerned must make any such request directly to the beneficiary that owns the results.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

31.5 Access rights for the EU institutions, bodies, offices or agencies and EU Member States

The beneficiaries must give access to their results — on a royalty-free basis — to EU institutions, bodies, offices or agencies, for developing, implementing or monitoring EU policies or programmes.

Such access rights are limited to non-commercial and non-competitive use.

This does not change the right to use any material, document or information received from the beneficiaries for communication and publicising activities (see Article 38.2).

31.6 Access rights for third parties

Not applicable

31.7 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

SECTION 4 OTHER RIGHTS AND OBLIGATIONS

ARTICLE 32 — RECRUITMENT AND WORKING CONDITIONS FOR RESEARCHERS

32.1 Obligation to take measures to implement the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers

The beneficiaries must take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers²³, in particular regarding:

- working conditions;
- transparent recruitment processes based on merit, and
- career development.

The beneficiaries must ensure that researchers and third parties involved in the action are aware of them.

32.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

ARTICLE 33 — GENDER EQUALITY

33.1 Obligation to aim for gender equality

The beneficiaries must take all measures to promote equal opportunities between men and women in the implementation of the action. They must aim, to the extent possible, for a gender balance at all levels of personnel assigned to the action, including at supervisory and managerial level.

33.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

ARTICLE 34 — ETHICS AND RESEARCH INTEGRITY

34.1 Obligation to comply with ethical and research integrity principles

The beneficiaries must carry out the action in compliance with:

- (a) ethical principles (including the highest standards of research integrity)
- and
- (b) applicable international, EU and national law.

²³ Commission Recommendation 2005/251/EC of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers (OJ L 75, 22.3.2005, p. 67).

Funding will not be granted for activities carried out outside the EU if they are prohibited in all Member States or for activities which destroy human embryos (for example, for obtaining stem cells).

The beneficiaries must ensure that the activities under the action have an exclusive focus on civil applications.

The beneficiaries must ensure that the activities under the action do not:

- (a) aim at human cloning for reproductive purposes;
- (b) intend to modify the genetic heritage of human beings which could make such changes heritable (with the exception of research relating to cancer treatment of the gonads, which may be financed), or
- (c) intend to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer.

In addition, the beneficiaries must respect the fundamental principle of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity²⁴.

This implies compliance with the following fundamental principles:

- **reliability** in ensuring the quality of research reflected in the design, the methodology, the analysis and the use of resources;
- **honesty** in developing, undertaking, reviewing, reporting and communicating research in a transparent, fair and unbiased way;
- **respect** for colleagues, research participants, society, ecosystems, cultural heritage and the environment;
- **accountability** for the research from idea to publication, for its management and organisation, for training, supervision and mentoring, and for its wider impacts

and means that beneficiaries must ensure that persons carrying out research tasks follow the good research practices and refrain from the research integrity violations described in this Code.

This does not change the other obligations under this Agreement or obligations under applicable international, EU or national law, all of which still apply.

34.2 Activities raising ethical issues

Activities raising ethical issues must comply with the ‘**ethics requirements**’ set out as deliverables in Annex 1.

Before the beginning of an activity raising an ethical issue, each beneficiary must have obtained:

- (a) any ethics committee opinion required under national law and

²⁴ European Code of Conduct for Research Integrity of ALLEA (All European Academies)
http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf

- (b) any notification or authorisation for activities raising ethical issues required under national and/or European law

needed for implementing the action tasks in question.

The documents must be kept on file and be submitted upon request by the coordinator to the Agency (see Article 52). If they are not in English, they must be submitted together with an English summary, which shows that the action tasks in question are covered and includes the conclusions of the committee or authority concerned (if available).

34.3 Activities involving human embryos or human embryonic stem cells

Activities involving research on human embryos or human embryonic stem cells may be carried out, in addition to Article 34.1, only if:

- they are set out in Annex 1 or
- the coordinator has obtained explicit approval (in writing) from the Agency (see Article 52).

34.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or participation of the beneficiary may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 35 — CONFLICT OF INTERESTS

35.1 Obligation to avoid a conflict of interests

The beneficiaries must take all measures to prevent any situation where the impartial and objective implementation of the action is compromised for reasons involving economic interest, political or national affinity, family or emotional ties or any other shared interest ('**conflict of interests**').

They must formally notify to the Agency without delay any situation constituting or likely to lead to a conflict of interests and immediately take all the necessary steps to rectify this situation.

The Agency may verify that the measures taken are appropriate and may require additional measures to be taken by a specified deadline.

35.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or participation of the beneficiary may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 36 — CONFIDENTIALITY

36.1 General obligation to maintain confidentiality

During implementation of the action and for four years after the period set out in Article 3, the

parties must keep confidential any data, documents or other material (in any form) that is identified as confidential at the time it is disclosed (**‘confidential information’**).

If a beneficiary requests, the Agency may agree to keep such information confidential for an additional period beyond the initial four years.

If information has been identified as confidential only orally, it will be considered to be confidential only if this is confirmed in writing within 15 days of the oral disclosure.

Unless otherwise agreed between the parties, they may use confidential information only to implement the Agreement.

The beneficiaries may disclose confidential information to their personnel or third parties involved in the action only if they:

- (a) need to know to implement the Agreement and
- (b) are bound by an obligation of confidentiality.

This does not change the security obligations in Article 37, which still apply.

The Agency may disclose confidential information to its staff, other EU institutions and bodies. It may disclose confidential information to third parties, if:

- (a) this is necessary to implement the Agreement or safeguard the EU's financial interests and
- (b) the recipients of the information are bound by an obligation of confidentiality.

Under the conditions set out in Article 4 of the Rules for Participation Regulation No 1290/2013²⁵, the Commission must moreover make available information on the results to other EU institutions, bodies, offices or agencies as well as Member States or associated countries.

The confidentiality obligations no longer apply if:

- (a) the disclosing party agrees to release the other party;
- (b) the information was already known by the recipient or is given to him without obligation of confidentiality by a third party that was not bound by any obligation of confidentiality;
- (c) the recipient proves that the information was developed without the use of confidential information;
- (d) the information becomes generally and publicly available, without breaching any confidentiality obligation, or
- (e) the disclosure of the information is required by EU or national law.

36.2 Consequences of non-compliance

²⁵ Regulation (EU) No 1290/2013 of the European Parliament and of the Council of 11 December 2013 laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" (OJ L 347, 20.12.2013 p.81).

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 37 — SECURITY-RELATED OBLIGATIONS

37.1 Results with a security recommendation

Not applicable

37.2 Classified information

Not applicable

37.3 Activities involving dual-use goods or dangerous materials and substances

Not applicable

37.4 Consequences of non-compliance

Not applicable

ARTICLE 38 — PROMOTING THE ACTION — VISIBILITY OF EU FUNDING

38.1 Communication activities by beneficiaries

38.1.1 Obligation to promote the action and its results

The beneficiaries must promote the action and its results, by providing targeted information to multiple audiences (including the media and the public) in a strategic and effective manner.

This does not change the dissemination obligations in Article 29, the confidentiality obligations in Article 36 or the security obligations in Article 37, all of which still apply.

Before engaging in a communication activity expected to have a major media impact, the beneficiaries must inform the Agency (see Article 52).

38.1.2 Information on EU funding — Obligation and right to use the EU emblem

Unless the Agency requests or agrees otherwise or unless it is impossible, any communication activity related to the action (including in electronic form, via social media, etc.) and any infrastructure, equipment and major results funded by the grant must:

- (a) display the EU emblem and
- (b) include the following text:

For communication activities:

“This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 814961”.

For infrastructure, equipment and major results:

“This *[infrastructure]/[equipment]/[insert type of result]* is part of a project that has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 814961”.

When displayed together with another logo, the EU emblem must have appropriate prominence.

For the purposes of their obligations under this Article, the beneficiaries may use the EU emblem without first obtaining approval from the Agency.

This does not, however, give them the right to exclusive use.

Moreover, they may not appropriate the EU emblem or any similar trademark or logo, either by registration or by any other means.

38.1.3 Disclaimer excluding Agency and Commission responsibility

Any communication activity related to the action must indicate that it reflects only the author's view and that the Agency and the Commission are not responsible for any use that may be made of the information it contains.

38.2 Communication activities by the Agency and the Commission

38.2.1 Right to use beneficiaries’ materials, documents or information

The Agency and the Commission may use, for its communication and publicising activities, information relating to the action, documents notably summaries for publication and public deliverables as well as any other material, such as pictures or audio-visual material received from any beneficiary (including in electronic form).

This does not change the confidentiality obligations in Article 36 and the security obligations in Article 37, all of which still apply.

If the Agency’s or the Commission’s use of these materials, documents or information would risk compromising legitimate interests, the beneficiary concerned may request the Agency or the Commission not to use it (see Article 52).

The right to use a beneficiary’s materials, documents and information includes:

- (a) **use for its own purposes** (in particular, making them available to persons working for the Agency, the Commission or any other EU institution, body, office or agency or body or institutions in EU Member States; and copying or reproducing them in whole or in part, in unlimited numbers);
- (b) **distribution to the public** (in particular, publication as hard copies and in electronic or digital format, publication on the internet, as a downloadable or non-downloadable file, broadcasting by any channel, public display or presentation, communicating through press information services, or inclusion in widely accessible databases or indexes);
- (c) **editing or redrafting** for communication and publicising activities (including shortening, summarising, inserting other elements (such as meta-data, legends, other graphic, visual, audio

or text elements), extracting parts (e.g. audio or video files), dividing into parts, use in a compilation);

(d) translation;

(e) giving **access in response to individual requests** under Regulation No 1049/2001²⁷, without the right to reproduce or exploit;

(f) **storage** in paper, electronic or other form;

(g) **archiving**, in line with applicable document-management rules, and

(h) the right to authorise **third parties** to act on its behalf or sub-license the modes of use set out in Points (b), (c), (d) and (f) to third parties if needed for the communication and publicising activities of the Agency or the Commission.

If the right of use is subject to rights of a third party (including personnel of the beneficiary), the beneficiary must ensure that it complies with its obligations under this Agreement (in particular, by obtaining the necessary approval from the third parties concerned).

Where applicable (and if provided by the beneficiaries), the Agency or the Commission will insert the following information:

“© – [year] – [name of the copyright owner]. All rights reserved. Licensed to the Innovation and Networks Executive Agency (INEA) and the European Union (EU) under conditions.”

38.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 39 — PROCESSING OF PERSONAL DATA

39.1 Processing of personal data by the Agency and the Commission

Any personal data under the Agreement will be processed by the Agency or the Commission under Regulation No 45/2001²⁸ and according to the ‘notifications of the processing operations’ to the Data Protection Officer (DPO) of the Agency or the Commission (publicly accessible in the DPO register).

Such data will be processed by the ‘**data controller**’ of the Agency or the Commission for the purposes of implementing, managing and monitoring the Agreement or protecting the financial interests of the EU or Euratom (including checks, reviews, audits and investigations; see Article 22).

The persons whose personal data are processed have the right to access and correct their own personal data. For this purpose, they must send any queries about the processing of their personal data to the

²⁷ Regulation (EC) No 1049/2001 of the European Parliament and of the Council of 30 May 2001 regarding public access to European Parliament, Council and Commission documents, OJ L 145, 31.5.2001, p. 43.

²⁸ Regulation (EC) No 45/2001 of the European Parliament and of the Council of 18 December 2000 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data (OJ L 8, 12.01.2001, p. 1).

data controller, via the contact point indicated in the privacy statement(s) that are published on the Agency and the Commission websites.

They also have the right to have recourse at any time to the European Data Protection Supervisor (EDPS).

39.2 Processing of personal data by the beneficiaries

The beneficiaries must process personal data under the Agreement in compliance with applicable EU and national law on data protection (including authorisations or notification requirements).

The beneficiaries may grant their personnel access only to data that is strictly necessary for implementing, managing and monitoring the Agreement.

The beneficiaries must inform the personnel whose personal data are collected and processed by the Agency or the Commission. For this purpose, they must provide them with the privacy statement(s) (see above), before transmitting their data to the Agency or the Commission.

39.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Article 39.2, the Agency may apply any of the measures described in Chapter 6.

ARTICLE 40 — ASSIGNMENTS OF CLAIMS FOR PAYMENT AGAINST THE AGENCY

The beneficiaries may not assign any of their claims for payment against the Agency to any third party, except if approved by the Agency on the basis of a reasoned, written request by the coordinator (on behalf of the beneficiary concerned).

If the Agency has not accepted the assignment or the terms of it are not observed, the assignment will have no effect on it.

In no circumstances will an assignment release the beneficiaries from their obligations towards the Agency.

CHAPTER 5 DIVISION OF BENEFICIARIES' ROLES AND RESPONSIBILITIES **— RELATIONSHIP WITH COMPLEMENTARY BENEFICIARIES —** **RELATIONSHIP WITH PARTNERS OF A JOINT ACTION**

ARTICLE 41 — DIVISION OF BENEFICIARIES' ROLES AND RESPONSIBILITIES **— RELATIONSHIP WITH COMPLEMENTARY BENEFICIARIES —** **RELATIONSHIP WITH PARTNERS OF A JOINT ACTION**

41.1 Roles and responsibility towards the Agency

The beneficiaries have full responsibility for implementing the action and complying with the Agreement.

The beneficiaries are jointly and severally liable for the **technical implementation** of the action as described in Annex 1. If a beneficiary fails to implement its part of the action, the other beneficiaries

become responsible for implementing this part (without being entitled to any additional EU funding for doing so), unless the Agency expressly relieves them of this obligation.

The **financial responsibility** of each beneficiary is governed by Article 44.

41.2 Internal division of roles and responsibilities

The internal roles and responsibilities of the beneficiaries are divided as follows:

(a) Each **beneficiary** must:

- (i) keep information stored in the Participant Portal Beneficiary Register (via the electronic exchange system) up to date (see Article 17);
- (ii) inform the coordinator immediately of any events or circumstances likely to affect significantly or delay the implementation of the action (see Article 17);
- (iii) submit to the coordinator in good time:
 - individual financial statements for itself and, if required, certificates on the financial statements (see Article 20);
 - the data needed to draw up the technical reports (see Article 20);
 - ethics committee opinions and notifications or authorisations for activities raising ethical issues (see Article 34);
 - any other documents or information required by the Agency or the Commission under the Agreement, unless the Agreement requires the beneficiary to submit this information directly to the Agency or the Commission.

(b) The **coordinator** must:

- (i) monitor that the action is implemented properly (see Article 7);
- (ii) act as the intermediary for all communications between the beneficiaries and the Agency (in particular, providing the Agency with the information described in Article 17), unless the Agreement specifies otherwise;
- (iii) request and review any documents or information required by the Agency and verify their completeness and correctness before passing them on to the Agency;
- (iv) submit the deliverables and reports to the Agency (see Articles 19 and 20);
- (v) ensure that all payments are made to the other beneficiaries without unjustified delay (see Article 21);
- (vi) inform the Agency of the amounts paid to each beneficiary, when required under the Agreement (see Articles 44 and 50) or requested by the Agency.

The coordinator may not delegate or subcontract the above-mentioned tasks to any other beneficiary or third party (including linked third parties).

41.3 Internal arrangements between beneficiaries — Consortium agreement

The beneficiaries must have internal arrangements regarding their operation and co-ordination to ensure that the action is implemented properly. These internal arrangements must be set out in a written ‘**consortium agreement**’ between the beneficiaries, which may cover:

- internal organisation of the consortium;
- management of access to the electronic exchange system;
- distribution of EU funding;
- additional rules on rights and obligations related to background and results (including whether access rights remain or not, if a beneficiary is in breach of its obligations) (see Section 3 of Chapter 4);
- settlement of internal disputes;
- liability, indemnification and confidentiality arrangements between the beneficiaries.

The consortium agreement must not contain any provision contrary to the Agreement.

41.4 Relationship with complementary beneficiaries — Collaboration agreement

Not applicable

41.5 Relationship with partners of a joint action — Coordination agreement

Not applicable

CHAPTER 6 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — SANCTIONS — DAMAGES — SUSPENSION — TERMINATION — FORCE MAJEURE

SECTION 1 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — SANCTIONS

ARTICLE 42 — REJECTION OF INELIGIBLE COSTS

42.1 Conditions

The Agency will — after **termination of the participation of a beneficiary**, at the time of an **interim payment, at the payment of the balance or afterwards** — reject any costs which are ineligible (see Article 6), in particular following checks, reviews, audits or investigations (see Article 22).

The rejection may also be based on the **extension of findings from other grants to this grant** (see Article 22.5.2).

42.2 Ineligible costs to be rejected — Calculation — Procedure

Ineligible costs will be rejected in full.

If the rejection of costs does not lead to a recovery (see Article 44), the Agency will formally notify the coordinator or beneficiary concerned of the rejection of costs, the amounts and the reasons why (if applicable, together with the notification of amounts due; see Article 21.5). The coordinator or beneficiary concerned may — within 30 days of receiving notification — formally notify the Agency of its disagreement and the reasons why.

If the rejection of costs leads to a recovery, the Agency will follow the contradictory procedure with pre-information letter set out in Article 44.

42.3 Effects

If the Agency rejects costs at the time of an **interim payment** or **the payment of the balance**, it will deduct them from the total eligible costs declared, for the action, in the periodic or final summary financial statement (see Articles 20.3 and 20.4). It will then calculate the interim payment or payment of the balance as set out in Articles 21.3 or 21.4.

If the Agency rejects costs **after termination of the participation of a beneficiary**, it will deduct them from the costs declared by the beneficiary in the termination report and include the rejection in the calculation after termination (see Article 50.2 and 50.3).

If the Agency — **after an interim payment but before the payment of the balance** — rejects costs declared in a periodic summary financial statement, it will deduct them from the total eligible costs declared, for the action, in the next periodic summary financial statement or in the final summary financial statement. It will then calculate the interim payment or payment of the balance as set out in Articles 21.3 or 21.4.

If the Agency rejects costs **after the payment of the balance**, it will deduct the amount rejected from the total eligible costs declared, by the beneficiary, in the final summary financial statement. It will then calculate the revised final grant amount as set out in Article 5.4.

ARTICLE 43 — REDUCTION OF THE GRANT

43.1 Conditions

The Agency may — **after termination of the participation of a beneficiary, at the payment of the balance or afterwards** — reduce the grant amount (see Article 5.1), if :

- (a) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed:
 - (i) substantial errors, irregularities or fraud or
 - (ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles) or
- (b) a beneficiary (or a natural person who has the power to represent or take decision on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a

material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2).

43.2 Amount to be reduced — Calculation — Procedure

The amount of the reduction will be proportionate to the seriousness of the errors, irregularities or fraud or breach of obligations.

Before reduction of the grant, the Agency will formally notify a '**pre-information letter**' to the coordinator or beneficiary concerned:

- informing it of its intention to reduce the grant, the amount it intends to reduce and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If the Agency does not receive any observations or decides to pursue reduction despite the observations it has received, it will formally notify **confirmation** of the reduction (if applicable, together with the notification of amounts due; see Article 21).

43.3 Effects

If the Agency reduces the grant **after termination of the participation of a beneficiary**, it will calculate the reduced grant amount for that beneficiary and then determine the amount due to that beneficiary (see Article 50.2 and 50.3).

If the Agency reduces the grant **at the payment of the balance**, it will calculate the reduced grant amount for the action and then determine the amount due as payment of the balance (see Articles 5.3.4 and 21.4).

If the Agency reduces the grant **after the payment of the balance**, it will calculate the revised final grant amount for the beneficiary concerned (see Article 5.4). If the revised final grant amount for the beneficiary concerned is lower than its share of the final grant amount, the Agency will recover the difference (see Article 44).

ARTICLE 44 — RECOVERY OF UNDUE AMOUNTS

44.1 Amount to be recovered — Calculation — Procedure

The Agency will — after **termination of the participation of a beneficiary, at the payment of the balance or afterwards** — claim back any amount that was paid, but is not due under the Agreement.

Each beneficiary's financial responsibility in case of recovery is limited to its own debt, except for the amount retained for the Guarantee Fund (see Article 21.4).

44.1.1 Recovery after termination of a beneficiary's participation

If recovery takes place after termination of a beneficiary's participation (including the coordinator), the Agency will claim back the undue amount from the beneficiary concerned, by formally notifying it a debit note (see Article 50.2 and 50.3). This note will specify the amount to be recovered, the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Agency or the Commission will **recover** the amount:

- (a) by ‘**offsetting**’ it — without the beneficiary’s consent — against any amounts owed to the beneficiary concerned by the Agency, the Commission or another executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU’s financial interests, the Agency or the Commission may offset before the payment date specified in the debit note;

- (b) not applicable;

- (c) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial regulation No 966/2012.

If payment is not made by the date specified in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Agency or the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC²⁹ applies.

44.1.2 Recovery at payment of the balance

If the payment of the balance takes the form of a recovery (see Article 21.4), the Agency will formally notify a ‘**pre-information letter**’ to the coordinator:

- informing it of its intention to recover, the amount due as the balance and the reasons why;
- specifying that it intends to deduct the amount to be recovered from the amount retained for the Guarantee Fund;
- requesting the coordinator to submit a report on the distribution of payments to the beneficiaries within 30 days of receiving notification, and
- inviting the coordinator to submit observations within 30 days of receiving notification.

If no observations are submitted or the Agency decides to pursue recovery despite the observations it has received, it will **confirm recovery** (together with the notification of amounts due; see Article 21.5) and:

- pay the difference between the amount to be recovered and the amount retained for the Guarantee Fund, **if the difference is positive** or

²⁹ Directive 2007/64/EC of the European Parliament and of the Council of 13 November 2007 on payment services in the internal market amending Directives 97/7/EC, 2002/65/EC, 2005/60/EC and 2006/48/EC and repealing Directive 97/5/EC (OJ L 319, 05.12.2007, p. 1).

- formally notify to the coordinator a **debit note** for the difference between the amount to be recovered and the amount retained for the Guarantee Fund, **if the difference is negative**. This note will also specify the terms and the date for payment.

If the coordinator does not repay the Agency by the date in the debit note and has not submitted the report on the distribution of payments: the Agency or the Commission will **recover** the amount set out in the debit note from the coordinator (see below).

If the coordinator does not repay the Agency by the date in the debit note, but has submitted the report on the distribution of payments: the Agency will:

- (a) identify the beneficiaries for which the amount calculated as follows is negative:

$$\left\{ \left\{ \left\{ \text{beneficiary's costs declared in the final summary financial statement and approved by the Agency} \right. \right. \right. \\ \left. \left. \left. \text{multiplied by the reimbursement rate set out in Article 5.2 for the beneficiary concerned} \right\} \right. \right. \\ \text{divided by} \\ \left. \left. \left. \text{the EU contribution for the action calculated according to Article 5.3.1} \right\} \right. \right. \\ \text{multiplied by} \\ \left. \left. \left. \text{the final grant amount (see Article 5.3)} \right\} \right. \right. \\ \text{minus} \\ \left. \left. \left. \text{\{pre-financing and interim payments received by the beneficiary\}} \right\} \right. \right.$$

- (b) formally notify to each beneficiary identified according to point (a) a **debit note** specifying the terms and date for payment. The amount of the debit note is calculated as follows:

$$\left\{ \left\{ \text{amount calculated according to point (a) for the beneficiary concerned} \right\} \right. \\ \text{divided by} \\ \left. \left. \left. \text{the sum of the amounts calculated according to point (a) for all the beneficiaries identified according} \right. \right. \\ \left. \left. \left. \text{to point (a)} \right\} \right. \right. \\ \text{multiplied by} \\ \left. \left. \left. \text{the amount set out in the debit note formally notified to the coordinator} \right\} \right.$$

If payment is not made by the date specified in the debit note, the Agency or the Commission will **recover** the amount:

- (a) by **offsetting** it — without the beneficiary's consent — against any amounts owed to the beneficiary concerned by the Agency, the Commission or another executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU's financial interests, the Agency or the Commission may offset before the payment date specified in the debit note;

- (b) by **drawing on the Guarantee Fund**. The Agency or the Commission will formally notify the beneficiary concerned the debit note on behalf of the Guarantee Fund and recover the amount:

- (i) not applicable;

- (ii) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Agency or the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.

44.1.3 Recovery of amounts after payment of the balance

If, for a beneficiary, the revised final grant amount (see Article 5.4) is lower than its share of the final grant amount, it must repay the difference to the Agency.

The beneficiary's share of the final grant amount is calculated as follows:

$\{ \{ \text{beneficiary's costs declared in the final summary financial statement and approved by the Agency} \}$
multiplied by the reimbursement rate set out in Article 5.2 for the beneficiary concerned}

divided by

the EU contribution for the action calculated according to Article 5.3.1}

multiplied by

the final grant amount (see Article 5.3)}.

If the coordinator has not distributed amounts received (see Article 21.7), the Agency will also recover these amounts.

The Agency will formally notify a **pre-information letter** to the beneficiary concerned:

- informing it of its intention to recover, the due amount and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If no observations are submitted or the Agency decides to pursue recovery despite the observations it has received, it will **confirm** the amount to be recovered and formally notify to the beneficiary concerned a **debit note**. This note will also specify the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Agency or the Commission will **recover** the amount:

- (a) by **offsetting** it — without the beneficiary's consent — against any amounts owed to the beneficiary concerned by the Agency, the Commission or another executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU's financial interests, the Agency or the Commission may offset before the payment date specified in the debit note;

(b) by **drawing on the Guarantee Fund**. The Agency or the Commission will formally notify the beneficiary concerned the debit note on behalf of the Guarantee Fund and recover the amount:

(i) not applicable;

(ii) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the date for payment in the debit note, up to and including the date the Agency or the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.

ARTICLE 45 — ADMINISTRATIVE SANCTIONS

In addition to contractual measures, the Agency or the Commission may also adopt administrative sanctions under Articles 106 and 131(4) of the Financial Regulation No 966/2012 (i.e. exclusion from future procurement contracts, grants, prizes and expert contracts and/or financial penalties).

SECTION 2 LIABILITY FOR DAMAGES

ARTICLE 46 — LIABILITY FOR DAMAGES

46.1 Liability of the Agency

The Agency cannot be held liable for any damage caused to the beneficiaries or to third parties as a consequence of implementing the Agreement, including for gross negligence.

The Agency cannot be held liable for any damage caused by any of the beneficiaries or third parties involved in the action, as a consequence of implementing the Agreement.

46.2 Liability of the beneficiaries

Except in case of force majeure (see Article 51), the beneficiaries must compensate the Agency for any damage it sustains as a result of the implementation of the action or because the action was not implemented in full compliance with the Agreement.

SECTION 3 SUSPENSION AND TERMINATION

ARTICLE 47 — SUSPENSION OF PAYMENT DEADLINE

47.1 Conditions

The Agency may — at any moment — suspend the payment deadline (see Article 21.2 to 21.4) if a request for payment (see Article 20) cannot be approved because:

- (a) it does not comply with the provisions of the Agreement (see Article 20);
- (b) the technical or financial reports have not been submitted or are not complete or additional information is needed, or
- (c) there is doubt about the eligibility of the costs declared in the financial statements and additional checks, reviews, audits or investigations are necessary.

47.2 Procedure

The Agency will formally notify the coordinator of the suspension and the reasons why.

The suspension will **take effect** the day notification is sent by the Agency (see Article 52).

If the conditions for suspending the payment deadline are no longer met, the suspension will be **lifted** — and the remaining period will resume.

If the suspension exceeds two months, the coordinator may request the Agency if the suspension will continue.

If the payment deadline has been suspended due to the non-compliance of the technical or financial reports (see Article 20) and the revised report or statement is not submitted or was submitted but is also rejected, the Agency may also terminate the Agreement or the participation of the beneficiary (see Article 50.3.1(l)).

ARTICLE 48 — SUSPENSION OF PAYMENTS

48.1 Conditions

The Agency may — at any moment — suspend payments, in whole or in part and interim payments or the payment of the balance for one or more beneficiaries, if:

- (a) a beneficiary (or a natural person who has the power to represent or take decision on its behalf) has committed or is suspected of having committed:
 - (i) substantial errors, irregularities or fraud or
 - (ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles) or
- (b) a beneficiary (or a natural person who has the power to represent or take decision on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a

material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2).

If payments are suspended for one or more beneficiaries, the Agency will make partial payment(s) for the part(s) not suspended. If suspension concerns the payment of the balance, — once suspension is lifted — the payment or the recovery of the amount(s) concerned will be considered the payment of the balance that closes the action.

48.2 Procedure

Before suspending payments, the Agency will formally notify the coordinator or beneficiary concerned:

- informing it of its intention to suspend payments and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If the Agency does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify **confirmation** of the suspension. Otherwise, it will formally notify that the suspension procedure is not continued.

The suspension will **take effect** the day the confirmation notification is sent by the Agency.

If the conditions for resuming payments are met, the suspension will be **lifted**. The Agency will formally notify the coordinator or beneficiary concerned.

During the suspension, the periodic report(s) for all reporting periods except the last one (see Article 20.3), must not contain any individual financial statements from the beneficiary concerned. The coordinator must include them in the next periodic report after the suspension is lifted or — if suspension is not lifted before the end of the action — in the last periodic report.

The beneficiaries may suspend implementation of the action (see Article 49.1) or terminate the Agreement or the participation of the beneficiary concerned (see Article 50.1 and 50.2).

ARTICLE 49 — SUSPENSION OF THE ACTION IMPLEMENTATION

49.1 Suspension of the action implementation, by the beneficiaries

49.1.1 Conditions

The beneficiaries may suspend implementation of the action or any part of it, if exceptional circumstances — in particular *force majeure* (see Article 51) — make implementation impossible or excessively difficult.

49.1.2 Procedure

The coordinator must immediately formally notify to the Agency the suspension (see Article 52), stating:

- the reasons why and
- the expected date of resumption.

The suspension will **take effect** the day this notification is received by the Agency.

Once circumstances allow for implementation to resume, the coordinator must immediately formally notify the Agency and request an **amendment** of the Agreement to set the date on which the action will be resumed, extend the duration of the action and make other changes necessary to adapt the action to the new situation (see Article 55) — unless the Agreement or the participation of a beneficiary has been terminated (see Article 50).

The suspension will be **lifted** with effect from the resumption date set out in the amendment. This date may be before the date on which the amendment enters into force.

Costs incurred during suspension of the action implementation are not eligible (see Article 6).

49.2 Suspension of the action implementation, by the Agency

49.2.1 Conditions

The Agency may suspend implementation of the action or any part of it, if:

- (a) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed or is suspected of having committed:
 - (i) substantial errors, irregularities or fraud or
 - (ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles);
- (b) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2), or
- (c) the action is suspected of having lost its scientific or technological relevance.

49.2.2 Procedure

Before suspending implementation of the action, the Agency will formally notify the coordinator or beneficiary concerned:

- informing it of its intention to suspend the implementation and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If the Agency does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify **confirmation** of the suspension. Otherwise, it will formally notify that the procedure is not continued.

The suspension will **take effect** five days after confirmation notification is received (or on a later date specified in the notification).

It will be **lifted** if the conditions for resuming implementation of the action are met.

The coordinator or beneficiary concerned will be formally notified of the lifting and the Agreement will be **amended** to set the date on which the action will be resumed, extend the duration of the action and make other changes necessary to adapt the action to the new situation (see Article 55) — unless the Agreement has already been terminated (see Article 50).

The suspension will be lifted with effect from the resumption date set out in the amendment. This date may be before the date on which the amendment enters into force.

Costs incurred during suspension are not eligible (see Article 6).

The beneficiaries may not claim damages due to suspension by the Agency (see Article 46).

Suspension of the action implementation does not affect the Agency's right to terminate the Agreement or participation of a beneficiary (see Article 50), reduce the grant or recover amounts unduly paid (see Articles 43 and 44).

ARTICLE 50 — TERMINATION OF THE AGREEMENT OR OF THE PARTICIPATION OF ONE OR MORE BENEFICIARIES

50.1 Termination of the Agreement, by the beneficiaries

50.1.1 Conditions and procedure

The beneficiaries may terminate the Agreement.

The coordinator must formally notify termination to the Agency (see Article 52), stating:

- the reasons why and
- the date the termination will take effect. This date must be after the notification.

If no reasons are given or if the Agency considers the reasons do not justify termination, the Agreement will be considered to have been '**terminated improperly**'.

The termination will **take effect** on the day specified in the notification.

50.1.2 Effects

The coordinator must — within 60 days from when termination takes effect — submit:

- (i) a periodic report (for the open reporting period until termination; see Article 20.3) and
- (ii) the final report (see Article 20.4).

If the Agency does not receive the reports within the deadline (see above), only costs which are included in an approved periodic report will be taken into account.

The Agency will **calculate** the final grant amount (see Article 5.3) and the balance (see Article 21.4) on the basis of the reports submitted. Only costs incurred until termination are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Improper termination may lead to a reduction of the grant (see Article 43).

After termination, the beneficiaries' obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

50.2 Termination of the participation of one or more beneficiaries, by the beneficiaries

50.2.1 Conditions and procedure

The participation of one or more beneficiaries may be terminated by the coordinator, on request of the beneficiary concerned or on behalf of the other beneficiaries.

The coordinator must formally notify termination to the Agency (see Article 52) and inform the beneficiary concerned.

If the coordinator's participation is terminated without its agreement, the formal notification must be done by another beneficiary (acting on behalf of the other beneficiaries).

The notification must include:

- the reasons why;
- the opinion of the beneficiary concerned (or proof that this opinion has been requested in writing);
- the date the termination takes effect. This date must be after the notification, and
- a request for amendment (see Article 55), with a proposal for reallocation of the tasks and the estimated budget of the beneficiary concerned (see Annexes 1 and 2) and, if necessary, the addition of one or more new beneficiaries (see Article 56). If termination takes effect after the period set out in Article 3, no request for amendment must be included unless the beneficiary concerned is the coordinator. In this case, the request for amendment must propose a new coordinator.

If this information is not given or if the Agency considers that the reasons do not justify termination, the participation will be considered to have been **terminated improperly**.

The termination will **take effect** on the day specified in the notification.

50.2.2 Effects

The coordinator must — within 30 days from when termination takes effect — submit:

- (i) a report on the distribution of payments to the beneficiary concerned and
- (ii) if termination takes effect during the period set out in Article 3, a '**termination report**' from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, an overview of the use of resources, the individual financial statement and, if applicable, the certificate on the financial statement (see Articles 20.3 and 20.4).

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 20.3).

If the request for amendment is rejected by the Agency (because it calls into question the decision

awarding the grant or breaches the principle of equal treatment of applicants), the Agreement may be terminated according to Article 50.3.1(c).

If the request for amendment is accepted by the Agency, the Agreement is **amended** to introduce the necessary changes (see Article 55).

The Agency will — on the basis of the periodic reports, the termination report and the report on the distribution of payments — **calculate** the amount which is due to the beneficiary and if the (pre-financing and interim) payments received by the beneficiary exceed this amount.

The **amount which is due** is calculated in the following steps:

Step 1 — Application of the reimbursement rate to the eligible costs

The grant amount for the beneficiary is calculated by applying the reimbursement rate(s) to the total eligible costs declared by the beneficiary in the termination report and approved by the Agency.

Only costs incurred by the beneficiary concerned until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Step 2 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations

In case of a reduction (see Article 43), the Agency will calculate the reduced grant amount for the beneficiary by deducting the amount of the reduction (calculated in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations, in accordance with Article 43.2) from the grant amount for the beneficiary.

If the payments received **exceed the amounts due**:

- if termination takes effect during the period set out in Article 3 and the request for amendment is accepted, the beneficiary concerned must repay to the coordinator the amount unduly received. The Agency will formally notify the amount unduly received and request the beneficiary concerned to repay it to the coordinator within 30 days of receiving notification. If it does not repay the coordinator, the Agency will draw upon the Guarantee Fund to pay the coordinator and then notify a **debit note** on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);
- in all other cases, in particular if termination takes effect after the period set out in Article 3, the Agency will formally notify a **debit note** to the beneficiary concerned. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Agency the amount due and the Agency will notify a debit note on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);
- if the beneficiary concerned is the former coordinator, it must repay the new coordinator according to the procedure above, unless:
 - termination takes effect after an interim payment and

- the former coordinator has not distributed amounts received as pre-financing or interim payments (see Article 21.7).

In this case, the Agency will formally notify a **debit note** to the former coordinator. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Agency the amount due. The Agency will then pay the new coordinator and notify a debit note on behalf of the Guarantee Fund to the former coordinator (see Article 44).

If the payments received **do not exceed the amounts due**: amounts owed to the beneficiary concerned will be included in the next interim or final payment.

If the Agency does not receive the termination report within the deadline (see above), only costs included in an approved periodic report will be taken into account.

If the Agency does not receive the report on the distribution of payments within the deadline (see above), it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that
- the beneficiary concerned must not repay any amount to the coordinator.

Improper termination may lead to a reduction of the grant (see Article 43) or termination of the Agreement (see Article 50).

After termination, the concerned beneficiary's obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

50.3 Termination of the Agreement or the participation of one or more beneficiaries, by the Agency

50.3.1 Conditions

The Agency may terminate the Agreement or the participation of one or more beneficiaries, if:

- (a) one or more beneficiaries do not accede to the Agreement (see Article 56);
- (b) a change to their legal, financial, technical, organisational or ownership situation is likely to substantially affect or delay the implementation of the action or calls into question the decision to award the grant;
- (c) following termination of participation for one or more beneficiaries (see above), the necessary changes to the Agreement would call into question the decision awarding the grant or breach the principle of equal treatment of applicants (see Article 55);
- (d) implementation of the action is prevented by force majeure (see Article 51) or suspended by the coordinator (see Article 49.1) and either:
 - (i) resumption is impossible, or
 - (ii) the necessary changes to the Agreement would call into question the decision awarding the grant or breach the principle of equal treatment of applicants;

- (e) a beneficiary is declared bankrupt, being wound up, having its affairs administered by the courts, has entered into an arrangement with creditors, has suspended business activities, or is subject to any other similar proceedings or procedures under national law;
- (f) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has been found guilty of professional misconduct, proven by any means;
- (g) a beneficiary does not comply with the applicable national law on taxes and social security;
- (h) the action has lost scientific or technological relevance;
- (i) not applicable;
- (j) not applicable;
- (k) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed fraud, corruption, or is involved in a criminal organisation, money laundering or any other illegal activity;
- (l) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed:
 - (i) substantial errors, irregularities or fraud or
 - (ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles);
- (m) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2);
- (n) not applicable.

50.3.2 Procedure

Before terminating the Agreement or participation of one or more beneficiaries, the Agency will formally notify the coordinator or beneficiary concerned:

- informing it of its intention to terminate and the reasons why and
- inviting it, within 30 days of receiving notification, to submit observations and — in case of Point (l.ii) above — to inform the Agency of the measures to ensure compliance with the obligations under the Agreement.

If the Agency does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify to the coordinator or beneficiary concerned **confirmation** of the termination and the date it will take effect. Otherwise, it will formally notify that the procedure is not continued.

The termination will **take effect**:

- for terminations under Points (b), (c), (e), (g), (h), (j), (l.ii) and (n) above: on the day specified in the notification of the confirmation (see above);
- for terminations under Points (a), (d), (f), (i), (k), (l.i) and (m) above: on the day after the notification of the confirmation is received.

50.3.3 Effects

(a) for **termination of the Agreement**:

The coordinator must — within 60 days from when termination takes effect — submit:

- (i) a periodic report (for the last open reporting period until termination; see Article 20.3) and
- (ii) a final report (see Article 20.4).

If the Agreement is terminated for breach of the obligation to submit reports (see Articles 20.8 and 50.3.1(l)), the coordinator may not submit any reports after termination.

If the Agency does not receive the reports within the deadline (see above), only costs which are included in an approved periodic report will be taken into account.

The Agency will **calculate** the final grant amount (see Article 5.3) and the balance (see Article 21.4) on the basis of the reports submitted. Only costs incurred until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

This does not affect the Agency's right to reduce the grant (see Article 43) or to impose administrative sanctions (Article 45).

The beneficiaries may not claim damages due to termination by the Agency (see Article 46).

After termination, the beneficiaries' obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

(b) for **termination of the participation of one or more beneficiaries**:

The coordinator must — within 60 days from when termination takes effect — submit:

- (i) a report on the distribution of payments to the beneficiary concerned;
- (ii) a request for amendment (see Article 55), with a proposal for reallocation of the tasks and estimated budget of the beneficiary concerned (see Annexes 1 and 2) and, if necessary, the addition of one or more new beneficiaries (see Article 56). If termination is notified after the period set out in Article 3, no request for amendment must be submitted unless the beneficiary concerned is the coordinator. In this case the request for amendment must propose a new coordinator, and
- (iii) if termination takes effect during the period set out in Article 3, a **termination report** from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, an overview of the use of resources,

the individual financial statement and, if applicable, the certificate on the financial statement (see Article 20).

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 20.3).

If the request for amendment is rejected by the Agency (because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the Agreement may be terminated according to Article 50.3.1(c).

If the request for amendment is accepted by the Agency, the Agreement is **amended** to introduce the necessary changes (see Article 55).

The Agency will — on the basis of the periodic reports, the termination report and the report on the distribution of payments — **calculate** the amount which is due to the beneficiary and if the (pre-financing and interim) payments received by the beneficiary exceed this amount.

The **amount which is due** is calculated in the following steps:

Step 1 — Application of the reimbursement rate to the eligible costs

The grant amount for the beneficiary is calculated by applying the reimbursement rate(s) to the total eligible costs declared by the beneficiary in the termination report and approved by the Agency.

Only costs incurred by the beneficiary concerned until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Step 2 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations

In case of a reduction (see Article 43), the Agency will calculate the reduced grant amount for the beneficiary by deducting the amount of the reduction (calculated in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations, in accordance with Article 43.2) from the grant amount for the beneficiary.

If the payments received **exceed the amounts due**:

- if termination takes effect during the period set out in Article 3 and the request for amendment is accepted, the beneficiary concerned must repay to the coordinator the amount unduly received. The Agency will formally notify the amount unduly received and request the beneficiary concerned to repay it to the coordinator within 30 days of receiving notification. If it does not repay the coordinator, the Agency will draw upon the Guarantee Fund to pay the coordinator and then notify a **debit note** on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);
- in all other cases, in particular if termination takes effect after the period set out in Article 3, the Agency will formally notify a **debit note** to the beneficiary concerned. If payment is not made by the date in the debit note, the Guarantee Fund will pay to

the Agency the amount due and the Agency will notify a debit note on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

- if the beneficiary concerned is the former coordinator, it must repay the new coordinator according to the procedure above, unless:
 - termination takes effect after an interim payment and
 - the former coordinator has not distributed amounts received as pre-financing or interim payments (see Article 21.7).

In this case, the Agency will formally notify a **debit note** to the former coordinator. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Agency the amount due. The Agency will then pay the new coordinator and notify a debit note on behalf of the Guarantee Fund to the former coordinator (see Article 44).

If the payments received **do not exceed the amounts due**: amounts owed to the beneficiary concerned will be included in the next interim or final payment.

If the Agency does not receive the termination report within the deadline (see above), only costs included in an approved periodic report will be taken into account.

If the Agency does not receive the report on the distribution of payments within the deadline (see above), it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that
- the beneficiary concerned must not repay any amount to the coordinator.

After termination, the concerned beneficiary's obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

SECTION 4 FORCE MAJEURE

ARTICLE 51 — FORCE MAJEURE

‘Force majeure’ means any situation or event that:

- prevents either party from fulfilling their obligations under the Agreement,
- was unforeseeable, exceptional situation and beyond the parties' control,
- was not due to error or negligence on their part (or on the part of third parties involved in the action), and
- proves to be inevitable in spite of exercising all due diligence.

The following cannot be invoked as force majeure:

- any default of a service, defect in equipment or material or delays in making them available, unless they stem directly from a relevant case of force majeure,

- labour disputes or strikes, or
- financial difficulties.

Any situation constituting force majeure must be formally notified to the other party without delay, stating the nature, likely duration and foreseeable effects.

The parties must immediately take all the necessary steps to limit any damage due to force majeure and do their best to resume implementation of the action as soon as possible.

The party prevented by force majeure from fulfilling its obligations under the Agreement cannot be considered in breach of them.

CHAPTER 7 FINAL PROVISIONS

ARTICLE 52 — COMMUNICATION BETWEEN THE PARTIES

52.1 Form and means of communication

Communication under the Agreement (information, requests, submissions, ‘formal notifications’, etc.) must:

- be made in writing and
- bear the number of the Agreement.

All communication must be made through the Participant Portal **electronic** exchange system and using the forms and templates provided there.

If — after the payment of the balance — the Agency finds that a formal notification was not accessed, a second formal notification will be made by registered post with proof of delivery (‘formal notification on **paper**’). Deadlines will be calculated from the moment of the second notification.

Communications in the electronic exchange system must be made by persons authorised according to the Participant Portal Terms & Conditions. For naming the authorised persons, each beneficiary must have designated — before the signature of this Agreement — a ‘legal entity appointed representative (LEAR)’. The role and tasks of the LEAR are stipulated in his/her appointment letter (see Participant Portal Terms & Conditions).

If the electronic exchange system is temporarily unavailable, instructions will be given on the Agency and Commission websites.

52.2 Date of communication

Communications are considered to have been made when they are sent by the sending party (i.e. on the date and time they are sent through the electronic exchange system).

Formal notifications through the **electronic** exchange system are considered to have been made when they are received by the receiving party (i.e. on the date and time of acceptance by the receiving party, as indicated by the time stamp). A formal notification that has not been accepted within 10 days after sending is considered to have been accepted.

Formal notifications **on paper** sent by **registered post** with proof of delivery (only after the payment of the balance) are considered to have been made on either:

- the delivery date registered by the postal service or
- the deadline for collection at the post office.

If the electronic exchange system is temporarily unavailable, the sending party cannot be considered in breach of its obligation to send a communication within a specified deadline.

52.3 Addresses for communication

The **electronic** exchange system must be accessed via the following URL:

<https://ec.europa.eu/research/participants/portal/desktop/en/projects/>

The Agency will formally notify the coordinator and beneficiaries in advance any changes to this URL.

Formal notifications on paper (only after the payment of the balance) addressed **to the Agency** must be sent to the official mailing address indicated on the Agency's website.

Formal notifications on paper (only after the payment of the balance) addressed **to the beneficiaries** must be sent to their legal address as specified in the Participant Portal Beneficiary Register.

ARTICLE 53 — INTERPRETATION OF THE AGREEMENT

53.1 Precedence of the Terms and Conditions over the Annexes

The provisions in the Terms and Conditions of the Agreement take precedence over its Annexes.

Annex 2 takes precedence over Annex 1.

53.2 Privileges and immunities

Nothing in the Agreement may be interpreted as a waiver of any privileges or immunities accorded to the *EUROCONTROL - EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION*, *WORLD MARITIME UNIVERSITY* by its constituent documents or international law.

ARTICLE 54 — CALCULATION OF PERIODS, DATES AND DEADLINES

In accordance with Regulation No 1182/71³⁰, periods expressed in days, months or years are calculated from the moment the triggering event occurs.

The day during which that event occurs is not considered as falling within the period.

ARTICLE 55 — AMENDMENTS TO THE AGREEMENT

55.1 Conditions

³⁰ Regulation (EEC, Euratom) No 1182/71 of the Council of 3 June 1971 determining the rules applicable to periods, dates and time-limits (OJ L 124, 8.6.1971, p. 1).

The Agreement may be amended, unless the amendment entails changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

Amendments may be requested by any of the parties.

55.2 Procedure

The party requesting an amendment must submit a request for amendment signed in the electronic exchange system (see Article 52).

The coordinator submits and receives requests for amendment on behalf of the beneficiaries (see Annex 3).

If a change of coordinator is requested without its agreement, the submission must be done by another beneficiary (acting on behalf of the other beneficiaries).

The request for amendment must include:

- the reasons why;
- the appropriate supporting documents, and
- for a change of coordinator without its agreement: the opinion of the coordinator (or proof that this opinion has been requested in writing).

The Agency may request additional information.

If the party receiving the request agrees, it must sign the amendment in the electronic exchange system within 45 days of receiving notification (or any additional information the Agency has requested). If it does not agree, it must formally notify its disagreement within the same deadline. The deadline may be extended, if necessary for the assessment of the request. If no notification is received within the deadline, the request is considered to have been rejected

An amendment **enters into force** on the day of the signature of the receiving party.

An amendment **takes effect** on the date agreed by the parties or, in the absence of such an agreement, on the date on which the amendment enters into force.

ARTICLE 56 — ACCESSION TO THE AGREEMENT

56.1 Accession of the beneficiaries mentioned in the Preamble

The other beneficiaries must accede to the Agreement by signing the Accession Form (see Annex 3) in the electronic exchange system (see Article 52) within 30 days after its entry into force (see Article 58).

They will assume the rights and obligations under the Agreement with effect from the date of its entry into force (see Article 58).

If a beneficiary does not accede to the Agreement within the above deadline, the coordinator must — within 30 days — request an amendment to make any changes necessary to ensure proper

implementation of the action. This does not affect the Agency's right to terminate the Agreement (see Article 50).

56.2 Addition of new beneficiaries

In justified cases, the beneficiaries may request the addition of a new beneficiary.

For this purpose, the coordinator must submit a request for amendment in accordance with Article 55. It must include an Accession Form (see Annex 3) signed by the new beneficiary in the electronic exchange system (see Article 52).

New beneficiaries must assume the rights and obligations under the Agreement with effect from the date of their accession specified in the Accession Form (see Annex 3).

ARTICLE 57 — APPLICABLE LAW AND SETTLEMENT OF DISPUTES

57.1 Applicable law

The Agreement is governed by the applicable EU law, supplemented if necessary by the law of Belgium.

57.2 Dispute settlement

If a dispute concerning the interpretation, application or validity of the Agreement cannot be settled amicably, the General Court — or, on appeal, the Court of Justice of the European Union — has sole jurisdiction. Such actions must be brought under Article 272 of the Treaty on the Functioning of the EU (TFEU).

As an exception, if such a dispute is between the Agency and ISTANBUL TEKNİK UNIVERSİTESİ, ARCHIPELAGO PHILIPPINE FERRIES CORPORATION, INSTITUT TEKNOLOGI SEPULUH NOPEMBER, ROLLS-ROYCE MARINE AS, the competent Belgian courts have sole jurisdiction.

As an exception, for the following beneficiaries:

- EUROCONTROL - EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION
- FEDERAL STATE UNITARY ENTERPRISE THE CENTRAL AEROHYDRODYNAMIC INSTITUTE NAMED AFTER PROF. N.E. ZHUKOVSKY
- STATE RESEARCH INSTITUTE OF AVIATION SYSTEMS
- STATE EDUCATIONAL INSTITUTION OF HIGHER PROFESSIONAL EDUCATION MOSCOW AVIATION INSTITUTE STATE TECHNICAL UNIVERSITY
- KONSERN INNOVATSIONNYYE TEKHNologii
- MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY (STATE UNIVERSITY)
- WORLD MARITIME UNIVERSITY
- Wuhan University of Technology

such disputes must — if they cannot be settled amicably — be referred to arbitration. Each party must formally notify to the other party its intention of resorting to arbitration and the identity of the arbitrator. The Permanent Court of Arbitration Optional Rules for Arbitration Involving International Organisations and States in force at the date of entry into force of the Agreement will apply. The appointing authority will be the Secretary-General of the Permanent Court of Arbitration following a written request submitted by either party. The arbitration proceedings must take place in Brussels and the language used in the arbitral proceedings will be English. The arbitral award will be binding on all parties and will not be subject to appeal.

If a dispute concerns administrative sanctions, offsetting or an enforceable decision under Article 299 TFEU (see Articles 44, 45 and 46), the beneficiaries must bring action before the General Court — or, on appeal, the Court of Justice of the European Union — under Article 263 TFEU. Actions against offsetting and enforceable decisions must be brought against the Commission (not against the Agency).

ARTICLE 58 — ENTRY INTO FORCE OF THE AGREEMENT

The Agreement will enter into force on the day of signature by the Agency or the coordinator, depending on which is later.

SIGNATURES

For the coordinator

For the Agency



EUROPEAN COMMISSION
Innovation and Networks Executive Agency
Transport Research



ANNEX 1 (part A)

Research and Innovation action

NUMBER — 814961 — SAFEMODE

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1.1. The project summary

Project Number ¹	814961	Project Acronym ²	SAFEMODE
One form per project			
General information			
Project title ³	Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation		
Starting date ⁴	The first day of the month after the signature by the Commission		
Duration in months ⁵	36		
Call (part) identifier ⁶	H2020-MG-2018-TwoStages		
Topic	MG-2-1-2018 Human Factors in Transport Safety		
Fixed EC Keywords	Human Factors HFA		
Free keywords	Safety, Maritime, Aviation		
Abstract ⁷			
<p>Currently, both maritime and aviation sectors are lacking a systematic approach to collect and assess Human Factors information in normal and emergency conditions. There is also a lack of agreed methodology to assess human-related risks with the aim of influencing design and operation of aircraft and ships. Therefore, the research question being addressed in this project is “How to fully capture human elements and their interaction with the other system elements to enhance safety in maritime and aviation operations?”</p> <p>It is important to address Human Factors aspects in relation to risk-based design of system and operations in a measurable manner by taking the variation in human behaviour over time and the non-flexibility of machines into consideration.</p> <p>The main aim of SAFEMODE project is to develop a novel HUman Risk Informed Design (HURID) framework in order to identify, collect and assess Human Factors data to inform risk-based design of systems and operation. These aims have not been achieved previously at a desirable level due to the unavailability of systematically collected data and lack of cooperation between different transport modes.</p> <p>The focus will be to reduce risks for safety critical situations, (e.g. mid-air collisions, grounding, evacuation, runway excursions etc.) through the enhancement of human performance. This will be achieved through investigation of past accidents, incidents, near-misses, reports, data from everyday operations, including previously unknown uncertainties such as increasing levels of automation and increased number of drones in transportation.</p> <p>This information will be incorporated the HURID framework and tools and into SHIELD, the open data repository and the living database, that will be maintained and continuously updated.</p>			

1.2. List of Beneficiaries

Project Number ¹	814961	Project Acronym ²	SAFEMODE
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List of Beneficiaries

No	Name	Short name	Country	Project entry month ⁸	Project exit month
1	DEEP BLUE SRL	DEEP BLUE	Italy	1	36
2	UNIVERSITY OF STRATHCLYDE	USTRAT	United Kingdom	1	36
3	EUROCONTROL - EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION	EUROCONTROL	Belgium	1	36
4	STICHTING NATIONAAL LUCHT- EN RUIMTEVAARTLABORATORIUM	NLR	Netherlands	1	36
5	HUNGAROCNTRAL MAGYAR LEGIFORGALMISZOLGALAT ZARTKORUEN MUKODO RESZVENYTARSASAG	HUNGAROCNTRAL	Hungary	1	36
6	ECOLE NATIONALE DE L AVIATION CIVILE	ENAC	France	1	36
7	UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA	UniSap	Italy	1	36
8	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS	CERTH	Greece	1	36
9	CETENA S.p.A. Centro per gli Studi di Tecnica Navale	CETENA	Italy	1	36
10	ISTANBUL TEKNIK UNIVERSITESI	ITU	Turkey	1	36
11	CALMAC FERRIES LTD	CalMac	United Kingdom	1	36
12	CHALMERS TEKNISKA HOEGSKOLA AB	CHALMERS	Sweden	1	36
13	EMBRAER PORTUGAL SA	EMBPT	Portugal	1	36
14	FEDERAL STATE UNITARY ENTERPRISE THE CENTRAL AEROHYDRODYNAMIC INSTITUTE NAMED AFTER PROF. N.E. ZHUKOVSKY	TsAGI	Russian Federation	1	36
15	STATE RESEARCH INSTITUTE OF AVIATION SYSTEMS	GosNIIAS	Russian Federation	1	36
16	STATE EDUCATIONAL INSTITUTION OF HIGHER PROFESSIONAL EDUCATION MOSCOW AVIATION INSTITUTE STATE TECHNICAL UNIVERSITY	MAI	Russian Federation	1	36
17	KONSERN INNOVATIONNYE TEKHNologii	Innoteh	Russian Federation	1	36
18	MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY (STATE UNIVERSITY)	MIPT	Russian Federation	1	36
19	DE MONTFORT UNIVERSITY	DMU	United Kingdom	1	36

1.2. List of Beneficiaries

No	Name	Short name	Country	Project entry month ⁸	Project exit month
20	NATIONAL TECHNICAL UNIVERSITY OF ATHENS - NTUA	NTUA	Greece	1	36
21	WORLD MARITIME UNIVERSITY	WMU	Sweden	1	36
22	AIRBUS OPERATIONS SAS	AIRBUS	France	1	36
23	ANDREAS PAPADAKIS NAUTILIAKES KAI EMPORIKES EPICHEIRISEIS MONOPROSOPI ETAIREIA PERIORISMENHS EFTHINIS	APA	Greece	1	36
24	RYANAIR DESIGNATED ACTIVITY COMPANY	RYANAIR	Ireland	1	36
25	PANEPISTIMIO PATRON	UPATRAS	Greece	1	36
26	RAIL SAFETY AND STANDARDS BOARD LIMITED	RSSB	United Kingdom	1	36
27	UNIVERSITEIT VAN AMSTERDAM	UVA	Netherlands	1	36
28	WAERTSILA NETHERLANDS B.V.	Wartsila NL	Netherlands	1	36
29	ARCHIPELAGO PHILIPPINE FERRIES CORPORATION	APFC	Philippines	1	36
30	INSTITUT TEKNOLOGI SEPULUH NOPEMBER	INSTITEKNO	Indonesia	1	36
31	ROLLS-ROYCE MARINE AS	ROLLS-ROYCE MAR	Norway	1	36
32	Wuhan University of Technology	WUT	China (People's Republic of)	1	36
33	TUI AIRWAYS LIMITED	TUI Airways ltd	United Kingdom	1	36
34	DEMIRAL ALI	BeeBI	Germany	1	36

1.3. Workplan Tables - Detailed Implementation

Associated with document Ref: Ares(2019)2589997 - 12/04/2019

1.3.1. WT1 List of work packages

WP Number ⁹	WP Title	Lead beneficiary ¹⁰	Person-months ¹¹	Start month ¹²	End month ¹³
WP1	Project Management	1 - DEEP BLUE	50.00	1	36
WP2	Development of SHIELD Open Data Repository	4 - NLR	142.00	1	36
WP3	Development of methodologies for assuring human performance	1 - DEEP BLUE	141.50	1	36
WP4	Development of Human Factors Based Risk Models	3 - EUROCONTROL	185.00	1	34
WP5	Definition and consolidation of the Human Risk Informed Design Framework – HURID	2 - USTRAT	174.00	7	36
WP6	Forward looking Scenarios and Domain Case Studies – Aviation	5 - HUNGAROCONTROL	311.00	1	34
WP7	Domain Case Studies and Forward-looking Scenarios – Maritime	9 - CETENA	154.00	1	36
WP8	Dissemination and Communication Activities	8 - CERTH	83.00	1	36
WP9	Policy recommendations, Institutionalization and Exploitation Activities	21 - WMU	94.60	1	36
WP10	Ethics requirements	1 - DEEP BLUE	N/A	1	36
Total			1,335.10		

1.3.2. WT2 list of deliverables

Deliverable Number ¹⁴	Deliverable Title	WP number ⁹	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D1.1	Project Management Plan	WP1	1 - DEEP BLUE	Report	Public	3
D1.2	Social, Ethical, Legal, Privacy issues identification and monitoring (initial)	WP1	1 - DEEP BLUE	Report	Public	4
D1.3	Project Management Plan - second release	WP1	1 - DEEP BLUE	Report	Public	18
D1.4	Social, Ethical, Legal, Privacy issues identification and monitoring (final)	WP1	1 - DEEP BLUE	Report	Public	36
D1.5	Open Research Data Pilot	WP1	1 - DEEP BLUE	ORDP: Open Research Data Pilot	Public	6
D2.1	SHIELD human factors taxonomy for risk analysis	WP2	1 - DEEP BLUE	Report	Public	6
D2.2	Design of the SHIELD Open Data Repository	WP2	4 - NLR	Report	Public	12
D2.3	Data sources and implementation of the SHIELD Open Data Repository	WP2	3 - EUROCONTROL	Report	Confidential, only for members of the consortium (including the Commission Services)	18
D2.4	Implemented SHIELD Open Data Repository, including initial data sources	WP2	4 - NLR	data sets, microdata, etc	Confidential, only for members of the consortium (including the Commission Services)	18
D2.5	Updated SHIELD Open Data Repository, including advanced data analytics and text mining tools and results, Database and Open-Source Software	WP2	27 - UVA	data sets, microdata, etc	Confidential, only for members of the consortium (including the Commission Services)	30
D2.6	Updated SHIELD Open Data Repository, including results from the active learning process with experts	WP2	4 - NLR	data sets, microdata, etc	Confidential, only for members of the consortium (including the Commission Services)	36

Deliverable Number¹⁴	Deliverable Title	WP number⁹	Lead beneficiary	Type¹⁵	Dissemination level¹⁶	Due Date (in months)¹⁷
D2.7	Advanced data analytics and text mining for SHIELD Open Data Repository	WP2	27 - UVA	Report	Public	30
D2.8	Validation and active learning processes of SHIELD Open Data Repository	WP2	4 - NLR	Report	Public	36
D3.1	Human Assurance toolkit and guidance on Human Assurance Levels	WP3	1 - DEEP BLUE	Report	Public	18
D3.2	Predictive models of human performance and Human Assurance Levels	WP3	3 - EUROCONTROL	Report	Public	24
D3.3	HF methods and techniques for case studies	WP3	7 - UniSap	Report	Public	18
D3.4	HF methods and techniques for forward-looking scenarios	WP3	7 - UniSap	Report	Public	36
D4.1	Risk framework (methodology) for the development of different safety models incorporating Human Factors in both transport modes	WP4	3 - EUROCONTROL	Report	Public	9
D4.2	Risk models of major accident types in both domains	WP4	2 - USTRAT	Report	Public	18
D4.3	Risk framework validation with incident cases and domain case studies	WP4	12 - CHALMERS	Report	Public	27
D4.4	Risk framework to assess the impact and guide design decisions	WP4	3 - EUROCONTROL	Report	Public	34
D5.1	HURID Use Cases and HURID First Release	WP5	2 - USTRAT	Report	Public	18
D5.2	HURID and existing risk-based design frameworks	WP5	20 - NTUA	Report	Public	27
D5.3	HURID Final release and practical guidance	WP5	3 - EUROCONTROL	Report	Public	36

Deliverable Number¹⁴	Deliverable Title	WP number⁹	Lead beneficiary	Type¹⁵	Dissemination level¹⁶	Due Date (in months)¹⁷
D5.4	Living Lab and online platform, first release	WP5	34 - BeeBI	Other	Public	27
D5.5	Living Lab and online platform, final release	WP5	34 - BeeBI	Other	Public	36
D6.1	List of domain case studies and defined scenario with HF analysis - air	WP6	6 - ENAC	Report	Public	15
D6.2	Validation Plan: CONOPS, scenarios, technical equipment, experimental design	WP6	5 - HUNGAROCONTROL	Report	Public	18
D6.3	First Validation Report - air	WP6	6 - ENAC	Report	Public	27
D6.4	Second Validation Report - air	WP6	5 - HUNGAROCONTROL	Report	Public	34
D7.1	List of domain case studies and defined scenario with HF analysis - sea	WP7	20 - NTUA	Report	Public	15
D7.2	Validation Plan: CONOPS, scenarios, technical equipment, exp. design	WP7	9 - CETENA	Report	Public	18
D7.3	First Validation Report - sea	WP7	9 - CETENA	Report	Public	27
D7.4	Second Validation Report - sea	WP7	10 - ITU	Report	Public	34
D8.1	Project social media interfaces	WP8	8 - CERTH	Other	Public	1
D8.2	Project logo, leaflets and posters	WP8	8 - CERTH	Report	Public	3
D8.3	Project website	WP8	8 - CERTH	Websites, patents filling, etc.	Public	4
D8.4	Dissemination strategy	WP8	8 - CERTH	Report	Public	6
D8.5	Report on communication activities	WP8	8 - CERTH	Report	Public	36
D8.6	Report on actions for regional, national and European uptake	WP8	8 - CERTH	Report	Public	34
D9.1	Exploitation Plan	WP9	1 - DEEP BLUE	Report	Public	18

Deliverable Number¹⁴	Deliverable Title	WP number⁹	Lead beneficiary	Type¹⁵	Dissemination level¹⁶	Due Date (in months)¹⁷
D9.2	Institutionalization Strategy	WP9	21 - WMU	Other	Public	24
D9.3	Stakeholder analysis and Identification of policy recommendation	WP9	21 - WMU	Report	Public	12
D9.4	Policy notes and/or recommendation in required format	WP9	21 - WMU	Report	Public	36
D9.5	Capacity building training package	WP9	21 - WMU	Other	Public	30
D9.6	Report on Just Culture Framework	WP9	3 - EUROCONTROL	Report	Public	30
D9.7	Aviation and Maritime analysis and cross-fertilization opportunities	WP9	21 - WMU	Report	Public	36
D10.1	NEC - Requirement No. 1	WP10	1 - DEEP BLUE	Ethics	Confidential, only for members of the consortium (including the Commission Services)	6

1.3.3. WT3 Work package descriptions

Work package number ⁹	WP1	Lead beneficiary ¹⁰	1 - DEEP BLUE
Work package title	Project Management		
Start month	1	End month	36

Objectives

This work package aims to enable efficient management of the project in relation to all the activities carried out by the different partners and to ensure the integration of skills and resources in order to reach the targeted global project result. In particular, the SAFEMODE management approach has the following specific objectives:

- Co-ordination, monitoring and reporting of the project
- Administrative and financial management of the project
- Data management of the research activities
- Innovation management to maximize chances of success

Description of work and role of partners

WP1 - Project Management [Months: 1-36]

DEEP BLUE, USTRAT, EUROCONTROL, NLR, HUNGAROCONTROL, CERTH, CETENA, WMU, WUT

Task 1.1 - Project coordination and management, Lead: DBL, Participants: UoS, ECTL, NLR, HC, CERTH, CET, WMU, WTU [M1-M36]

This task will be devoted to project management. The Project Coordinator (PC) will be assisted for administrative issues by DBL administration. The PC will be in charge of distributing all necessary information to the whole Consortium, collecting the contributions to prepare Periodic Technical and Financial Reports, reviewing milestones, updating risk analysis and ensuring the quality level of all deliverables. The WP leaders will be responsible for the organisation of internal meetings and compilation of technical reports related to their work packages. Finally, a continuous ethical monitoring by the Internal Ethics Committee will be implemented to assess the execution of the different EC Ethical Requirements within the project in compliance with H2020 Ethical Standards and Guidelines (for details see Section 5). A detailed description of the management structure and procedures are provided in section 3.2. For this task, there will be only one deliverable (D1.1), but all the activities related to the project management will be directly generated in the technical and activity report and in the financial report, that will be reported on the ECAS portal during the “Continuous Reporting” activities.

Task 1.2 - Innovation Management, Lead: DBL, Participants: UoS, ECTL, NLR, CET, WMU [M11-M36]

Beyond the conventional managerial activities, DBL will be in charge of the identification of exploitable ideas and results generated within the project. A key objective of publicly funded research, is in fact that it should lead to the exploitation of results, which goes one step further than the mere production and dissemination of new scientific knowledge. Such an approach is essential to tackle the “European paradox”: a strong science base but weak innovation performance (exploitation). The PC will be responsible for the close involvement of stakeholders and potential users of the project outputs, for protecting and managing Intellectual Property Rights (IPR), for exploring market opportunities and for prototyping scenarios and responsive business models.

Task 1.3 - Social, Ethical, Legal, Privacy issues identification and monitoring, Lead: DBL, Participants: UoS [M1-M36]

This task aims at ensuring that the project activities are respectful of human rights, particularly the right to privacy and data protection, and do not generate ethically unwanted personal or social effects. The partners in charge of the empirical studies will provide detailed information on privacy/confidentiality and the procedures that will be implemented for data collection, storage, access, sharing policies. It will identify privacy, ethical and other legal concerns, propose mitigation measures to address the legal and ethical risks, continuously monitor SELP issues in both project activities and results, by performing a PEIA (privacy and ethical impact assessment) to discern how the principles identified are likely to apply within the context of SAFEMODE. The task will deliver detailed information on Ethics, Privacy and Confidentiality and the procedures that should be implemented: informed consent and staff recruitment, data collection, storage, access, sharing policies when third countries are concerned, protection, retention and destruction and confirmation, national and international/EU legislation.

Participation per Partner

Partner number and short name	WP1 effort
1 - DEEP BLUE	24.00
2 - USTRAT	12.00
3 - EUROCONTROL	2.00
4 - NLR	2.00
5 - HUNGAROCNTROL	2.00
8 - CERTH	2.00
9 - CETENA	2.00
21 - WMU	2.00
32 - WUT	2.00
Total	50.00

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D1.1	Project Management Plan	1 - DEEP BLUE	Report	Public	3
D1.2	Social, Ethical, Legal, Privacy issues identification and monitoring (initial)	1 - DEEP BLUE	Report	Public	4
D1.3	Project Management Plan - second release	1 - DEEP BLUE	Report	Public	18
D1.4	Social, Ethical, Legal, Privacy issues identification and monitoring (final)	1 - DEEP BLUE	Report	Public	36
D1.5	Open Research Data Pilot	1 - DEEP BLUE	ORDP: Open Research Data Pilot	Public	6

Description of deliverables

D1.1 Project Management Plan (DBL), Report, Public [M3]
This deliverable will include the detailed work plan and the description of the project management processes including Data Management and Quality Assurance.

D1.2 Social, Ethical, Legal, Privacy issues identification and monitoring (initial), Report, Public [M4]
This deliverable will identify the guidelines for the project and the required documentations.

D1.3 Social, Ethical, Legal, Privacy issues identification and monitoring (final), Report, Public [M36]
Final report of all the activities done and collected about ethical requirements, to be compliant

D1.1 : Project Management Plan [3]
This deliverable will include the detailed work plan and the description of the project management processes including Data Management and Quality Assurance.

D1.2 : Social, Ethical, Legal, Privacy issues identification and monitoring (initial) [4]
This deliverable will identify the guidelines for the project ethics and the required documentations.

D1.3 : Project Management Plan - second release [18]

Second release of the PMP, including the detailed work plan and the description of the project management processes including Data Management and Quality Assurance.

D1.4 : Social, Ethical, Legal, Privacy issues identification and monitoring (final) [36]

Final report of all the activities done and collected about ethical requirements

D1.5 : Open Research Data Pilot [6]

Open access to research data - to be completed

Schedule of relevant Milestones

Milestone number ¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS5	Cooperation Agreement with EASA	1 - DEEP BLUE	6	Cooperation Agreement with EASA finalised, agreed and signed.

Work package number ⁹	WP2	Lead beneficiary ¹⁰	4 - NLR
Work package title	Development of SHIELD Open Data Repository		
Start month	1	End month	36

Objectives

- Develop the human factors taxonomy for risk analysis.
- Develop the Open Data Repository for safety occurrence reports and safety-relevant human performance and contextual data.
- Collect data (via databases and via dedicated campaigns with SAFEMODE partners) and develop automatic data and text mining processes to identify incident types, human performance events and contextual conditions.
- Determine statistical measures of human performance for air transport and marine risk models.
- Validation and active learning of the Open Data Repository.

Description of work and role of partners

WP2 - Development of SHIELD Open Data Repository [Months: 1-36]

NLR, DEEP BLUE, USTRAT, EUROCONTROL, ENAC, CERTH, CETENA, ITU, CalMac , CHALMERS, EMBPT, TsAGI, MAI , NTUA, WMU, AIRBUS, APA, RYANAIR , RSSB, UVA, Wartsila NL, APFC, INSTITEKNO, ROLLS-ROYCE MAR, WUT, TUI Airways ltd, BeeBI

Task 2.1. Development of the SHIELD human factors taxonomy for risk analysis Lead: DBL, Participants: UoS, ECTL, NLR, CERTH, ITU, CAL, CHAL, TsAGI, MAI, RSSB, UVA, APFC, RRM [M1-M6]

Development of the SHIELD human factors taxonomy, which presents the logical framework to describe human performance in safety-relevant tasks and the influence of contextual conditions. Gap analysis of existing taxonomies and data sources with respect to the needs for effective HF feedback to design for the various layers in the Human Factors Iceberg. Description of the use of the taxonomy for aviation and maritime operations. In addition, migration possibilities of the SHIELDS HF taxonomy to an ontology (describing not only hierarchical relations between concepts, but also horizontal relations), will be assessed -and where applicable- implemented in this task. Having a full ontology allows for ontology-based (role- or policy-based, privacy-aware) access to data and increases the reusability of the knowledgebase, via interfacing with other ontologies, such as risk ontologies.

Task 2.2. Design and implementation of the SHIELD Open Data Repository – Lead: NLR, Participants: – ECTL, RSSB, UoS, CAL, NTUA, WTU, BEEBI [M4-M18]

Analysis of the needs of the end-users of the SHIELD Open Data Repository for risk analysis and design. Design of the database, describing the database objectives, the types of data to be stored, the relationships between the data elements, and the logical structure of the database. Key types of data elements will include: raw performance data, including narratives of safety occurrence reports, human performance data from normal operations and training sessions, and contextual data of operations; extracted data features, including incident classes, human performance events, and contextual classes; and data statistics, including conditional human event probabilities and probability density functions of human performance. Confidence levels that reflect the quality and quantity of the underlying data will be incorporated. Implementation of a first prototype version of the SHIELD software (excluding the data).

Task 2.3. Collection and processing of data for the SHIELD Open Data Repository Lead: UoS, Participants: ECTL, NLR, CERTH, ENAC, TsAGI, MAI, UoS, CAL, ITU, APFC, WTU, AIRBUS, ITS, APA, WRT [M4-M18]

This concerns the identification, screening, collection, and harmonisation of raw performance data for inclusion in SHIELD. Data sources regard safety occurrence reports and operational performance data in the maritime and air transport sector, such as indicated in the Approach and Methodology. A connection will be sought with the Data4Safety programme supported by EASA. Pre-processed available data features (e.g. incident classes, human events) are included in SHIELD and statistics are calculated based on these data features. Dedicated data generation activities will be initiated where data are lacking. Means for attaining sufficient quality and quantity of data in organizations are addressed as part of the HURID framework (WP5) and its institutionalization (WP9).

Task 2.4. Advanced data analytics and text mining for the SHIELD Open Data Repository – Lead: UVA, Participants: NLR, RSSB, UoS, NTUA, WTU, BEEBI [M4 – M30]

Evaluation of state-of-the-art data and text mining techniques for extraction of data features from occurrence reports and safety-related data. Development of data and text mining methods and SHIELD tools to support effective analysis and categorization of safety occurrence reports, and safety-relevant human performance and contextual data. Such methods and tools are crucial for effectively managing and interpreting the large volume of available data and occurrence reports. Development of multi-language support for the processing of textual data from a variety of EU sources. These data

features will be compatible with (and partially driven by) the taxonomy/ontology derived in Task 2.1. Special attention will be paid to explainable methods and tools that produce outcomes that are intelligible to humans (see Task 2.5).

Task 2.5. Validation and active learning processes of the SHIELD Open Data Repository – Lead: NLR, Participants: UVA, UoS, CAL, CHAL, WMU, CET, APFC, APA, WRT [M24-M36]

The validation in this task concerns three main components. The first validation component concerns the validity of the extracted data features by experts and automatic mining techniques and the validity of the derived data statistics. Active learning approaches will be used to couple expert-based labelling with machine learning techniques to achieve a continuous training loop enriching the data-driven tools in a partnership between human experts and artificial intelligence. A second validation will be performed by receiving feedback from other WPs on the effectiveness of the use of the SHIELD Open Data Repository for the development of risk models (WP4) and in the case studies (WP6, WP7). Thirdly, the explainability and transparency of the extracted data features produced by automatic mining techniques and the derived data statistics will be assessed in user experiments.

Participation per Partner

Partner number and short name	WP2 effort
1 - DEEP BLUE	9.00
2 - USTRAT	16.00
3 - EUROCONTROL	5.00
4 - NLR	23.00
6 - ENAC	2.00
8 - CERTH	2.00
9 - CETENA	0.50
10 - ITU	5.00
11 - CalMac	2.00
12 - CHALMERS	2.00
13 - EMBPT	1.00
14 - TsAGI	3.00
16 - MAI	3.00
20 - NTUA	5.00
21 - WMU	2.00
22 - AIRBUS	0.50
23 - APA	4.00
24 - RYANAIR	1.00
26 - RSSB	2.00
27 - UVA	30.00
28 - Wartsila NL	2.00
29 - APFC	7.00
30 - INSTITEKNO	5.00
31 - ROLLS-ROYCE MAR	1.00
32 - WUT	6.00
33 - TUI Airways ltd	1.00

Partner number and short name	WP2 effort
34 - BeeBI	2.00
Total	142.00

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D2.1	SHIELD human factors taxonomy for risk analysis	1 - DEEP BLUE	Report	Public	6
D2.2	Design of the SHIELD Open Data Repository	4 - NLR	Report	Public	12
D2.3	Data sources and implementation of the SHIELD Open Data Repository	3 - EUROCONTROL	Report	Confidential, only for members of the consortium (including the Commission Services)	18
D2.4	Implemented SHIELD Open Data Repository, including initial data sources	4 - NLR	data sets, microdata, etc	Confidential, only for members of the consortium (including the Commission Services)	18
D2.5	Updated SHIELD Open Data Repository, including advanced data analytics and text mining tools and results, Database and Open-Source Software	27 - UVA	data sets, microdata, etc	Confidential, only for members of the consortium (including the Commission Services)	30
D2.6	Updated SHIELD Open Data Repository, including results from the active learning process with experts	4 - NLR	data sets, microdata, etc	Confidential, only for members of the consortium (including the Commission Services)	36
D2.7	Advanced data analytics and text mining for SHIELD Open Data Repository	27 - UVA	Report	Public	30
D2.8	Validation and active learning processes of SHIELD Open Data Repository	4 - NLR	Report	Public	36

Description of deliverables

D2.1 SHIELD human factors taxonomy for risk analysis (DBL) Report, Public [M6]
D2.2 Design of the SHIELD Open Data Repository (NLR) Report, Public [M12].
D2.3 Data sources and implementation of the SHIELD Open Data Repository (ECTL) Report, Confidential [M18].

D2.4a Implemented SHIELD Open Data Repository, including initial data sources (NLR) Database, Confidential, [M18].

D2.4b Updated SHIELD Open Data Repository, including advanced data analytics and text mining tools and results, Database and Open-Source Software (UVA) Confidential [M30]

D2.4c Updated SHIELD Open Data Repository, including results from the active learning process with experts (NLR) Database, Confidential [M36]

D2.5 Advanced data analytics and text mining for SHIELD Open Data Repository (UVA) Report, Public [M30]

D2.6 Validation and active learning processes of SHIELD Open Data Repository (NLR) Report, Public [M36]

D2.1 : SHIELD human factors taxonomy for risk analysis [6]

This report will detail the SHIELD human factors taxonomy, which presents the logical framework to describe human performance in safety-relevant tasks and the influence of contextual conditions. It will also include: (i) the gap analysis of existing taxonomies and data sources with respect to the needs for effective HF feedback to design for the various layers in the Human Factors Iceberg; (ii) Description of the use of the taxonomy for aviation and maritime operations.

D2.2 : Design of the SHIELD Open Data Repository [12]

Analysis of the needs of the end-users of the SHIELD Open Data Repository for risk analysis and design. Design of the database, describing the database objectives, the types of data to be stored, the relationships between the data elements, and the logical structure of the database.

D2.3 : Data sources and implementation of the SHIELD Open Data Repository [18]

This deliverable includes the identification, screening, collection, and harmonisation of raw performance data for inclusion in SHIELD. Pre-processed available data features (e.g. incident classes, human events) are included in SHIELD and statistics are calculated based on these data features.

D2.4 : Implemented SHIELD Open Data Repository, including initial data sources [18]

First implementation of the SHIELD repository, including initial data sources

D2.5 : Updated SHIELD Open Data Repository, including advanced data analytics and text mining tools and results, Database and Open-Source Software [30]

SHIELD repository, integrated with advanced data analytics and text mining tools and results

D2.6 : Updated SHIELD Open Data Repository, including results from the active learning process with experts [36]

SHIELD repository with results from the active Learning process

D2.7 : Advanced data analytics and text mining for SHIELD Open Data Repository [30]

Data and text mining methods and SHIELD tools to support effective analysis and categorization of safety occurrence reports, and safety-relevant human performance and contextual data.

D2.8 : Validation and active learning processes of SHIELD Open Data Repository [36]

Validation of the SHIELD repository: extracted data feature, feedback from other WPs on the effectiveness of the use of the SHIELD Open Data Repository for the development of risk models (WP4) and in the case studies (WP6, WP7), explainability and transparency of the extracted data features produced by automatic mining techniques and the derived data statistics will be assessed in user experiments

Schedule of relevant Milestones

Milestone number ¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	HURD Use Case / Design of SHIELD	2 - USTRAT	12	Delivery of HURID use cases and design of SHIELD repository
MS4	Final SAFEMODE Closure Event	8 - CERTH	36	Final HURID framework and Final event

Work package number ⁹	WP3	Lead beneficiary ¹⁰	1 - DEEP BLUE
Work package title	Development of methodologies for assuring human performance		
Start month	1	End month	36

Objectives

The high-level objective for this WP is to design and deliver risk-based tools that can be used by designers, safety assessors or operational developers to make risk-informed decisions on new designs or procedures. The WP will firstly address the present scenario, then reconsider all the outcomes in the light of future technological developments and trends.

Detailed objectives are:

- Design and develop guidance and checklists of HF aspects to consider – the Human Performance Assurance Toolkit, e.g. what are the important, critical factors when designing a new ship bridge or alarm system, or automation to support the airport ground handler, which technique to use to “predict” workload and attention drops, and so on.
- Develop predictive models of human performance, based on WP2 data and extensive Human Factors knowledge on human capabilities and limitations.
- Develop a structured framework of human assurance levels (HALs) and a Standard of Excellence for Human Factors, to ensure a proportional HF application to the criticality of human performance being considered.
- Ensure that the above tools can be easily used by target users, by putting them into a user-friendly format.
- Review and shortlist HF methods and tools to collect and analyse data in the WP6&7 case studies.

Description of work and role of partners

WP3 - Development of methodologies for assuring human performance [Months: 1-36]

DEEP BLUE, USTRAT, EUROCONTROL, NLR, HUNGAROCNTRONL, ENAC, UniSap, CERTH, CETENA, ITU, CalMac, CHALMERS, EMBPT, TsAGI, MAI, Innotech, MIPT, DMU, NTUA, AIRBUS, APA, RSSB, Wartsila NL, APFC, ROLLS-ROYCE MAR, WUT, BeeBI

Task 3.1. Design and development of the human assurance toolkit - Lead: DBL, Participants: UoS, ECTL, HC, ENAC, CERTH, CET, CAL, ITU, CHAL, EMBRAER, AIRBUS, RRM, APFC, BEEBI [M1-M18]

This task will design and develop guidance of HF aspects to consider when making design or operational decisions. The toolkit will provide guidance on the generation, assessment, and selection of alternative options, with the requirement of minimal additional effort from target users to integrate them in current processes.

The toolkit will include different “tools”. At the current stage, the expected outcomes are: (i) checklists of aspects to consider when designing/assessing a new procedure or system, (ii) fact sheets of “Facts about humans that every designer should know”, (iii) Best practice examples, (iv) Guidance on HF tools and techniques to use, considering what the user has to do (safety analysis, procedure design, tool design, etc...) and in which phase of the lifecycle (development, implementation, operations). The lessons learnt from SHIELD data collection and analysis will be used to develop (v) guidance materials and tools for safety investigators and managers for effective monitoring of everyday operations and feedback, going beyond incident analysis to monitor aspects like “work as done”.

This task will address the development of HF methods and tools requiring minimal work to be adopted by SAFEMODE (see step 3 and 4a of the Approach Section 1.3.5).

Task 3.2. Develop evidence-based models of human performance – Lead: ECTL, Participants: DBL, NLR, RSSB, MAI, TsAGI, MIPT, UoS, ITU, CHAL, NTUA, WTU, APFC [M13-M24]

This task will develop predictive models of human performance, in support of risk modelling and safety assessment. Such models are used to analyse the human role in a sociotechnical system (e.g. a new design, technical system, procedure). The models will include Human Reliability Assessment (HRA) techniques as used in barrier-based risk models, predicting what can go wrong and how likely it will be to go wrong, depending on human performance influencing factors. In addition, human performance models will be developed, which give a broader account of human performance variability in safety-relevant conditions, such as timing characteristics for recognition and acting in critical situations, information transfer in sociotechnical systems, and human workload. The models will be developed by reviewing the state of the art in other domains (i.e. nuclear, Oil&Gas, railways) and what is already available in aviation (Kirwan, et al., 2007) and maritime. After defining the expected outcome for aviation and for maritime (which may be different), this task will collect and analyse data (from WP2, interviews, observations) and produce customised versions of the evidence-based models, including at least a description of reference tasks, failure modes for HRA, likelihood and

frequency indications, and influencing factors. This task will address HF methods and tools requiring dedicated efforts for their integration into HURID (see step 3 and 4b of the Approach Section).

Task 3.3. Design and development of HALs and HF Standard of Excellence - Lead: UoS, Participants: DBL, CHAL, ITU, RRM, CAL, APA, WRT [M13-M24]

This task will design and develop a framework of human assurance levels (HALs) and a Human Factors Standard of Excellence. The aim of this task is to encourage industry to adopt HF practice in a way that is scalable to their business interests and operations HALs are equivalent to software assurance levels. The idea is simply that designers consider the criticality of human performance, and apply more stringent Human Factors standards of design to those situations more susceptible to human-related risk. The framework will be developed by referring to existing HALs (Mana, et al., 2007), customizing them by involving aviation and maritime experts, and final validation with the SAFEMODE end-users. The Human Factors Standard of Excellence will have five levels. Companies can evaluate their operations and determine which level of HF adherence they would need, according to the human risk levels in their operations. Such a standard is near completion in air traffic management (EUROCONTROL, 2015), which will be further researched and adapted for wider implementation in aviation and maritime. The standard of excellence will be co-developed with end users, by reviewing the existing one and adapting its elements to the different aviation/maritime segments.

Task 3.4. Review and selection of HF methods and techniques for case studies – Lead: CHAL, Participants: NLR, UniSap, RSSB, HC, TsAGI, MAI, MIPT, JSCITC, DMU, UoS, CAL, ITU, NTUA, APFC [M7-M18]

This task will carry out preparatory work to select HF method and techniques for data gathering in the SAFEMODE case studies (WP6 and WP7). Methods and techniques will include qualitative measures, subjective assessments, and neurophysiological indicators. The complementarity of these techniques with the ones defined in the previous tasks will be assessed, to ensure full integration of SAFEMODE HF tools across the whole project. The expected outcome of this task is a toolkit of HF data gathering and analysis techniques to be used in the case studies,

Task 3.5. Review and selection of HF methods and techniques for forward-looking scenarios – Lead: UniSap, Participants: DBL, NLR, RSSB, HC, TsAGI, MAI, MIPT, JSCITC, DMU, UoS, ITU, CHAL, NTUA, APFC, WTU, APA [M25-M36]

This task will re-consider all the outcomes of WP3 in the light of future technological developments and trends. The task will start by defining future reference scenarios, detailing technologies in use (e.g. miniaturized sensors, distributed data capture and processing, non-intrusive personal monitoring tools, etc...) and potential impact on operations and business models. A multi-criteria assessment – including cost, benefits, intrusiveness, acceptability, trustworthiness, security, and so on - will be carried out on future WP3 HF methods and tools, to derive recommendations on the ones to be adopted and integrated into HURID now and for future operations. For instance, the deployment of real-time monitoring tools into operations will be assessed, to detect emerging risks.

The expected outcome is a shortlist of methods and techniques to be integrated into the HURID framework to address future operations and emerging risks, ensuring applicability of SAFEMODE results to future scenarios. Tools and techniques will mostly focus on collecting data from operations, to monitor and provide feedback to system/operations designers, safety managers, and regulators.

Participation per Partner

Partner number and short name	WP3 effort
1 - DEEP BLUE	18.00
2 - USTRAT	23.00
3 - EUROCONTROL	6.00
4 - NLR	6.00
5 - HUNGAROCNTR	2.50
6 - ENAC	2.00
7 - UniSap	15.00
8 - CERTH	2.00
9 - CETENA	1.00
10 - ITU	5.00

Partner number and short name	WP3 effort
11 - CalMac	3.00
12 - CHALMERS	8.00
13 - EMBPT	1.00
14 - TsAGI	5.00
16 - MAI	10.00
17 - Innotek	1.00
18 - MIPT	1.00
19 - DMU	0.50
20 - NTUA	5.00
22 - AIRBUS	0.50
23 - APA	2.50
26 - RSSB	2.00
28 - Wartsila NL	0.50
29 - APFC	5.00
31 - ROLLS-ROYCE MAR	1.00
32 - WUT	12.00
34 - BeeBI	3.00
Total	141.50

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D3.1	Human Assurance toolkit and guidance on Human Assurance Levels	1 - DEEP BLUE	Report	Public	18
D3.2	Predictive models of human performance and Human Assurance Levels	3 - EUROCONTROL	Report	Public	24
D3.3	HF methods and techniques for case studies	7 - UniSap	Report	Public	18
D3.4	HF methods and techniques for forward-looking scenarios	7 - UniSap	Report	Public	36

Description of deliverables

D3.1: Human Assurance toolkit and guidance on Human Assurance Levels (DBL), Report, Public [M18]
D3.2: Predictive models of human performance and Human Assurance Levels (ECTL), Report, Public [M24]
D3.3: HF methods and techniques for case studies (UniSap), Report, Public [M18]
D3.4: HF methods and techniques for forward-looking scenarios (UniSap), Report, Public [M36]

D3.1 : Human Assurance toolkit and guidance on Human Assurance Levels [18]

This task will design and develop guidance of HF aspects to consider when making design or operational decisions. The toolkit will provide guidance on the generation, assessment, and selection of alternative options, with the requirement of minimal additional effort from target users to integrate them in current processes.

D3.2 : Predictive models of human performance and Human Assurance Levels [24]

This task will develop predictive models of human performance, in support of risk modelling and safety assessment. The models will include Human Reliability Assessment (HRA) techniques as used in barrier-based risk models, predicting what can go wrong and how likely it will be to go wrong, depending on human performance influencing factors. In addition, human performance models will be developed, which give a broader account of human performance variability in safety-relevant conditions, such as timing characteristics for recognition and acting in critical situations, information transfer in sociotechnical systems, and human workload.

D3.3 : HF methods and techniques for case studies [18]

This task will carry out preparatory work to select HF method and techniques for data gathering in the SAFEMODE case studies (WP6 and WP7). Methods and techniques will include qualitative measures, subjective assessments, and neurophysiological indicators.

D3.4 : HF methods and techniques for forward-looking scenarios [36]

This task will re-consider all the outcomes of WP3 in the light of future technological developments and trends. The task will start by defining future reference scenarios, detailing technologies in use (e.g. miniaturized sensors, distributed data capture and processing, non-intrusive personal monitoring tools, etc...) and potential impact on operations and business models.

Schedule of relevant Milestones

Milestone number¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	HURD Use Case / Design of SHIELD	2 - USTRAT	12	Delivery of HURID use cases and design of SHIELD repository
MS4	Final SAFEMODE Closure Event	8 - CERTH	36	Final HURID framework and Final event

Work package number ⁹	WP4	Lead beneficiary ¹⁰	3 - EUROCONTROL
Work package title	Development of Human Factors Based Risk Models		
Start month	1	End month	34

Objectives

Objectives The overall objective of this WP is to develop a set of quantified risk models for aviation and maritime representing the major accident categories in each sector, including human actions and influences.

WP4 will take industry standard approaches to model risk and augment them with specific human actor contributions to failures, incidents and occurrences. The models will be based on incidents and occurrences identified in the maritime and aviation industries (identified by WP2) and will provide a quantified approach that allows the contribution of human failure events to the overall system failure to be derived. For each failure, the factors that characterise and influence the likelihood of the failure will be captured. The resulting models will satisfy the following requirements:

- Allow designers to understand the potential impact of their design on human performance,
- Allow designs to be targeted at minimising current human factors problems, and significantly boosting the chances of recovery from system failures and adverse events,
- Provide a repository for quantified (as much as feasible) human contributions to pivotal risk events.

The detailed objectives are:

- Develop a cross-industry approach for the capture and analysis of operational incidents,
- Develop a number of alternative risk models for key safety (e.g. mid-air collisions and runway excursions, ship collisions and groundings, etc.) events that allow human actions to be understood in relation to an incident – for both positive and negative contribution - and the key factors that influence human performance to be described,
- Validate the models using WP2 data and WP6-7 Case Studies,
- Refine some of the models for use in WP6-7 Case Studies.

In summary, the risk models developed by WP4 will show what can go wrong and, as well as what currently creates safety, i.e. the sources of good safety performance. This latter aspect will be either modelled in the structure of the models, or as one additional element/barrier. The models will show how to improve design based on this information to make operations safer.

Description of work and role of partners

WP4 - Development of Human Factors Based Risk Models [Months: 1-34]

EUROCONTROL, DEEP BLUE, USTRAT, CERTH, ITU, CalMac, CHALMERS, EMBPT, TsAGI, GosNIIAS, MAI, Innotek, MIPT, DMU, NTUA, AIRBUS, APA, APFC, INSTITEKNO, ROLLS-ROYCE MAR, WUT

Task 4.1. Development of a barrier-based risk framework – Lead: ECTL, Participants: DBL, UoS, CERTH, EMBRAER, AIRBUS, TsAGI, GosNIIAS, MAI, JSCITC, MIPT, ITU, NTUA, WTU, RRM [M1-M9]

The framework will be barrier-based and allow the key defences to be described in each transport modality, allowing aviation and maritime incidents to be understood and modelled. A number of modelling techniques will be considered, assessing their strengths and weaknesses. It is expected that fault trees and event trees will be among these techniques, as their use is well understood in all transport sectors as a key engineering approach to safety.

Task 4.2. Selection of key categories of risk events – Lead: NTUA, Participants: DBL, ECTL, CERTH, EMBRAER, AIRBUS, TsAGI, GosNIIAS, MAI, JSCITC, MIPT, ITU, UoS, WTU, APFC, ITS [M10-M18]

For the major classifications of incidents identified in WP2, like Runway Excursion, Wake Encounter, Mid Air Collision, Controlled flight into terrain, Ship Collision, Grounding, Fire on Board Vessel, etc., and for which data exist, models will be deployed that describe the major incidents in each transport domain. Where necessary the models will be revised to allow them to account fully for the incidents observed.

Task 4.3. The human components of failure and success – Lead: ECTL, Participants: DBL, UoS, CERTH, EMBRAER, AIRBUS, TsAGI, GosNIIAS, MAI, JSCITC, MIPT, CHAL, ITU, WTU, RRM [M10-M18]

Within the context of the models, this task will review the structure and content of each building block, and identify the typical human contribution to safety (positive or negative). The model logic will be reviewed to show discrete human activities that contributed to the overall failure, or guaranteed a high safety level. This approach will also ensure that the human activities that contributed to preventing the incident from escalating further (so-called recovery factors) can also be captured. The set of human performance influencing factors will be identified (based on WP2 and WP3) and will be integrated as an additional layer within the risk models.

Task 4.4. Validation of the models – Lead: CHAL, Participants: DBL, UoS, ECTL, CERTH, EMBRAER, TsAGI, GosNIIAS, MAI, JSCITC, MIPT, CAL, ITU, APFC, RRM, ITS, APA [M10-M27]

A set of incidents from both maritime and aviation will be analysed using the risk models to ensure the framework is sufficiently flexible to account for typically observed incidents. The models will be tested with a set (e.g. 10) of typical incidents. A selection of incident analysis reports from WP2 will be taken from the maritime and aviation sectors and compared to the models. The point at which the incident starts, the barriers that are defeated, the point the incident is stopped and the barrier that provided protection will be captured. The human factors influences will also be allocated to each event based on the information present in the incident report.

Task 4.5. Key human contributions to risk – Lead: UoS, Participants: DBL, ECTL, EMBRAER, AIRBUS, TsAGI, GosNIIAS, MAI, JSCITC, MIPT, CAL, ITU, CHAL, APFC, RRM [M24-M27] & [M32-M34]

For each incident category, the failures will be ‘pinned’ to components and events in the model structure, together with the influences that were considered to contribute to the failure. This provides a basis for the quantification of the number of events that can be attributed to human failure events and a quantification of the influences. This quantification provides direct evidence of the distribution of the Human Factors contribution to risk.

Task 4.6. Using the models to support risk mitigation and change assessment – Lead: ECTL, Participants: DBL, UoS, CERTH, EMBRAER, TsAGI, GosNIIAS, MAI, JSCITC, MIPT, DMU, CAL, APFC, RRM, WTU [M16-M18] & [M25-M27]

Considering some of the domain Case Studies developed in WP6 and WP7, a first conceptual validation of the models will be performed by assessing if the models can support their intended use and deliver the expected benefit. For instance, it is likely that the models may support system or procedure change in two ways: (i) the impact of the change will be assessed against the barriers and influences in the risk models, the impact on the human predicted, thus assessing the likely change in overall risk; (ii) the parts of the model that carry highest risk (from a quantitative perspective) become the focus of targeted mitigations of new designs. This helps answer the key question: what are the major human risks emerging from the model, and what design features of new tools can best ensure that those risks are better mitigated. Put simply, where can we best invest to make operations safer? The conceptual validation will be done by walk-through and contextual interview/workshops with target users.

Participation per Partner

Partner number and short name	WP4 effort
1 - DEEP BLUE	10.00
2 - USTRAT	19.00
3 - EUROCONTROL	5.00
8 - CERTH	2.00
10 - ITU	6.00
11 - CalMac	3.00
12 - CHALMERS	5.00
13 - EMBPT	1.50
14 - TsAGI	45.00
15 - GosNIIAS	17.00
16 - MAI	10.00
17 - Innoteh	10.00
18 - MIPT	10.00
19 - DMU	0.50
20 - NTUA	8.00
22 - AIRBUS	1.00
23 - APA	3.00

Partner number and short name	WP4 effort
29 - APFC	8.00
30 - INSTITEKNO	3.00
31 - ROLLS-ROYCE MAR	2.00
32 - WUT	16.00
Total	185.00

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D4.1	Risk framework (methodology) for the development of different safety models incorporating Human Factors in both transport modes	3 - EUROCONTROL	Report	Public	9
D4.2	Risk models of major accident types in both domains	2 - USTRAT	Report	Public	18
D4.3	Risk framework validation with incident cases and domain case studies	12 - CHALMERS	Report	Public	27
D4.4	Risk framework to assess the impact and guide design decisions	3 - EUROCONTROL	Report	Public	34

Description of deliverables

D4.1: Risk framework (methodology) for the development of different safety models incorporating Human Factors in both transport modes (ECTL), Report, Public [M9]

D4.2: Risk models of major accident types in both domains (UoS), Report, Public [M18]

D4.3: Risk framework validation with incident cases and domain case studies (CHAL), Report, Public [M27]

D4.4: Risk framework to assess the impact and guide design decisions (ECTL), Report, Public [M34]

D4.1 : Risk framework (methodology) for the development of different safety models incorporating Human Factors in both transport modes [9]

The framework will be barrier-based and allow the key defences to be described in each transport modality, allowing aviation and maritime incidents to be understood and modelled.

D4.2 : Risk models of major accident types in both domains [18]

For the major classifications of incidents identified in WP2, like Runway Excursion, Wake Encounter, Mid Air Collision, Controlled flight into terrain, Ship Collision, Grounding, Fire on Board Vessel, etc., and for which data exist, models will be deployed that describe the major incidents in each transport domain.

D4.3 : Risk framework validation with incident cases and domain case studies [27]

A set of incidents from both maritime and aviation will be analysed using the risk models to ensure the framework is sufficiently flexible to account for typically observed incidents. The models will be tested with a set (e.g. 10) of

typical incidents. A selection of incident analysis reports from WP2 will be taken from the maritime and aviation sectors and compared to the models.

D4.4 : Risk framework to assess the impact and guide design decisions [34]

First conceptual validation of the models will be performed by assessing if the models can support their intended use and deliver the expected benefit.

Schedule of relevant Milestones

Milestone number¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS4	Final SAFEMODE Closure Event	8 - CERTH	36	Final HURID framework and Final event

Work package number ⁹	WP5	Lead beneficiary ¹⁰	2 - USTRAT
Work package title	Definition and consolidation of the Human Risk Informed Design Framework – HURID		
Start month	7	End month	36

Objectives

The main objective of this WP is to develop a human risk-informed design and operation framework which will facilitate the integration of Human Factors into system and operations design, safety assessment, and regulation, in normal and emergency conditions. WP5 will consolidate the capabilities developed in previous work packages and integrate them into the novel Human Risk Informed Design Framework (HURID).

Specific objectives are to:

- Identify the current design challenges and approaches to address human factors, and Use Cases to be used HURID development
- Harmonise and integrate WP2-3-4 outcomes (i.e. SHIELD, HP Assurance Toolkit, Risk Models) into customised versions of HURID, each one of them specifically targeted to a specific end-user,
- Deliver the final version of HURID - including all the tools and guidelines addressing all the users
- Integrate HURID framework into existing regulatory and risk-based design frameworks,
- Build a mechanism for continuous monitoring and learning into HURID, to address future emerging risks.

Description of work and role of partners

WP5 - Definition and consolidation of the Human Risk Informed Design Framework – HURID [Months: 7-36]

USTRAT, DEEP BLUE, EUROCONTROL, NLR, HUNGAROCONTROL, ENAC, UniSap, CERTH, CETENA, ITU, CalMac, CHALMERS, EMBPT, TsAGI, MAI, Innotech, MIPT, NTUA, WMU, AIRBUS, RYANAIR, UPATRAS, RSSB, Wartsila NL, APFC, INSTITEKNO, ROLLS-ROYCE MAR, WUT, TUI Airways Ltd, BeeBI Task 5.1. Identification of current challenges and HURID Use Cases for system and operations design - Lead: DBL, Participants: UoS, HC, ENAC, EBRAER, AIRBUS, RYAN, CET, TUI, RRM, ECTL, CAL, NTUA, PATRON, RSSB, CHAL, APFC, WTU, ITS, WRT [M7-M12]

Existing design processes will be analysed, and existing approaches to include Human Factors in design will be assessed for both sectors, to define the current levels of human factors considerations in design. Design in this context also refers to design of operations besides design of systems. A comprehensive multi-levelled analysis will be carried out to understand specific and high-level design problems as well as operational decision-making. The regulatory landscape will also be analysed. Challenges preventing integration of Human Factors into design frameworks will be captured and documented, together with opportunities to better integrate HF knowledge into the current processes. A workshop with SAFEMODE end-users (partners and External Advisory group) will be organized to validate the findings. The same workshop will serve the definition of typical use cases, i.e. description of how HURID can be used by system/operations designers, safety assessors, or regulators to inform their decisions. The outcome of this task is a list of HURID Use Cases, addressing all the SAFEMODE target users, e.g. designers, safety assessors, operation managers, regulators.

Task 5.2 Integration and customisation of the “Human Risk Informed Design” Framework - Lead: UOS, Participants: DBL, ECTL, UniSap, CET, RRM, NTUA, CAL, ITU, APFC, WTU, WRT [M13-M18]

This task will map the outcomes of WP2-3-4 on the HURID Use Cases and against the gaps and challenges identified in T5.1. A first version of the Human Informed Risk Based Design Framework (HURID) will be delivered, integrating all the tools and models, and addressing normal and emergency situations. The first HURID release will be customized for application in each Domain Case Study, by taking into account its specific challenges, available data, case study objectives, and involved end users. As a result, this task will develop a number of customised versions of HURID, ensuring that all the HURID components are coherently integrated across all the different moments of use (e.g. for design, for assessing current operations, for monitoring, for adapting and learning). These HURID versions will be validated in the WP6&7 Case Studies.

Task 5.3. Integration with current regulatory and risk-based design frameworks - Lead: NTUA, Participants: UOS, RRM, RSSB, TsAGI, MAI, MIPT, JSCITC, WRT, CHAL, WMU, APFC, WTU, ITS [M15-M18] & [M24-27]

Task 5.3 will customise and integrate the HURID framework into the existing design practice(s), for both aviation and maritime domains, and into the maritime Risk-Based Design (RBD) framework. During this task, the existing RBD frameworks, and how they treat various human factor issues, in the maritime and aviation industries will be identified. For the maritime industry, this task will focus on the RBD concept, which was formulated during the EU SAFEDOR project, and IMO Goal Based Standards including Formal Safety Assessment (FSA). The HURID framework will be

adapted to complement these frameworks for HF aspects. After the validation in WP6&7, the integrated HURID for regulatory framework will be given as an input to WP9 to inform the development of the regulatory framework.

Task 5.4. Finalisation of the HURID Framework for System and Operations Design - Lead: ECTL, Participants: UoS, DBL, NLR, CERTH, RSSB, ITU, WMU, APFC, WTU [M25-M36]

This task will process the feedback received from Domain Case Studies, in order to finalise the Human Risk Informed Design Framework into a coherent framework. The framework will be accompanied by practical guidance for the end users, with examples derived from the Domain Case Studies. It will also include the related business cases, for demonstrating how to assess the (safety and Human Factors) benefits in different types of operation and design activities. The guidance material will facilitate and enhance industry uptake.

Task 5.5. Platform for continuous monitoring and learning - Lead: BEEBI, Participants: UOS, ECTL, DBL, WRT, RSSB, CAL, ITU, CHAL [M19-M36]

This task will develop the IT platform integrating HURID tools, to enable a continuous monitoring and learning cycle. The platform will offer the capabilities of capturing and analysing data, updating risk models, anticipating new risks, etc. A road map for future data generation will be prepared, considering the scenarios defined by T3.5.

Task 5.6. Living Lab for continuous monitoring and learning - Lead: UOS(4), Participants: BEEBI, ECTL, DBL, NLR, RSSB, NTUA, CET, WTU, WRT [M13-M36]

This task will establish a 'LIVING LAB' for European Human Factors, a virtual centre of excellence, easy to access by all the stakeholders from maritime and aviation. The Living Lab will make the SAFEMODE expertise, tools, and simulation capacity available to an extended network of the users, academic and industrial.

The Living Lab is currently designed around three pillars, with the possibility to add more if needed.

Pillar 1: Project web platform – to allow public interaction, with online forms to collect various inquiries and data. It will also host information about the project concept and partner information, and expected outcomes.

Pillar 2: SEABrary – the Maritime Library. SEABrary will contain an electronic repository of safety knowledge related to maritime operations, marine safety and Human Factors. It will become a common entry point, to access safety data and documents made available by various organisations - regulators, service providers, industry. SEABrary can be considered the Maritime version of SKYbrary (EUROCONTROL, 2008).

Pillar 3: e-HURID. The platform will eventually host all the HURID tools and other SAFEMODE outcomes, e.g. training modules, solutions developed in Case Studies.

Participation per Partner

Partner number and short name	WP5 effort
1 - DEEP BLUE	12.00
2 - USTRAT	33.00
3 - EUROCONTROL	6.00
4 - NLR	1.00
5 - HUNGAROCNTR	1.00
6 - ENAC	9.00
7 - UniSap	2.00
8 - CERTH	2.00
9 - CETENA	6.00
10 - ITU	6.00
11 - CalMac	2.00
12 - CHALMERS	6.00
13 - EMBPT	1.50
14 - TsAGI	10.00
16 - MAI	5.00
17 - Innotech	2.00

Partner number and short name	WP5 effort
18 - MIPT	2.00
20 - NTUA	9.00
21 - WMU	3.00
22 - AIRBUS	1.50
24 - RYANAIR	1.00
25 - UPATRAS	5.00
26 - RSSB	2.50
28 - Wartsila NL	6.00
29 - APFC	7.00
30 - INSTITEKNO	3.00
31 - ROLLS-ROYCE MAR	5.00
32 - WUT	10.00
33 - TUI Airways ltd	0.50
34 - BeeBI	14.00
Total	174.00

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D5.1	HURID Use Cases and HURID First Release	2 - USTRAT	Report	Public	18
D5.2	HURID and existing risk-based design frameworks	20 - NTUA	Report	Public	27
D5.3	HURID Final release and practical guidance	3 - EUROCONTROL	Report	Public	36
D5.4	Living Lab and online platform, first release	34 - BeeBI	Other	Public	27
D5.5	Living Lab and online platform, final release	34 - BeeBI	Other	Public	36

Description of deliverables

D5.1: HURID Use Cases and HURID First Release (UOS), Report, Public [M18]
D5.2: HURID and existing risk-based design frameworks (NTUA), Report, Public [M27]
D5.3: HURID Final release and practical guidance (ECTL), Report, Public [M36]
D5.4: Living Lab and online platform, first release (BEEBI), Other, Public [M27]
D5.5: Living Lab and online platform, final release (BEEBI), Other, Public [M36]

D5.1 : HURID Use Cases and HURID First Release [18]

Definition of typical use cases, i.e. description of how HURID can be used by system/operations designers, safety assessors, or regulators to inform their decisions. The HURID Use Cases address all the SAFEMODE target users, e.g. designers, safety assessors, operation managers, regulators.

D5.2 : HURID and existing risk-based design frameworks [27]

Customisation and integration of the HURID framework into the existing design practice(s), for both aviation and maritime domains, and into the maritime Risk-Based Design (RBD) framework.

D5.3 : HURID Final release and practical guidance [36]

Finalisation of the Human Risk Informed Design Framework into a coherent framework. The framework will be accompanied by practical guidance for the end users.

D5.4 : Living Lab and online platform, first release [27]

First release of the Living Lab, including: Pillar 1: Project web platform Pillar 2: SEAbrary – the Maritime Library Pillar 3: e-HURID. The platform will eventually host all the HURID tools and other SAFEMODE outcomes, e.g. training modules, solutions developed in Case Studies.

D5.5 : Living Lab and online platform, final release [36]

Final release of the Living Lab, including: Pillar 1: Project web platform Pillar 2: SEAbrary – the Maritime Library Pillar 3: e-HURID. The platform will eventually host all the HURID tools and other SAFEMODE outcomes, e.g. training modules, solutions developed in Case Studies.

Schedule of relevant Milestones

Milestone number ¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	HURID Use Case / Design of SHIELD	2 - USTRAT	12	Delivery of HURID use cases and design of SHIELD repository
MS2	HURID 1st release	2 - USTRAT	18	HURID elements, including toolkit
MS3	HURID 2nd release	2 - USTRAT	26	Refinement of HURID elements and toolkit
MS4	Final SAFEMODE Closure Event	8 - CERTH	36	Final HURID framework and Final event

Work package number ⁹	WP6	Lead beneficiary ¹⁰	5 - HUNGAROCNTR0L
Work package title	Forward looking Scenarios and Domain Case Studies – Aviation		
Start month	1	End month	34

Objectives

The overall objective of this WP is to demonstrate the HURID suitability to support risk-based system and operations design, by applying HURID to at least two Aviation Domain Case Studies or Forward looking Scenarios.

Domain case studies and forward-looking scenarios will provide a realistic context where HURID will be validated, by applying it for analysing HF issues, specifying design solutions, implementing and testing them. Two validation iterations will be performed, at increasing levels of fidelity and realism. This WP will make use of a variety of simulation facilities, made available by the partners.

More detailed objectives are to:

- Identify relevant domain case studies, considering the call objective and the expected HURID support,
- Organize and carry out a number of validation activities linked to the case studies, ranging from gaming exercises, to prototyping sessions, to Human-in-the-Loop simulations,
- Consolidate case studies results to refine HURID and the underlying risk models.

Description of work and role of partners

WP6 - Forward looking Scenarios and Domain Case Studies – Aviation [Months: 1-34]

HUNGAROCNTR0L, DEEP BLUE, EUROCONTROL, NLR, ENAC, UniSap, EMBPT, TsAGI, GosNIIAS, MAI, Innoteh, MIPT, DMU, AIRBUS, RYANAIR, UPATRAS, TUI Airways Ltd

Task 6.1. Selection and preparation of Domain case studies and Forward-looking scenarios – Lead: HC, Participants: ENAC, DBL, ECTL, NLR, TsAGI, MAI, MIPT, JSCITC, GosNIIAS [M1-M8]

This task will define the SAFEMODE the case studies, i.e. structured scenarios of operations, including critical and emergency situations, taking as input the preliminary results of WP2 and expert's input from the External Advisory group. Although designers and other experts will find SHIELD data certainly useful, it is unlikely that SHIELD will contain many events related to their specific concern, nor will it address future emerging risks. To tackle this issue, case studies will also be defined by analysing trends and developments of advanced automation and artificial intelligence in transport and their impact on human roles, to look forward and prepare for novel situations. A set of long-term, disruptive case studies (named “forward-looking scenarios”) will be included, to ensure that HURID is capable of addressing future emerging risks. Such disruptive case studies will be selected based on a thorough literature review and by gathering outcomes from projects with a special focus on innovation and future concepts (e.g. NINA, STRESS, MOTO, AUTOPACE).

At the present moment, the consortium has identified two main areas of work (more details in section 1.3.5):

- Human response in high workload and time pressure, in high automation cockpits or integrated controller working positions; or in the context of a highly automated vehicle (i.e. RPAS) with ground piloting capability;
- Human response in emergencies: upset recovery in severe weather; wake vortex detection and avoidance in en-route/cruise phase for business jets and general aviation by relaying the warning from ATC to Flight Crew.

During the project, new areas of interest can be identified, with corresponding new domain case studies. A set of criteria will be established to ensure a robust selection process of the final domain case studies.

Task 6.2. Definition of scenarios of operations, technologies, and emergency situations to be studied – Lead: ENAC, Participants: HC, DBL, ECTL, NLR, TsAGI, MAI, MIPT, JSCITC, GosNIIAS, DMU [M9-M15]

The aim of this task is to review incident reports in detail and interview end-users (e.g. pilots, air traffic controllers, drone users) to ensure the applicability and relevance of the tested case, including all the required elements at the adequate level of detail. The maritime environment will be also taken into account to ensure compatibility with WP7. Workshops will enable to develop the concept of operations, to be applied during the validation.

In addition, these workshops will also enable to present the rather disruptive forward-looking scenarios to operators (controllers, pilots, drone users), gather their feedback on the envisaged concepts, and on their potential impact on HF-related risks. Once the case studies and forward-scenarios have been selected, the list will feed back to WP3 and WP4, in order to:

- WP3: review and select the relevant HF methods and techniques for the assessment and categorization of human factors, including the deployment of real-time monitoring tools – Task 4 and 5.
- WP4: Refinement of the models in the context of Case Studies – Task 6

Task 6.3. Exploration and design with HURID – Lead: ENAC, Participants: HC, DBL, ECTL, NLR, EMBRAER, AIRBUS, TsAGI, MAI, MIPT, JSCITC, GosNIIAS [M16-M32]

For this step, HURID will be used by system and operation designers to: (1) Analyse the selected Domain Case Studies/ Forward-looking Scenarios on HF aspects of interest; (2) Specify design solutions, by generating design alternatives, assessing them, and shortlisting a number of options. The Domain Case Studies/Forward-Looking Scenarios cover both normal conditions, as well as emergencies and extreme situations, which the design solution should take into account. The outcome of this task is refined concepts of operations, with a full understanding of the HF-related risks and benefits to be assessed for each of the design options. The task will have two iterations, supporting the two validation sessions. For instance, for the proposed En-route wake turbulence case study, this will mean evaluating design alternative to add one more safety barrier against in-flight loss of control due to Wake Vortex. Various potential design solutions for alerting the Flight Crew will be evaluated, such as different look-ahead times of the wake-alert, data-driven definition of airspace hotspots, dedicated training, and so on.

Task 6.4. Specify the Validation Requirements – Lead: HC, Participants: ENAC, DBL, ECTL, NLR, UniSap, TsAGI, MAI, MIPT, JSCITC, GosNIIAS, DMU [M16-M18]

For each particular case study, it is necessary to define the validation objectives (why are we doing the case study? Which part of HURID are we testing?), to then detail the required validation activities. After these aspects have been clarified, the validation setting has to be prepared, e.g. specifying the technological requirements for the simulation platform. Furthermore, as psychophysiological metrics are expected to be part of the HF evaluation methodology in SAFEMODE, the integration of sensors into the platforms needs to be thoroughly addressed.

Variables and experimental scenarios to be tested with validation activities will be defined at this stage, together with the data collection plans (performance, neurophysiological, and subjective).

Task 6.5. Implement Design Solutions – Lead: HC, Participants: ENAC, DBL, ECTL, NLR, TsAGI, MAI, MIPT, JSCITC, GosNIIAS, PATRON, DMU [M16-M32]

The Design Solution, as specified in T6.3 will be implemented in sufficient detail and level of integration such that it can be properly tested in an experiment. This may be a paper procedure, a low tech mock-up implementation, an implementation in an artificial task environment, such as a serious game, or a high fidelity prototype integrated into an existing simulator. Two iterations are planned, with increasingly higher fidelity. It may include the integration of psycho-physiological measurements with sensors, wearables, etc. specified in T6.4.

Task 6.6. Perform the experiments, collect and analyse data in simulation facilities – Lead: HC, Participants: ENAC, DBL, ECTL, NLR, UniSap, TsAGI, MAI, MIPT, JSCITC, GosNIIAS, RYAN, TUI, DMU [M19-M24] & [M28-M32]

In this step, the input given by HURID elements (SHIELD, risk models, Human Assurance toolkit) to system and operations design will be validated by executing the required activities. At the present stage, it is expected to run the validation exercises in different settings, with different levels of fidelity, e.g. gaming sessions, prototyping exercises, Human-in-the-Loop simulations. Two main validation sessions are planned, one between M19-24, the second between M28-32.

At least 2 validation exercises will be carried out with the highest level of fidelity (Human-in-the-Loop). The human-in-the loop simulation will enable human operators to provide feedback on the tested concept and its technological realization. Post-simulation workshops may be organised to discuss the potential implication of the findings on future trends and design decisions.

Task 6.7. Inclusion of case study results in SAFEMODE tools and methodology – Lead: ENAC, Participants: ENAC, DBL, ECTL, NLR, TsAGI, MAI, MIPT, JSCITC, GosNIIAS, DMU [M25-M27] & [M33-M34]

The outcomes of the validation will enable to release a refined version of HURID, including a major focus on emerging risks and advanced automation scenarios. Relying on the lessons learnt from past projects (e.g. Man4Gen), the use of the repository to develop training requirements and formats for extreme situations will be assessed. This task will be reported in D6.4.

Participation per Partner

Partner number and short name	WP6 effort
1 - DEEP BLUE	8.00
3 - EUROCONTROL	16.00
4 - NLR	9.00
5 - HUNGAROCNTR	36.00
6 - ENAC	22.00

Partner number and short name	WP6 effort
7 - UniSap	10.00
13 - EMBPT	5.00
14 - TsAGI	83.00
15 - GosNIIAS	40.00
16 - MAI	25.00
17 - Innoteh	15.00
18 - MIPT	15.00
19 - DMU	13.50
22 - AIRBUS	2.50
24 - RYANAIR	2.50
25 - UPATRAS	5.50
33 - TUI Airways ltd	3.00
Total	311.00

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D6.1	List of domain case studies and defined scenario with HF analysis - air	6 - ENAC	Report	Public	15
D6.2	Validation Plan: CONOPS, scenarios, technical equipment, experimental design	5 - HUNGAROCNTR	Report	Public	18
D6.3	First Validation Report - air	6 - ENAC	Report	Public	27
D6.4	Second Validation Report - air	5 - HUNGAROCNTR	Report	Public	34

Description of deliverables

D6.1 List of domain case studies and defined scenario with HF analysis (ENAC), Report, Public [M15]
D6.2 Validation Plan: CONOPS, scenarios, technical equipment, experimental design (HC), Report, Public [M18]
D6.3 First Validation Report (ENAC), Report, Public [M27]
D6.4 Second Validation Report (HC), Report, Public [M34]

D6.1 : List of domain case studies and defined scenario with HF analysis - air [15]
Definition of the SAFEMODE the case studies.

D6.2 : Validation Plan: CONOPS, scenarios, technical equipment, experimental design [18]
Validation objectives and required validation activities. Details of the validation setting and integration of sensors into the platforms. Variables and experimental scenarios, with the data collection plans.

D6.3 : First Validation Report - air [27]

Report with the validation exercises results.

D6.4 : Second Validation Report - air [34]

Final Validation report, including HURID review after case studies.

Schedule of relevant Milestones

Milestone number¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS2	HURID 1st release	2 - USTRAT	18	HURID elements, including toolkit
MS3	HURID 2nd release	2 - USTRAT	26	Refinement of HURID elements and toolkit
MS4	Final SAFEMODE Closure Event	8 - CERTH	36	Final HURID framework and Final event

Work package number ⁹	WP7	Lead beneficiary ¹⁰	9 - CETENA
Work package title	Domain Case Studies and Forward-looking Scenarios – Maritime		
Start month	1	End month	36

Objectives

The overall objective of this WP is to demonstrate the HURID suitability to support risk-based system and operations design, by applying HURID to at least two maritime Domain Case Studies or Forward-looking Scenarios. Domain case studies and forward-looking scenarios will provide a realistic context where HURID will be validated, by applying it for analysing HF issues, specifying design solutions, implementing and testing them. Two validation iterations will be performed, at increasing levels of fidelity and realism. This WP will make use of a variety of simulation facilities, made available by the partners.

More detailed objectives are to:

- Identify relevant domain case studies, considering the call objective and the expected HURID support,
- Organize and carry out a number of validation activities linked to the case studies, ranging from gaming exercises, to prototyping sessions, to Human-in-the-Loop simulations,
- Consolidate case studies results to refine HURID and the underlying risk models.

Description of work and role of partners

WP7 - Domain Case Studies and Forward-looking Scenarios – Maritime [Months: 1-36]

CETENA, DEEP BLUE, USTRAT, EUROCONTROL, UniSap, CERTH, ITU, CalMac, CHALMERS, NTUA, WMU, APA, Wartsila NL, APFC, INSTITEKNO, ROLLS-ROYCE MAR, WUT

Task 7.1. Selection and Preparation of Domain case studies and Forward-looking scenarios - Lead: NTUA, Participants: DBL, UoS, WRT, APA, WMU, CET, RRM, CAL, ITU, CHAL, WMU, WTU [M1-M8]

This task will define the SAFEMODE the case studies, i.e. structured scenarios of operations, including critical and emergency situations, taking as input the preliminary results of WP2 and expert's input from the External Advisory group. Although designers and other experts will find SHIELD data certainly useful, it is unlikely that SHIELD will contain many events related to their specific concern, nor will it address future emerging risks. To tackle this issue, case studies will also be defined by analysing trends and developments of advanced automation and artificial intelligence in transport and their impact on human roles, to look forward and prepare for novel situations. A set of long-term, disruptive case studies (named "forward-looking scenarios") will be included, to ensure that HURID is capable of addressing future emerging risks. Such disruptive case studies will be selected based on a thorough literature review and by gathering outcomes from projects with a special focus on innovation and future concepts. At the present moment, the consortium has identified some scenarios (more details in Section 1.3.5). During the project, new areas of interest can be identified, with corresponding new domain case studies. A set of criteria will be established to ensure a robust selection process of the final domain case studies.

Task 7.2. Definition of scenarios of operations, technologies, and emergency situations to be studied - Lead: APA, Participants: DBL, ECTL, UoS, CET, RRM, CAL, NTUA, CAL, ITU, CHAL, WMU, CERTH, WTU, ITS [M9-M15]
The aim of this task is to review incident reports in detail and interview end-users (e.g. operational and technical seafarers from both passenger and cargo ships) to ensure the applicability and relevance of the tested case, including all the required elements at the adequate level of detail. The aviation environment will be also taken into account to ensure compatibility with WP6. Workshops will enable to develop the concept of operations, to be applied during the validation. In addition, these workshops will also enable to present the rather disruptive forward-looking scenarios to operators (seafarers, ship operators), gather their feedback on the envisaged concepts, and on their potential impact on HF-related risks. Once the domain case studies and forward-looking scenarios have been selected, the list will feed back to WP3 and WP4, in order to review and select the relevant HF methods and techniques for the assessment and categorization of human factors, including deployment of real-time monitoring tools in WP3 and refine the models in the context of Case Studies for WP4.

Task 7.3. Exploration and design with HURID - Lead: CET, Participants: DBL, UoS, RRM, CAL, NTUA, ITU, CHAL, WMU, WTU, ITS [M16-M32]

HURID will be used by system and operations designers to: (i) Analyse the selected Domain Case Studies/Forward-looking Scenarios on HF aspects of interest; (ii) Specify design solutions, by generating design alternatives, assessing them, and shortlisting a number of options. The Domain Case Studies/Forward-looking Scenarios cover both normal conditions, as well as emergencies and extreme situations, which the design solution should take into account. The

outcome of this task is refined concepts of operations, with a full understanding of the HF-related risks and benefits to be assessed for each of the design options. The task will have two iterations, supporting the two validation sessions. For instance, for the proposed Human Response in Maritime Emergency Situations case study, this may mean evaluating design alternatives for alarm handling, decision support, e.g., collision avoidance support, and (after an incident) damage control communication & coordination operating procedures

Task 7.4. Specify the Validation Requirements - Lead: CHAL, Participants: DBL, UoS, UniSap, CET, WRT, RRM, NTUA, CAL, ITU, APFC, WTU M16-M18]

For each particular case study it is necessary to define the validation objectives (why are we doing this particular case study? Which part of HURID are we testing?), to then detail the required validation activities. After these aspects have been clarified, the validation setting has to be prepared, e.g. specifying the technological requirements for the simulation platform. Furthermore, as psychophysiological metrics are expected to be part of the HF evaluation methodology in SAFEMODE, the integration of sensors into the platforms needs to be thoroughly addressed. Variables and experimental scenarios to be tested with validation activities will be defined at this stage, together with the data collection plans (performance, neurophysiological, and subjective).

Task 7.5. Implement Design Solutions - Lead: CET, Participants: DBL, UoS, RRM, CAL, NTUA, CHAL, APFC, WTU [M16-M32]

The Design Solution, as specified in T7.3 will be implemented in sufficient detail and level of integration such that it can be properly tested in an experiment. This may be a paper procedure, a low tech mock-up implementation, an implementation in an artificial task environment, such as a serious game, or a high fidelity prototype integrated into an existing simulator. Two iterations are planned, with increasingly higher fidelity. It may include the integration of psycho-physiological measurements with sensors, wearables, etc.

Task 7.6 Perform the experiments and analyse the data - Lead: ITU, Participants: UoS, UniSap, WRT, APA, CET, RRM, CAL, WTU [M19-M24] & [M28-M32]

In this step, the input given by HURID elements (SHIELD, risk models, Human Assurance toolkit) to system and operations design will be validated by executing the required activities. At the present stage, it is expected to run the validation exercises in different settings, with different levels of fidelity, e.g. gaming sessions, prototyping exercises, Human-in-the-Loop simulations. Two main validation sessions are planned, one between M19-24, the second between M28-32. At least 2 validation exercises will be carried out with the highest level of fidelity (Human-in-the-Loop). The human-in-the loop simulation will enable for human operators to provide feedback on the tested concept and its technological realization. Post-simulation workshops may be organised to discuss the potential implication of the findings on future trends and design decisions.

Task 7.7. Inclusion of case study results in SAFEMODE tools and methodology - Lead: RRM, Participants: DBL, UoS, ECTL, NTUA, CHAL, CET, CAL, APFC, WTU, WRT [M25-M27] & [M33-M34]

The outcomes of the validation will enable to release a refined version of HURID, including a major focus on emerging risks and advanced automation scenarios. Relying on the lessons learnt of past projects (e.g. Man4Gen), the use of the repository to develop training requirements and formats for extreme situations will be assessed. This task will be reported in D7.4.

Participation per Partner

Partner number and short name	WP7 effort
1 - DEEP BLUE	11.00
2 - USTRAT	17.00
3 - EUROCONTROL	1.00
7 - UniSap	10.00
8 - CERTH	3.00
9 - CETENA	13.00
10 - ITU	9.00
11 - CalMac	6.00
12 - CHALMERS	10.00
20 - NTUA	8.00

Partner number and short name	WP7 effort
21 - WMU	6.00
23 - APA	10.00
28 - Wartsila NL	7.00
29 - APFC	10.00
30 - INSTITEKNO	6.00
31 - ROLLS-ROYCE MAR	7.00
32 - WUT	20.00
Total	154.00

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D7.1	List of domain case studies and defined scenario with HF analysis - sea	20 - NTUA	Report	Public	15
D7.2	Validation Plan: CONOPS, scenarios, technical equipment, exp. design	9 - CETENA	Report	Public	18
D7.3	First Validation Report - sea	9 - CETENA	Report	Public	27
D7.4	Second Validation Report - sea	10 - ITU	Report	Public	34

Description of deliverables

D7.1 List of domain case studies and defined scenario with HF analysis (NTUA), Report, Public [M15]
D7.2 Validation Plan: CONOPS, scenarios, technical equipment, exp. design (CET), Report, Public [M18]
D7.3 First Validation Report (CET), Report, Public [M27]
D7.4 Second Validation Report (ITU), Report, Public [M34]

D7.1 : List of domain case studies and defined scenario with HF analysis - sea [15]
Definition of the SAFEMODE the case studies.

D7.2 : Validation Plan: CONOPS, scenarios, technical equipment, exp. design [18]
Validation objectives and required validation activities. Details of the validation setting and integration of sensors into the platforms. Variables and experimental scenarios, with the data collection plans.

D7.3 : First Validation Report - sea [27]
Report with the validation exercises results.

D7.4 : Second Validation Report - sea [34]
Final Validation report, including HURID review after case studies.

Schedule of relevant Milestones

Milestone number¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS2	HURID 1st release	2 - USTRAT	18	HURID elements, including toolkit
MS3	HURID 2nd release	2 - USTRAT	26	Refinement of HURID elements and toolkit
MS4	Final SAFEMODE Closure Event	8 - CERTH	36	Final HURID framework and Final event

Work package number ⁹	WP8	Lead beneficiary ¹⁰	8 - CERTH
Work package title	Dissemination and Communication Activities		
Start month	1	End month	36

Objectives

- To widely disseminate the project's activities and outcomes to a wide range of stakeholders in Europe and beyond.
- To engage a broad range of stakeholders (from maritime and aviation sectors) in project activities.
- To implement and update an appropriate online presence (web-site, social media) and other relevant dissemination material to ensure continuous outreach of the project outcomes
- To reach target groups (scientific community, industry end users, operational representatives, policy makers and general public) at regional, national, European and Global level.
- To organise project key events and demonstrations and ensure cooperation with the most important international forums, as well as liaise with related projects and initiatives

Description of work and role of partners

WP8 - Dissemination and Communication Activities [Months: 1-36]

CERTH, DEEP BLUE, USTRAT, EUROCONTROL, NLR, HUNGAROCNTRONL , UniSap, CETENA, ITU, CalMac , CHALMERS, EMBPT, TsAGI, MAI , NTUA, WMU, APA, UPATRAS, RSSB, Wartsila NL, APFC, INSTITEKNO, ROLLS-ROYCE MAR, WUT, BeeBI

Task 8.1 Dissemination strategy - Lead: CERTH, Participants: All WP8 Partners [M1-M6]

An effective and efficient dissemination strategy plan for SAFEMODE will be defined at the beginning of the project's implementation phase. Key elements include: identification of target audiences; specification of channels for connecting with audiences (events and media platforms); cross-integration of dissemination output (print, electronic and face-to-face). All dissemination activities will follow the dissemination strategy plan developed in the early stage of the project. In addition, the dissemination will also cover publication of project results in conference proceedings and peer-reviewed scientific journals throughout various phases of the project. The goal of dissemination is to comprehensively disseminate the technical and scientific advancements developed in SAFEMODE. This strategy will include a clear commitment to be undertaken by all partners towards contributing to its dissemination actions. It will describe in detail which stakeholders will be addressed by means of which tailored messages, which adapted communication tools and through which communication channels. The strategy will be built around key Milestones and Deliverables which are particularly suitable for outreach and promotion towards the outside world as well as list relevant external events and media which could be used to further enhance the project's dissemination and take-up activities. The dissemination strategy will be the project's guidance document for all dissemination and communication activities. The project will be able to capitalize on the networking potential of each partner involved and multiply the outreach of the project's dissemination and awareness-raising activities. Thus, the project will establish at an early stage a pool of user representatives, developers and other relevant stakeholders at the national, regional and European level, who are interested or have an expertise in this field. The targeted participants will be regularly informed on the project and will be asked to take part in the relevant events. A high effort will be put to build a strong project profile to the industry, policy-makers, the scientific community and users.

Task 8.2 Dissemination activities and tools - Lead: CERTH, Participants: All WP8 Partners [M1-M36]

The following dissemination activities are planned to be implemented during the project lifetime:

Project website. A user-friendly website will be developed presenting initially the project concept and plans. It will follow the W3C accessibility guidelines. It will be continuously updated, to incorporate the step-by-step outcomes of the project. Special care will be given to have an easy-to-follow menu. Emphasis will be also given to include explanatory diagrams and images, in addition to text, for better understanding. A part of the website will be devoted to include key results of the developed domain case studies. Finally, an internal repository area will be linked to the website, for internal use by the Consortium.

Social media interfaces. The Consortium aims to set the channels of communication using the social media, with a wider audience of transport safety which is divided into (i) end users and researchers, and (ii) industry and policy-makers. Official SAFEMODE profiles on Twitter, LinkedIn and on Facebook will be created. Target groups will be sought and linked/liked, regular posts will be scheduled in order to create a community and gain relevance.

Dissemination material. The project will produce leaflets and posters that will outline the main achievements and the rules/regulations proposed by the project.

Task 8.3 Communication activities and events - Lead: CERTH, Participants: All WP8 Partners [M1-M36]

The following communication activities are planned to be implemented during the project lifetime:

Short Project presentation. A 2-pages summary of the project aim and objective will be prepared, to be used as a concise tool that depicts what are the key issues of SAFEMODE. Also, a PowerPoint presentation will be prepared, that will be available to all partners, and be used in order to present the project in various workshops, meetings, events, and general opportunities to promote SAFEMODE. This presentation will be updated on a yearly basis.

Scientific and industry outreach. The Consortium aims to realize a series of publications in conferences and/or scientific journals, during the project life. All the key partners of the project are expected to take part in scientific conferences and also submit articles to research journals. Furthermore, the participation of consortium members in exhibitions and technical workshops is expected, in order to reach key stakeholders.

Project events. Two events will be organized during the project life (the first one at M18, the second at M34), targeting developers and policymakers, aiming at providing input for the project's view and activities. These events which will serve as a concrete platform to test ideas, technologies and services and discuss future steps, will be an integral part of the project. These events may coincide with other project activities or relevant events (i.e. key conferences such as IMAM, POSIDONIA, World ATM Congress, ETSC, TRA; and organized meetings such as EMSA, IMO, EASA, EUROCAE, etc.). The objective of these events will be to gather the views of stakeholders, so that they are able to influence the project outcomes. Among others, they will discuss technical aspects, usability of the SAFEMODE outcomes (e.g. SHIELD, toolkit, risk models), barriers and drivers to acceptance, scenarios of use, ethics, exploitation opportunities, links with policies, etc., focusing on the issue of critical importance for the project at the period of each event. Feedback will be provided to the various workings teams of the project. The final event that will be held in the last year of the project, will aim to spread the achievements of SAFEMODE to all potentially interested parties. In the first event of the project, at least 30 (external to the project) participants are targeted, with the final event being attended by at least 50 external participants. Feedback gathered during these events will be included in a dedicated Internal Deliverable, capturing the main issues raised and will serve as a basis for action to be taken by the project partners.

Task 8.4 Actions for regional, national, European and International (extra-EU) uptake - Lead: CERTH, Participants: All WP8 Partners [M19-M36]

In order to maximize the impact of the current project and an efficient consideration of its results and conclusions, several efforts will be undertaken to convene meetings with maritime and aviation industry, other EC funded projects on similar topics as well as with regulation authorities, both at national level – in the countries in which SAFEMODE has partners – as well as at European and International (extra-EU) level. This task will cluster and liaise with other relevant RDI projects and also other initiatives at European context.

Presentations will be made at national and international Transport related conferences (i.e. Transport Research Arena, Air Transport Research Society Conference, Air Traffic Management Seminar, European Aviation Conference, International Congress of International Maritime Association of the Mediterranean, POSIDONIA “The International Shipping Exhibition”, Transportation Research Board, World Conference on Transport Research etc.). Contacts will be also sought with national and international sectoral federations. These interventions will aim at: presenting SAFEMODE results, conclusions and recommendations; fostering implementation and exploitation of SAFEMODE results; discussing context-specific issues in the considered regions/countries and ways to address them and overcome potential obstacles; ensuring coherence and achieve harmonization of measures uptake between EU countries, transport sectors, and through each considered level (EU, National/regional, sectorial); providing input to WP9 for evaluating the transferability potential in other regions to ensure their successful broad implementation. The purpose here is to facilitate the adoption of SAFEMODE guidance and recommendations by the (national/regional) transport safety world. Dedicated efforts will be made to augment communication channels between industry, research world, policy-makers and authorities.

SAFEMODE will organise an international conference towards the end of project to increase the dissemination and take up globally.

Participation per Partner

Partner number and short name	WP8 effort
1 - DEEP BLUE	6.00
2 - USTRAT	8.50
3 - EUROCONTROL	2.00
4 - NLR	2.00

Partner number and short name	WP8 effort
5 - HUNGAROCNTROL	2.00
7 - UniSap	5.00
8 - CERTH	18.00
9 - CETENA	1.00
10 - ITU	4.00
11 - CalMac	1.50
12 - CHALMERS	2.50
13 - EMBPT	1.00
14 - TsAGI	1.00
16 - MAI	1.00
20 - NTUA	4.00
21 - WMU	1.50
23 - APA	1.50
25 - UPATRAS	1.00
26 - RSSB	0.50
28 - Wartsila NL	1.50
29 - APFC	7.00
30 - INSTITEKNO	4.00
31 - ROLLS-ROYCE MAR	0.50
32 - WUT	4.00
34 - BeeBI	2.00
Total	83.00

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D8.1	Project social media interfaces	8 - CERTH	Other	Public	1
D8.2	Project logo, leaflets and posters	8 - CERTH	Report	Public	3
D8.3	Project website	8 - CERTH	Websites, patents filling, etc.	Public	4
D8.4	Dissemination strategy	8 - CERTH	Report	Public	6
D8.5	Report on communication activities	8 - CERTH	Report	Public	36

List of deliverables

Deliverable Number¹⁴	Deliverable Title	Lead beneficiary	Type¹⁵	Dissemination level¹⁶	Due Date (in months)¹⁷
D8.6	Report on actions for regional, national and European uptake	8 - CERTH	Report	Public	34

Description of deliverables

D8.1: Project social media interfaces (CERTH), Other, Public [M1]
D8.2: Project logo, leaflets and posters (CERTH), Report, Public [M3]
D8.3: Project website (CERTH), Other, Public [M4]
D8.4: Dissemination strategy (CERTH), Report, Public [M6, updated on M14 and M20]
D8.5: Report on communication activities (CERTH), Report, Public [M36]
D8.6: Report on actions for regional, national and European uptake (CERTH), Report, Public [M34]

D8.1 : Project social media interfaces [1]
Set up of the social media for SAFEMODE.

D8.2 : Project logo, leaflets and posters [3]
Design of the project visual identify.

D8.3 : Project website [4]
Design and development of the project website.

D8.4 : Dissemination strategy [6]
Key elements include: identification of target audiences; specification of channels for connecting with audiences (events and media platforms); cross-integration of dissemination output (print, electronic and face-to-face).

D8.5 : Report on communication activities [36]
Report and impact monitoring of the dissemination activities.

D8.6 : Report on actions for regional, national and European uptake [34]
Report and impact tracking of actions for regional, national and European uptake.

Schedule of relevant Milestones

Milestone number¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS4	Final SAFEMODE Closure Event	8 - CERTH	36	Final HURID framework and Final event

Work package number ⁹	WP9	Lead beneficiary ¹⁰	21 - WMU
Work package title	Policy recommendations, Institutionalization and Exploitation Activities		
Start month	1	End month	36

Objectives

- To support exploitation of the project results and thus contribute to the increase of EU leadership and excellence in the area of Safety in transport
- To investigate pertinent existing rules and regulations in order to identify gaps and propose evolutions
- To prepare a stakeholder analysis and determine involvement strategy
- To identify barriers and risks related to policy alteration and industry uptake
- To submit notes, information papers and proposals to international arenas such as EMSA, IMO, EASA, ICAO, ITU, etc., for regional, national and European uptake
- To develop educational, training and promotional material for policy-makers and training institutions

Description of work and role of partners

WP9 - Policy recommendations, Institutionalization and Exploitation Activities [Months: 1-36]

WMU, DEEP BLUE, USTRAT, EUROCONTROL, NLR, HUNGAROCNTRAL , ENAC, UniSap, CERTH, CETENA, ITU, CalMac , CHALMERS, EMBPT, NTUA, AIRBUS, APA, RYANAIR , UPATRAS, RSSB, Wartsila NL, APFC, INSTITEKNO, ROLLS-ROYCE MAR, WUT, TUI Airways ltd, BeeBI

Task 9.1 – Exploitation Plan - Lead: DBL, Participants: ALL WP9 partners, [M1-M36]

SAFEMODE will put in place several actions aimed at making the project sustainable and durable. The main exploitation targets are policy-makers and industry. In the first year, an Exploitation Plan will be developed setting the guidelines for exploitation of the SAFEMODE outcomes and its exploitation path, including institutionalisation activities. At M18 an exploitation workshop will be organized to enable partners to share the exploitation strategy and revise it, if needed. For the industrial target users, the Plan will also include business cases supporting the adoption of SAFEMODE results (cost/benefit analysis and return on investment study), and a plan to involve additional external stakeholders through tailored activities. The Exploitation agreement will be part of the Consortium Agreement signed between the project partners at the beginning of the project. Exploitation activities will start early in the project and will follow an Exploitation path which will evolve with the project. For further details please see par. (2.2.2)

Task 9.2 – Institutionalization strategy and policy identification - Lead: WMU, Participants: ALL WP9 partners, [M7-M36]

Dedicated exploitation efforts will go into the institutionalisation of SAFEMODE outcomes, i.e. making SAFEMODE both part of the regulatory framework and industry best practice. The approach aims to ensure absorption of key technical and scientific SAFEMODE outcomes by the relevant organizations, institutions and communities. For this reason, a separate strategy will be developed. First, there will be the identification of SAFEMODE outcomes needing particular attention from policy-makers. Second, determination by partners of rules needing attention and eventually areas requiring policy recommendations. Institutionalization requires the participation of all partners which clear commitments. Therefore, regular meetings (once every 6 months after the first year and ad hoc workshops) will be organized to identify key aspects of the research to relay to policy-makers. To reduce risks of overestimating or underestimating SAFEMODE outcomes, a collective determination and selection of main elements to promote will conclude the task. A step-by-step institutionalization strategy will be determined at an early stage of the project to guide the overall process and keep its cohesiveness (initial discussion with partners, selection of focus, the schedule for the meeting, preparation for meetings, identification of target groups and arena, planning information strategy, etc.).

Task 9.3 Stakeholder analysis and involvement strategy - Lead: WMU, Participants: ALL WP9 partners, [M1-M36]

Exploitation and Institutionalization require proper mapping of stakeholders involved in air and maritime sectors. A thorough analysis of each sector made in cooperation with SAFEMODE partners and collecting data within international organizations such as EMSA, EASA, IMO, and ICAO. Additionally, industrial stakeholder organisations will be consulted, including ACARE, CANSO, IFALPA, IFATCA and ECA for example on the aviation side, and IACS, ICS, ITF, CLIA, INTERCARGO, INTERFERRY & INTERTANKO, WATERBORNE TP and BIMCO on the maritime industry. International workshops will also be held, inviting major aviation and maritime players (airlines, airports and airframe and equipment manufacturers, as well as ferry and cargo shipping companies and ship-builders). It is essential to gain as much buy-in as possible from industry, to understand their wishes and constraints, and to facilitate the smoother integration of SAFEMODE into both business practice and the regulatory landscape. An aim here will be to see if certain

companies are willing to take the lead via early adoption of the SAFEMODE approach. The purpose of the analysis is to determine the best strategies to attract stakeholders' interest in SAFEMODE project. The overall aim of the analysis is not only to identify, prioritize, visualize, engage and monitor their role and anticipate their behaviour; but also to assess their power, support, influence, interest and attitude toward changes. As soon as such analysis is completed, an involvement strategy will be prepared in order to target stakeholders and policy-makers. From this engagement, it is expected to identify and assess barriers that may obstruct policy changes, or industry take-up. The strategy will be documented in D9.2.

Task 9.4 Policy notes and recommendations - Lead: WMU, Participants: ALL WP9 partners, [M19-M36]

In order to maximize the impact of SAFEMODE, it is expected that each partner will (after determination of policy recommendations in Task 9.2) support the preparation of notes, information, and recommendations to present in international organizations and consequently enter SAFEMODE in international debates on safety. Notes may relate to topics such as technical specifications, operational procedures, training and certification issues. Such papers may be information paper and/or policy recommendations and will be written in a user-friendly format, for straightforward use in policy development. The SAFEMODE consortium has already in place privileged links with EASA, EMSA and other intergovernmental organizations such as IMO, as demonstrated by the support letters received, as well as excellent industrial links and partners in the Consortium. Identification of relays to support SAFEMODE papers will be conducted as by T9.3. Papers to present will be shaped respecting each organization's procedures and format. This task will position SAFEMODE inside those agencies' agenda.

This task will support regulatory activities with aim of supporting IMO Human Element Framework and Goal Based Standards. To achieve this aim, advisory board members from national authorities will be engaged to facilitate the awareness at IMO level. UK MCA and their Human Element Policy Manager (UK representative at IMO) will be asked to oversee the transformation of SAFEMODE outputs into IMO suitable formats.

Task 9.5 Capacity-building supporting training/toolkit Lead: WMU Participants: ALL WP9 partners, [M19-M30]

Acceptance of changes often operates via facilitators, i.e. persons promoting the implementation of changes. In this respect, training facilitators is an initial step in capacity building, to create an enabling environment. It is a process to support changes and prepare/adapt institutions by enhancing their understanding and skills. This task will develop and deliver a short course for a selected number of training institution, policy-makers, and industries/operators, with the objectives of (i) present an overview of SAFEMODE findings, (ii) highlight policy gaps, (iii) discuss potential policy recommendations. The training package may be delivered in different versions, to better address specific needs of the target institutions, for instance EU versus extra-EU ones, and will integrate SAFEMODE web-based solution.

Task 9.6 Just Culture Framework - Lead ECTL, Participants: ALL WP9 partners, [M13-M30]

The foundation stone of SAFEMODE is data, and these often come from reports. But if there is no Just Culture, then reports are scant and the kind of detail SAFEMODE needs, pertaining to human performance may be omitted or distorted. There needs to be a Just Culture framework put in place to facilitate reporting, and thus learning. Guidance and a framework will be developed in SAFEMODE, based on leading edge work ongoing in the aviation domain, and early work already happening within the maritime industry with one of the maritime partners.

Task 9.7 Aviation and Maritime comparative analysis to support Cross-fertilisation opportunities - Lead WMU, Participants: ALL WP Leaders, [M13-M36]

This task will collect input from all the WPs about commonalities and differences between the aviation and the maritime domains. It will analyse the structural characteristics of each domain and identify cross-fertilisation and leveraging opportunities. The opportunities will be fed back to the WPs to pursue them, or traced in a final deliverable for future research work. The information exchange will happen via the involvement of all WP leaders.

Participation per Partner

Partner number and short name	WP9 effort
1 - DEEP BLUE	9.00
2 - USTRAT	9.50
3 - EUROCONTROL	5.00
4 - NLR	2.00
5 - HUNGAROCNTR	1.00
6 - ENAC	1.00
7 - UniSap	3.00

Partner number and short name	WP9 effort
8 - CERTH	9.00
9 - CETENA	1.00
10 - ITU	6.00
11 - CalMac	1.00
12 - CHALMERS	1.00
13 - EMBPT	1.00
20 - NTUA	3.00
21 - WMU	18.00
22 - AIRBUS	1.10
23 - APA	2.75
24 - RYANAIR	0.50
25 - UPATRAS	1.00
26 - RSSB	0.50
28 - Wartsila NL	1.25
29 - APFC	6.00
30 - INSTITEKNO	3.00
31 - ROLLS-ROYCE MAR	0.50
32 - WUT	6.00
33 - TUI Airways ltd	0.50
34 - BeeBI	1.00
Total	94.60

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D9.1	Exploitation Plan	1 - DEEP BLUE	Report	Public	18
D9.2	Institutionalization Strategy	21 - WMU	Other	Public	24
D9.3	Stakeholder analysis and Identification of policy recommendation	21 - WMU	Report	Public	12
D9.4	Policy notes and/or recommendation in required format	21 - WMU	Report	Public	36
D9.5	Capacity building training package	21 - WMU	Other	Public	30
D9.6	Report on Just Culture Framework	3 - EUROCONTROL	Report	Public	30

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D9.7	Aviation and Maritime analysis and cross-fertilization opportunities	21 - WMU	Report	Public	36

Description of deliverables

D9.1: Exploitation Plan (DBL), Report, Public [M18]
D9.2: Institutionalization Strategy (WMU), Other, Public [M24]
D9.3: Stakeholder analysis and Identification of policy recommendation (WMU), Report, Public [M12].
D9.4: Policy notes and/or recommendation in required format (WMU), Report, Public [M36].
D9.5: Capacity building training package (WMU), Other, Public [M30]
D9.6: Report on Just Culture Framework (ECTL), Report, Public [M30]
D9.7: Aviation and Maritime analysis and cross-fertilization opportunities (WMU), Report, Public [M36]

D9.1 : Exploitation Plan [18]
The Exploitation Plan contains the guidelines for exploitation of the SAFEMODE outcomes and its exploitation path, including institutionalisation activities.

D9.2 : Institutionalization Strategy [24]
Step-by-Step institutionalisation strategy, with identification of SAFEMODE outcomes needing particular attention from policy-makers and determination by partners of rules needing attention and eventually areas requiring policy recommendations.

D9.3 : Stakeholder analysis and Identification of policy recommendation [12]
Stakeholders analysis, Identification of policy recommendation, and definition of actions.

D9.4 : Policy notes and/or recommendation in required format [36]
Drafting and preparation of policy notes and recommendations.

D9.5 : Capacity building training package [30]
Training package of a short course for a selected number of training institution, policy-makers, and industries/operators, with the objectives of (i) present an overview of SAFEMODE findings, (ii) highlight policy gaps, (iii) discuss potential policy recommendations.

D9.6 : Report on Just Culture Framework [30]
Just Culture framework to facilitate reporting, including guidance material.

D9.7 : Aviation and Maritime analysis and cross-fertilization opportunities [36]
Analysis of commonalities and differences between the aviation and the maritime domains. Analysis of structural characteristics of each domain and identify cross-fertilisation and leveraging opportunities.

Schedule of relevant Milestones

Milestone number ¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS4	Final SAFEMODE Closure Event	8 - CERTH	36	Final HURID framework and Final event

Work package number ⁹	WP10	Lead beneficiary ¹⁰	1 - DEEP BLUE
Work package title	Ethics requirements		
Start month	1	End month	36

Objectives

The objective is to ensure compliance with the 'ethics requirements' set out in this work package.

Description of work and role of partners

WP10 - Ethics requirements [Months: 1-36]

DEEP BLUE

This work package sets out the 'ethics requirements' that the project must comply with.

List of deliverables

Deliverable Number ¹⁴	Deliverable Title	Lead beneficiary	Type ¹⁵	Dissemination level ¹⁶	Due Date (in months) ¹⁷
D10.1	NEC - Requirement No. 1	1 - DEEP BLUE	Ethics	Confidential, only for members of the consortium (including the Commission Services)	6

Description of deliverables

The 'ethics requirements' that the project must comply with are included as deliverables in this work package.

D10.1 : NEC - Requirement No. 1 [6]

4.5. In case personal data are transferred from the EU to a non-EU country or international organisation, confirmation that such transfers are in accordance with Chapter V of the General Data Protection Regulation 2016/679, must be submitted as a deliverable. 4.6. In case personal data are transferred from a non-EU country to the EU (or another third state), confirmation that such transfers comply with the laws of the country in which the data was collected must be submitted as a deliverable. 4.7. In case the research involves profiling, the beneficiary must provide explanation how the data subjects will be informed of the existence of the profiling, its possible consequences and how their fundamental rights will be safeguarded. This must be submitted as a deliverable.

Schedule of relevant Milestones

Milestone number ¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
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1.3.4. WT4 List of milestones

Milestone number ¹⁸	Milestone title	WP number ⁹	Lead beneficiary	Due Date (in months) ¹⁷	Means of verification
MS1	HURD Use Case / Design of SHIELD	WP2, WP3, WP5	2 - USTRAT	12	Delivery of HURID use cases and design of SHIELD repository
MS2	HURID 1st release	WP5, WP6, WP7	2 - USTRAT	18	HURID elements, including toolkit
MS3	HURID 2nd release	WP5, WP6, WP7	2 - USTRAT	26	Refinement of HURID elements and toolkit
MS4	Final SAFEMODE Closure Event	WP2, WP3, WP4, WP5, WP6, WP7, WP8, WP9	8 - CERTH	36	Final HURID framework and Final event
MS5	Cooperation Agreement with EASA	WP1	1 - DEEP BLUE	6	Cooperation Agreement with EASA finalised, agreed and signed.

1.3.5. WT5 Critical Implementation risks and mitigation actions

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
1	Too large consortium, too much coordination required Probability: High Consequence: Medium	WP1	Partners are divided into the Core Team in charge of carrying out the research work, Dedicated contributors for very specific highly specialised tasks, End User (EU and Extra EU). Coordination and information exchange will be continuous in the Core Team, while it will be highly focused with the other partners. The role of the “End Users Interface” will manage all the interactions with the end users, to ensure efficiency.
2	Safety data not available, data not informative enough Probability: Medium Consequence: Medium	WP2	SAFEMODE end-users partners and External Stakeholders members of the AB will provide data and enhance current datasets according to research partners requirements. For drones: link to the European network of U-space demonstrations (supported by EUROCONTROL) to reach out to the full range of drone actors and applications
3	Risk Models and Tools do not address emergent risks Too resource intensive Probability: Low Consequence: High	WP3	There is already a dedicated task T3.6 for the analysis and modelling of future scenarios and emerging risks. Moreover, the adoption of methods such as HALs and HFSOE will support the addressing of emergent risks.
4	Complexity of models Probability: High Consequence: Medium	WP4	Models will be validated with multiple stakeholders for readability and fitness-for-purpose. Different views may be implemented depending on the stakeholder.
5	HURID does not address user needs Probability: Low Consequence: High	WP5	SAFEMODE guarantees a great and continuous end-users involvement. Relevant use cases will be defined at an early stages of the project and continuously updates, the validation of SAFEMODE results will be carried out in realistic case studies with two iteration loops.
6	Results from the technical WPs are delayed and may cause delay or lack in verification/end-user evaluation. Probability: Medium Consequence: Medium	WP3, WP4, WP5	SAFEMODE partners will isolate areas that can be completed and re-plan for areas that can be delayed. The SAFEMODE WP leaders will follow-up closely the ongoing progress. Technical partners will focus on key requirements, with rapid iterations in dedicated task forces.
7	Validation facilities become not available Probability: Low Consequence: High	WP6, WP7	SAFEMODE partners have access to a number of different simulation facilities in the two transport modes.
8	No industrial or regulatory take-up Probability: Low Consequence: High	WP8, WP9	Dedicated tasks to interact with stakeholders, analyse their needs and plan the right involvement strategy is in WP8. Moreover, SAFEMODE partners include both industrial partners and EU Agencies.

1.3.6. WT6 Summary of project effort in person-months

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	Total Person/Months per Participant
1 - DEEP BLUE	24	9	18	10	12	8	11	6	9		107
2 - USTRAT	12	16	23	19	33	0	17	8.50	9.50		138
3 - EUROCONTROL	2	5	6	5	6	16	1	2	5		48
4 - NLR	2	23	6	0	1	9	0	2	2		45
5 - HUNGAROCNTR	2	0	2.50	0	1	36	0	2	1		44.50
6 - ENAC	0	2	2	0	9	22	0	0	1		36
7 - UniSap	0	0	15	0	2	10	10	5	3		45
8 - CERTH	2	2	2	2	2	0	3	18	9		40
9 - CETENA	2	0.50	1	0	6	0	13	1	1		24.50
10 - ITU	0	5	5	6	6	0	9	4	6		41
11 - CalMac	0	2	3	3	2	0	6	1.50	1		18.50
12 - CHALMERS	0	2	8	5	6	0	10	2.50	1		34.50
13 - EMBPT	0	1	1	1.50	1.50	5	0	1	1		12
14 - TsAGI	0	3	5	45	10	83	0	1	0		147
15 - GosNIIAS	0	0	0	17	0	40	0	0	0		57
16 - MAI	0	3	10	10	5	25	0	1	0		54
17 - Innoteh	0	0	1	10	2	15	0	0	0		28
18 - MIPT	0	0	1	10	2	15	0	0	0		28
19 - DMU	0	0	0.50	0.50	0	13.50	0	0	0		14.50
20 - NTUA	0	5	5	8	9	0	8	4	3		42
21 - WMU	2	2	0	0	3	0	6	1.50	18		32.50
22 - AIRBUS	0	0.50	0.50	1	1.50	2.50	0	0	1.10		7.10
23 - APA	0	4	2.50	3	0	0	10	1.50	2.75		23.75

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	Total Person/Months per Participant
24 - RYANAIR	0	1	0	0	1	2.50	0	0	0.50		5
25 - UPATRAS	0	0	0	0	5	5.50	0	1	1		12.50
26 - RSSB	0	2	2	0	2.50	0	0	0.50	0.50		7.50
27 - UVA	0	30	0	0	0	0	0	0	0		30
28 - Wartsila NL	0	2	0.50	0	6	0	7	1.50	1.25		18.25
29 - APFC	0	7	5	8	7	0	10	7	6		50
30 - INSTITEKNO	0	5	0	3	3	0	6	4	3		24
31 - ROLLS-ROYCE MAR	0	1	1	2	5	0	7	0.50	0.50		17
32 - WUT	2	6	12	16	10	0	20	4	6		76
33 - TUI Airways Ltd	0	1	0	0	0.50	3	0	0	0.50		5
34 - BeeBI	0	2	3	0	14	0	0	2	1		22
Total Person/Months	50	142	141.50	185	174	311	154	83	94.60		1335.10

1.3.7. WT7 Tentative schedule of project reviews

Review number ¹⁹	Tentative timing	Planned venue of review	Comments, if any
RV1	18		
RV2	36		

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

2. Project acronym

Use the project acronym as given in the submitted proposal. It can generally not be changed. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

3. Project title

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB : entry into force = signature by the Commission). Please note that if a fixed starting date is used, you will be required to provide a written justification.

5. Duration

Insert the duration of the project in full months.

6. Call (part) identifier

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Abstract

8. Project Entry Month

The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

9. Work Package number

Work package number: WP1, WP2, WP3, ..., WPn

10. Lead beneficiary

This must be one of the beneficiaries in the grant (not a third party) - Number of the beneficiary leading the work in this work package

11. Person-months per work package

The total number of person-months allocated to each work package.

12. Start month

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

13. End month

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

14. Deliverable number

Deliverable numbers: D1 - Dn

15. Type

Please indicate the type of the deliverable using one of the following codes:

R	Document, report
DEM	Demonstrator, pilot, prototype
DEC	Websites, patent filings, videos, etc.
OTHER	
ETHICS	Ethics requirement
ORDP	Open Research Data Pilot
DATA	data sets, microdata, etc.

16. Dissemination level

Please indicate the dissemination level using one of the following codes:

- PU Public
- CO Confidential, only for members of the consortium (including the Commission Services)
- EU-RES Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)
- EU-CON Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)
- EU-SEC Classified Information: SECRET UE (Commission Decision 2005/444/EC)

17. Delivery date for Deliverable

Month in which the deliverables will be available, month 1 marking the start date of the project, and all delivery dates being relative to this start date.

18. Milestone number

Milestone number: MS1, MS2, ..., MSn

19. Review number

Review number: RV1, RV2, ..., RVn

20. Installation Number

Number progressively the installations of a same infrastructure. An installation is a part of an infrastructure that could be used independently from the rest.

21. Installation country

Code of the country where the installation is located or IO if the access provider (the beneficiary or linked third party) is an international organization, an ERIC or a similar legal entity.

22. Type of access

- VA if virtual access,
- TA-uc if trans-national access with access costs declared on the basis of unit cost,
- TA-ac if trans-national access with access costs declared as actual costs, and
- TA-cb if trans-national access with access costs declared as a combination of actual costs and costs on the basis of unit cost.

23. Access costs

Cost of the access provided under the project. For virtual access fill only the second column. For trans-national access fill one of the two columns or both according to the way access costs are declared. Trans-national access costs on the basis of unit cost will result from the unit cost by the quantity of access to be provided.

Edition	Date	Status	Justification
00.00.01	24/02/2019	Draft	<p>First version of Annex 1 Part B generated from the proposal.</p> <p>Gap comments addressed:</p> <ul style="list-style-type: none"> - Depreciation costs for equipment text included - More details provided on exploring market opportunities in Section 2.2.2.3 of the Part B - Risk 'complexity of model' in Section 3.2.5 will be amended - We will also consider this comment when drafting the consortium Agreement and as part of the Exploitation activities - Detail of ODC exceeding 15% of the personnel costs added to Section 3.4b - Section 4.2 amended to include details on DMU subcontracts
00.00.02	15/03/2019	Draft	<p>Comments by PO included</p> <p>Ethics comment addressed by adding risk table in section 5.1.7.</p>
00.00.03	22/03/2019	Draft	Adjustments due to new Consortium structure and comments by PO included
00.00.03	29/03/2019	Draft	Adjustments due to new Consortium structure
00.00.04	04/04/2019	Draft	Changes to Section 4.2 for partners DBL and DMU.
00.00.05	09/04/2019	Draft	Changes to Section 3.4.2 ODC description and to Section 4.2 for partners DBL and DMU.

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Human operators play crucial roles in the safe, resilient and efficient conduct of maritime and air transport operations. Consequently, human errors are often reported as contributors to maritime and airline accidents. The importance of supporting the human roles and trying to reduce human errors by addressing Human Factors in the design and conduct of transport operations is recognised as being fundamental by researchers, regulators and the transport industry. Moreover, the impacts of Human Factors in safety are likely to evolve and become even more prominent in the future. Indeed, challenges such as increasing automation, remotely operated ships and aircraft, multicultural crews, mixed types of traffic to be managed together, and so on, are transforming people-machine interactions in all transportation modes and are likely to introduce new and as yet unknown risks.

As analysed by previous EU projects (namely SEAHORSE and EXCROSS), many of these challenges are common to water and air transport. A pragmatic response is to tackle them with a collaborative and multidisciplinary approach while taking into account transport mode specific conditions and barriers.

The SAFEMODE project aims to strengthen the previously established synergies between aviation and maritime sectors and to further enhance the developed methodologies in order to address the emerging need of better addressing Human Factors in transport safety, while acknowledging the specifics of each sector. This will assure safety for travelling European citizens and businesses alike, well into the future.

1.1 Objectives

It is rarely questioned that Human Factors (HF) are key to safety, and the aviation and maritime industries are investing considerable resources into dedicated HF activities. Yet the discipline, data and available techniques are rarely applied at the design and safety assessment stages, when they can be most effective. The problem lies firstly in the scarcity of good HF data derived from the investigation of safety events, and secondly in the lack of effective feedback loops from operations back to designers. The only recommendations likely to be seen as cost-effective are changes to training or procedures, i.e. training or telling operators how to cope with a poorly designed system.

SAFEMODE aims to correct this, **via improved assessment and management of human risk factors within a Risk-Based Design and Operation Framework** for maritime and aviation industries, in order to **facilitate the involvement of HF disciplines and techniques in the design and safety assessment stages**. This will be achieved by pursuing the following objectives with associated measurable associated outcomes.

Objective	Measurable outcomes	WP
1. Collect, analyse and structure safety data into an Open Data Repository (named SHIELD) for both the maritime and the aviation sectors.	Gap analysis of currently available data versus desired data (quality and quantity), with analysis of shortcomings of current methodologies.	2
	Pilot implementation of recommendations to address the gaps, with collection and generation of data within selected SAFEMODE partner organisations.	2
	Development of the Open Data repository, with analysis of Human Factors aspects, contextual elements and typical scenarios. The repository will be a living, usable database called SHIELD (Safety Human Incident & Error Learning Database).	2
2. Define sustainable state-of-the-art standards of Human Factors analysis for safety events in the maritime and aviation domains, founded on SHIELD	Automatic data and text mining processes to identify incident types, human performance events and contextual conditions, including multi-language support.	2
	Knowledge-base and guidance for key Human Factors issues resulting from the operational environment and from organisational factors.	3
	Human Assurance toolkit: checklists, fact sheets, best practice examples, guidance and techniques for designers and analysts, including evidence-based models of human performance and a framework of Human Assurance Levels.	3
3. Design, develop, and validate a risk-informed framework to support Human	Quantification of the human contribution to risk (positive and negative) in a series of risk models, addressing events gathered in SHIELD and existing Risk Portfolios (e.g. the EASA Safety Risk Portfolio).	4

Objective	Measurable outcomes	WP
Factors analysis in design and operations (Human Risk-Informed Design, HURID). Validate in domain case studies, with strong industry involvement.	Human Assurance toolkit (same as above), linked with SHIELD and Risk Models.	3
	Human Assurance toolkit for future emerging risks, for monitoring and analysis, including design methods and tools for higher levels of automation, and early consideration of future AI and man-machine teaming.	3
	HURID validated by end-users in the domain case studies, with strong end-user participation and regulator involvement. These cases will ensure that HURID leads to effective solutions, addressing current and future risks.	5-6-7
4. Customise HURID to the specific characteristics of the maritime and aviation domains, in order to maximise its effectiveness and suitability to the domain characteristics, whilst distilling and leveraging common lessons and Human Factors best practices across the two domains.	Domain-specific requirements for the framework, taxonomy (ontologies), techniques, and risk models.	2-3-4
	Focused risk models for top risks in safety portfolios (e.g. the EASA Safety Risk Portfolio).	4
	HURID integration with current regulatory frameworks, and risk-based design frameworks (for the maritime).	5
	Analysis of commonalities and specificities of each sector in order to identify and exploit cross-fertilisation opportunities.	9
	Development of a Human Factors ‘Standard of Excellence’ for aviation and maritime domains, based on 5-level maturity approach, to allow organisations to take a step-wise and scalable approach to enhance Human Factors in their operations.	3
5. Support the Regulatory Framework developments in maritime and aviation, with guidelines and recommendations for effective and sustainable Human Factors analysis of safety events, within a Just Culture framework to encourage reporting, and utilising best practices (e.g. from aviation and other industries) to facilitate continuous monitoring and learning from operations, across and between the two domains.	Guidelines, policy notes and recommendations presented to EU and extra-EU bodies, including EASA, EMSA, International Maritime Organisation (IMO), ICAO, IATA, ACARE, JARUS (for drones), as well as civil aviation and maritime/coastguard agencies.	9
	Capitalization activities guiding interested stakeholders (from EU and extra-EU) to improve the rules and regulations in the Maritime and Aviation sector regarding transport safety.	9
	Dissemination activities of guidelines and recommendations carried out by extra-EU partners and Advisors.	8
	Training package for capacity building in training institutions, policy-makers, industries/operators.	9
	Exploitation plan identifying the replication and institutionalisation potential for the SAFEMODE outcomes.	9

1.1.1 The Challenge: decoding Human Factors as a multi-layer topic

Considering Human Factors in safety is complex, because it is multi-layered in nature, as shown below, via the Human Factors ‘Iceberg’ (similarly to Heinrich’s iceberg (Heinrich, 1931; Hollnagel E. , 2009)). Two reasons justify this analogy: (i) what you typically see in incident reports is the tip; there is usually much more underneath; ii) if you wish to prevent recurrence of an incident, you need to take care with what is under the waterline, and not only focus on what is above. Since the whole SAFEMODE approach will be founded on data, understanding the different levels of Human Factors data in incidents and accidents is key to resolving them (Figure 1).

While the tip of the Iceberg represents what is visible (the human involvement in accidents/incidents), the next three layers are the province of the Human Factors specialist, as well as specifically-trained investigators.

It is usually easy to see what happened following an event, because there are facts: who did what, and what then happened, are usually known or at least strongly suspected. Most investigations stop there. The analysis focus at this level is *observable performance*, or the event itself, e.g. productivity, safety (or lack of), errors, flexibility, etc. There is usually little or no design insight, and the reasons it happened are not uncovered, which means the event is likely to recur. Somebody (if they survived) can be blamed and re-trained, until the next occurrence. The issue is seen as dealt with, but safety learning has failed.

The second layer is the level of the actual **human performance**. Here, a range of factors affecting performance are considered, including well-researched and validated Human Factors concepts such as workload, situation awareness, stress and fatigue (i.e. elements of the **Human Performance Envelope** (Edwards, 2013)), human-system interface and equipment design, crew resource management, training, procedures and teamwork. If these factors are within reasonable tolerance, performance will be resilient or at least acceptable, and any incidents or accidents are highly unlikely. These are also the factors most often used in quantified human reliability prediction, as well as those that can be used for more qualitative approaches such as Human Factors Assurance Levels and Standards of Excellence. Investigating or analysing incidents at this level *will* lead to more effective prevention strategies and counter-measures, addressing systemic and structural aspects, e.g. job design and interface design (e.g. cockpit and bridge design). The **analysis focus** is on the **actual interactions between system elements** (people, procedures, equipment), using standard Human Factors methods such as HFACS and the SHEL model, or task analysis techniques (including cognitive task analysis for less observable tasks such as diagnosis and decision-making).

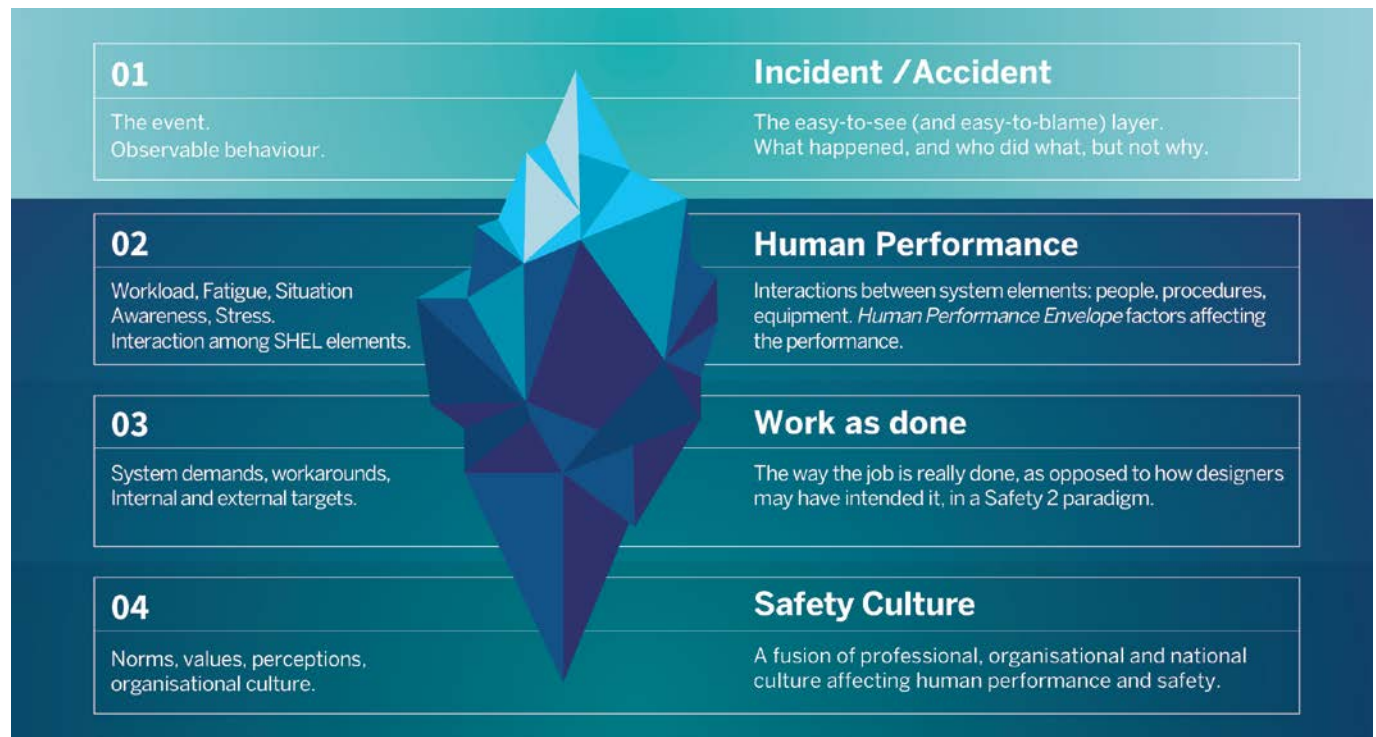


Figure 1. The Human Factors Iceberg

The third layer concerns the need to decipher **how the job is actually performed** (known as ‘work as done’ as opposed to ‘work as imagined’), rather than presuming everyone follows procedures and training to the letter. Real work is always variable, especially in open systems such as air and sea transport where weather and other factors play a role, and people adapt accordingly. There are internal and external targets placing demands on the operators, and workarounds may be the result. Often this leads to more efficient and productive work, but sometimes it can allow risks to emerge. The challenge is determining how jobs and tasks are really performed, especially in complex emergency situations where human performance counts most. The problem with ignoring this third layer is that any attempt to ‘fix’ an existing problem may not succeed if it relates to the formal prescription of work, rather than actual way work happens. Recently Layer 3 has been renewed under the ‘Safety 2’ paradigm (EUROCONTROL, 2013; Hollnagel, et al., 2015). Analysis at this level requires sense-making from narratives (story-telling) to understand how the real constraints and practices affect performance and safety, and is often done by focus groups, the Critical Incident Technique (used for this purpose in the nuclear industry), detailed interviews and via the use of field experts. It was applied out in the SEAHORSE project by members of the SAFEMODE consortium, using the Procedure Improvement system (Arslan, et al., 2015; Kurt, et al., 2016; Kurt, et al., 2016).

The fourth and final layer considers the culture and socioeconomics of each sector which affect individuals, organisations and industries. Usually professional culture is dominant, e.g. for pilots, controllers, ship’s captains or engineers. But organisational culture (e.g. how hierarchical a company is, how much it focuses on safety or rule-following, and its level of Just Culture and fairness to employees) can have large effects on safety performance, and national culture also has its part to play. For instance, how safety culture is being embraced by the new myriad of SMEs developing and operating drones (or operating in new market conditions (EASA, 2017), notably in safety-critical urban low-level operations is a key question that SAFEMODE will address. Another key question relates to

the differences between the aviation and the maritime safety cultures, with potentially differing implications for each transport mode.

This layer is key to ensuring that derived safety solutions and countermeasures are sustainable. Otherwise, they may be rejected, as the staff, workers and managers may not see them as fitting in with their values, and how they do things. Analysis focus at this layer is on norms, values, and ways of seeing the world and doing things. Despite this being a complex layer, safety culture surveys have proven effective in unravelling this layer in the aviation, maritime, and other industries (e.g. nuclear, oil and gas, rail, healthcare) (Arslan, et al., 2016; Bhattacharya, 2015; Ventikos, et al., 2014; Onyemechi, 2014; Håvold, 2010).

1.2 Relation to the work programme

This project relates to the H2020 topic MG-2-1-2018 Human Factors in Transport Safety, subtopic B. The following aspects of the topic are addressed.

Scope in the Work programme	SAFEMODE contribution
Improve the assessment of human risk factors in risk-based design and operation within waterborne/air transport	SAFEMODE will build upon previous work carried out in the SAFEDOR, FAROS, EXCROSS, CyClades and SEAHORSE EU projects to enhance existing risk models by integrating and quantifying the human contribution (positive and negative) to the safety of maritime and aviation operations. Human Factors and Safety experts from both domains will work together to define and formalise Human Factors-based risk models and assurance processes, making them usable for regulators, risk assessors, designers, technology providers and operators to support risk-informed design of tools, procedures and organizational processes, as well as fostering continuous monitoring and learning from operations.
Including crew resource management, crew awareness and response in extreme cases (e.g collision, evacuation, aircrafts upset recovery, runway excursions, etc)	SAFEMODE will consider relevant scenarios that will focus on human-machine interaction, crew resource management and crew response in extreme cases, e.g. i) Ship Collision Avoidance System to enhance crew awareness and response; ii) the role of the (remote) pilot in case of automation failure in sea and air unmanned systems, integration of manned vehicles with drones and autonomous ships; iii) human response in emergencies: upset recovery in severe weather; wake vortex detection and avoidance for business jets, general aviation, and drones; grounding and collision, fire, loss of propulsion/steering, shallow water effect, parametric rolling, and surf-riding in extreme weather conditions.
Identify new (and presently unknown) risk factors which might arise in the transformation towards increasing automation.	SAFEMODE will address the human ability to respond to emergencies in highly automated settings, e.g. advanced cockpits/ship bridges, drones, etc.. HURID and the Human Factors Risk Models will be informed by the SESAR Levels of Automation Guidelines to support risk identification in increasing automation.
Compile and analyse a large quantity of global real world accident, incident, near miss and other safety event data.	SAFEMODE will collect and analyse safety data in the two domains both from publicly available and confidential datasets (see Section 1.3.5). Both quantitative and qualitative data (narratives) will be analysed to gather new insights and inform the risk models through advanced data analytics techniques. The analysis will be supported and validated by field experts and researchers from various disciplines, and complemented with human-in-the-loop validation in Case Studies.
Use this data to develop improved methodologies to address human factors within risk based comprehensive design models and operational safety assessment for waterborne and air transport.	The SAFEMODE methodological approach will be structured around five strands of activity: i) collection, analysis and formalisation of safety data; ii) development of a toolkit for human performance assurance, iii) delivery and update of Human Factors-based risk models and (iv) the HURID process to support risk-informed design and operations in both waterborne and air transport, and v) conduct of case studies & forward-looking scenarios, including high levels of automation, to validate and refine the approach. Data gathering in case studies will be performed from different perspectives (qualitative measures, subjective assessments, and neurophysiological indicators), and then analysed by machine-learning algorithms.
The data (where necessary anonymised) should be retained as an open source beyond the project, and be maintained and updated.	One of the main results of the project will be an Open Data repository and living database (SHIELD), with a catalogue of HF, contextual elements and typical scenarios derived from accident, incident, near miss and other safety data. The repository will serve as a consultation tool for designers and risk assessors to inform their activities. SAFEMODE will strive to retain the data as an open source,

	ensuring maintenance and uptake. The data will serve to support training and standards development in both sectors.
Standardised guidelines should be developed for assessing and categorising human factors within investigations of accidents, incidents and near misses and other safety events.	SAFEMODE will develop guidelines, a multi-levelled taxonomy (ontologies), and recommendations to analyse Human Factors aspects of near-misses, incidents, and accidents, including a quality checklist to validate the Human Factors quality of an investigation. The overall framework will be common for air and sea transportation modes, with sector (and organisation) specific guidelines, taxonomy, and techniques, validated by their application to the target scenarios.
Guidelines should be developed and, if necessary, recommendations to amend existing rules and regulation should be made.	SAFEMODE will involve Maritime and Aviation Authorities and EU Agencies, Regulators and Policy Makers in the transport safety domain (e.g. ICAO, IATA, IMO, EASA, FAA, CANSO, IFALPA, ECA, EMSA, FEPORTS, ESPO etc.). Policy notes, recommendations and information papers will be prepared, on topics such as technical specifications, operational procedures, training and certification issues. Notes will support the regulatory framework to maximize the regional, national and European uptake.

1.3 Concept and methodology

1.3.1 The SAFEMODE concept: making the human contribution to risk tractable and usable

SAFEMODE will make the information about the **human contribution to risk tractable and usable** for system and operations design, for safety assessment, and for regulatory assessments. This will require a strong focus on users, in order to understand their current challenges and needs, and to determine which formats can be readily integrated into current practices. Achieving the above goal will deliver a number of tools that can support the industries in all phases of design and operation, as summarised below and in Figure 2.

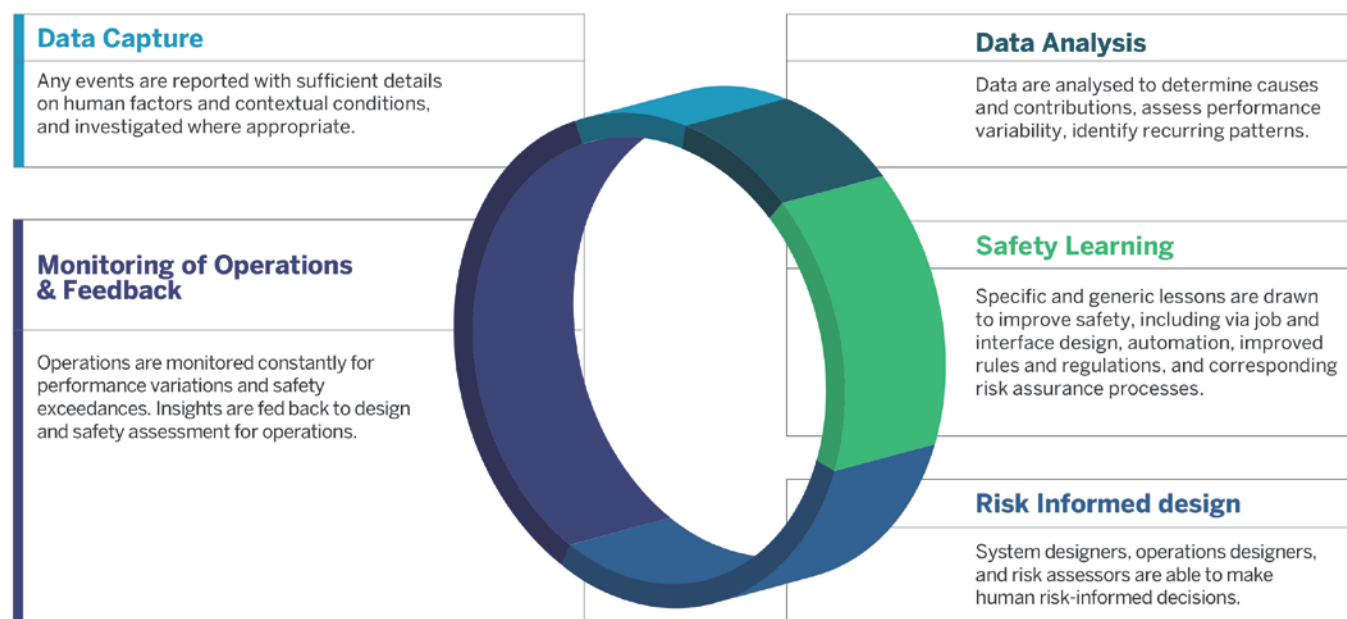


Figure 2. Human Risk Informed Design (HURID)

- **Data capture.** The data capture includes the (anonymized) recording of events, incidents and accidents in combination with sufficient details on human factors and contextual conditions in the safety occurrences. In addition, data are gathered about normal operations for situations considered in the safety occurrences. The aim is to go as deep in the ‘Iceberg’ as possible.

- **Data analysis.** Data are analysed to determine causes and contributions, assess performance variability in normal and extreme situations, and identify recurring patterns and scenarios in safety occurrences. The aim of this analysis is to dip deeper than Layer 1 of the ‘Iceberg’, addressing Layers 2 and 3 as well.

- **Safety learning.** Specific and generic lessons are drawn to improve safety. Lessons are widely distributed across the industry via periodic ‘alerts’ on special risk issues or key learning topics, similar to what already happens in air traffic via the SKYBRARY system, and has been in place in the nuclear industry for decades via the industry-wide Operational Feedback system run by the World Association of Nuclear Operators (WANO). Best practices and design principles will evolve and lead to evidence-based standards, e.g. on human-centred automation.

- **Risk-informed design.** System designers, operations designers, and risk assessors are able to make *human-risk informed decisions* on aspects such as interface and tools design, procedures, tasks and job re-design. For instance, designers can check *what went wrong before*, key contributory factors, statistics, and can then determine what Human Factors approaches to apply, the recommended level of automation, or use quantitative risk models to calculate the impact on system risk and top risk categories according to their design choices.

- **Monitoring of operations and feedback.** Operations are monitored constantly for performance variations in normal, abnormal and extreme conditions. Data and insights are fed back to design and safety assessment for operations, thus updating guidance, rules and regulations. Collection of data on site with front line operators will support the identification of adjustments and workarounds executed at the workplace.

Supporting all the above phases will enable **a continuous learning cycle to be developed**, which can inform design practice, operations, and safety assurance. Each step of the process will be supported by dedicated methods and tools with the aim of delivering a systematic fully integrated process. At this stage, it will be important to ensure seamless integration of the SAFEMODE models with existing risk based design frameworks (e.g. IMO Guidelines for FSA, SAFEDOR Risk Based Design Framework). The figure below shows how SAFEMODE tools map on the various phases.

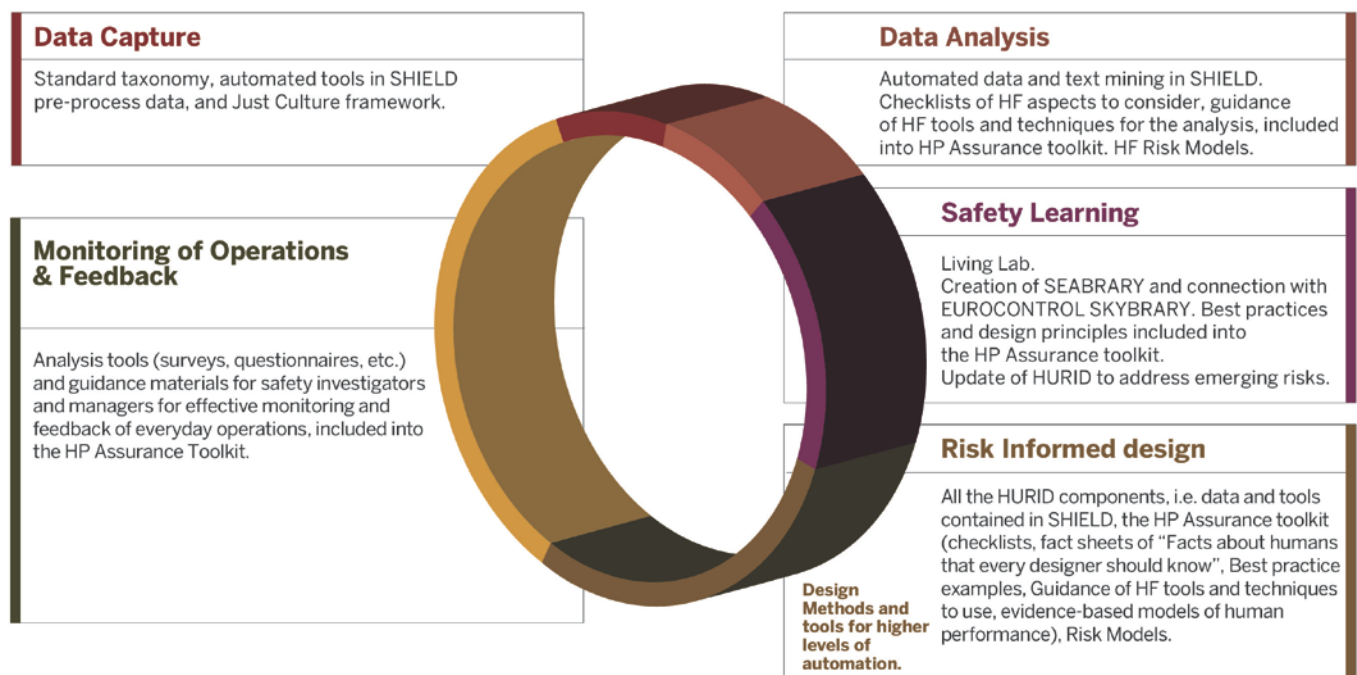


Figure 3. Map of SAFEMODE tools

1.3.2 The SAFEMODE Outcome: a Human Risk-Informed Design Framework

The proposed approach to deliver the above results is based on two inter-connected threads of activity, the end outcome of which will be the HURID (Human Risk-Informed Design) framework.

The first area includes the design and development of **tools, methods and materials for the analysis of HF** in incidents, accidents, near-misses, and in everyday operations.

The second area will focus on the **integration** of the above outcomes into a **risk-informed design framework (named HURID)** and on its **validation** in domain case studies. A key characteristic of this second area of work is the strong user-centred focus – i.e. actively engaging SAFEMODE end-users into the design of the HURID elements and testing it in applied Domain Case Studies.

More details on the activities and connected main outcomes are reported in the figure below.

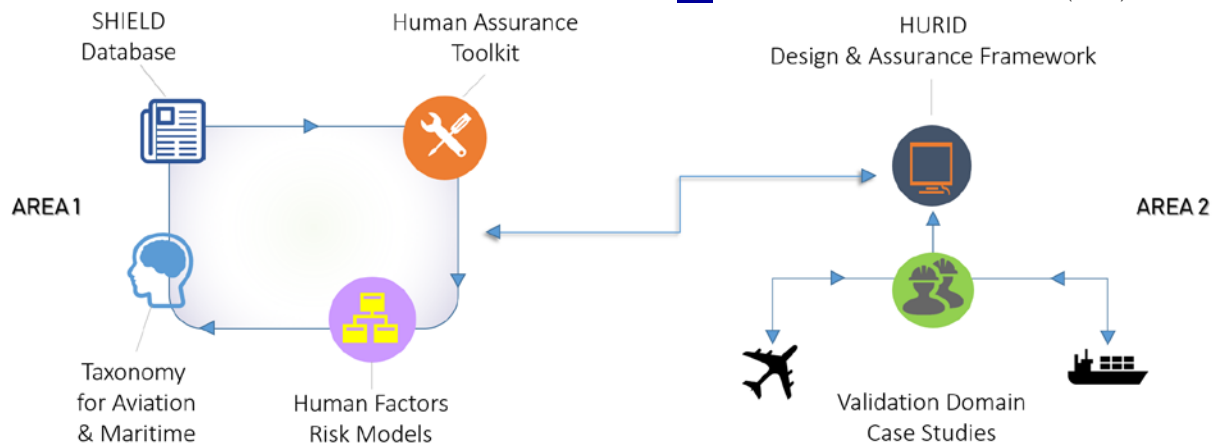


Figure 4. The SAFEMODE approach

1. A Human Factors Risk Event Database in aviation and maritime sectors (SHIELD): Risk-based design and operation need to account for the human element, whether as a source of error (what can go wrong) or as a means of safety and recovery (saving the day). In order to assess and manage this human element, it first needs to be understood in its context, and this means collecting data on incidents and human performance. The first step in any scientific endeavour, and human behaviour is no exception, is collection of evidence, compiling a database from which to draw upon, learn, and develop better models of how humans will perform in existing and future situations. Once such a database exists, it can be analysed, whether using advanced techniques such as data analytics and text mining, or more basic approaches such as expert judgement, or else drawing on the wealth and breadth of existing Human Factors techniques and theories. Although the different types of errors in industrial situations may be endless, the actual way humans make mistakes is not, and similarly, only a limited set of factors tend to matter from a risk perspective. This is good news. It means that a taxonomy (a common descriptive language) can be developed which can be used in the incident investigation to capture the essentials and what matters, and explain these in terms that can be useful to designers and safety assessors.

2. A set of tools and methodologies for assuring human performance (Human Assurance Toolkit for Design and Assessment): Whilst designers and others will find such a database useful, inevitably the database is unlikely to have many events related to their specific concern, because humans do not have that many safety-related events, and also because systems developers are often considering novel ways of doing business, so there is as yet no experience and hence no data on human performance with such new approaches. The next step is therefore to use the data we have and to develop human risk-based tools that can be used by designers, safety assessors or operational developers to make risk-informed decisions on new designs or procedures. The SAFEMODE toolkit will include different “tools”. At the present moment, the expected outcomes are: (i) checklists of aspects to consider when designing/assessing a new procedure or system, (ii) fact sheets of “*Facts about humans that every designer should know*”, (iii) Best practice examples (e.g. on colour coding for instruments and alarms, etc.), (iv) Guidance of Human Factors tools and techniques to use, considering what the designer has to do and the stage of maturity of the project, and (v) evidence-based models of human performance. The evidence-based models will include Human Reliability techniques, as used in nuclear power, chemical process and oil & gas industries, and models of Human Performance. The Toolkit will also include a framework of **human assurance levels (HALs)** and a **Human Factors Standard of Excellence**, to ensure that the adoption of Human Factors is sustainable in terms of resources, and proportionate to the potential level of risk associated with the operation.

3. Developing Human Factors-based risk models. The inclusion of human factors in risk models for transport operations is a complex task. Traditional risk models consider the human primarily as a failure mechanism rather than representing a broader scope of human performance, i.e. including contributions in assuring safe operations. The SAFEMODE project will develop broad-scope human performance models for risk modelling of transport operations, building on leading-edge research such as in Future Sky Safety and SESAR. SAFEMODE will develop a number of alternative risk models for key safety events (e.g. mid-air collisions and runway excursions; ship collisions and groundings, emergency situations, etc.) that allow human actions to be understood in relation to an incident – highlighting both positive and negative contributions - and the key factors that influence human performance to be described. Where a probability of human error/recovery is required, this will be derived from SHIELD and evidence-based models. Systemic models to assess changes in the overall risk picture in high-impact changes – for instance, the introduction of autonomous vehicles – will also be developed. The resulting models will satisfy the following requirements: (i) Allow designers to understand the potential impact of their design on human performance, (ii) Allow designs to be targeted at minimising current human factors problems, while significantly

boosting the chances of recovery from system failures and adverse events, (iii) Provide a repository for quantified human contributions to pivotal events in risk modelling.

4. Integration and customization of the “Human Risk-Informed Design Framework”. Once the above outcomes are delivered, their use for risk based-design will be tested in Domain Case Studies, to integrate all of them into a unified coherent risk-informed framework, named HURID (Human Risk-Informed Design). The goal of HURID is to provide tools which designers and risk assessors can use on a daily basis for their activities, addressing gaps in current design and operational processes, as far as the consideration of HF risks is concerned. HURID needs to be resource-flexible and multi-levelled, so that it can focus on specific design or operational issues, or system-wide ones. It also needs to ensure that all the tools and guidance and solutions are linked together, to inform all the phases of design and operations with human risk-based considerations. SHIELD data will be linked to methods and tools in the Human Assurance Toolkit, whenever real-world examples or data are needed. As highlighted in Figure 5, HURID will include guidance and tools to address typical challenges faced by system/operations designers, safety assessors, and regulators, answering questions like the following: (i) What went wrong before with this type of system or operation or interface? (ii) What are the key human performance drivers with this type of situation? (iii) Where do I really need to focus, and what is considered best practice in those areas? (iv) What are the tools or models I need to apply? (v) How much effort should I invest into HF aspects? Designers and safety assessors will be able to search HURID resources via different views, e.g. Type of system, Type of interface, Type of action/task, Type of risk, Level of automation, Type of change to be implemented.

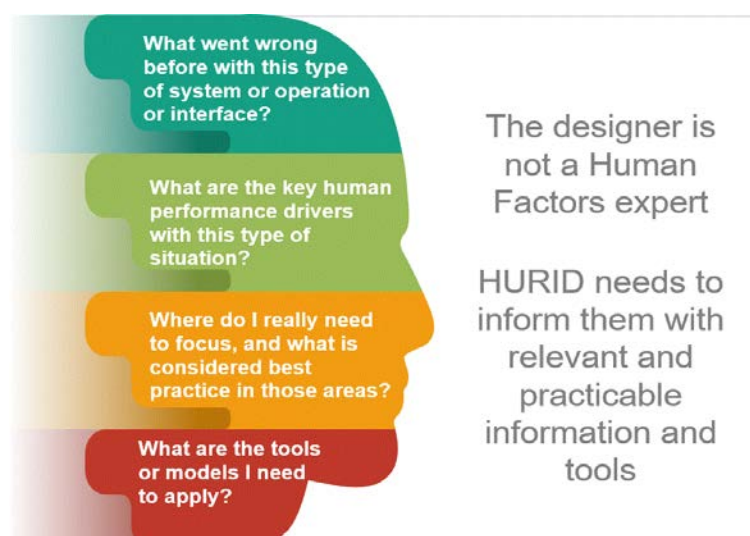


Figure 5. Human Factors experts' support to designers

(iii) Where do I really need to focus, and what is considered best practice in those areas? (iv) What are the tools or models I need to apply? (v) How much effort should I invest into HF aspects? Designers and safety assessors will be able to search HURID resources via different views, e.g. Type of system, Type of interface, Type of action/task, Type of risk, Level of automation, Type of change to be implemented.

5. Validation in Domain Case Studies. HURID will be designed starting from the analysis of current challenges in system and operations design, defining Use Cases of “how the situation should be” with the contribution of the SAFEMODE end-user. HURID will be tested in a number of Case Studies (2 aviation and 2 maritime), identifying Human Factors aspects to consider, to generate alternative options for design and operations, and to assess Human Factors risks. The final selection of Domain Case Studies will be determined by reviewing SHIELD data, existing documents (e.g. EASA key risk areas in the Annual Safety Review, Allianz Safety and Shipping review, EMSA annual overview of marine casualties and incidents, MAIB Annual Reports), experts’ input (as outlined below in Section 1.3.5). Input from the SAFEMODE end-users will be critical at this stage, to define the scope of the study and to define the details of technological innovations and human role changes to be considered. Case Studies will include forward-looking scenarios to tackle the upcoming challenges of a rapidly evolving transportation sector.

The validation will be performed in two iterations. The first validation will happen during the second year of the project. It will focus on the HURID elements that will be ready at that moment (more details in the WBS) and will make use of low fidelity validation settings, such as desktop exercises, gaming exercises, and prototyping sessions. The main goal of this first validation is to steer the HURID design in the right direction, collecting early and timely feedback from end users. The second iteration will take place during the third year of the project. It will focus on the first complete release of HURID, testing its application via high fidelity Human-in-the-Loop simulations. Results from this iteration will validate HURID’s suitability to support risk-based design and operations, and will also be used to fine-tune its risk models and the Human Assurance toolkit.

1.3.3 Positioning of the project

The SAFEMODE project is generally positioned between TRL3 (starting TRL) and TRL6, as the project will carry out active R&D studies, testing the use of the SAFEMODE outcomes to inform design and operations via a number of domain case studies in simulation environments. Results will be discussed and refined with policy-makers, to define guidelines for wide-spread adoption, associated obstacles, and strategies to overcome them.

The main outcomes and target TRL will be: 1) **Open Data repository (SHIELD)**: TRL6. Real-world data collection and analysis; 2) **Toolkit of methods and tools for Human Assurance**: TRL5&6. The project will deliver state-of-the-art methods and tools for addressing HF aspects in: monitoring everyday operations; analysis of near-misses, incidents and accidents; design/assessment of a new procedure/system; guidance for higher levels of automation. The toolkit will be tested in the case studies; 3) **HF Risk models**: TRL5. Risk models for current and future risks will be tested in a number of case studies; 4) **HURID framework to support design, operations, and continuous monitoring**: TRL5. HURID will be tested in a number of case studies involving end-users.

1.3.4 Related national or international research and innovation activities

SAFEMODE partners are the top Human Factors and Safety European research organisations in the Aviation and Maritime domains, with an extensive **portfolio of relevant projects** under different topics.

Regarding projects related to **Human Factors analysis and methodologies**, main examples in the Aviation domain are: HILAS, ALICIA, ACROSS, SDiT, Future Sky Safety P6, and the SESAR2020 Solution projects (PJ10, PJ05, PJ03, PJ18 etc) in which some of the SAFEMODE partners are involved as Human Performance Assessment experts. In the Maritime domain SEAHORSE, CyCLades, Horizon, and SilenV cover this aspect.

Projects, which are more related to **Human Performance measurements through neurophysiological** parameters are, in the Aviation domain: NINA, STRESS, MINIMA and MOTO, and in the maritime domain: HORIZON.

Another relevant group of projects is related to **safety methods and technologies to analyse and address incidents**. To this group belong projects like EXCROSS (across the 4 transport modes), SUPRA, MAN4GEN, ARISTOTEL in Aviation. STM, MUNIN, SEDNA and EfficienSea2 in Maritime.

Risk Model Definition was the main focus of the FAROS and SAFEDOR projects. Finally, other projects are dedicated to skills requirements to address changes, in order to decrease accident risks. SKILLFUL covers the 4 transport modes, KAAT and AIRVET are in Aviation. EU-PORTRAIT, MATES and MAIDER are in Maritime.

1.3.5 Methodology

The SAFEMODE methodological approach is structured in three steps: (i) Collection and analysis of safety data, (ii) Development of the Human Assurance toolkit and HF Risk Models, (iii) Conduct of domain case studies & forward-looking scenarios. The end outcome of these three strands is the definition and test of the HURID framework, for risk-informed design and operations.

COLLECTION AND ANALYSIS OF SAFETY DATA

This strand of work will develop the SHIELD Open Data Repository. It will gather data on human performance in safety-relevant situations: narratives of safety occurrence reports, human performance data from (marine and air transport) normal operations and training sessions, and contextual data of operations (e.g. work as done, workarounds, actual trajectories, weather). It will structure and analyze the data using a Human Factors taxonomy and advanced data analytics and text mining processes. It will validate the data quality and quantity across the whole process.

Data sources available to SAFEMODE

SAFEMODE will use public sources where possible, but access to confidential datasets will be acquired to ensure compatibility and transversality of the proposed approach, especially when public data are not enough to support the development of HF-based risk models. The considerable network of the SAFEMODE participants and its partners assure that an extensive data set is available for the effective development of SHIELD.

A preliminary list of available data sources is reported below. Sources with * are accessible to SAFEMODE partners, or have already agreed to provide data for SAFEMODE.

- Aviation: EVAIR European ATM Safety Occurrences (public), ECCAIRS (confidential), EASA Data4Safety (confidential), National NSAs (Austria, Hungary, Italy*, The Netherlands, UAE*, UK Public), Automatic Safety Data Monitoring data (via EUROCONTROL, 10 users), Proprietary Databases* of SAFEMODE partners or External Advisors concerning Safety Events and/or Normal Operations (MUAC, BULATSA, HungaroControl, ENAV, Luton Airport, Ryanair, Air Dolomiti, TUI, NetJets, ENAC, HungaroControl), TNO FRMS database*.

- Maritime: EMSA EMCIP Database for marine casualties involving all types of ships and occupational accidents, CHIRP reporting programme for near miss and hazardous occurrences. IMO Global Integrated Shipping Information System, Casualties and Incidents database, OCIMF Vessel Incident Repository. Marine Accident Investigation Board (MAIB) UK database* (via UoS), SEAHORSE database of Safety Culture Assessments of shipping companies* (via UoS) and database for maritime workarounds*(via UoS), Chemical Tanker Ships SIRE and CDI inspection database* (via ITU), National Investigation Agencies (Italy*, United Kingdom*, Turkey*, Australia), Proprietary Databases* of SAFEMODE partners or External Advisors concerning Safety Events and/or Normal Operations*(via CALMAC, EAGLESTAR, HELLENIC TANKERS, DLU, APFC). Data generated from previous projects (such as MAIDER, SILENV, SEAHORSE, FAROS). Other safety-related data: Private shipping companies crew performance evaluation database* (via ITU). Tele health service statistics for ships related to medical records*(via ITU).
- Previous experiments conducted by SAFEMODE aviation partners (ENAC, HungaroControl, NLR, DMU, UniSap, Deep Blue) have led to the collection of numerous physiological and subjective data, together with the traffic situation recordings. This is material for data mining and can be analysed specifically from a safety angle (e.g. focusing on moments where triggering of Short Term Conflict Alerts is detected). For the maritime, this includes: Ship manoeuvrings risk analysis database simulator based* (via ITU). Lactate tests and psychometric performance results of the crew members data base from a ship* (via ITU). Measuring Distraction for OOW (simulator based), Peripheral detection task results*(via UoS), Human Response models to Noise, Vibration and ship motions* (via UoS).

The above data sources **do not only contain Safety data, but also human performance data** like task analyses, workflows, task criticality, behavioural data (reaction times, time on task, task frequency, physical movements), shifts, rosters, duty and rest times. Training and experimental datasets will also contain neurophysiological data (brain activity, eye tracking, and stress levels).

Previous approaches to collect Human Factors data (e.g. in nuclear power) have found it useful to determine the **quality of the data collected**, especially if it is intended to inform design, or quantification of human performance in safety studies. When recording and investigating events (e.g. incidents and accidents) in any industry, often the investigators focus on the aspects they know can be changed, such as training and procedures, and do not record aspects of design that may have contributed to human error, because they know it will be too costly to change an already-existing system. A challenge, therefore, for SHIELD is to find data-sets that do include such design-rich information, so that SHIELD can inform HURID and thus aid designers. Some existing datasets do include such information (e.g. COREDATA, and some of the data collected in the field of air traffic management).

Where the data are lacking, however, **SAFEMODE will initiate dedicated data generation activities**, by relying on the support of SAFEMODE partners, especially airlines and shipping companies. These activities will include the collection of new data using SHIELD formats, or the conversion of existing in-house databases. Investigators will be supported by dedicated guidance materials for effective monitoring and feedback. This further data generation will undergo a cost/benefit and ethical assessment before being initiated. Further, ENAC recently modified a training plane of its fleet to make a Flying Laboratory for Human Factors and HMI research and prototyping. This plane has been configured with a “big data” mode which enables the collection of many aircraft and physiological data, even outside of research activities (most of the time being devoted to conventional training). This mode can accumulate numerous flight hours of data and constitute a resource for data mining and analysis.

Structuring and analysis of the data

The basis for the development of the SHIELD Open Data Repository is a Human Factors taxonomy, which presents a logical framework to describe human performance in safety-relevant tasks, and the influence of contextual conditions. The taxonomy will be sufficiently broad to support the provision of human performance data (e.g. event probabilities, performance timing, different layers of analysis) for the variety of events, tasks, and risk models supported by SHIELD. The design of the taxonomy will effectively use existing taxonomies for safety occurrence reporting and Human Factors (e.g. ECCAIRS, SACADA, TOKAI, COREDATA, Rail Incident Factor Classification System) and related methods for HF near-miss and incident analysis. The taxonomy will be common to aviation and maritime as far as possible, with sector-specific items where needed. A gap analysis of the currently available taxonomies and data sources with respect to the needs (i.e. effective Human Factors input to system and operations design) - and in consideration of the various layers in the Human Factors ‘Iceberg’ - will support the development of the taxonomy for the SHIELD development. The database development will be based upon an analysis of the needs of its end-users for risk analysis in design. The following types of interrelated data elements are foreseen:

- Raw performance data: narratives of safety occurrence reports, human performance data from (marine and air transport) normal operations and training sessions, and contextual data of operations (e.g. work as done, workarounds, actual trajectories, weather).
- Extracted data features: incident classes, human performance events, and contextual classes. These extracted data features are directly associated with the raw performance data elements.
- Data statistics: conditional human event probabilities and probability density functions of human performance, including confidence levels that reflect the quality, contextual relevance and quantity of the underlying data.

To overcome the limitations of manual processing by human experts, and to support the automatic building of the SHIELD Open Data Repository, data and text mining techniques will be developed for processing human performance data. In SAFEMODE, the utility of various text mining techniques in categorizing and clustering safety occurrence narratives will be evaluated. The data generated by the text mining will be combined with class and safety indicator data from the safety databases in statistical analyses, leading to a quantification of Human Factors aspects, across the various layers of the 'HF Iceberg'. The data and text mining results will include confidence levels to effectively support the combination of data of varying quality levels. Multi-language evaluation will be included to support the processing of textual data from a variety of EU sources.

Validation of the data and the analysis processes

SAFEMODE will borrow from work in the nuclear power field where a data quality rating system was developed so that the quality or 'pedigree' of the data is evaluated via a number of classes, based on statistical robustness and contextual relevance. This means that all data can be coded in SHIELD, but some may be only of interest qualitatively (e.g. for designers to know that something happened once), whereas other data can be used in the risk models because there is more certainty about its integrity, as well as the conditions that led to the event. Both types of information are useful, but we must separate the two uses. SAFEMODE will be clear on the relative degrees of confidence it has in the various data-sets. Hopefully, this will encourage more comprehensive reporting in the future, and the collection of strong data-sets for quantification and risk-modelling purposes, as is starting to happen in ATM today.

The validation addresses two components. **The first validation component** concerns the validity of the extracted data features by experts and automatic mining techniques, and the validity of the derived data statistics. This means an evaluation of the consistency of the feature extraction process by human experts (do they classify occurrences in the same way?) and a comparison of human classification results with the text mining results. Active learning approaches will be used to couple expert-based labelling with machine learning techniques, to achieve a continuous training loop enriching the data-driven tools in a partnership between human experts and machine learning. **The second validation** component concerns an evaluation of the usefulness of the SHIELD Open Data Repository for the other WPs. What are potential gaps in SHIELD and its data sources for the development of the human assurance toolkit in WP3, for the risk models in WP4, and for the HURID framework in WP5? What is the effectiveness of SHIELD in support of the case studies in WP6 and WP7? This validation will lead to refinements to SHIELD, as well as to recommendations for the continuous development of the database, its data sources and its interaction with the various SAFEMODE components.

DEVELOPMENT OF THE HUMAN ASSURANCE TOOLKIT

The approach for developing the toolkit for Human Assurance will be relatively straightforward, profiting from the large body of knowledge produced by the Human Factors community in recent years. The approach will go through four main steps:

- First, a comprehensive review of Human Factors methods and tools will be performed, to build a catalogue and identify "best in class" methods already adopted by the industry and in operations. EUROCONTROL has already performed similar reviews (EUROCONTROL, 2008), which can be used as a starting point.
- Second, methods will be mapped onto the HURID Use Cases, assessing their suitability and identifying any gaps or challenges in their application. This mapping will provide a prioritization of methods, ranking them from "extremely useful" to "nice to have" to "not useful".
- Third, methods will be differentiated into two categories, one requiring minimal work to be adopted by SAFEMODE and integrated into the Toolkit, the second requiring more extensive work.
- Fourth (a), for the first category (ready to go), a workshop will be performed with end-users, to agree on the required customizations; (b), the second category will require more dedicated effort. Dedicated working groups will be formed for each method/tool, whose first goal will be defining what needs to be done and how (strategy and plan). A typical plan may involve a number of consultations with experts and end-users, plus some dedicated data collection, either in the field or in simulators. Considerations of costs will play a role in this stage, to prioritise efforts towards the refinements of methods with the best costs/benefit ratios.

At present, it is expected that the first category will include **methods and techniques** such as EUROCONTROL SOAM, HFACS, TRACER, task analysis techniques, SHEL analysis, checklists of HF aspects including the SESAR Human Performance Arguments (SESAR, 2018), Human Entropy model (HENT by Strathclyde University), and the Human Performance Standard of Excellence for aviation (EUROCONTROL, 2015). For the maritime domain, National and European accident investigation databases such as Marine Accident Investigation Board (MAIB) or EMSA's EMCIP database use a standard taxonomy which provides information mostly on the layers of 1 & 2 of the Iceberg model. Some of the layer 3 information can be obtained from accident reports and from anonymous reporting databases such as CHIRP, as well as shipping companies' near-miss data. Methods from other domains will also be considered, for instance, the SACADA database approach from the nuclear power sector, and the Incident Factor Classification System and the RARA technique for the Railways (Gibson W. H., et al., 2015; Gibson W. , et al., 2013).

At the moment, the second category includes the development of **Risk Models** themselves (to which a specific WP is devoted), the **adaptation of the Human Performance Standard of Excellence to maritime**, the development of **predictive models of human performance** (including Human Reliability Assessment – HRA), the development of a framework of **Human Assurance Levels (HALs)** (Mana, et al., 2007), the development of **bespoke neurophysiological indicators** for well-known Human Factors concepts including workload, stress, situation awareness, out-of-the-loop effect, etc. (as already performed for Air Traffic Control by Deep Blue, ENAC and University of Rome Sapienza in the NINA, STRESS and MOTO projects), and the development of Human Factors methods for **monitoring everyday operations**. This list will be completed and refined according to the findings of Step 1 (review of state of the art). This work will be guided by three principles: (i) the Human Assurance toolkit needs to be **flexible**, being able both to support relatively small-scale or focused design or operational changes, as well as to consider large-scale impacts associated with system-architecture-level changes, such as a step change in automation or the widespread introduction of drones into civil airspace; (2) the whole process has to be **sustainable**, to foster quick adoption by the industry. The methods need to be accepted and integrated into design and engineering practices, as well as regulatory frameworks; (3) the toolkit should provide support for all the daily activities of aviation or maritime end-users, with an **integrated** framework and guidance. The HURID framework and the underlying concept of the 'Iceberg' will provide such an integration.

DEVELOPMENT OF HUMAN FACTORS RISK MODELS

The step-by-step process for the Human Factors Risk Models definition is detailed in WP4. This section presents the approach to define the models and to quantify Human aspects.

How Risk Models work. Risk models are used in many industries to determine whether a system is safe or not. They are also used to consider how to improve safety, and to understand accidents when they happen. Typically risk models consider the physical and procedural barriers that keep system operations safe, and then model how these barriers can fail. The two most traditional models used across a range of industries (e.g. nuclear power, space, chemical, oil and gas) are fault and event trees. Fault trees determine how a system can fail, leading to an undesirable 'top event', e.g. a runway excursion where the landing aircraft veers off the runway, or a ship-to-ship collision. Event trees consider the potential outcomes following such events, (e.g. aircraft damage, potential outbreak of fire, evacuation of crew and passengers; ship foundering, evacuation and rescue). These models are then quantified using a mixture of historical data and mathematical models, to develop a prediction of the top events and their outcomes. These system risk predictions are then compared to regulatory risk criteria, to see if the system is safe enough, or if it needs to be improved before it can be allowed to operate.

Towards Human Factors Risk Models. In industries where the human plays a key safety role, including aviation and maritime, it is essential that both the humans' negative and positive human contributions (errors and recoveries) are represented in the risk models. Until now, this has not usually occurred, due to a lack of adequate statistical data on human performance. SAFEMODE will change this, however, via the data collected in SHIELD (WP2) and the evidence-based models developed in WP3. The approach has already been piloted in air traffic management by EUROCONTROL (EUROCONTROL, 2018), with development and validation of several large fault trees for top events such as mid-air collision, where human contributions to risk are modelled both qualitatively and quantitatively, based on extensive reviews of air traffic incident reports (see Figure 6). This approach will be extended for aviation and adapted for maritime. The approach to develop HF risk models will therefore build upon the well-understood modelling approach already piloted in ATM and expand it to address the human component of aviation and maritime safety. The models will provide a full description of the broader context of human performance in system safety. Such modelling gives clear insights into how and where to improve system safety and reduce the frequency of accident outcomes such as ship collisions and runway excursions or wake encounters.

Human Factors risk models for Aviation and Maritime. Models will be developed for major events such as fire on board, ship collision or grounding in the maritime sector, and mid-air collision, runway excursion and wake

encounter in the aviation sector. These models will resemble standard fault trees, but will clearly highlight the barriers and human contributions (positive and negative) to safety. This approach will also ensure that the human activities that contributed to preventing the incident from escalating further (so-called recovery factors) can also be captured, especially in the event trees. This is a significant enhancement of current modelling techniques. The models may also be enriched by the WP6&7 domain case studies.

In order to manage the complexity of integrating HF considerations into a model of risk, different modelling approaches will be exploited. Modelling approaches will provide different views of the granularity depending on the level of analysis and type of user etc. “Views” will show the elements of the model from a specific event (e.g. the failure of a safety barrier). Each viewpoint may present specific elements, that are most relevant for the audience of that viewpoint. Views provide the ability to connect architecture data and organize it for several purposes. Viewpoints provide a reference model customisable to fit each user’s needs, as already successfully done by the EU PACAS project (PACAS, 2018).

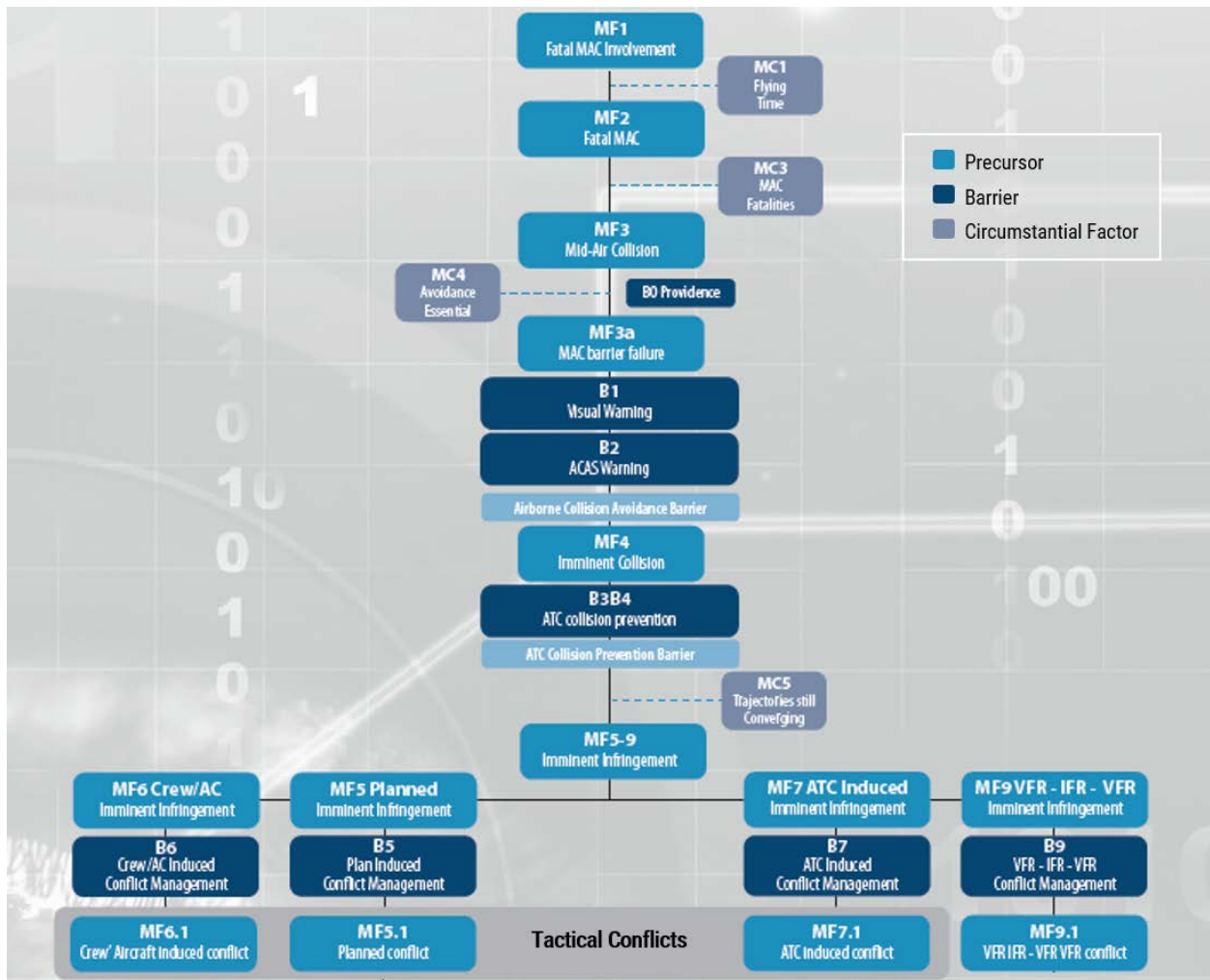


Figure 6. Excerpt from a simplified model for MAC-ER

‘Populating’ the models. A set of incidents from both maritime and aviation will be analysed using the risk models to ensure the framework is sufficiently flexible to account for typically observed incidents and provide validation of the model structure and content. The models will be quantified on the basis of existing accident and incident statistics. Where a probability of human error/recovery is required, this will be derived from SHIELD and the evidence-based models developed in WP3. The models will provide full traceability of the contribution of the human failure to the probability/frequency of a ‘top event’ – mid-air collision, ship collision etc.

What the models deliver. Because the models show the major contributors to risk in each domain, they will tell us:

- Those aspects of human performance that currently keep the system safe (*how we stay safe today*);
- The major human-centred risks emerging from the models (*where we could do better*);
- The design features that can best ensure that those risks are better mitigated (*how we could do better*);
- The impact of a change to the barriers, or to the design of the human’s tasks, on overall system risk (*how much better we could be*).

Put simply, development of HF risk models will tell us where can we best invest to make operations safer. This capability will be implemented and demonstrated in both domains via the WP6&7 case studies. The resultant

SAFEMODE HF Risk Models can then be deployed in the maritime and aviation industries, transforming the way safety is managed and regulated, by enabling evidence-based and risk-informed design and operations.

DOMAIN CASE STUDIES AND FORWARD-LOOKING SCENARIOS

Domain Case studies will be complementary to the data-driven approach, in order to address three distinctive challenges of incident data. Firstly, **incident reports may present different a level of details on Human Factors aspects and may require additional data gathering** to make data comparable. This will be addressed by further field data generation with SAFEMODE end-users, but also by model-based and real-time simulations performed as part of the Domain Case Studies. Secondly, **there will not be enough data on extreme cases**, which happen very rarely. Often, sufficient information on Human Factors and contextual aspects may be missing from the available reports on rare cases. These cases will therefore be reproduced in the simulator. Third, data will not be available for future unknown risks, so SAFEMODE will develop a set of dedicated *forward-looking scenarios*.

The main objective of the Domain Case Studies is to assess how HURID can support risk-based design and operations, i.e. if HURID can help the end-users in analyzing, generating, and assessing alternative options for system/operations design. A second objective is to validate HURID against emerging risks in future scenarios.

A **tentative list of Human Factors research areas** to be addressed in Domain Case Studies is reproduced below:

- **Alarm design for bridges, cockpits and remote working positions:** e.g. ‘Ship Collision Avoidance System’ (based on the aviation TCAS), Integrated Bridge Systems, Design and test of alarm hierarchies to cover degraded modes in the context of Remote Operations.
- **Sea and air unmanned systems:** the role of remote pilots in case of automation failure, remote-pilot intervention, integration of manned vehicles with unmanned ones. Emergency human response and remote intervention for autonomous/unmanned ships in safety-critical and emergency situations.
- **Human response in emergencies:** wake vortex detection and avoidance for business jets and general aviation; loss of propulsion/steering, collision and grounding, evacuation of the ship in emergencies, parametric rolling, shallow water effect, Sailing to Safety in storm conditions.
- **Human response in high workload and time-pressured situations, in a high automation cockpit and ship bridge,** e.g. go-around manoeuvres with lack of visual reference and poor crew resource management for aviation and maritime, or a series of alarms in a high-density traffic area for maritime.
- **Training for high automation:** Skill development for humans in the loop for autonomous and unmanned ships in normal operation and in emergencies considering the presence of both manned and unmanned ship traffic.

A set of Case Studies will address future emerging risks. These long-term, disruptive technology case studies (named “forward-looking scenarios”) will ensure that HURID is capable of addressing future emerging risks. Forward-looking case studies will be defined via a thorough analysis of trends and developments of advanced automation and artificial intelligence in transport, of the impact on human roles, and by gathering outcomes from projects with a special focus on innovation and future concepts (e.g. STRESS, NINA, AUTOPACE). More details on the case studies can be found at the end of this section.

Data to be collected include performance data, responses and actions in extreme cases, subjective data (e.g. situation awareness and workload self or expert assessment), neurophysiological data (e.g. stress level, cognitive control behaviour, engagement index, workload, attention and vigilance (Borghini, et al., 2017; Aricò, et al., 2017)).

The potential of using real-world data (when available) from training and selection will be explored, to analyse large datasets with high cultural and demographic variety. The use of the repository to develop training requirements and formats for extreme situations will be assessed (as in the Man4Gen project).

The **final set of case studies will be selected according to the following criteria** (list to be refined): Relevance to the Call (e.g. flight upset, etc.); criticality of human performance to risk/safety; incidence of Human Factors e.g. fatigue, high workload, vigilance, etc.; potential sources of existing data (incident/simulator/live/etc.); access to simulation or live situation for data collection; relevance to both sectors (aviation & maritime); design (and designer) relevance; enhancement potential for risk models; ability to realise impact (solution) within timeframe of project; importance of research to regulators (EASA/EMSA) and other safety research agendas (e.g. ACARE); addresses automation and new risks.

Manufacturers and operators will have a primary role in defining the domain case studies’ scope and elements. The table below lists current end-users and their primary research focus in SAFEMODE.

Research Focus	End-Users
Alarm design for bridges, cockpits and remote working positions	AIRBUS, EMBRAER, CETENA, Rolls-Royce Marine, RSSB, ENAC, HungaroControl, Drone Paris Region

Sea and air unmanned systems	AIRBUS, Drone Paris Region, Rolls-Royce Marine, ENAC
Human response in emergencies Human response in high workload and time-pressured situations, in a high automation cockpit and ship bridge	AIRBUS, EMBRAER, TUI Airways, Ryanair, Rolls-Royce Marine, Calmac Ferries, Institut Teknologi Sepuluh Nopember (Indonesia), Archipelago Philippine Ferries Corporation (Philippines)
Training for high automation	ENAC, HungaroControl, NLR

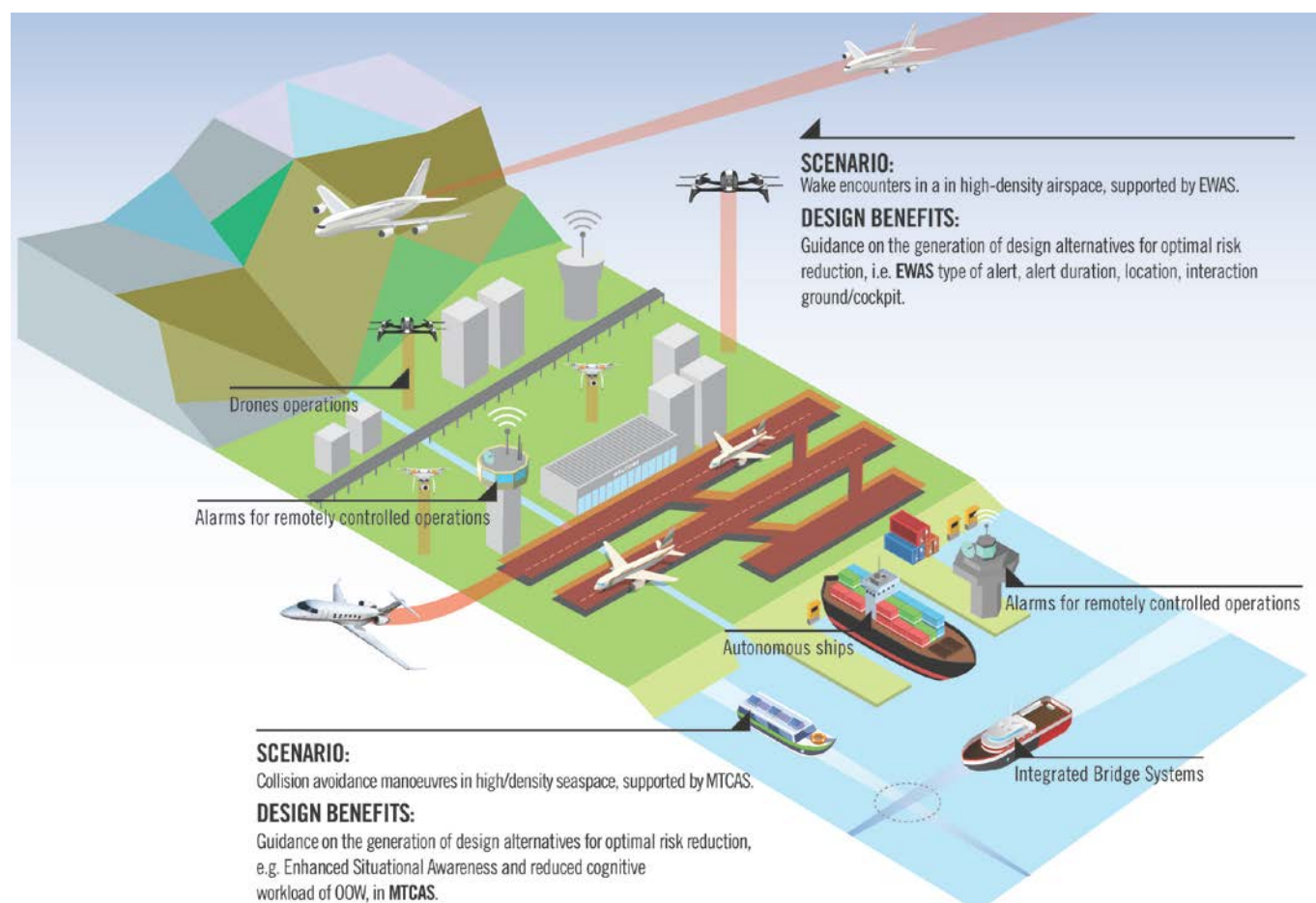


Figure 7. Concept image of SAFEMODE domain case studies examples.

Summary description of current Domain Case Studies

Aviation - En-Route Wake Turbulence – HURID for System Design

Background and Motivation

Wake turbulence encounters are being regularly reported in the en-route / cruise phase of flight in European airspace. Despite the corrected application of the airborne surveillance separation minima, some of these events have resulted in significant upsets, in particular for smaller aircraft types such as business jets.

In view of enhancing the awareness of Pilots about En-route wake turbulence encounter risk, EASA released last year a Safety Information Bulletin (EASA SIB No. 2017-10), highlighting how challenging it is for Flight Crews, or Air Traffic Controllers, to systematically detect the risk of significant wake turbulence.

To respond to this challenging situation, SAFEMODE will address a case study for cruise wake turbulence risk mitigation design and operations, addressing Human Factors aspects. This case study will build on previous European projects (R-WAKE).

Problem Statement

In such events, Human Factors plays an essential role. In most cases, the flight crews did not anticipate the upsets, creating a risk of loss of control in flight and cabin injuries. In worst case circumstances, pilots are suddenly thrown into a loss-of-control situation with a possible vertical stall.

Some in-flight incidents have demonstrated that if the pilot reacts at the first roll motion, when in the core of the

<p>vortex, the roll motion could be potentially amplified by initial pitching action, with rapid roll control reversals carried out in an “out of phase” manner, or, in case the autopilot is engaged, intentional disconnection can complicate the scenario.</p>
<p>Human Factors Risks (and other relevant HF aspects)</p> <p>The Flight Crews cannot anticipate the events, creating a risk of loss of control in flight and cabin injuries due to the pilot ‘startle’ situation.</p> <p>An alerting system may help Flight Crews take preventive actions (e.g. Cabin seat-belt sign ON, proceed with flight offset or ask for trajectory change), or help them anticipate upset management/recovery actions. In the longer term, the same system may propose resolution actions.</p> <p>The alerting system can directly assist pilots, or a ground-alert can be relayed by ATC to the Flight Crew.</p>
<p>Added Value of HURID</p> <p>This case study will evaluate the benefits of HURID for designing and assessing the risk reduction of a new safety barrier, called En-route Wake Alerting system (EWAS).</p> <p>Data retrieval, generation, and analysis in SHIELD: relevant events will be extracted from SHIELD and the dataset enriched with other data sources, notably proprietary databases of the SAFEMODE partners and External Advisors (airlines and ATC providers). The analysis will identify “from the HF perspective, what went wrong before in this type of situation?”</p> <p>HF Risk estimation and forecast: HURID will provide an estimation of the HF risk level, and its likely evolution considering traffic forecasts, using SAFEMODE risk models.</p> <p>Assessment of mitigation strategies: HURID will provide guidance on the definition of suitable mitigation strategies. Risk models will provide an estimate of the achieved risk reduction for both the airborne and the ground EWAS.</p> <p>Guidance on EWAS design: evidence-based models (e.g. What are the key human performance drivers with this type of situation?) and the HP Assurance toolkit (best practice examples, checklists on optimal design characteristics) will help system designers define the EWAS requirements (e.g. type of alert, level of reliability, timing), its interface (location, format and content), the optimal interaction between pilots and ATC.</p> <p>Guidance on validation activities: HURID will inform the definition of validation objectives for the Human-in-the-Loop simulations, identifying HF aspects to be analysed and the recommend tools and techniques. Data may include: Pilots, Air Traffic Controllers and Experts’ subjective assessments, performance metrics (i.e. flight upsets and control inputs), neurophysiological measurements</p>
<p>Case study approach and outcomes</p> <p>The case study will be performed with a first phase of data analysis and collection, including workshops and interviews with pilots and controllers. The second phase will see the detailed design of the EWAS, and then its validation with Human-in-the-Loop simulations (third phase). Apart from the validation of HURID, this case study will have the following outcomes: (i) Update of the Wake-encounter model with the validation results, (ii) Development of recommendations to EASA on wake encounter upset prevention and recovery, for inclusion in Pilot training/refresher modules.</p>
<p>Maritime - Maritime TCAS – HURID for System Design</p> <p>Background and Motivation</p> <p>The advancement in technologies allowed the rapid growth of sizes, capacities, numbers and speed of ships, making the navigation tasks harder and requiring more concentration. 60% of the navigational accidents are collisions, grounding and contact. More than 70% of accidents are reported to involve negative human contribution Although the OOW maintains a good level of safety when navigating the ship, they are still making errors – often due to lack of good sleep and food, workload, stress, noise levels, experience, ergonomics of bridges.</p> <p>Problem Statement</p> <p>In maritime navigation, all collision avoidance manoeuvres are made based on the Collision Regulations (the Rules of the Road) COLREG. There are a number of issues that can cause hassles or confusion for the OOW, including the subjective nature of the rules (“If the circumstances of the case admit” “In ample time” and “If there is sufficient sea room”), the need to collect all the navigational information from various sources to build up an adequate situational awareness (Abdushkour, et al., 2018; Belcher, 2002; Cockroft, et al., 2012).</p> <p>Human Factors Risks (and other relevant HF aspects)</p> <p>Reported incidents are often linked to human performance aspects, such as situational awareness, no or late actions. In critical situations, officers may experience information overload, high mental workload and stress situation, thus</p>

failing to utilize the electronic aids.

A support system – named the Maritime Traffic Alert and Collision Avoidance Support System (MTCAS), based on the Aviation TCAS principles - may be beneficial. The MTCAS will provide alerts and coordinated instructions for conflict resolution to OOW.

Added Value of HURID

This case study will evaluate the benefits of HURID for designing and assessing the risk reduction of a new safety barrier, the MTCAS.

Data retrieval, generation, and analysis in SHIELD: relevant events will be extracted from SHIELD and the dataset enriched with other data sources, notably proprietary databases of the SAFEMODE partners and External Advisors (shipping companies and incident investigation boards). The analysis will identify “from the HF perspective, what went wrong before in this type of situation?” quantifying when possible the underlying reasons for collision and contact.

HP Assurance evaluation of OOW’s situation awareness, and recommendations (training, Human Machine Interface design requirements, and communication protocols) to ensure safe situation awareness and hence safe separation between ships is maintained.

Assessment of mitigation strategies: HURID risk models will provide an estimate of the achieved risk reduction for different scenarios, e.g. percentage of ships equipped, type of ships equipped, type of support provided (only advisory or resolution), addressing the question “which solution will make operations safer?”

Guidance on MTCAS design: evidence-based models (e.g. What are the key human performance drivers with this type of situation?) and the HP Assurance toolkit (best practice examples; checklists on optimal alert design characteristics; situation awareness and vigilance guidance and measures) will help system designers define the MTCAS requirements (e.g. type of alert, level of reliability, timing), its interface (location, format and content), the optimal interaction between human and MTCAS and between conflicting ships.

Guidance on procedure design: evidence-based models (e.g. What are the key human performance drivers with this type of situation?) and the HP Assurance toolkit (best practice examples, relevant HF techniques to be applied) will help designers define the MTCAS SOPs.

Guidance on validation activities: HURID will inform the definition of validation objectives and activities, as detailed in the previous case study.

Case study approach and outcomes

The case study will be performed with the first phase of data analysis and collection, including workshops and interviews with OOW and system/procedure designers. The second phase will see the detailed design of the MTCAS, and then its validation with Human-in-the-Loop simulations (third phase), in Full mission simulators. The validation will include extreme/complex cases (generated from SHIELD). Apart from the validation of HURID, this case study will have the following outcomes: (i) Prototype MTCAS interface and SOPs, validated on collision prevention, (ii) Integration of MTCAS validation results into maritime risk models, with associated analysis of costs/benefits (risk reduction), (iii) Development of recommendations to IMO and EMSA on MTCAS system, (iv) recommendations for OOW training and certification strategy.

Aviation - Drone operations - HURID for risk assessment and design of safe & integrated operations

Background and Motivation

The transport sector is accelerating its digitalisation. Hence, in both aviation and maritime sectors aircraft/vessels and their associated traffic management systems will soon reach the highest levels of automation and connectivity. In the coming years and decades, drones will be fully integrated into European airspace and in some cases (in the longer term) may replace existing manned aircraft. Based on JARUS developments, EASA has proposed a risk and performance-based regulatory approach classifying drone operations under three categories Open, Specific and Certified. This approach will favour a case-by-case evaluation of all risks, including Human Factors, and an identification of appropriate mitigations extracted from a pre-defined list. The effect of those mitigations will depend on the complexity of the operational context envisaged (e.g. mixed manned & unmanned non-segregated traffic with drones).

For the EASA “specific” category, operators need to prepare a safety assessment addressing all possible risks including Human Factors, using the JARUS Specific Operations Risk Assessment (SORA) methodology. Moreover, EASA is currently developing standard scenarios using the SORA methodology, identifying Human Factors issues along with possible mitigation strategies in predefined operational scenarios.

Problem Statement

So far drone operations were limited to leisure drones at low altitude, military drones and specific drone

operations authorised in segregated airspace. Despite such operational limitations, airline pilots have already reported a large number of incidents in the close vicinity of airports, and risk of accidents is considered high.

Human Factors Risks (and other relevant HF aspects)

Reported incidents were often linked to obvious Human Factors issues such as lack of information on surrounding traffic, drone altitude measurement system, and the pilot's sensorial capabilities reduction. With the significant expected increase of low-level drone beyond visual line of site (BVLOS) operations, safety risk will increase unless appropriate risk mitigations are put in place such as U-SPACE services. Moreover, in the long term, with fully automated drones, there will need to be a paradigm shift in Human Factors risks, ensuring system-wide situation awareness to deliver safe separation between all vehicles despite a heterogeneous mixture of control, including conventional air traffic, remotely piloted drones, autonomous drone swarms, air taxis and personal vehicles.

Added Value of HURID

This case study will evaluate the benefits of HURID for the risk assessment and design of operations, complementing the current qualitative approach followed by EASA with SHIELD data and SAFEMODE risk models.

Data retrieval, generation, and analysis in SHIELD: drone-related events will be extracted from SHIELD and the dataset enriched with other data sources, notably incident data from European U-space demonstrations (e.g. SESAR U-space Very Large Scale demonstrations - the PODIUM project) as well as through the EUROCONTROL Voluntary ATM Incident Reporting (EVAIR) scheme. The EC is launching the EU Network of U-space demonstrators, which will provide further opportunities to populate the SAFEMODE drones Human Factors risk assessment database. Additionally, the Urban Air Mobility marketplace will offer opportunities in a number of European large cities to capture drone-related data and apply the SAFEMODE methodology and tools to this new aviation context. Through EUROCONTROL participation in SAFEMODE, the project will have direct access to the above-mentioned demonstration schemes.

HP Assurance evaluation of drone pilot and overall system situation awareness, and recommendations (training, Human Machine Interface design requirements, and communication protocols with ATC) to ensure safe situation awareness and hence safe separation between vehicles is maintained.

HF Risk Identification and assessment: HURID will help in assessing HF risks for drones operated in the "specific category", using SHIELD analysis results, HP models, and techniques for HF analysis. Risk identification will be associated to the specific scenarios of operations.

Assessment of mitigation strategies: HURID will provide guidance on the definition of suitable mitigation strategies with the support of risk models (where can we best intervene to make operations safer?) and evidence-based models (e.g. What are the key human performance drivers with this type of situation?), starting from those already identified by EASA in SORA and in the standard scenarios. Risk models will provide an estimate of the achieved risk reduction.

HF Risk forecast: the above risk models will be used to estimate HF risks in forward-looking scenarios of higher levels of automation, artificial intelligence adoption, and management of drone swarms.

Case study approach and outcomes

The case study will be performed with workshops and surveys with drone companies, hazard identification sessions (HAZOP), voluntary data collection and interviews with drone (RPAS) pilots, application of the (SESAR) Human Performance Case (Heintz) to selected drone operations, training and procedures, etc. Apart from the validation of HURID, this case study will have the following outcomes: (i) A HF-informed drone operating concept that reinforces the maintenance of safe separation via optimising situation awareness at drone operator and ATC system levels, (ii) the collection of appropriate drones and U-Space demonstration data into SHIELD. Links with Data4Safety PPP will also be investigated, (iii) recommendations regarding the potential use of HURID for EASA SORA and standard scenarios developments, (iv) recommendations to EASA in the context of their drone regulatory framework on HF data recording requirements to improve the identification and monitoring of HF risks in the drone sector, (v) integration of "drone traffic" into at least one of the 'macro' risk models in WP4, e.g. mid-air collision at low level.

Maritime-The Autonomous Ship - HURID for designing operations and informing the regulatory framework

Background and Motivation

Autonomous ships may start trialling in territorial waters around 2020-2021, with fully autonomous ships operating in international waters by 2035-2040. This year the IMO started a working group (MSC 99/22) to develop a regulatory framework for autonomous ships. The group is tackling different aspects: the present requirement of physical presence of a Master on-board, sensors capability, communication technology, cybersecurity, economic profits (costly investments), and operator competence and training depending on the level of autonomy. Other challenges relate to autonomous berthing (ship-port interaction), mixed traffic of manned/unmanned ships, liability.

Problem Statement

The exact concept of the Autonomous Ship has still to be refined. There may be different levels of autonomy, with different human roles, and HF risks associated. Technological developments may proceed faster than the regulation and/or the design practice. In the absence of past experience, a gap may emerge between *work as prescribed* and *work as done*. The current crew education and training system may not timely react to changes in the operations.

There is an opportunity to inform the regulatory framework and define a risk-based design approach for Autonomous Ship operations, relying on lessons learnt from aviation and HF evidence-based models.

Human Factors Risks (and other relevant HF aspects)

Autonomous ships may introduce HF issues like lack of information on surrounding traffic, crew's sensorial capabilities reduction, loss of situational awareness. For higher levels of automation (fully automated ship, the introduction of higher levels of artificial intelligence), there will be a need to be a paradigm shift in Human Factors risks, ensuring system-wide situation awareness to deliver safe separation between all vehicles despite a heterogeneous mixture of control.

Added Value of HURID

This case study will evaluate the benefits of HURID for the design of (highly disruptive) operations, and for providing recommendations for Regulatory Framework developments.

HF Risk Identification and assessment: HURID will help in assessing HF risks for autonomous operations, using SHIELD results, HP models, and techniques for HF analysis like the SESAR Human Performance Case (Heintz). Risk identification will be associated to the specific scenarios of operations.

Guidance of best level of automation: the HP Assurance toolkit (e.g. via the SESAR Levels of Automation guidelines) will support the generation of scenarios of operations at various levels of automation, and the identification of related HF risks and benefits (what is the best role for humans? Where is regulation mostly needed?).

Definition of the framework of future competences: task analysis methods and evidence-based models of human performance will be applied to future scenarios of operations to define future skills and competencies.

Case study approach and outcomes

The case study will be performed with workshops and surveys with industries, ship operators, and regulators, to first define target concepts of operations. Hazard identification sessions (HAZOP and SESAR Human Performance Case) will be performed to identify risks. Risks will be assessed and integrated into SAFEMODE risk models, for the main types of operations. The case study will benefit from the findings of previous EU projects (i.e. MUNIN). Apart from the validation of HURID, this case study will have the following outcomes: (i) top HF risk areas for Autonomous Ships operations, (ii) recommendations and regulatory gaps, (iii) development of risk-based design approach for Autonomous Ships, (iv) education and training framework for maritime schools and training institutions, with self-assessment matrix as part of the HP assurance toolkit, (v) integration of autonomous ships into at least one of the 'macro' risk models in WP4, e.g. ship-ship collision.

Maritime - Integrated Bridge Systems – HURID for design (life-cycle design of alarm management)

Background and Motivation

In high-risk industries, such as maritime, safety-critical situations exist as part of routine operations. Integrated Bridge Systems (IBS) form the maritime equivalence of a cockpit environment and it is within this environment that the operator must be able to deal with alerts/alarms generated in both abnormal and normal conditions from multiple system sources.

In safety-critical situations, cognitive load on the operator requires to be effectively managed. This is achieved principally through training and design. Establishing a minimum set of alarms that are necessary to keep a process safe is the goal of alarm rationalisation.

Problem Statement

Historically one of the key drivers in the design of aircraft cockpit avionics and systems has been spatial constraints, i.e. the requirement to capture a huge amount of system data in a limited display area. The same driver

has never existed to the same extent in the maritime domain. As ships bridges are generally very spacious (some bridges are well over 60m wide). This factor has resulted in the location and display of information being contained across multiple consoles, with a lot of variations in high-level philosophy, menu structures, ergonomics, audibility. In such a situation, human limitations and capabilities are often not properly considered, even though IMO is paying increasing attention to Bridge Alarm Management (BAM; (Pomeroy, et al., 2002)).

In the maritime industry, the fusion and integration of multiple systems within a system have made centralised alarm management a challenging area. Moreover, there is a gap between what is stated in rules and regulations, and the quality of alert management systems that are developed, programmed, and installed onboard ships.

Human Factors Risks (and other relevant HF aspects)

The problem is that the high number of nonuniform alerts and alarms (in other words alert flooding) on the bridge may overload the operator with workload, which causes fatigue and reduced ability to take the correct steps against a problem. Hence there is a risk of the bridge crew do not anticipate the risks which prevent them from taking effective corrective actions (Human Element in ECDIS related accidents, 2018).

The alert system needs to filter the information available in the system and present the navigator the actually important information.

Added Value of HURID

This case study will utilise HURID in order to design and validate the benefits of an integrated system for alert management on ships bridge.

Data retrieval, generation, and analysis in SHIELD: Data repository of SHIELD will be utilized to identify accidents that are related to ineffective alert and alarm management. The analyse will identify key success (and failure factors) to define specific design requirements: “from the HF perspective, what went wrong before in this type of situation, and what went right?”

Guidance on alarm design in integrated bridges: evidence-based models (e.g. What are the key human performance drivers with this type of situation?) and the HP Assurance toolkit (best practice examples; checklists on optimal alarm design characteristics; situation awareness and vigilance guidance and measures) will help system designers define the alarm philosophy, requirements (e.g. type of alarms, hierarchy, timing, colour and audio-coding, etc.), its interface (location, format and content) in different operating conditions.

Guidance on validation activities: a prototype/mock-up system will be developed and for Human-in-the-Loop validation. HURID will be used to inform the validation objectives as detailed in previous case studies.

Case study approach and outcomes

This case study will start by analysing the relevant accident information from the databases generated. Then SAFEMODE’s end-user partners Rolls Royce and CETENA shipyards will collaboratively work with research partners to define design requirements for a unified human-oriented system (Rolls Royce will bring their Unified Bridge Concept (Merwe, 2016)).

Once the design requirement and objectives are defined, a prototype system will be developed accordingly. Then, validation sessions will be performed to test different design options, e.g. the system can categorise the importance of the alarm and prioritise accordingly. Depending on the validation results, feasibility studies for implementation in new ships will be carried out. Apart from the validation of HURID, this case study will have the following outcomes: (i) Human-oriented design guidelines for bridge alert management systems, (ii) Prototype system SOPs, validated via Human-in-the-Loop simulations, (iii) Integration of validation results into maritime risk models, with associated analysis of costs/benefits (risk reduction), (iv) Recommendations to IMO and EMSA on the improved Integrated Bridge Systems and better information display and alarm management, (v) Recommendations and training package for effective alarm management.

Cross-modal - Alarms for Remotely Controlled Operations – HURID for system design

Remote Control of Operations include all those cases where the operator is not co-located with the objects on which s/he is acting and controlling. Vision is via displays, with various refresh rates or resolutions, and sound, vibrations, temperature, and other parameters are either not relayed, or re-transmitted with possible lag, or degradation in quality.

Furthermore, this context is very prone to the introduction of novel tools (image augmentation, visualisation of automated processing of images to extract features like position in space-speed of a target, parallel control of multiple locations). This leads to the creation and use of new working methods whose robustness to human failure have not been established yet and need to be tested and evaluated. In SAFEMODE this case study is relevant for both aviation and maritime (remotely-piloted vehicles and VTS/remote towers).

Problem Statement

Operators may experience a diminished “sense of presence”, which can affect human performance, e.g. longer reaction times, higher workload, less situational awareness, more fatigue, etc.

This effect may be particularly relevant when operating in degraded modes (due to technical failures, or cyber-attacks) or in adverse weather conditions (e.g. low visibility).

Human Factors Risks (and other relevant Human Factors aspects)

The “loss of presence” can induce a decrease or loss of situational awareness, which can be highly problematic in degraded modes. Operators may find themselves overloaded with alarms about the remote control system status, with less spare attention to address critical operational situations.

Design guidelines on how to integrate various types of alarms will be helpful to ensure consistency across different systems (cross-modal) and support the operator in prioritising efficiently alarms and actions.

Added Value of HURID

This case study will evaluate the benefits of HURID for designing alarm systems (and their hierarchy) in remotely controlled operations (e.g. remote tower of multiple airports, VTS) and in degraded modes.

Data retrieval, generation, and analysis in SHIELD: relevant events will be extracted from SHIELD and the dataset enriched with other data sources, notably proprietary databases of the SAFEMODE partners and External Advisors (e.g. ATC providers, SESAR Remote Tower projects). The analysis will identify “from the HF perspective, what went wrong before in this type of situation, and what went right?”

Guidance on alarms: evidence-based models (e.g. What are the key human performance drivers with this type of situation?) and the HP Assurance toolkit (best practice examples; checklists on optimal alarm design characteristics; situation awareness and vigilance guidance and measures) will help system designers define the alarm requirements (e.g. type of alarms, hierarchy, timing, colour and audio-coding, etc.), its interface (location, format and content) in different operating conditions and levels of automation.

Human Factors Risk Models: SESAR has carried out several evaluations of Remote Tower systems, and these safety case approaches can be used to estimate the risk level of remote control under degraded modes for both aviation and maritime scenarios.

Case study approach and outcomes

The case study will be performed with the first phase of data analysis and collection, including workshops and interviews with system designers and remote operators. The second phase will see the detailed design of the alerts for different types of scenarios (including degraded modes) and levels of automation, then its validation most likely via prototyping sessions (third phase). Apart from the validation of HURID for design of remote systems, this case study will have the following outcomes: (i) establish guidelines and best practices for alarms and supporting visual display features in remotely controlled operations, (ii) develop recommendations to regulators and guidance material for safety assessment of remotely controlled operations, (iii) definition of a risk model for remote operations, including focus on degraded modes, (iv) identification of emerging risks and forecast of risk level in future scenarios.

1.3.6 Sex and/or gender analysis

Gender has been shown to be relevant to human performance and safety. Gender aspects will be taken into account when developing SAFEMODE safety events analyses, scenarios and methodologies. Some papers show different levels of risk aversion in different kind of decisions and activities between women and men (Maxfield, et al., 2010; Borghans, et al., 2009). Other studies analysed safety attitude of non-professional and professional drivers (Rhodes, et al., 2011; Lewis, et al., 2007) that may be relevant for maritime and aviation operators. In higher levels of automation, different gender acceptance levels need to be considered (Webster, 2014; Grint, et al., 1995).

The SAFEMODE project aims to deliver solutions and carry out studies that are not gender-specific, so this aspect will be considered in enrolling experimental subjects and controlling for potential gender variations with the appropriate sample size.

Flexible and scalable risk-informed framework for evaluating and optimizing Human Factors in system and operations design, in Aviation and Maritime.
Continuous learning & ability to face emerging threats

Human Factors Risk Models
Quantified risk models (fault and event trees) incorporating human actions, errors and recovery.
Ability to evaluate design options against risk, and determine where best to invest

Human Assurance Toolkit
What designers need to know about human performance and corresponding design checklists
Human Assurance Levels to decide how much HF is needed
Human Reliability models for Maritime & Aviation
Guidance materials for investigators and managers for effective monitoring of everyday operations



Case Studies

Aviation:
Wake vortex encounter alert system
Drone integration into civil airspace
Maritime:
TCAS-like collision avoidance system
The Autonomous Ship
Cross-sector:
Alarm design for remote operations

Regulatory & Industry Engagement

Guidance to support regulatory frameworks in maritime and aviation for increased HF integration
Cross-domain Just Culture framework
Human Factors Standard of Excellence for industry benchmarking

SHIELD Database

Open repository of safety-related Human Factors incidents and their contributory factors, with semi-automatic analytics and multi-language text mining.

Figure 8. Graphical recap of SAFEMODE main building blocks

1.4 Ambition

1.4.1 Beyond the state of the art

Even though safety events/incident/accident data are systematically collected for aviation, by nature they offer limited insight into actual Human Factor issues at stake, because only high-level analysis of the frequency of HF issues reported (when–where) can be built using ECR data (and ECCAIRS) for instance. Similarly, in the maritime domain, incident/accident data provide insight into the problem but are insufficient for feeding back to design.

In this situation there are a number of research gaps that need to be tackled:

- The Human Factors contribution to risk is multi-faceted and neither well-agreed nor well-understood. Incident analyses may lack a high-level system view and focus too much on “what happened” and “who did it”, neglecting deeper causes, “the why”.
- The incident information needed to enable HF to inform design, whether it is design of systems or operations, is not generally reported or collected. Where such information is collected and analysed, it is not given to designers or risk assessors in a usable format, for instance by integrating it into existing risk models.
- Design and operational practices should be developed with the capacity to handle emergencies. However, especially in the maritime sector, design and operations are not generally fit for safety-critical and emergency situations, even though there are standards for emergencies (e.g. Safe return to port, SOLAS Regulation 21.1.4).
- Synergies, cross-fertilisation opportunities, and differences between the two transport modes need to be systematically analysed to enable effective transfer of knowledge.

Additionally, many risk models fail to take into consideration the human element of operations, beyond the requirement for an ‘operator’ to make an input to the system. It is often easier for current risk modelling approaches to focus on technical and equipment issues rather than the ‘softer’ issues relating to people, teams, organizations and their culture. **Yet current risk modelling approaches often show little insight into why human errors occur**, whether due to workload, situational awareness problems, teamwork (especially in multi-cultural teams such as on ships), fatigue, organizational focus on cost rather than safety, etc. It is worth noting that with **EU Common Regulation 2017/373**, the consideration of Human Factors issues in safety is now enshrined in regulation. **SAFEMODE aims to help this become a reality in safety management.**

The SAFEMODE approach to Human Factors Risk Models is based on a **strong cross-fertilisation** across safety-critical industries, to profit from **the best of both worlds** (aviation and maritime). For this reason, this state-of-the-art section is structured in three sub-sections presenting the most relevant outcomes in both sectors: “Overview of Risk models in Aviation”; “HF tools and methods”, “Risk-Based Design in Maritime”. The cross-fertilisation opportunities extend beyond these two worlds. SAFEMODE will profit from the extensive experience of its partners to enlarge the collaboration, as described in two dedicated sub-sections “Potential synergies with nuclear

Overview of Risk models in Aviation

This section provides information on the evolution of HF risk models from their early beginnings and includes, besides methods developed strictly for aviation, general frameworks and models of human performance from psychology, and those few models that can be adopted cross-domain, mainly from the nuclear industry.

Some of the early examples relate to psychology, cognition and decision-making processes, with Fitt's Law (Fitts P. M., 1964) being a great example of a predictive model of human movement. In its basic formulation, it predicts that the time required to rapidly move to a target area is a function of the ratio between the distance to the target and the width of the target. Another study by Fitts and Jones in the mid 20th century (Fitts P. M., 1947) marks the beginning of the systematic study of pilot's cognition and eye movements: the authors studied the most effective configuration of control knobs to be used in an aircraft cockpit. Current research, such as the Human Performance Envelope (HPE) deals with the initially developed concepts such as workload, attention, vigilance and memory and considers them together, in order to observe their combined effect on safety (Silvagni, 2016).

The initial elements of the HPE were identified and initially analysed individually. As technology advanced in the late 50s, more research went into the direction of Human Reliability (HR) or Human Performance (HP). Both are affected by a plethora of factors, such as age, state of mind, physical health, attitude, emotions, propensity for certain common mistakes, errors and cognitive biases, etc. The belief among researchers at that point was that quantifying error (Human Error) would capture the requirements of the system and the human cognitive limits in an accurate way. Since then, a number of Error Prediction models have been developed and used, one of the earliest being THERP (Technique for Human Error-Rate Prediction) (Swain, 1964). It models Human Error Probabilities (HEPs) using a fault-tree approach, but also accounts for performance shaping factors (PSFs) that may influence these probabilities. It has been validated by comparing its results with other HRA methods as well as against raw data, and has been used in Nuclear, Offshore and Medicine. THERP shortcomings are the high effort required to produce HEPs, (Castiglia, 2015), the low range of PSF typically applied and the absence of underlying psychological causes of errors (Kirwan, 1996).

Another widely used HRA method was developed in 1985 by Williams called HEART. It is a ‘first generation’ HRA technique, as it is THERP, yet it is dissimilar to many of its contemporaries in that it remains still used (Kirwan, 1996). It has been applied in Nuclear, chemical, aviation, rail and medical and has been empirically validated. Its shortcomings are those of considering human error as isolated, unaffected by other tasks (Castiglia, 2015), scarcity of contemporary data underpinning the method, and lack of consistency in treating errors of commission (when an operator does something unrequired). It is worth mentioning DYLAN (Cacciabue, 1986), because it has been very influential for the field as a whole. It represents a dynamic event tree, where the propagation through the tree is determined by a dynamic simulation of events, including probabilistic failures of components. Another cognitive model is COSIMO (Cognitive Simulation Model) 1987 (Cacciabue, 1992), simulating how operators manage complex environments/processes. It has been developed as a prototype.

CREAM (Cognitive Reliability and Error Analysis Method) is another proposal for a second generation HRA (Hollnagel E. , 1998), that aimed at determining situations in which reliability of human cognition may be reduced. Other techniques for HRA that can be mentioned are APJ (Absolute Probability Judgement) (Seaver, 1983) and PC (Paired Comparisons) (Hunns, 1982) that have little HF sensitivity. SLIM (Embrey, 1984) and Influence Diagrams (Phillips, 1983) had HF sensitivity, but had seen little use in a risk assessment frameworks.

In 1990, Prof. James Reason published the reference book for human error, discussing a two-fold approach: the person or the system view. (Reason J. , 1990). The person view is based on individual cognitive processes (perception, memory, attention, decision making) and it is linked to Jens Rasmussen's Skills, Rules Knowledge Model (SRK) (Rasmussen, 1983). For the system approach, he proposed the so-called "Swiss cheese model" in which accidents can be prevented by a series of barriers (human, procedural or operational), and the holes in the cheese represent either active or latent failures. Although widely used, it had been criticised as being too static and linear (Reason J. H., 2006). HFACS (Human Factors Analysis and Classification System), developed by Dr Scott Shappell and Dr Doug Wiegmann, is a broad human error framework that is heavily based upon Reason's Swiss cheese model. (Shappell, 2001). The HFACS framework provides a tool to assist in the investigation process, understand underlying causal factors, and target training and prevention efforts. Another well-known framework is SHELL-O (Software, Hardware, Environment, Lifeware, Organisation). First designed by Edwards in 1972 and later updated by Hawkins (Hawkins, 1987), it is used to understand HF as the analysis of “interactions between system elements”. SHELL is mentioned in various ICAO HF documents.

Barrier models can be extended to incorporate a fault tree structure that describes how the failures occur, using formal safety engineering notation to explore failures and then quantifying the likelihood of failure and recovery. Fault tree modelling approaches can then be extended to focus not only on equipment failures and reliability, but

also on operator tasks and actions. The integration of human tasks into fault tree modelling for human centred tasks provides a view on how operators contribute to failure *and* success in operational incidents. This approach was first used in nuclear power, but has since migrated to other industries including aviation and maritime. The latest development is the Accident Incident Model (AIM) and IRIS by (EUROCONTROL, 2006). Risk is modelled in a qualitative and quantitative manner, by assigning probabilities to situations. The model resembles a tree with hazardous situations developing from bottom to the top, potentially stopped by barriers. It is based on empirical data and has been in use for some time. It has some limitations in modelling dynamic situations and the HF aspects.

Overview of HF tools and methods

The SAFEMODE Risk models will be complemented by a toolkit of Human Performance Assurance methods. The toolkit will review the extensive body of knowledge produced by the HF community in recent years, including sources like the Federal Aviation Administration Human Factors Workbench (US Department of Transportation, 2018), the methods described in SKYbrary (EUROCONTROL, 2008) under the Human Performance and the Just Culture sections, the Human Factors Integration in Future Air traffic management systems (HIFA) repository of tools (currently hosted in SKYbrary). Other methods and techniques to be reviewed include EUROCONTROL SOAM (EUROCONTROL, 2005), TRACER (EUROCONTROL, 2004; Shorrock et al. 2002), HERA, task analysis techniques, checklists of HF aspects including the SESAR Human Performance Arguments (SESAR, 2018), **Human Assurance Levels (HALs)** (Mana, et al., 2007), Human Entropy model (HENT by Strathclyde University), and the Human Performance Standard of Excellence for aviation (EUROCONTROL, 2015). Methods from other domains will also be considered, for instance the SACADA database approach from the nuclear power sector, and the Incident Factor Classification System and the RARA technique for the Railways (Gibson W. H., et al., 2015) (Gibson W., et al., 2013).

Data collection in Case Studies will involve the development of **bespoke neurophysiological indicators** for well-known Human Factors concepts including workload, stress, situation awareness, out-of-the-loop. SAFEMODE includes partners with extensive expertise in a number of neurophysiological measures, such as Electroencephalogram (EEG, related to brain activity), Electrocardiogram (ECG, heart activity), Electrooculogram (EOG, ocular activity), Electromyogram (EMG, muscles activity), Galvanic Skin Response (GSR, skin sweating), Skin Temperature (ST), Body Posture (BP), and Facial Expression (Andreassi, 2000). Neurophysiological indicators will be compared with qualitative measures and subjective assessments, in order to characterize the considered Human Factors and related risk factors from different perspectives, and then analysed by using state-of-the-art machine-learning based algorithms (Aricò et al., 2017; Aricò et al. 2018), in order to fit the mathematical models to each operator and minimize inter-user variability. SAFEMODE will generate an innovative and systematic approach to quantify and objectively measure HF by taking into account, at the same time, the behaviours, emotions, and mental reactions of the operators, and integrating them with the data related to accident and incident investigations.

Risk-Based Design in the Maritime Industry

The Risk-Based Design (RBD) framework that resulted from the EU FP6 SAFEDOR research project defined RBD as "a formalised methodology that systematically integrates risk assessment in the design process with prevention/reduction of risk embedded as a design objective, alongside "conventional" design objectives" (Papanikolaou 2009; Vassalos et al. 2015). The basic objective of the RBD process is to provide evidence on the safety level of a specific design solution (Bainbridge et al. 2004) and subsequently demonstrate that it is within the acceptable limits). The motivation was to promote innovative ship designs that do not comply with the existing prescriptive regulations and optimize cost-effectiveness (Sames 2009). This framework enhances the conventional ship design process by treating safety as an additional design goal (Figure 9).

During the SAFEDOR project, several innovative ship concepts and technologies were used to validate the RBD framework (Breinholt et al. 2012). Some examples include a lightweight composite sandwich superstructure for a RoPax Ferry, a fast full displacement RoPax Ferry, and the risk-based optimization of the AFRAMAX tanker cargo space. The RBD framework demonstrated that these concepts are safer than corresponding conventional designs.

Industry Guidance on RBD. The use of risk-based approaches for ship designs that do not comply with the standard prescriptive international regulations has been accepted by the International Maritime Organisation (IMO) by allowing for alternative designs in the international Safety of Life at Sea (SOLAS) convention (SOLAS Part A, Reg.5) and introducing the concept of Goal-Based Standards (GBS), where the designer provides demonstration of an acceptable safety level (IMO 2006). In this context, the Lloyd's Register Classification Society has published guidelines for the application of the RBD process from ship designers that seek approval for an innovative design (LR 2016) (in Figure 10).

Tools and Models for RBD. Existing attempts to develop probabilistic simulation tools for integrating risk assessment into the ship design process have mainly focused on the technical system failures that contribute to the safety occurrences, as collision (Ståhlberg et al. 2013), fire/explosion, grounding, and flooding (see also

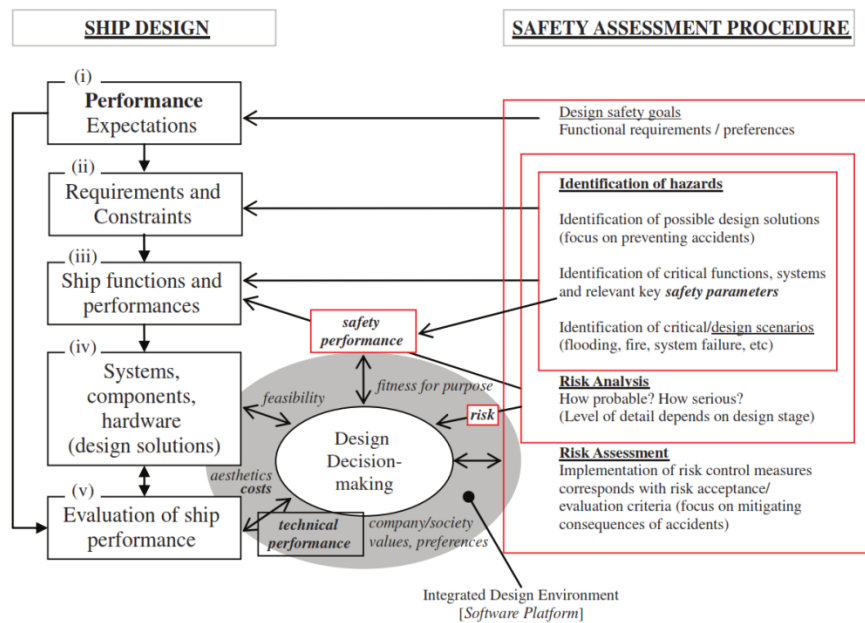


Figure 9: High-level SAFEDOR RBD framework (Vassalos 2009).

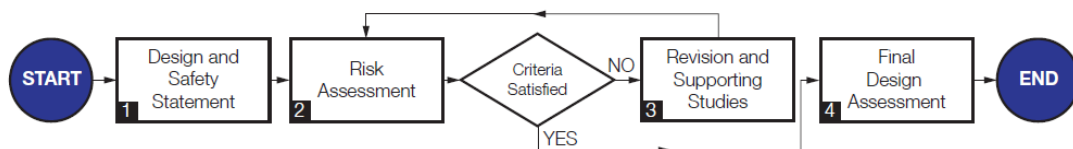



Figure 10: Generic RBD process outlined in the Lloyd's Register guidelines (LR 2016).

The quantification of human performance, and its impact/contribution to safety, has been treated in a limited manner in existing RBD probabilistic models. This research gap mainly relates to the lack of appropriate data for probabilistic modelling, as human factors are inconsistently recorded in existing marine accident databases (Konovessis et al. 2013). An advanced accident marine database was proposed to support high-quality risk assessments. However, the proposed database structure records the human contribution only as a binary variable (i.e. true or false), with no other details. The authors also proposed a data mining framework for building BN risk models from the accident database (Cai et al. 2014, 2015). A BN model describing the actions of an Officer On Watch (OOW) was developed in the SAFEDOR project (Leva et al. (2006), to calculate the probability of a collision accident.

Indicative examples of previous EU research projects on Human Factors in risk-based design are the EU FP7 CyClaDes and FAROS projects. The focus of the FAROS project was on modelling the relationship between Global Design Factors (e.g. ship motions, noise, vibrations, and human performance), human errors, and the occurrence of marine accidents. Bayesian Network risk models were developed both for estimating personal risk (i.e., injuries and individual fatalities) and societal risk, for collisions and groundings (Montewka et al. 2017). The CyClaDes project dealt with the concept of Crew-Centred Design (CCD). Sotiralis et al. (2016) developed a BN model that calculates the probability of a collision as a function of human performance in normal, abnormal, and critical operational conditions. Ventikos and Sotiralis (2016) applied a risk matrix to estimate the risk reducing effectiveness of human-centred measures for transportation of heavy equipment in the engine room of a ship. Another example focusing on organisational factors is Trucco, 2008.

In the maritime sector, the risk added in the system by humans is referred to in isolation, mainly looking at the human error linked to the afferent task. Therefore, the main research direction has been on human reliability analysis, task analysis and task allocation. General guidance on system design can be found in papers on task allocation, reviewed in Melanie et al., (1997). Williams (1988) complemented the existing research by developing a method for identifying situations where the involvement of more than one operator is required. Tainsh (1985) is one of the few methods used in practice for developing extensive decision criteria for human-machine and human-human task allocation, and comparing different configurations. Papantolopoulos, (1993) developed methods for organizing the allocation process in a systematic way and with a consistent iterative approach (Wei, 1994).

In practice, only a few methods are used and little evidence  as found that any of the methods is used as self-standing. Practitioners tend to 'mix and match' different HF methods in order to arrive at what they frequently refer to as a "pragmatic solution" to a particular problem, coping with individual methods insufficiencies.

Synergies with railways

SAFEMODE includes a partner from the railways sector, the Rail Safety Standards Board (RSSB). RSSB is involved because of their work on two areas closely related to the scope of the topic: (i) Incident analysis and development of a Human Factors Safety database, (ii) Use of Human factors data in design and safety, including via usage of a quantified Human Reliability tool (RARA).

Human factors safety databases. A key starting point for the development of the role of human factors in safety learning was an analysis of a sample of 280 Great Britain railway incident reports from 2005-2008 (RSSB 2009). This analysis was undertaken by Human Factors specialists at RSSB with support from operations specialists, and provided insights into the benefits of collecting human factors data on the underlying causes of incidents for the industry. Based on this initial research it was identified that this work should be carried on and delivered into national application as part of the national incident reporting database in the GB rail industry. This database is called the Safety Management Intelligence System (SMIS). SMIS began operating in 1997, and organisations such as Network Rail and the passenger/freight train operators enter about 75,000 events into it each year. Incidents reported include fatalities and injuries to people while they are on the rail network, whether they are a passenger, a member of the public or part of the workforce, as well as events which pose a risk such as signals passed at danger and derailments.

Through a user-centred development process, a national classification system which captures information on HF was developed as part of SMIS (RSSB, 2015). This part of SMIS is termed the Incident Factor Classification System (Gibson et al, 2012). Other processes undertaken during this work were a national quality review of investigation reports from a HF perspective and delivery of the framework into the National Railway Investigation Standard (RIS-3119-TOM).

Since its development and implementation, the Incident Factor Classification System has been used to develop strategy and learning in a number of areas for the British rail industry, including: Signals Passed at Danger (SPADs), Safety Critical Communications, Fatigue, and Route Knowledge (Bowler & Gibson 2015).

Human Factors in Design and Safety Decision Making

Another key HF-led development at RSSB has been the research and delivery of support to industry for considering human reliability as part of risk assessments for design and operation.

One tool which has been developed to support industry is Railway Action Reliability Assessment, which is used for the quantification of human reliability and provides generic estimates of human performance reliability (RSSB, 2012). The approach is based on knowledge from the Human Performance Database COREDATA, and is based on the previously-mentioned HEART technique. In addition, the Red Aspect Approaches To Signals (RAATS) toolkit has been developed for the GB rail industry by risk specialists from RSSB (Stow et al., 2016). The tool has been used to develop driver reliability estimates for SPADs.

Railway Action Reliability Assessment (RARA) has been used in a variety of practical applications within the British rail industry, for which examples are: Support to the development of equipment design, Supporting incident investigations, Supporting operational decision makers at companies.

Synergies with the nuclear sector

One of the first things the nuclear power industry did after its 'Human Factors wake-up call' (Three Mile Island in 1979) was to **develop a common way of looking at, and learning from, Human Factors safety-related events, via a common incident classification system** that codifies the errors and the factors that contributed to them. In parallel, it **developed guidance for designers** on how to design better equipment and interfaces, based on Human Factors knowledge of human capabilities and limitations. It then **collected and analysed human performance data** and generated a number of tools (called Human Reliability Assessment techniques) that can be used to predict likely responses in a range of risk-based scenarios, or for more automated designs. This led to the current practice of risk-informed decision-making about new designs and operational concepts, which always includes the human element.

Simultaneously, the industry began **integrating quantitative estimates of human failures and recovery actions into large risk models**, focusing on those accident categories which dominate risk for any nuclear power plant. Use of such Human Reliability Assessment tools inside large risk assessments is now mandated in many countries, with global standards and guidance available from the highest governing body in the industry, the International Atomic Energy Agency. The industry did one last, but important thing. It set up an **operational feedback system**, so that every nuclear power plant in the world has two operational feedback engineers, whose job is to help

disseminate insights from recent key incidents or accidents. Every nuclear power plant worldwide will have briefed its operational staff on recent important events and incidents with six months of the report being released. This allows all operational staff, as well as designers and researchers, to remain aware of newly developing issues.

Another lesser-known fact is that some of most innovative advances in Human Factors management did not come via enforcement from the nuclear regulatory authorities, but from the industry itself, in particular WANO, the World Association of Nuclear Operators.

There are a number of **lessons that both maritime and aviation can learn** from nuclear power. **First, determining a common way of describing human contributions** (positive and negative) to risk is absolutely key. This common language, known as a taxonomy, must be the basis both for investigation of events, as well as assessing risk or future performance. The **second lesson is that Human Factors models need to be flexible**, being able both to support relatively small-scale or focused design or operational changes, as well as to consider large-scale impacts associated with system-architecture-level changes, such as a step change in automation. **Third, Human Factors approaches need to be accepted and integrated into design and engineering practices**, as well as regulatory frameworks.

Referring to the research gaps at the beginning of this section, SAFEMODE will advance the state of the art by:

- Providing a cross-industry approach for the capture and analysis of safety events,
- Providing a finite series of risk models for key safety events that allow human actions to be understood in relation to an incident,
- Identifying the key **performance influencing factors that are appropriate for both domains**,
- Establishing a framework for Human Factors risk will allow the **human contribution to failure and success to be documented and assessed quantitatively**,
- Allowing designers to understand the potential impact of their design on human performance,
- Allowing designs to be targeted at minimising current Human Factors problems, and significantly boosting the chances of recovery from system failures and adverse events,
- perform an extensive review and selection of best in class HF methods and tools, customising them for incident investigation and system/operation design and integrating them into the HURID framework.

Advanced data analytics and text mining for automatic building of the Open Data repository

Current approaches for analysis of databases of safety occurrence reports mostly use manual processing by human experts for identifying event scenarios, contextual elements and Human Factors aspects. Such manual processing poses considerable limitations on learning the right lessons from the wealth of available reports, since it is highly time-consuming. It also suffers from differences in interpretations between human analysts, and does not support consistent analysis of reports in different (European) languages, nor identify patterns that are not obvious to the human eye. Data and text mining methods can help to overcome these limitations and support the automatic building of the Open Data Repository using large sets of internationally available safety occurrence reports and related contextual data.

Text mining is a process of retrieving underlying themes or concepts contained in a large collection of documents, in our case the safety data collection. Natural Language Processing (NLP) technologies, like categorization, clustering, summarization and information visualization are commonly used in the text mining process. Text categorization or classification is a supervised learning method which automatically assigns one or more categories to a free text document. Statistical classification techniques like Naive Bayesian classifier, Nearest Neighbour classifier, Decision Tree, Random Forest (RF) and Support Vector Machine (SVM) can be used to categorize text. Text clustering, on the other hand, is an unsupervised process which can be used to find groups of documents with similar content. In data mining, K-means and Graph-of-Words are frequently used clustering algorithms, and also in the text mining field they give good results. Both supervised and unsupervised techniques can effectively be used for data and text mining in support of safety management and improvement of transport operations (Shi, et al., 2017; Ghofrani, et al., 2018).

A key challenge in text mining is that often people use different words to describe the same concept. This becomes important during the analysis of incident reports, and the application of a taxonomy or ontology to new textual data. Pieces of text that refer to similar incidents must be grouped together even if the words used are different. Proposed techniques focus on projecting the lexical representation of textual data to a latent semantic space, where sentences close in semantics are lying close by in this latent space. Techniques that have been proposed in the past include Latent Semantic Analysis (LSA), Matrix Factorization (MF), their probabilistic counterparts, probabilistic LSA and probabilistic MF, topic models, such as LDA. Recently neural methods have risen as a way to create distributed representation of words, i.e. representations of words in some latent concept space, as well as representations of

utterances (Van Gysel, et al., 2018; Scheepers, et al., 2018). Incident narratives present a number of challenges to existing text mining techniques, either text classification or text clustering: (a) Incident narratives, as with any user-generated content, are known to contain noisy text, including typos and spelling errors, as well as use of idioms and culturally-specific nuances; (b) Incident narratives often contain ambiguous abbreviations, with different abbreviations referring to the same concept, but also the same abbreviation referring to different concepts; (c) Incident narratives are in a number of different languages, and often even contain multi-lingual text within the same narrative. To tackle these challenges, textual data will need to be carefully pre-processed by noise-removal and text normalization (Bo, et al., 2011). Herein text is normalized so that mis-spelled words are corrected, and abbreviations are disambiguated and connected to a single concept. This can be addressed by well-defined ontologies or by developing unsupervised methods for abbreviation normalization and disambiguation. Furthermore, identifying the language of specific words, and processing them towards classification or clustering is a hard problem. This project will focus on learning word representations of multiple languages jointly in a concept space, so that words of same meaning in different languages are mapped to the same concept (Waleed, et al., 2016; Hieu, et al., 2015).

Text mining for data extraction of HF aspects from safety occurrence reports is a highly innovative topic as well as a crucial contribution for building and maintaining the SHIELD Open Data Repository. SAFEMODE advancement beyond the state-of-the-art is the combination of the assessment of the most promising text mining techniques in categorizing and clustering safety occurrence narratives, with experts' input, and with existing best-in-class methods and tools for incident investigation, in order to **deliver a semi-automatic process of text retrieval, analysis, and population of the SHIELD Open Data repository**. NLP will be used in connection to experts in the field to understand what textual fragments in the incident narratives are actually indicative of the patterns we are seeking. This part is equally important to an accurate prediction, since it will allow us to look back at the raw text as evidence.

1.4.2 Innovation potential

Summarising, SAFEMODE outputs that represent an advancement beyond the current state of the art are:

- User-driven definition of the SHIELD Open Repository: SHIELD will integrate the analysis of Human Factors, contextual elements and typical scenarios, serving as a consultation tool for designers and risk assessors.
- Text mining on existing databases: SAFEMODE will test and select best-in-class techniques for systematic analysis of existing incidental databases and reports therein. Multi-language constraints will be addressed.
- Customisation of HURID to different users: HURID will be validated with a variety of end-users, to ensure acceptability and suitability across a large range of local, organisational and environmental constraints.
- State-of-the-art tools and methods for monitoring and assuring the Human Performance Envelope.
- Human Factors-informed Risk Based Design Framework, to support optimised safe system design and an effective regulatory framework.

Alignment with Research Agendas

SAFEMODE research focus is aligned with the ACARE Strategic Research Agenda, Action Area *Optimise human and organisational factors for safety*, addressing increased automation and smart human-computer interfaces, and monitoring of the Human Performance Envelope. It also addresses the Action Area *Collaborate for safety*, in particular, the development of “tools and methods to accurately determine the risk impact of evolving hazards and threats”, and the Action Area *Ensure operational safety* for the ‘Safety Radar’: near real time detection of deviations in safe performance within the total Air Transport System [ACARE SRIA Vol.1, 2017]. The project is also coherent with the Aviation Strategy for Europe-COM (2015)598, and the European ATM Master Plan (2015).

For the maritime, SAFEMODE research outputs contribute to EU Maritime Europe Strategy Action - MESA's, for the creation of Safest, Greenest and Smartest Maritime industry in Europe, in particular by developing the human factor risk models for current and emerging risks. SAFEMODE is aligned with EU maritime Policy (SWD (2016) 326). SAFEMODE case studies relate to the DIRECTIVE 2002/59/EC ‘establishing a Community vessel traffic monitoring and information system’ to prevent accidents and enhance safety in EU waters.

2 Impact

Even though human error is referred to in almost every accident investigation report, Human Factors are still not properly integrated into design (of vehicle, equipment, tools and procedures). Gaps between designers and operators, unharmonized Human Factors data collection, lack of understanding on human behaviour and performance shaping factors, as well as lack of Human Factors-integrated risk models, do not allow proper integration of Human Factors at the design stage. For example, in the maritime sector, Formal Safety Assessment and current risk-based design approaches use the outcome frequencies of accidents (i.e. accidents per ship-year)

from past occurrence data, and improvements generally focus on consequence analysis (modelling after the accident to mitigate its impact). Based on simplistic event tree and frequency analysis, the modules remain unable to address the complexity of human/system relationships. Therefore, the effectiveness of Human Factors improvements in design cannot be demonstrated. This will be the key impact area of SAFEMODE.

To maximise the impact of the project in aviation and maritime sectors, the project will have two Scientific Coordinators - EUROCONTROL (Dr. Barry Kirwan, aviation) and University of Strathclyde (Prof. Osman Turan, Shipping). Both have internationally recognised expertise in transport safety and Human Factors, long experience with EU research, wide industrial network and long association with international regulatory framework. Prof Turan, won TRA-VISION Senior Researcher competition in TRA 2018 in waterborne transport due to his contribution to EU research in Ship Safety and Human Factors. They will coordinate with relevant stakeholders to customize SAFEMODE results, ensuring that they fully address the industry needs. Support international regulatory framework with regards to transport safety and human factors and make sure industry take up in design, operation and trainings.

The cross-fertilisation between the two modes will be further improved by involving partners in cross-modal activities, and by applying the Smart Transfer methodology (developed in EXCROSS and SEAHORSE).

2.1 Expected impacts

2.1.1 Expected Impact mentioned in the Work programme

The SAFEMODE project brings together a consortium of experts from the leading organisations in the area of Human Factors. Partners will apply a systemic perspective to safety, to ensure effective multi-disciplinary international collaboration. The SAFEMODE Project will make a significant impact on the assessment and management of human risk factors by strengthening the synergies between maritime and aviation industries.

The SAFEMODE project aims to address Human Factors challenges in both transportation modes. The following table presents how SAFEMODE will contribute to the expected impact defined within the work programme.

Expected Impacts	SAFEMODE Contribution
A significant step towards a safe transport system [...]	<p>As Human Factors are reported as one of the main causes of maritime and airline accidents, it is expected that enhanced Human Factors integration in risk models will decrease incidents in maritime and aviation. Evidence shows that operators in maritime and aviation deviate from Standard Operating Procedures (SOPs) due to a wide range of reasons. SAFEMODE will utilise the SEAHORSE Procedure Improvement Tool (Kurt, et al., 2016) in order to improve work-as-done. SEAHORSE procedures improved the team performance by 70% in terms of preventing human errors and handling safety-critical situations. SAFEMODE considers that a 20% reduction in accidents can be achieved by monitoring work-as-done to improve work procedures.</p> <p>For aviation, typically 80% of accidents have human error contributions. For ground-handling related incidents, there needs to be a similar focus on understanding and improving 'work-as-done' as for the maritime industry. For flight upset, the current top EASA risk category, the HF issue is more to do with decision-making and recovery skills in the first minutes after the onset of the event, and this is where SAFEMODE will focus in one of the case studies and via the methods and Risk Models, but also considering where automation could aid safe performance. For drone integration, where there will soon be hundreds of new drone operating organisations, it is essential to get the Human Factors aspects of their safe operation and integration right. SAFEMODE will help by injecting HF safety-related guidance at a formative stage of drone's introduction into European airspace.</p>
[...] enabled by a decrease in collisions and incidents attributable to human factors by taking advantage of increasing automation in transport operation and control.	<p>SAFEMODE claims that a 25% decrease in accidents can be achieved by testing Human Factors aspects of automation of navigational information (e.g. Maritime Traffic Collision Avoidance System - MTCAS). The operational evidence from the aviation industry clearly shows that TCAS considerably reduced the risk of mid-air collisions (Kuchar, et al., 2007).</p> <p>A clear area for aviation in SAFEMODE is the wake vortex encounter, which can trigger a flight upset conditions (or even lead to a stall). SAFEMODE will look at ways of alerting pilots to this risk so that they are not 'startled' when it happens, which can lead to over-compensation by the pilots and loss of control of the aircraft. The SAFEMODE Human Factors Risk Models will also be used to generate insights on where automation could assist the pilot or air traffic controller, in preventing runway</p>

	incursions and excursions, mid-air collisions and controlled flight into terrain.
Enhanced transport safety for a diverse demographic by increasing consideration of HF within designs [...]. Improved selection and training of operators.	SAFEMODE end-users embrace EU and extra-European partners, in order to be representative of different safety attitudes, work-practices, working conditions, etc. SAFEMODE claims that a 15-20% reduction in accidents is attainable by delivering tailored resilience, safety culture and Human Factors training to deal with emergency situations using resilience approaches. Evidence shows that training improved team performance between 15-25% by using the transformational leadership approach (van der Kleij, et al., 2011). In aviation students reduced their task load by 30% using the principles of resilience engineering (Bergström, et al., 2015).
Enhanced international cooperation on HF.	External Stakeholders Group includes institutions from Brasil, Canada, China, Indonesia, Malaysia, Philippines, USA, UAE. Partners include Russia, China, Indonesia, and Philippines. South-East Asia partners will benefit from the SAFEMODE outputs to enhance maritime safety. SAFEMODE will also interface with CANSO, the air navigation service provider organisation, which has a truly global reach.
Improved international rules and regulations.	SAFEMODE will provide recommendations to policy-makers and regulators and will support the betterment of international regulations and standards, related to Human Factors in maritime and aviation. EU specialized bodies (e.g. EMSA and EASA) and International agencies (e.g. ICAO and IMO) will be actively engaged.
Learning and safety improvement from the assessment of HF within safety events, enabled through the provision of HF data resource.	SAFEMODE will collect and analyse safety data in the two domains both from publicly available and confidential datasets (e.g., Airprox UK, EVAIR ENAC, ENAV, Italian Ministry of Transport, ECCAIRS, MAIB, EMSA's EMCIP, CHIRP, SEAHORSE databases). While keeping confidentiality of data when necessary, SAFEMODE will provide an Open Data Repository maintained for at least 3 years after project end.
Contribute to ICAO, EASA and Flight-Path2050 goals. For maritime, to IMO, EMSA, EU maritime policy and UN Development Goal 14	Continuous engagement with relevant bodies in aviation (e.g. ICAO, EASA, CANSO, IFALPA, ECA, IFACTA, ACARE) and maritime sectors (e.g. IMO, EMSA, FEPORTS, ESPO, WATERBORNE TP, coastguard agencies) will be maintained throughout the project, as demonstrated by the support letters received.

2.1.2 Operational Impacts

For the Maritime Sector SAFEMODE outputs will impact on a number of key issues that influence maritime operations:

- 1- SAFEMODE through dedicated Human Informed Risk Assessment framework will assess the human contribution to safety and accidents in order to develop solutions to enhance safe operation.
- 2- Investigation of navigational aids is expected to reduce collisions, grounding and contact-related accidents. Vanem et al (2007) shows that implementing ECDIS properly will result in a 38% reduction in grounding accidents. Analysis of bridge simulator results measuring the collision avoidance behaviour showed that if a system intervened when the subject failed to react reliably; an accident probability reduction potential of 30%-60% could be obtained (Vanem, et al., 2007).
- 3- Reduce the losses of life both for crew and passengers by addressing the implementation of emergency plans in case of major casualties.
- 4- Enhancement in navigational safety will reduce the pollution caused by ship incidents and accidents.
- 5- From HURID (WP5), designs and operational procedures able to accommodate Human Factors will be developed for integration in system and equipment manufacturing processes.
- 6- SAFEMODE will impact capacity-building and education by developing material for decision-makers, builders and operators. Training will be developed on Risk-Based Design Frameworks and Human Factors. This will benefit the worldwide educational system in Seafarer training, and support policy changes. Evidence shows that seafarers deviate from SOPs due to a wide range of reasons. SAFEMODE will utilise the Procedure Improvement Tool (Kurt et al., 2016) in order to capture, assess and improve work-as-done. A study based on Dutch Labour Inspectorate revealed that 50% of the accidents related to procedures and this 50% consist of no or unclear procedure (10%), wrong procedures (12%) and current procedures which were not followed properly (28%) (Bieder, et al., 2013).

For aviation, as already mentioned, human error is attributed as a contributory or causal factor in 60-80% of aviation accidents. In the recent Projects for Policy (P4P) strategy for aviation safety research document produced by the EC, six top operational risks were identified (flight upset, ground handling safety, fire on board, mid-air collision, General Aviation/Rotorcraft safety, and terrain conflict).

Since aviation accidents are thankfully very rare in European airspace, it is harder (until we have quantified Human Factors risk models) to quantify the impact of SAFEMODE on the reduction of aviation accidents, but it is estimated that a 30-50% reduction should be feasible, depending on the uptake of SAFEMODE processes and tools by the industry, by impacting on a number of key issues:

1. The aviation Human Factors Risk Models will be used to determine the top five Human Factors actions to improve safety, across all the models. This can then be mapped onto EASA's top risks as well as EUROCONTROL's top 5 risks for the European air traffic Network.
2. SAFEMODE will be able to enhance EASA's ability to do 'Deep Dives' in its Data4Safety programme, e.g. by providing enriched human performance data from SHIELD, allowing Data4Safety to drill down into key underlying Human Factors issues such as fatigue or the impact of new business models, as well as more traditional problems areas such as Go-Arounds or Flight Upset Recovery.
3. SAFEMODE will be able to consider three of the P4P top risks (i.e., flight upset, ground handling safety and terrain conflict), and its outputs should be able to help the others via general support in procedures and training, and for handling emergencies. Added to these risk categories will be drone safety, an emerging risk.
4. Aviation is already used to a fair degree of automation, but via SAFEMODE it can start to consider more advanced kinds of automation, and begin to prepare for issues such as single-pilot operations, remote aircraft, or even use of Artificial Intelligence in the cockpit. SAFEMODE will begin to consider how Crew Resource Management (CRM) – Human Factors' biggest impact to date on aviation safety – could be enlarged to consider automation as part of the 'crew', and how this crew situation awareness can best be maintained in the highly automated cockpit.
5. Currently, Human Factors in aviation system design and operations largely occurs informally, with limited use of scientific techniques and data, instead relying significantly on operational expertise. SAFEMODE will upgrade the processes and practices for the integration of Human Factors across the aviation industry, supplementing the operational expertise that will remain an essential guiding input. Whilst aviation focuses mainly on what happens prior to an event (e.g. a crash), maritime focuses much more on what happens afterwards (e.g. evacuation etc.). The EC has noted in its P4P Aviation Safety Strategy document that aviation should focus more on post-accident survivability. In this respect, aviation hopes to learn from, and/or be leveraged by, the Maritime sector.

2.1.3 Economic Impacts

The Maritime European Strategy Action Vision is to create the Safest, Greenest and Smartest Maritime industry in Europe. By developing Human Factor risk models, and integrating them into current Risk Based Design, SAFEMODE aligns with these objectives and can adapt to emerging trends such as unmanned/autonomous vehicles and their impacts. Applying SAFEMODE tools will facilitate safer design of new systems and operational procedures able to incorporate advanced human/technology interactions. It will represent a game change in the industry, because the roles and positions of people will be reviewed and their strengths and weaknesses assessed. Innovative design of vehicles, equipment and systems, and human/systems interaction will allow unprecedented industrial development. The Human Risk Informed Design Framework (HURID) will support the industry to develop products and services for Europe and the world. Our External Stakeholder Group members and our overseas partners (Philippines, China, Indonesia, Bangladesh, Brazil, USA, Canada) will play a key role in achieving the envisaged global impact and capacity building.

The aforementioned novel outputs of SAFEMODE Project will result in a positive economic impact not only by reducing the consequences to the environment, human life and goods, due to accidents, and increasing efficiency, but also by creating a new human-centred design attitude for ships and aircraft, generating economic benefits for all EU manufacturers and designers. This human-focused approach will set European industry apart, resulting in highly efficient systems that are not only safer, but also suffer fewer delays and downtime, require less training, and are quicker to market.

2.1.4 Social Impacts

According to EU Maritime Strategy, 90% of world trade is carried by sea, short-sea shipping is carrying 40% of intra-European freight in ton-kilometres while more than 400 million passengers pass through European ports each year. Maritime transport has also a direct impact on the quality of life of European citizens (<https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52009DC0008>).

Maritime and aviation industries are also major economic and employment sectors. Maintaining innovation capacities will secure employment, perpetuate know-how and prompt new opportunities. Considering the

magnitude of the present maritime and air vehicles, developing safer transportation will avoid social destabilization related to major accidents, which also affects coastal ecosystems.

Enhanced safety via SAFEMODE will also ensure both sectors' attractiveness and reputation. Providing competitive tools to European industry will generate novel opportunities inside and outside its borders. Not limited to Europe, SAFEMODE outcomes will support accident reduction in maritime countries like the Philippines (which supply 30% of the world's seafarers), Bangladesh and Indonesia.

The overall social impacts will be in the safety and resilience of transportation services. This is directly supporting the realisation of EU's maritime strategy, promoting safe, secure, clean, efficient shipping.

2.1.5 Impact on new regulation and standards

SAFEMODE is aligned with EU maritime Policy until 2018 which prioritises (SWD (2016) 326) Maritime Transport Safety through enforcement of international rules, increased effectiveness of EU involvement in the IMO, and strengthened international cooperation. By providing solutions for the management of human error and enhanced design, SAFEMODE supports work of regional and international agencies (e.g. EMSA and IMO). It will support the effectiveness of EU involvement at the IMO by prompting submission of policy papers. SAFEMODE will also reinforce international cooperation and supports technical assistance to member states and the EC.

Including EMSA and IMO in the communication loop of SAFEMODE will allow these organizations to utilize and eventually incorporate outputs and principles developed during SAFEMODE. SAFEMODE intends to support and complement the EMSA European Marine Casualty Information Platform (EMCIP). By developing accident reduction strategies, SAFEMODE will help reducing risks of accidental pollution.

SAFEMODE intends to produce tools and methods to enhance Formal Safety Assessment and participate in the development of goal-based standards in ship design. Moreover, other international instruments such as STCW or ILO Maritime Labour Convention, 2006 will be evoked during the research progress. Any potential alternation will be considered and addressed. Constant engagement with the regulatory authorities such as EMSA, or national authorities such as UK, Sweden, Norway, Greece, Turkey, Indonesia, Philippines and Bangladesh will assist in shaping contributions to maximise SAFEMODE impacts in the maritime sector.

SAFEMODE will also be working closely with EASA and industry forums such as the EUROCONTROL Safety Team, and CANSO, the global organisation of ANSPs. One of the most useful standards in aviation today is the SMS Standard of Excellence, and SAFEMODE will build upon work by EUROCONTROL & FAA, and more lately CANSO, to develop a Human Performance Standard of Excellence. EASA may also be interested in SAFEMODE's Human Assurance Levels (HALs) approach, in principle equivalent to SWALs (Software Assurance Levels), and could become the basis for regulation of Human Factors in different industry sectors.

2.1.6 Barriers to Achieve the Impact


Given the mapping of stakeholders' interests and strategies, it is expected to determine barriers to overcome. However, some barriers are already visible:

1- Regulatory Acceptance and Integration of innovative ideas and rules can require a long time for processes to be accepted and eventually implemented, particularly in the shipping sector. National interests and the role of lobbies constitute strong political and economic interests that need to be convinced. In order to push forward SAFEMODE outputs, the consortium will engage national and regional authorities such as EMSA and EASA, as well as international bodies such as the IMO, ICAO, CANSO. SAFEMODE consortium has been constructed to facilitate political interface by incorporating national authorities, industry partners and regional and international bodies.

2- Considering each industry's safety culture, industrial take-up strategies will be developed for each sector. Involvement of aviation and shipping partners in the consortium will guide the SAFEMODE project to acceptance. Furthermore, aviation and maritime academies, universities and training institutions will support the determination of an education and capacity-building strategy to accelerate the take-up. The engagement of the External Advisors, and the organization of workshops with an extended network of stakeholders, will significantly expand leverage and acceptance.

2.2 Measures to maximise impact

The SAFEMODE consortium will promote the project and its results, in accordance with Article 38.1 of the Annotated Grant Agreement, in order to maximise the expected impacts of the project. Therefore, comprehensive plans for Communication, Dissemination and Exploitation will define clear objectives and set out a concrete strategic planning for each measure to maximise the impact of the project (including a description and timing for each activity throughout the project duration). For each targeted audience, a specific strategy using appropriate means and language will be planned. Measures to maximize impact will rely on this plan and they will be divided into three axes as follows:

1. Dissemination of key information (approach, technologies, ults, etc.) generated during the project's lifetime.
2. Exploitation of the results in applicative context to ensure maturation of the concepts towards higher levels of TRL and facilitate their successful institutionalisation.
3. Communication on the progress from the beginning of the project onwards to create awareness about the project and to make stakeholders participate in the project activities.

2.2.1 Dissemination

The SAFEMODE approach can be presented to a mixed industrial and academic audience: by publication in open-access peer-reviewed journals, and by presenting at scientific conferences; by Interactive workshops with stakeholders from the maritime and aviation domains, organized yearly; by inclusion of the results of the project in university and Ph.D. courses; by participation in international and local exhibitions, workshops, webinars and seminars for specific audiences; by developing training package dedicated to capacity-building for administration from developing countries. The dissemination of the results from the consortium will be done by several means, around a unified strategy, leveraging consortium members' strong relationships with a range of audiences – academic, industrial, operational and governmental.

The dissemination plan seeks to engage with the classes of stakeholders in the aviation and maritime domains that have most to gain in the near-term from the results of the project, as well as the research communities that could build upon more fundamental findings. An effective and efficient communication requires that results are personalised for the different categories of stakeholders, in terms of content, style, format and information use. Personalisation will not be limited to information content, but will consider also the style of the message and the means through which it is disseminated (e.g. document, report, web site, video, seminar, forum). The project dissemination plan will identify the most appropriate means for each stakeholders category to ensure that activities are: (1) effective (i.e. suited to achieving the action's communication goals), (2) proportionate to the scale of the action, (3) address audiences that go beyond the action's own community (including the media and the public).

The Dissemination Plan will, at least, include activities relating to:

TARGET AUDIENCE	EXAMPLES OF DISSEMINATION ACTIVITIES
Maritime industrial and operational community	<ul style="list-style-type: none"> - Participation in relevant workshops and fairs - Organisation of annual industry focused SAFEMODE international and regional workshops - Participation in, and networking activities with, EMSA, IMO as well as professional associations like Intertanko, BIMCO, Nautical Institute, - Engagement of Maritime Stakeholders through the SAFEMODE External Stakeholder Group (ESG) - Publications on scientific journals and magazines (e.g.: Marine Policy; etc.) - Presentation at international conferences (e.g.: Navigation and Control conference; IMAM; TRANSNAV; etc.)
Aviation industrial and operational community	<ul style="list-style-type: none"> - Participation in relevant workshops and fairs (ATM Global) - Organisation of annual industry focused SAFEMODE international and regional workshops - Participation in and networking activities with EASA and EUROCAE - Engagement of Aviation Stakeholders through the SAFEMODE External Stakeholder Group (ESG) - Publications on scientific journals and magazines (e.g.: Journal of Aircraft; Journal of Aviation Psychology; etc.) - Presentation at international conferences (e.g.: Annual AIAA Flight Mechanic conference; EUCASS; ICAS; IACAS; etc.)
Trade exhibitions	<ul style="list-style-type: none"> - Participation to main trade exhibitions such as: AIAA Science meeting forum and exposition; ILA; International Air Safety Summit of the Flight Safety Foundation; MosAviaShow; Nor Shipping; Paris aerospace salon; POSIDONIA 2020; The annual World ATM Congress.
SESAR ATM Research Community	<ul style="list-style-type: none"> - Participation at SESAR Innovation Days (scientific papers, posters, demonstrators) - Publication of papers for scientific ATM and Aviation journals (e.g. ATC Quarterly, Journal of ATM, Transportation Research Part A: Policy and Practice) - Participation and presentation at ATM and Aviation scientific conferences aimed at informing about project results, innovative methods, tools, etc. - Creation of an External Stakeholders Group to be consulted at regular points in order to

	receive feedback on project methodology and results
Safety Research Community	<ul style="list-style-type: none"> - Publications on scientific journals and magazines (e.g.: Accident Analysis and Prevention; Safety Science; Reliability Engineering & System Safety; Frontiers in Human Neuroscience; Human Factors etc.) - Presentation at international conferences (e.g.: Conference of the Resilience Engineering Association; ESRL; etc.)
Human Factors and Ergonomics Research Community	<ul style="list-style-type: none"> - Publications on scientific journals and magazines (e.g.: Journal of Cognitive Engineering and Decision Making; Journal of Ergonomics in Design; Applied Ergonomics, etc.) - Presentation at international conferences (e.g.: AHFE; Annual AIAA Motion Simulation Technology conference; HFES; IFAC; RINA Human Factors Conferences; etc.)
EC Research and Innovation events	<ul style="list-style-type: none"> - Participation in relevant conferences (Transport Research Arena, Air Transport Research Society Conference, ATM Seminar, European Aviation Conference) - Participation in EC transport platforms (e.g., ACARE, Waterborne) and working groups - Networking with other EC funded projects on similar topics (e.g. OPTICS2)
General Public	<ul style="list-style-type: none"> - Web communication: communication through partners institutional websites, presence on the social networks (i.e., Linkedin and Twitter), the creation of a project website where the abstracts of project deliverables and publications will be made available with a regular update, a dedicated blog on Medium. - Other communications on project objectives and results through general press, magazines, brochures, news, interview opportunities with the media and dedicated press releases, will be aimed at raising interest and increasing knowledge to the general public. - Organisation of dissemination events dedicated to the General Public, - Organisation of SAFEMODE conference.

Table 1 - Target audience and dissemination activities

2.2.2 Exploitation

A successful exploitation strategy will create more acceptance amongst stakeholders, and contributes to the further growth of the transport industry, maintaining the EU industrial leadership in the sector. During the SAFEMODE project a set of specific actions will be undertaken to ensure a comprehensive and effective exploitation of project results and outcomes, in particular: (i) An articulated **Exploitation Plan**, to be considered as a clear guideline for market exploitation of the results will be delivered indicating the full exploitation strategy, return on investment analysis and main actions to be conducted by partners well after the project to guarantee exploitation of the project results. Consequently, **Business plans** for the relevant exploitation assets will be developed to ensure sustainability of SAFEMODE; (ii) A detailed **exploitation agreement** (that will integrate the Consortium Agreement) will be defined among partners to establish clear commercial routes with which project results and knowhow will be exploited in the defined market providing commercial opportunities for all involved parties. The exploitation agreement will address protection and management of the Intellectual Property Rights (IPR), for exploring market opportunities; (iii) A **Return On Investment study** to analyse what kind of return on investment can be foreseen by an organisation (or set of organisations) adopting the SAFEMODE solutions. This analysis will conduct a comprehensive return assessment (i.e. not exclusively monetary) taking into account aspects such as increased reputational aspects, social/economic costs, etc. The analyses will on the one hand help to validate the project results from a business/impact point of view, and on the other hand, help the project shape a value proposition; (iv) An **Exploitation Workshop** to be held in the advanced phase of the project. This will enable all partners to share the exploitation strategy and vision as well as discuss and agree on the best ways forward. (v) **Involvement of relevant external stakeholders in the exploitation** through tailored activities such as expert interviews and focus groups.

Exploitation activities will start early in the project and will follow an Exploitation path which will evolve with the evolution of the project. The Exploitation path is organised in 3 phases:

1. **Initial phase (month 6):** initial mapping of project results, preliminary market analysis
2. **Mid phase (month 18):** market analysis and initial exploitation plan, validation of plan with stakeholders, exploitation workshop
3. **Final phase (month 24):** finalization of exploitable results, ROI analysis, exploitation agreement.

Potential issues related to protection and management of the Intellectual Property Rights (IPR) will be identified early - since the initial phase - by clarifying ownership (or joint ownership) of results, identifying involved partners, and supplementing the Consortium Agreement provisions with separate written agreements, whenever necessary.

As the first step of an exploitation activity, it would be important to identify all the main exploitable assets produced by the project. The SAFEMODE exploitation will be based on the main SAFEMODE exploitable assets delivered by the project, as reported in the following table.

SAFEMODE Results	TRL	Target Users ¹
Human Factors Risk Event Database in aviation and maritime (SHIELD)	TRL6	Civil Aviation/Maritimes Authorities, Safety Managers, Policy Makers, EU Agencies, Civil Society Associations.
Data and expert-driven method to monitor emerging Human Factors issues in incidents and everyday operations	TRL5	Safety Managers, Human Factors experts, Designers.
Human Factors-based risk models	TRL5	Universities, Research Centers, Safety Managers, Human Factors experts, Designers.
Design methods and tools for human-centred higher levels of automation	TRL5	Universities, Research Centers, Safety Managers, Human Factors experts, Designers.
Guidelines, taxonomy, and recommendation to analyse Human Factors aspects	TRL6	Policy Makers, EU Agencies, Safety Managers, Human Factors experts, Designers.
Toolkit and supporting educational material for monitoring and managing HF in everyday operations	TRL5	Universities, Safety Managers, Human Factors experts.
HURID framework to support design, operations, and continuous monitoring	TRL5	Civil Aviation/Maritimes Authorities, Safety Managers, Policy Makers, EU Agencies, Safety Managers, Human Factors experts, Designers.

Table 2 - SAFEMODE exploitation assets, TRL levels and target users.

2.2.2.2 *SAFEMODE Exploitation Plan*

As explained above, a detailed Business Plan will be delivered as part of the SAFEMODE Exploitation activities. Nonetheless, at this stage the SAFEMODE partners have already developed preliminary Joint and Individual Business Plans which will ensure full impact for the project and are outlined below.

The **joint Exploitation Plan** of SAFEMODE will be carried out along 5 axes:

- **Generate and advance Human Factors Risk Models to assess human performance** in real-life operations. Developing new Human Factors-based risk models, incorporating detailed analyses of actual work processes and developing novel techniques for assessing the current risk levels and comparing alternative design solutions, and integrating them into the design/safety assessment process.
- **Identifying trends and designing for higher levels of automation.** New technologies will be designed, integrated and tested on simulator platforms, with the help of the SAFEMODE approach.
- **Develop incident classification systems** and enhance the Human Factors classification of incidents and case studies. The results of SAFEMODE will enhance standardisation and integration of existing methods (e.g. RAT, SOAM, TOKAI, etc).
- **Develop aircraft/ships control systems, to improve interactive systems.** The results will be useful for establishing industrial guidelines for cockpit/bridge HMI design, informing new design concepts and assessing current ones.

¹ It is important to note that the professions reported are intended to be part of the relevant stakeholders' organisations, such as: Service Providers, Manufacturers, Airlines and Ferry Companies, etc.

- **Communicate, educate and influence** both practice and policy and the different governmental organizations and companies working in Safety (more specifically Incident Investigation) and Human Factors, across maritime, aviation, and railways.

Related to the **Individual Exploitation Plans**, they can be clustered by type of organization, as in the table below:


Industry - Partner's Exploitation Plan
SAFEMODE results will be useful for improving interactive systems, such as the development of automation and pilot-aircraft interfaces preventing upsets and other critical modes, according to the focus of the organization. It will be useful to include advanced Human Factors Risk Models to assess human performance in critical and new situations such as: rare critical flight modes, wake vortex encounter, modern control inceptors, automated technologies and warning systems in aircraft upset situations and to recover the normal flight. The incident classification systems and the database of aspects of Human Factors, as well as quantitative models and qualitative information about Human Factors risks, will help concretize the problems affecting human performance.
SME - Partner's Exploitation Plan
SAFEMODE results will be used to enrich SMEs' portfolio of services and consultancy activities. Toolkit and supporting educational material could be implemented directly in SMEs' existing training activities, and/or could support the setup of new training activities. For instance, the development of training packages directed to administrations will allow facing barriers and obstacles related to limited resources and time to develop toolkits positioning the SME's as policy support and capacity-building system for aviation/maritime stakeholders. Exploitable assets can develop new technologies and products, reinforcing existing guidelines for human-centred design or creating opportunities for future research projects. In addition, all project activities will increase the network of potential partners and clients, for new business opportunities and research partnerships.
Academia and Research - Partner's Exploitation Plan
The high scientific level of the SAFEMODE outputs and the duration of the project will allow educating new specialists among students and post-graduate students and they will influence research, knowledge transfer, and links between the academic and the aviation/maritime communities. In addition, SAFEMODE research activities will produce scientific publications at international conferences and in international scientific journals that (along with communication and dissemination activities) would also be exploitable for Academia using publication-related credit systems.
Agencies and Institutions - Partner's Exploitation Plan
SAFEMODE partners who work closely with EU agencies such as EASA/EMSA will work to ensure that good research is translated into operational practice and can overcome and pass through any regulatory steps necessary. Exploitable assets will help maximize the safety benefits of sound research, facilitate collaboration to ensure the applicability of results to future trends, and ensure their entrance into design and operational practices. The simulator facility will be further developed to test the forward-looking scenarios and would enable to refine a toolkit for monitoring Human Factors aspects and validate risk models for human-centred design purposes. The developed Human Factors Risk Models will enable the application of new technology for automation design, providing the minimization of human error. The results will influence the development of standards in the aircraft system, interface design and utilization.

Table 3 SAFEMODE Individual Exploitations Plans

2.2.2.3 IPR and Knowledge

Special attention will be given to knowledge management and data-protection issues (see Section 5) from the beginning, and during the whole lifetime of the project. All details regarding management and protection of knowledge created within SAFEMODE will be specified in the Consortium Agreement (CA), following well-known models, such as the DESCA Horizon 2020 document (DESCA, 2014). The Consortium Agreement will address (a) **confidentiality** of the information disclosed by partners during the project, **ownership** of results resulting from the execution of the project, (b) **legal protection** of results resulting from the execution of the project through patent rights, (c) **commercial utilisation** of results, also taking into account joint ownership of the results, and separate agreements when necessary, (d) **patents**, know-how and information related to the use of knowledge owned by one of the partners, resulting from work carried out prior to the agreement and (e) **sublicenses** to third parties within clearly defined limits. The cited Consortium Agreement will implement the Grant Agreement defining the distribution of the EU funds and the Intellectual Property. The principle basis of the information and know-how exchange will be based on free access right. The general outline of the IP rules agreed by SAFEMODE partners is as follows:

- Pre-existing partners' knowledge (background) will be specified in the Consortium Agreement.

- Knowledge that is generated within SAFEMODE project  will remain the property of the partner that generated it. If more than one partner generates that knowledge and it is not possible to separate their contributions, the knowledge will be jointly owned.
- Access rights to knowledge that is needed by a partner for the execution of its part in SAFEMODE shall be granted to the partner on a royalty-free non-transferable basis, unless otherwise agreed before the signature of the Consortium Agreement.
- A partner will not publish any knowledge provided by another partner and identified as confidential, without the other Partner's prior written approval. However, if open source software licenses apply, the open source software license rules will apply for publishing knowledge.
- To meet the need of both industrial partners with commercial and IP interests and research partners in the project, which have a major role in ensuring results are wide, disseminated, dissemination assets will be submitted to the Project Coordinator and the Dissemination Leader and distributed to the other relevant partners who may object within a small time period (no more than a month) which is agreed upon in the Consortium Agreement. Otherwise, the dissemination may proceed.
- Ownership or joint ownership of project results will be identified and agreed early in the project. Appropriate IPR protection measures will be included in the Joint and Individual Business Plans, targeted to the chosen business model and market opportunity.

2.2.2.4 *Open Source approach and Standards*

One of the aims of the SAFEMODE project is to provide benefits to European citizens through increased safety. To this end project partners in the consortium believe in the **value of adopting Open Source** and standards during the project: in fact, various project partners may be either using the Open Source code in their deliverables or contributing their deliverables to the Open Source communities.

2.2.2.5 *Open Access to project results*

Open access to scientific publications: Each beneficiary must ensure open access (free of charge) to all peer-reviewed scientific publications relating to its results (in accordance with Article 29 of the Annotated Grant Agreement). In particular, SAFEMODE project participants are committed to Open Access Publishing and will prioritise publication venues and also promote Open Access to its publications. Furthermore at the beginning of the project, the consortium will set up a repository for publications coming out of the project following the green open access principle.

Open access to research data: Regarding digital research data, the beneficiaries will deposit in a research data repository and take measures to make it possible for third parties to access, mine, exploit, reproduce and disseminate — free of charge for any user — i.e. the data, including associated metadata, needed to validate the results presented in scientific publications as soon as possible. As an exception, the beneficiaries do not have to ensure open access to specific parts of their research data if the achievement of the action's main objective, would be jeopardised by making those specific parts of the research data openly accessible.

2.2.3 **Communication activities**

The communication activities will be designed to reach a broad range of stakeholders by providing different levels of information and using different communication means, tailored on the basis of the phase of the project and the related stakeholder characteristics.

The communication plan and strategy will be designed to combine the contents, the target audience and the means used, while striving to achieve sound visibility across a multi-layered community. Four main objectives will steer the communication activities:

1. The first phase of communication will especially aim at **raising awareness**, by impacting on the target audience to feed and increase awareness of the project (conceptual use). The main effort will be devoted to make the project known and spread information about the objectives and scope over the wide and different communities of reference.
2. **Generating understanding** in the form of transferring specific messages to the target audience (instrumental use) will be constant during the two years, as progress and achievements of the project need to be constantly disseminated and explained to different audiences. To achieve this objective the communication activities will be planned to foster interaction and exchange among the target audience, showing the relevance of our work to their own practices and collecting feedback and comments (instrumental use).
3. **Getting key messages to key decision makers** so that developed methods, tools and good practices have an impact on policies or practices (strategic use).

4. The organization of **cross-fertilization exchanges with other projects** will create and feed synergies with other co-funded projects, whose research questions, solutions and processes could be shared to improve the quality of the European R&D.

SAFEMODE will build its identity through a logo, a unique format for sharing template (publications, leaflets, technical reports, etc.) and characteristic slogans. SAFEMODE Communication activities will be a continuous process and will include the internal and external interactions with project members and stakeholders, including the industrial partners, the potential end-users, policy makers and the public. For instance, for the Aviation domain, the SAFEMODE approach will be presented to the EUROCONTROL Safety Team, a group of around 25 EUROPEAN ANSPs, to determine how it serves their interests and fits within their processes and regulatory requirements. Other opportunities will be CANSO (Civil Air Navigation Services Organisation) meetings and meetings on Human Factors with the FAA. For the Maritime domain, existing collaborations with the ports and maritime industries and relevant organizations will support the SAFEMODE communication activities. More specifically, project findings will be communicated to FEPORTS and ESPO with the aim to reach out to the European ports industry, as well as to IAPH, representing the port sector at an international level. Additional presentations at WATERBORNE TP events will be pursued as well. SAFEMODE will also organize a program of dedicated events which are described in detail below. The initial set of communication materials will include general information about the concept of the project, objectives and expected impact. These communication materials will be updated along the whole project lifecycle until the final results. Communication activities will be based on several vectors to target the appropriate stakeholders based on the communication aims as shown in Table 4.

Communication & Dissemination Activities	Aims	Description
Workshops	Engage Inform	Workshops will be organised as interactive events held to achieve specific objectives (e.g. get feedback from users or from experts on a particular issue).
Participation to Conferences	Engage Ensure impact	National and international conferences will be an important opportunity to share achievements with experts in the field.
Organisation of SAFEMODE conference	Engage Awareness impact	Dedicated International Conference will be organized to disseminate the results to wider global community to share the outcomes to increase wider engagement, exploitation of results at different platforms.
Scientific articles	Inform Ensure Impact	Write papers for scientific journals/conferences in relevant disciplines when some data and results to report will be available.
Leaflet/brochures	Awareness	Printed flyers and brochures will be produced during the project in connection to public events (e.g. to hand out at conferences, forums).
Presentations, posters	Engage Ensure impact	When participating in forum, conferences or public events, work in progress will be presented through presentations and posters to engage people, gauge their reactions, and get feedbacks. The public presentations will be available on the project website.
E-news and articles	Awareness Inform	E-news and articles will be sent to a number of contacts to advertise public initiatives and outcomes. Every public event, dissemination activity or publication of documents will be announced also through the e-news.
Project website	Awareness Inform Engage	The project website presents information for different audiences. Regularly updated with the public information, it allows “presenting” the project and engaging the community.
Public reports	Inform	Public reports, will be posted on the website so they are accessible to a wide audience.
Stakeholders engagement	Inform Engage Ensure Impact	Stakeholders will be engaged through the External Stakeholders Group that will steer project activities and provide expert feedback. Three dedicated events will be organized involving the External Stakeholders Group members (M12, M24, M36) and additional feedbacks will be through periodic conference calls.
Video	Awareness	A video will be created and distributed to increase awareness about SAFEMODE scopes, objectives and results, to reach a broad general audience.

Finally, each SAFEMODE partner is committed to engage in communication activities leveraging its own networks and internal and external communications with project members and stakeholders, including the industrial partners, the potential end-users, policy makers and the public. SAFEMODE individual partners' membership to national/international working groups in aviation/maritime/safety domains will guarantee a targeted communication to the public as well as to the regulatory and industrial groups, supporting even more the SAFEMODE communication activities aims. For instance, SAFEMODE partners will: participate in industry fairs and conferences; will contribute to the publication of papers in peer-reviewed journals and conference proceedings; will present SAFEMODE results to their main clients and partners in Europe and to the SESAR 2020 projects in which is active; will foster cross-fertilization and exchange of best practices among SAFEMODE and the other H2020 and National projects which each partner is involved in; will contribute to the development the project coordinated image and the dissemination material (including poster, brochures, videos, etc.) contributing and /or implementing and maintain the SAFEMODE website and social media (e.g. LinkedIn, Twitter, Medium, etc.).

2.2.4 Measurements for communication

Communication is not an exact science and it is very difficult to measure success as it is intangible in many ways. However, we consider important to set some measures which will be used to know if this dissemination strategy is achieving its aims. Table 5 below presents a cumulative list of all dissemination and communication Key Performance Indicators for the SAFEMODE project, corresponding to activities and measures presented above.

	Key Performance Indicators for Dissemination & Communication	Phase 1 M1-M18	Phase 2 M19-M36	Overall
Application focus	Number of events organized for external audiences	1	2	3
	Number of events attended representing the project	2	4	6
	Presence at tradeshow and business events	2	3	5
	Communications with SMEs	2	4	6
	Communications with medium-large corporate organizations	2	4	6
	Communications with representatives of users at a local, regional and national level	2	6	8
	Organisation of International Conference		1	1
Outreach focus	Number of scientific publications in peer-review journals	2	6	8
	Number of scientific publications in peer-review international conferences and workshops	4	8	12
	Number of general press/magazine articles published	2	3	5
	Number of special sessions/workshops at conferences	1	1	2
	Number of press releases delivered to traditional media	1	2	3
	Number of unique visitors to the Website (Google Analytics)	600	1000	1600
	Number of references of SAFEMODE in other websites	3	5	8
	Number of multimedia material downloads (website)	12	18	30
	Scientific publications as Open Access	2	3	5

Table 5 - SAFEMODE Dissemination and Communication KPIs

3 Implementation

3.1 Work plan

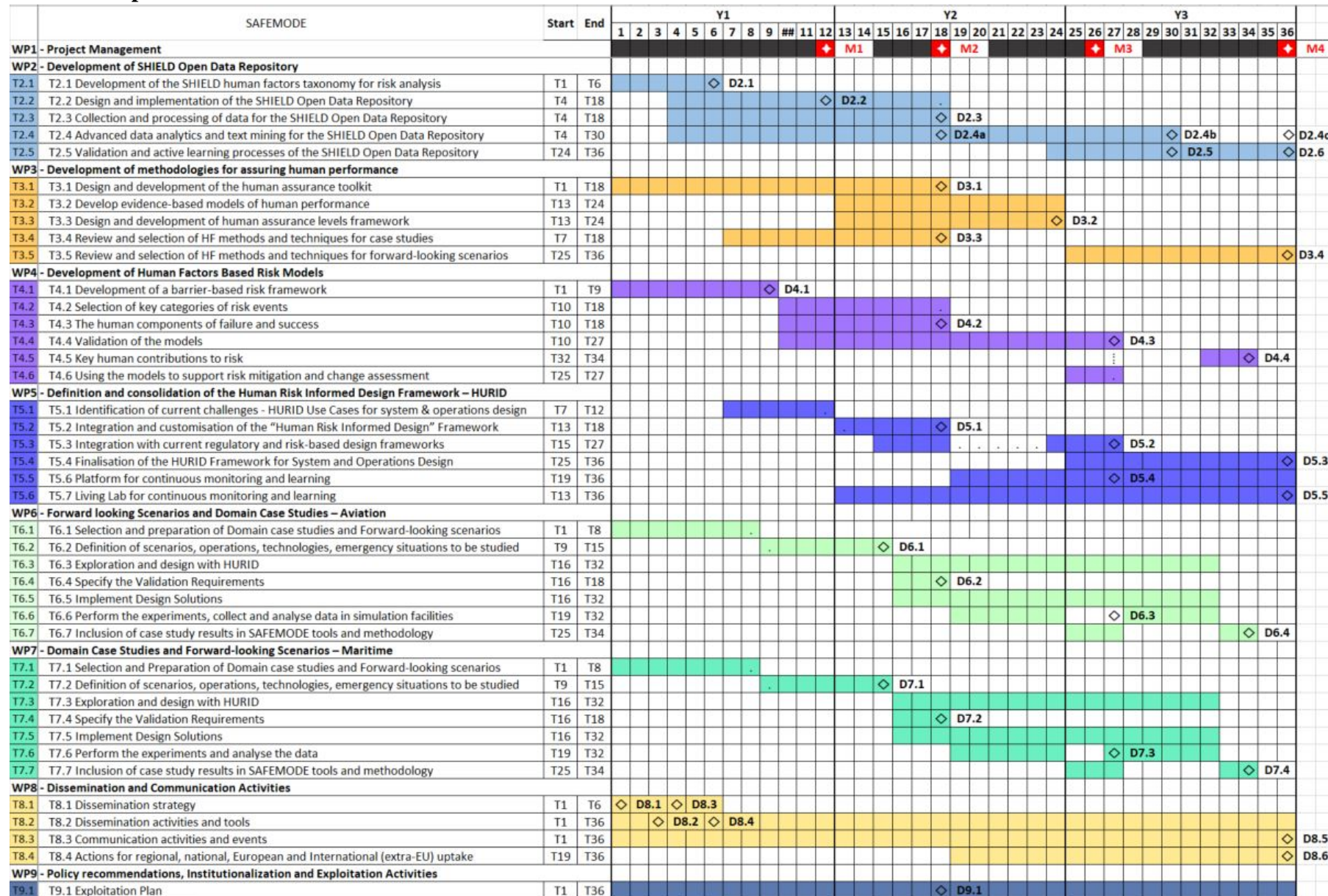


Figure 11
SAFEMODE
GANTT
Chart

3.2 Management structure and procedures

3.2.1 Project management implementation

A Project management, to be effective, must be sized and tailored according to the duration and complexity of the project. DBL's Managing System is certified to be compliant with the requirements of EN ISO 9001:2008 for the sector EA35 - Design and implementation of consulting services in the field of Transport. Consequently, the Company will apply quality control and management decision schemes according to the procedures foreseen by the certification itself. Moreover, DBL will assure a project management approach in line with the standards and the defined interfaces applicable to Horizon 2020 Programme, having DBL an extensive experience in coordinating R&D projects under various EU and National Programmes. In particular, DBL coordinated three CSAs in H2020, five RIAs in SESAR 2020 Exploratory Research Programme, two Eurostars projects and more than five Italian National Projects.

In addition, the Scientific Coordination in the two application domains will be ensured by Prof. Osman Turan from Strathclyde University and Dr. Barry Kirwan from EUROCONTROL.

The project management will focus on creating the necessary governance structure for an effective project direction and management; performing the financial, legal, administrative and technical coordination; establishing the communication flow and methods for reporting, progress monitoring and quality assurance; management of knowledge and intellectual property promoting the gender equality and the networking with other related projects and networks. A Consortium Agreement (CA) will be signed among partners in accordance with the H2020 rules for participation.

The **Project Coordinator** (PC) will be responsible for the proper use of the funding by the recipients and will ensure that they comply with certain obligations under the Grant Agreement through control measures and corrective actions. She/he will define: the project management plan at WP and task level; the overall time schedule, risk and quality management; the organization of project meetings (the host-partner takes care of the logistics; the financial management; the elaboration of the internal and external reporting and documentation, including the deliverables review processes and the procedure and responsibilities towards their approval; the overall quality control of deliverables and project outputs sent by the WP leaders.

During the project's life, a **Financial/Administrative manager** will be appointed. He/she will be in charge of the administrative rules and procedures and will clarify the obligations agreed by the beneficiaries in the Grant Agreement.

The **General Assembly** (GA) will be the main decision-making body which holds the highest level of authority in the project, being the responsible to ensure agile and effective decision process and project completion. It consists of one representative from each partner, having one vote. The GA will meet in face-to-face meetings. The GA will discuss and decide on strategic project orientation, updated work programmes, approval of Periodic Reports and Deliverables, resource allocation. Finally, the GA will act as the highest conflict resolution body within the project.

The **Core Team** (CT) will consist of all Work Package leaders and it is chaired by the project coordinator. The CT supports the coordinator on the technical and scientific work by ensuring and supervising the quality of the project's results through the revision of each deliverable. This includes planning and control of the activities within the WPs, the preparation of deliverables and the collection of the contributions from other partners participating in each WP. The CT can raise important issues and propose solutions to the General Assembly, but does not have a decision-making capacity.

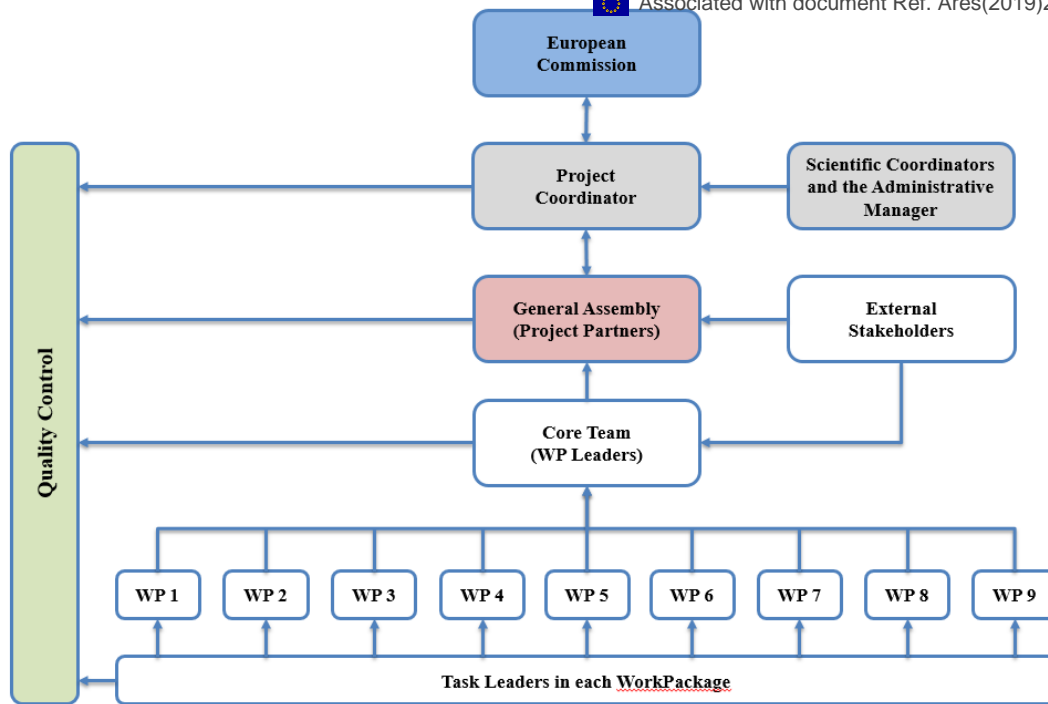


Figure 12. SAFEMODE management structure and roles.

The **External Stakeholders Groups** (ESG) will consist of individuals which have been identified as highly influential and knowledgeable from the partners. The ESG will include policy makers and regulators, sector associations, end-users and technical advisors. The ESG will be informed about the project strategic goals and progress and it will provide feedback and valuable knowledge stream based on their own experience and information during workshops or remote requests for support (such as participating to interviews or surveys). Additionally, it will facilitate the dissemination of the project results. Expression of interest have already been collected from many different EU and extra-EU partners (see attached Support Letters and emails).

The **End-users' Manager** coordinates and centralises end-users interaction with research partners, gathers end-user input and desiderata, ensures dissemination of results in easy to read format, extend the end users network, supports the identification of commonalities and synergies in the two domains.

3.2.2 Quality management

The PC will be in charge of the Quality & Risk Management procedures and will be responsible for the monitoring of any critical issues that might arise during project implementation.

The project consortium is deeply committed to assure high-quality results. All relevant quality assurance procedures and structures will be summarized in a "Quality Assurance Plan" which will be developed at the beginning of the project in WP1. These quality assurance procedures will be applied to all internal and external results and Deliverables and constantly monitored through the reaching of relevant project milestones.

3.2.2.1 Consortium agreement and progress monitoring

Before the start of the project, the consortium members will sign a **Consortium Agreement**. Each WP Leader (WPL) will be responsible for the correct execution of the implementation plan for the corresponding WP. The WPL will be in close contact with the project coordinator (e.g. via email, teleconferences). This bi-lateral communication will allow the coordinator to keep a close watch on the project progress. In addition, regular teleconferences will be arranged by the project coordinator with the Steering Committee including all WPL in order to monitor the progress. In case there is a deviation from the work plan, the coordinator will initiate corrective actions through the WPL, who will be responsible to implement these actions in dialogue with the different partners involved in the WP. The Consortium Agreement will include rules regarding conflict resolution, clear IPR and exploitation regulations regarding background, foreground, side ground and jointly owned knowledge.

3.2.2.2 Reporting

The WPL will be responsible for preparing individual reports covering WP progress, deliverables, achievement of milestones and compliance with the implementation plan. The PC will have the final responsibility for editing according to a standard layout, summarising the overall project status, looking for inconsistencies, further elaborating the reports (if needed) and taking care of final distribution.

The project management will be assisted in her/his role as project coordinator by the financial/administrative manager. The coordinator will submit to the European Commission a Progress Report for each reporting period providing a qualitative summary of the work performed according to H2020 guidelines and the technical and financial reports according to the GA. They will be drawn up using the forms and templates provided in the electronic exchange system. The coordinator will submit both: a 'periodic report' after the end of each reporting period (including the last one) and a 'final report' at the end of the action. The periodic technical report will include an explanation of work carried out, an overview of progress, a publishable summary and a questionnaire. The final technical report will contain a publishable summary of the entire action; a (periodic or final) financial report: the periodic financial report will include the individual financial statements, an explanation of the use of resources and the periodic summary financial statement.

A publishable report of the research activities (including a self-assessment of the TRL achieved at the end of the project according to the guidance provided by the EC) will be delivered in order to be used for transition to subsequent development stages if applicable.

3.2.2.3 *Internal communication and meetings managements*

The internal communication strategy will focus on maximizing interaction and knowledge transfer between partners to ensure the success of the project. Efforts will be made to reduce travel costs (choosing cost-effective locations, etc.) without compromising the integrity of the communication strategy. Partners will interact and will organize regular teleconferences to follow up on progress and anticipate potential showstoppers. Furthermore, the project will make use of a number of project management tools to maximize the effectiveness of internal communication and collaboration between partners: online secure intranet featuring project and file management tools to be selected according to partners' system compatibility and internal rules; appropriate project mailing lists (e.g. Core Team, General Assembly, whole consortium, External Stakeholder Group) that facilitate the smooth implementation of the project; teleconferences and video conferences systems (eg. WebEx, GotoMeeting, Skype, etc). For both remote and face2face meetings, particular attention will be given to the follow-up by sending the minutes quickly, checking commitment on decisions and actions with Partners, checking that decisions are respected and actions executed.

3.2.3 **Innovation management**

Innovation management is quickly becoming a critical requirement for enabling sustainable Research and Innovation Actions that may lead to properly exploit all their relevant innovative outcomes (new ideas, new methods, new concepts, new prototypes/products, new services, etc.).

Control and monitor the innovation process is extremely complex and involves the effective management of many different activities and the collaboration of partners with different expertise.

To ensure an effective innovation management, innovation will be managed in all stages of the SAFEMODE project, not only during the final exploitation phase. An "innovation governance model" will be then set up within the consortium in order to allocate responsibilities for innovation management (see Section 2.2 for further details).

3.2.4 **Data management and privacy**

Any sensitive or confidential data will be processed legally and fairly: collection of data will be adequate, relevant and not excessive in relation to the purposes of the project; data that identifies individuals (personal data) will not be kept any longer than necessary: once the project has finished, data will be completely anonymized, meaning links to lists of names and contact-information will be deleted. No personal data will be stored after the end of the project period. The Consortium will comply with European (i.e., GDPR) and national legislation relevant to the countries where data collection is taking place (refer to Section 5 for further details).

3.2.5 **Risk analysis and contingency planning**

Measures for managing risks related to financial, legal, administrative and technical coordination will be established from the beginning of the project. A contingency plan will be done at the beginning of the project and will be immediately at disposal to be launched when necessary and updated along the project execution. Regarding conflict resolution, the PC will try to minimize conflict and should it arise, act to minimize its effect through arbitration with the involved partners. As soon as a risk has been identified and needs to be addressed, the PC will be responsible for: the definition of new project activities necessary to ensure the mitigation of risk; the assignment of the priority level of activity in mitigating the risk index and status of the project; the allocation of human resources required to perform the activities of risk mitigation.

3.3 **Consortium as a whole**

The success of a collaborative innovation project unquestionably relies on the quality of the consortium. For that purpose, SAFEMODE consortium is constituted starting from an already existent and tested kernel. The

SAFEMODE Consortium was extended to other relevant partners to ensure broad applicability of results, access to relevant safety data and future regulatory and industrial take-up, as requested by the Topic.

In order to successfully achieve the goal of SAFEMODE project, a number of different organisations and expertise must be included in the consortium: big and medium-size companies, research centres, authorities and end-users, competencies in the field of aviation and maritime domains, technology and engineering, social safety, Human Factors, data analysis, law & regulations in privacy and ethics. SAFEMODE has made every effort in bringing together the best possible group of European Agencies, manufactures, service providers, airlines and ferry companies, researchers and practitioners in Europe and in countries abroad (through partners in Russia, North and South America, Asia and in the Gulf Area).

To avoid the risk of diluting resources in extensive coordination, the consortium is organized as follows: (a) **Core partners**: 10 organizations, performing the research work and involved transversally across the WPs; (b) **Focused contributors**: 7 partners with a focused contribution to one specific, highly technical aspect, like text mining or IT development; (c) **End-users**: 10 partners, with the main roles of providing access to proprietary databases and/or acting as the HURID target users. They are typically involved only in WP2 and WP6/7. This group also includes organizations that are part of the External Stakeholder Group. (d) 8 **Extra-EU partners** to ensure coverage of system and operations design, of regulatory aspects, and to provide extra EU dissemination channels.

The coordination between **Core partners** and **End-users** will be ensured by a dedicated interface, the End-users' Manager, as described in Section 3.2.

3.3.1 Soundness of institutions

The consortium represents a comprehensive and multi-disciplinary group of organisations, combining together (a) research skills, (b) academic background, (c) technical competences, (d) industrial presence, (e) relevant current products, (f) exploitation capabilities, (g) end-user experience and (h) access to relevant research networks.

Table 9 - Distribution of SAFEMODE partners by category

Core Partners	Focused Contributors	End-users	International (extra-EU)
Deep Blue Srl University of Strathclyde EUROCONTROL NLR ENAC HungaroControl CERTH CETENA Chalmers Tekniska Högskola World Maritime University	University of Rome La Sapienza Istanbul Teknik Universitesi De Montfort University NTUA Panepistimio Patron University of Amsterdam Beebi	AIRBUS EMBRAER TUI Airways Ryanair Calmac Ferries Rolls Royce Marine AP&A RSSB Wärtsilä	Federal State Unitary Enterprise The Central Aerohydrodynamic Institute (Russian Fed.) State Research Institute of Aviation Systems (Russian Federation) State Educational Institution of Higher Professional Education Moscow Aviation Institute State (Russian Federation) Joint Stock Company Innovative Technologies Concern (Russian Federation) Moscow Institute of Physics And Technology (Russian Federation) Wuhan University of Technology (China) Institut Teknologi Sepuluh Nopember (Indonesia) Archipelago Philippine Ferries Corporation (Philippines)

3.3.2 Complementary Scientific Excellence

SAFEMODE includes all the expertise required for the successful execution of the project. One of the key criteria in the definition of the partnership was related to the availability of already tested methodologies and solution in the different sectors. All partners bring complementary capabilities and some very distinctive competences.

Moreover, the Consortium ensures the Scientific Excellence in Human Factors for Aviation and Maritime, since on all projects funded on Human Factors and Aviation by FP7, Horizon 2020 and SESAR programs in the last 10 years, 80.7% included SAFEMODE partners in the consortium (source: OPTICS2 repository), while in the Maritime, 83.3% of all the project on Human Factors founded by FP7 and Horizon 2020 programs included at least one SAFEMODE partner in the consortium (source: cordis.europa.eu).

3.3.3 Wide geographical coverage

The project aims at approaching as wide target audience as possible. The geographic diversity of the Consortium plus External Stakeholders Group and the various languages the partners speak, as well as various cultural origins will strengthen the capabilities of SAFEMODE. The multilingual nature of the Consortium and External Stakeholders Group overcoming language barrier enables wider approach to the national data (online/offline sources, national projects and initiatives) and expands the vision of the project. The SAFEMODE Consortium is composed of 34 main partners representing 17 different countries, 11 of which are Member States of the European Union and the other 2 countries are associated to Horizon 2020: Belgium (1), France (4), Germany (2), Greece (4), Hungary (1), Ireland (1), Italy (2), Netherlands (4), Norway (1), Portugal (1), Sweden (2), United Kingdom (5), Turkey (1). Other 4 extra EU countries involved are: Russian Federation (5), China (1), Philippines (1), Indonesia (1). External Stakeholders Group covers other EU and non EU countries, such as: Austria, Bulgaria, Canada, United States of America, United Arab Emirates, etc.

WHY SAFEMODE FOCUSES ON INTERNATIONAL DIMENSION?

Aviation and shipping sectors are truly international transport businesses without borders. International regulatory framework dictates the safety regime they operate under, which are generally adopted with the agreement of individual countries. Furthermore, Philippines, China, Indonesia and Russia are the top 4 seafarer providing countries in the world while 30% the crew on European ships are supplied by Philippines. While 90% of world cargo transported by sea (<http://www.ics-shipping.org>), Aviation carries 3.1 billion passengers a year in the world (www.icao.int). Any safety enhancement in aviation and shipping, will impact worldwide and requires international cooperation. Therefore, SAFEMODE project, in line with EU's policy in international dimension with regards to transport safety, intelligently brings key extra-EU partners to generate worldwide data, share experience, to address regional issues and more importantly to generate same understanding world-wide resulting in worldwide impact with regards to safety enhancement.

Any safety enhancement in aviation and shipping, including regulatory enhancement, will impact worldwide and therefore require understanding and the acceptance by other countries. Similar understanding on risks, design, human factors, training, safe operation and regulations. Therefore, SAFEMODE project, in line with EU's policy in international dimension with regards to transport safety, intelligently brings key extra-EU partners to generate worldwide data, share experience, to address regional issues and more importantly to generate same understanding world-wide resulting in worldwide impact with regards to safety enhancement. Without International Dimension desired transport safety standards cannot be achieved.

3.4 Resources to be committed

3.4.1 Summary of staff effort

The resources necessary to successfully achieve the objectives of the SAFEMODE project, will be distributed to perform mainly research activities, roughly an 80%, 4% will be dedicated to management and another 15% to dissemination and exploitation. One important aspect to consider is that more than 30% of the total effort will be provided in-kind by EUROCONTROL as European Agency and by the extra-EU partners from the Russian Federation and China. The effort is balanced among partners, with slightly greater work foreseen for the technical WP leaders and for the project coordinator, while slightly less effort is foreseen for end users. An exception is partner TSAGI, that has a major role within the Russian Federation group of partners.

Should this tender be successful EUROCONTROL, the Russian partners, and Wuhan University of Technology, as part of the consortium, will participate in the project actions without requesting funding. EUROCONTROL, the Russian partners, and Wuhan University will, however, fully engage in the project and in particular is committed to providing the effort, contributions to deliverables and to other activities as set out in this tender and in the accompanying administrative forms. Their contribution is detailed in the WPs description.

Given the high contribution brought by Russian partners, their main activities are summarised below:

- Collection and preliminary statistical analysis of dangerous pilot-aircraft interaction cases leading to aviation incidents/accidents, and classification according to the SAFEMODE taxonomy,
- Definition of methods of mathematical modeling of pilot-aircraft system in normal and abnormal piloting conditions, in order to conduct predictive analysis of human factor risks,
- Definition of methods of comprehensive assessment of pilot physiological state and control activity parameters,
- Development and piloted validation of a representative flight simulation model for a transport aircraft in all its configurations for LOC-I and WVE (in collaboration with DMU).
- Definition of aviation case studies and forward-looking scenarios for manual control risk models specific to modern control inceptors (i.e. passive/active sidestick) and deficiencies of display indicators, pilot warning system implementation, in critical situations (for example, LOC-I, WVE).

- Piloted simulation of the defined scenarios and case studies using PSPK-102 and AIRFOX CPRT High simulators (with DMU).
- Analysis of the results from the perspective of HF Risk Models and HURID concepts (with DMU).

3.4.2 Other direct cost items

Tables below refer to partners for which the sum of the costs for 'travel', 'equipment', and 'goods and services' exceeds 15% of their personnel costs.

All depreciation costs for equipment, infrastructure or other assets in the project are in compliance with Article 6 and will be recorded in the appropriate beneficiary's accounts, purchased in accordance with Article 10 of the grant agreement and written off in accordance with international accounting standards and the beneficiary's usual accounting practices.

5- Hungarocontrol	Cost (€)	Justification
Travel	15.000,00	As a work package leader (WP6) and a contributor to WP3 in the project of 36 month duration, traveling is an essential part of task execution (T3.1; T6.1; 6.2; 6.3;6.5). Workshops and core team meetings are planned to be held at foreign premises, such as France (ENAC), Russia (Tsagi), Italy (Deep Blue), Brussels (EUROCONTROL) with technical, human factors experts and air traffic controller participation. 5-8 business trips are expected during the project, including the traveling to the kick-off meeting.
Equipment	47.255,00	The cost has been calculated by first defining the depreciation cost of the real-time simulator platform in accordance with the usual in-house cost accounting practices for real-time simulations. Then, the costs for the simulator usage per day has been multiplied with 13 (number of days assumed to be required to run the validations in two iterations, thus calculated only for the portion corresponding to the project duration and for the rate of actual use for the project).
Other goods and services	6.087,00	This category entails the costs for dissemination activities and the costs for consumables (pens, printouts for handbooks which contain the concept of operations and simulation design).
Total	68.342,00	

10 - ITU	Costs	Justification
Travel	€15.000,00	20 Travels for 13 technical meeting and 3 local workshops. 16 meetings with 1 staff participation, 4 meetings with 2 staff participation. Average cost per travel is 750 Euro.
Equipment	€5.000,00	Costs for operating the maritime simulator plus the organisation of a national workshop in Turkey.
Total	€20.000,00	

13 - EMBRAER	Costs	Justification
Travel	€11.500,00	13 Travels for Technical Meetings 1 staff personnel , average cost per travel €885,00
Equipment	€500,00	Support material (books, articles)
Total	€12.000,00	

19 - DMU	Costs	Justification
Travel	€15.000,00	Travel to project meetings – average cost = €750 to €1,500 – 2ppl; Travel to project meetings – ave cost = €750 to €1,500 – 2ppl
Equipment	€13.000,00	Hardware components and software for upgrade of flight simulators to implement broadcast of flight/pilot parameters to WiFi. Biometrics hardware – depreciated cost

Total	€28.000,00
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22 – Airbus	Costs	Justification
Travel	€15.000,00	Key end-user, involved in all the aviation case studies. Travel to WP meetings and Project Meetings.
Total	€15.000,00	

23 – AP&A	Costs	Justification
Travel	€12.800,00	13 Travels for Technical Meetings 1 staff personnel, average cost per travel €800,00 3 Travels for Workshops 1 staff personnel, average cost per travel €800,00
Equipment	€4.200,00	Organizing 2 stakeholders engagement meetings/workshops (€2100x2)
Total	€17.000,00	

28 – WARTSILA NL	Costs	Justification
Travel	€€23.000,00	Number of travels foreseen 13 Number of staff travelling per occasion 2 Estimate of an average cost per flight €885,00
Equipment	€2000,50	Costs for meeting organization and dissemination activities
Total	€25.000,50	

29 - APFC	Costs	Justification
Travel	€12.000,00	6 travel needed (ca. 2000 euro each) to attend project meeting
Other goods and services	€1.500,00	Organization of local workshops and dissemination activities
Total	€13.500,00	

30 - ITS	Costs	Justification
Travel	€7.500,00	Institekno will attend every second meeting (6 travels to Europe: 1person *1250 euro)
Other goods and services	€4.500,00	2 National workshop organizations and data collection campaign, 1500 each
Total	€12.000,00	

34 - BeeBI	Costs	Justification
Travel	€11.900,00	Travel to consortium meetings. 17 Travels (13 TM + 4 workshops) for 1 staff personnel, average cost per travel €700
Equipment	€1.600,00	Consumables: Amazon Web Server and certification costs (Apprx. 30 months duration.)
Total	€13.500,00	

4 Section 4. Members of the consortium

4.1 Participants (applicants)

4.1.1 DEEP BLUE s.r.l.

Deep Blue is a research and consultancy Italian SME specialising in human factor, safety, validation and scientific dissemination. From its foundation, Deep Blue has significantly contributed to European research development, serving many European and international bodies. These include the European Commission, EUROCONTROL and the SESAR Joint Undertaking. The company operates in context with high security, dependability and resilience requirements, such as Air Traffic Management (ATM), Aviation, Railways Transportation and Healthcare. The main area of activity of the company is the analysis and evaluation of interactive complex systems, with particular focus on the interactions, integration and allocation of functions between humans, procedures and equipment. With a multidisciplinary team of specialists in dependability, human factors, cognitive psychology, interaction design and software engineering, DBL is dealing with activities such as:

- evaluation of dependability and resilience in socio-technical systems;
- analysis, evaluation and validation of concepts and systems in transportation;
- generation of innovative design concepts for interactive systems;
- dissemination and transfer of research results.

Evaluation, testing and validation is an area of excellence of DBL that contributed to the development and refinement of the European Operational Concept Validation Methodology (E-OCVM), within the CAATS and CAATS II projects. The methodology was used as the reference validation methodology for the SESAR, and in several projects of the 7th FP in transportation and healthcare. DBL is responsible for evaluation, testing and validation in a large number of international research projects and is coordinator of the INNOVATE Consortium selected to provide validation services and support to SESAR.

DBL will be responsible for the overall project management and coordination. It will also exploit its competence in evaluation, testing and validation adopting an approach based on the main principles of the E-OCVM, offering also support and contribute to the description of the cases studies and related scenarios.

DBL was responsible for the scientific dissemination in several international projects of the 7th FP and HORIZON2020, including same Integrated Projects with very large consortia (more than 35 partners each), and is used to facilitate the interactions between consortia and project stakeholders. Because of its skills and competencies in dissemination, it will also have a role in this activity.

4.1.1.1 Key personnel

- **Simone Pozzi (M)** has been working as Human Factors and Safety R&D expert in Deep Blue since 2001, first as part of PhD (achieved in 2006, specialisation in Human-Computer Interaction) and then as a consultant. His expertise covers the application of Human Factors in everyday life and in safety critical systems, like Civil Aviation, Oil & Gas, Healthcare, with a long experience in user research and assessment methods. He is member of the ACARE WG4 on Safety & Security, Lecturer in Human Factors at the EUROCONTROL Training Institute (IANS) in Luxembourg, for the International Air Transport Association (IATA), and at the Design Master Degree Course of the University of San Marino-Bologna (Italy), HF Expert for the European Union Agency for Railways (ERA). In the past 5 years, he personally designed, planned and wrote 5 winning EU proposals: ELSA (Empirically grounded agent based models for the future ATM scenario), NINA (Neurometrics Indicators for ATM), STRESS (HP neurometrics toolbox for highly automated systems design) and MOTO (The Embodied Remote Tower), OPTICS2 (Observation Platform for Technological and Institutional Consolidation of research in Safety and Security), coordinating them from the proposal stage to the execution (apart from STRESS).

- **Alessandra Tedeschi (F)** holds a PhD in Applied Mathematics from the University of L'Aquila and Rome 'La Sapienza'. Her research interests include the analysis and modelling of Complex Systems with Game Theory techniques. She is co-author of several scientific papers in the field of Software Engineering, Security and Dependability. She has been working with Deep Blue since 2007, where she has been involved as Security expert and Project Manager in EU funded projects under the Transport, Security and ICT themes, such as SERENITY (2006-2008), SecureChange (2009-2012), ARCA (2009-2012), ANIKETOS (2010-2013), SECONOMICS (2012-2014), EMFASE (2013-2016) and National funded projects such as SeparA (2010-2012) and PRIMO (2012-2015). She was Project Coordinator of the IMPACT CSA concerning multi-cultural aspects for emergency prevention and management. She is currently involved in the HERMENEUT project about human factors in cybersecurity with application in the healthcare domain and she is part of the SESAR Cyber-Security Coordination Group. She is company responsible for co-funded EU and National R&D projects, being in charge of the relationship with the European Commission and with the National Contact Points for EU funding and of the selection and preparation of R&D proposals for European funding (FP7, H2020, SESAR, CleanSky, Erasmus+, LIFE, etc.) and National funding (PON, POR Lazio Region, etc.). Alessandra is Member of the "Advisory Council for Aviation Research and Innovation in Europe" (ACARE) Working Group 4 about Safety and Security, of the "Secure ICT Research and Innovation" of the EU Public Private Platform on Network and Information Security (NIS) Working Group 3 and member of the "Security Research in Italy" (SERIT) platform.
- **Vanessa Arrigoni (F)** graduated in 2013 in Organisation Science and Management at the University of Milan-Bicocca. She has an extensive experience as Human Factors Specialist and is part of the Deep Blue Team since June 2015. She is currently involved in a variety of Consultancy and EU Research Projects in the field of transportation, with a strong focus on the Aviation domain. Project n. 6 of the Future-Sky Safety Programme is one of her main projects, where she is involved in usability tests of new cockpit design via real-time simulations and Human Factors analysis of pilots' behaviours and performance. She is also in charge of both the development and coordination of the technical, communication and dissemination activities of the OPTICS2 Project, and involved in a Human Factors Consultancy Project to EUROCONTROL-Maastricht Upper Area Control Centre.
- **Daniele Ruscio (M)** is a human factors expert. He holds a Ph.D. in Cognitive Psychology at the "Catholic University of Sacred Heart" of Milan, Italy in 2014 and two fellowships research positions at the "Center for Driving Evaluation, Education and Research (D.E.E.R. Center)" - Central Michigan University, MI, USA and at the "LDRIVE lab: Interaction between Driver Road-Infrastructure Vehicles and Environment" of the Polytechnic of Milan, Italy. Within these activities he gained experience in the collection and analysis of the cognitive phenomena most relevant to the transportation domain, working for bringing the "human factors" contributions along with the ones from mechanical and civil engineers, biologists, informatics and designers. His research activity has been primarily addressed to the human performance assessment in the interaction with safety-critical systems in road and air transport, using physiological measures, virtual environments and cognitive processes analysis. He is part of the Deep Blue team since 2017, contributing, as team member, in HMI design and end-users evaluation in the EU funded project "Future-Sky Safety" (P6); in RPAS consultancy project for EuroUSC Italia and ENEL on the human performance assessment for BVLOS flights, and in the "Pilot evaluation" activities and also in the exploitation activities, as task leader, for the EU funded project on resilience "DARWIN" (Improving responses to expected and unexpected crises affecting critical infrastructures).

4.1.1.2 Publications

1. Borghini, G., Aricò, P., Ferri, F., Graziani, I., Pozzi, S., Napoletano, L., Imbert, J. P., Granger, G., Benhacene, R. and Babiloni, F. (2014) A neurophysiological training evaluation metric for Air Traffic Management. 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC'14).
2. Tomasello, F., Ducci, M. (2016), Research for TRAN Committee: Safe Integration of Drone into Airspace, European Parliament, *Directorate-General for Internal Policies*.
3. Ruscio, D., Bos A. J., Ciceri, M. R. (2017). Distraction or cognitive overload? Using modulations of the autonomic nervous system to discriminate the possible negative effects of advanced assistance system. *Accident Analysis & Prevention*. Volume 103, June 2017, Pages 105 – 111
4. Rozzi, S., Bonelli, S., Ferreira, A., Napoletano, L. Bécouarn, L. (2015). The Operational Potential of an In-Flight Weather Awareness System: An Explorative Pilot-in-the-loop simulation. Paper presented at Human Factors and Ergonomics Society Europe Chapter 2014 Annual Conference.
5. Taurino D., Taraglio S., Tedeschi A., Pasquini A., Nanni V. (2011), Satisficing Game Theory for Enhancing Autonomy in Unmanned Aerial Vehicles, Special Issue on Intelligent Unmanned Systems of the International Journal of Artificial Intelligence (IJAI) ISSN 0974-0635. Pp. 316-328.

4.1.1.3 Relevant Previous Projects

Name	Description	Reference
FAROS FP7 Project	FAROS is an EC FP7 funded, three-year project to develop an approach to incorporate human factors into Risk-Based Design of ships. The project consortium consists of 12 members including industry, academia and research institutes. FAROS will use experimental data, simulations, parametric ship design models and optimisation processes to integrate human factors into the ship design process at a conceptual stage. This will include global and local ship design factors features. This project builds on previous research and development of Risk-Based Design (RBD) for ships which began with SAFEDOR, and encompasses damage stability (GOALDS), fire safety (FIREPROOF), flooding control (FLOODSTAND) and environmental impact (FLAGSHIP). The FP7 Programme is also funding two partner projects on Human Factors in ship design: Crew-centered Design and Operations of Ships and Ship Systems (CyClaDes); Model-based Cooperative and Adaptive Ship-based Context Aware Design (CASCADE)	http://www.faros-project.eu
ACROSS FP7 Project	<p>The ACROSS – Advanced Cockpit for the Reduction of Stress and Workload, project aims to develop pioneering solutions to reduce pilots' peak workload and stress, supporting them when dealing with difficult situation. More specifically, the ACROSS applications are to:</p> <ul style="list-style-type: none"> • Promote workload reduction during normal operations; • Provide support for reduced crew operations, either because one pilot has temporarily left the cockpit, or because s/he has become incapacitated; • Provide safe recover from total crew incapacitation situations. <p>The ACROSS consortium consists of 35 partners from 12 different European countries. Deep Blue leads and coordinates the ACROSS validation activities. Validation wise, ACROSS is a quite articulated project as it requires the integration of validation results generated by different validation exercises—each exercise executed by different partners at their own validation facilities, and focused on different technologies (more than 15 cockpit applications have been evaluated). In order to address this challenge,</p>	http://www.across-fp7.eu

Name	Description	Reference
	<p>Deep Blue defined a common E-OCVM based validation strategy; provided validation guidance to the partners conducting the exercises; and defined common templates in support of the planning and reporting of the local exercises. Also, one key measure was the definition of a common performance framework to ensure the effective integration and comparability of the validation results generated in the project in the area of human performance, safety, and cost-benefit. Deep Blue also contributes to the transversal work packages of human factors and safety. Finally, we lead the project Dissemination and Exploitation activities. Deep Blue takes care of project identity design, website, brochure and videos production and scientific communication coordination.</p>	
<p>SESAR PJ19</p>	<p>SESAR 2020 takes an integrated approach to modernising Europe's air traffic management (ATM), with over 18 projects developing solutions addressing different aspects of system. To ensure that the solutions delivered are interoperable, the programme relies on the Content Integration (PJ19) project. PJ19 CI assesses the completeness, consistency and coherency of the solutions from a holistic perspective as represented in the SESAR Concept of Operations. The Project also contributes to assessing the maturity of SESAR Solutions and their readiness for deployment. The project maintains SESAR's performance framework, ensuring its applicability. As such PJ19 CI maps the overall performance of the SESAR Solutions brought together against the expected performance improvements as outlined in the European ATM Master Plan, the roadmap for modernising ATM in Europe. PJ19 CI created common content baseline such as the first SESAR 2020 CONOPS and European Enterprise Architecture. It defined also the Performance Framework and the European ATM Architecture Framework. These have provided a common foundation and solid view and way of working to all SESAR Partners. Combined with the ATM Master Plan, this constitutes a substantial improvement in the way European ATM Stakeholders are working together as it is about to provide European decision makers at all level (Airspace Users, Service provider, System provider (Ground & Air Industry), Regulation bodies) means to assess on a common basis the usefulness of a change and take the relevant decision being at regulation, standardisation and deployment level.</p>	<p>https://www.se-sarju.eu/index.php/projects/ci</p>
<p>FUTURE SKY SAFETY (P6) Horizon 2020</p>	<p>Future Sky Safety (research and innovation programme under grant agreement No 640597.) is a joint research programme aiming at addressing the main aeronautical safety risk priority areas: Reducing risk of accidents; strengthening the capability to manage risks; building ultra-resilient systems; building ultra-resilient vehicles. Through its collaborative projects, Future Sky Safety will deliver innovative solutions such as a total system risk observatory and enhanced HMI to recover from pilot's performance decrement. Within Project n.6 of the EU Horizon 2020 Research and Innovation Programme "Future Sky Safety" (FSS), the usability and potential safety impact of a completely touchscreen cockpit was assessed. One of the objective of the FSS Project 6 was to conduct a series of flight simulator experiments in order to identify performance boundaries using the Human Performance Envelope (HPE) framework. Rather than focusing on a single factor, the HPE concept combines a set of interdependent factors (including stress, workload and situation awareness), aiming at shedding some light on how the different factors, alone or in combination, influence pilots' performance and, in turn, the safety of operation. The methodology used integrated different set of data thru qualitative and quantitative methods aimed to measure pilot's perception and executive functions. Deep Blue is</p>	<p>https://www.futuresky-safety.eu/project-6/</p>

Name	Description	Reference
	involved in Project #6 “Human Performance Envelope” aiming at defining and applying the Human Performance Envelope in pilot’s perception of benefits and acceptance of cockpit operations and design, and determining methods to recover crew’s performance to the centre of the envelope, and consequently to augment this envelope, through HMI acceptance thru procedures or training.	
STRESS SESAR 2020	Human Performance Neurometrics Toolbox for Highly Automated Systems Design (SESAR H2020). STRESS started from the analysis of the current expectations of ATM stakeholders towards automation. European research agenda is working to introduce higher levels of automation in air traffic control. In the future, a new generation of highly automated supporting technologies will be developed. They are expected to autonomously (or partially autonomously) manage tasks that are currently carried out by human operators and/or to support humans in making decisions that the operators will hardly be in a position to question. To address all these implications, the project selected as a theoretical framework for automation definition and classification the research carried out by different authors such as Sheridan, Parasuraman and Bainbridge. The main goal of the project is to generate guidelines to be followed to design future automated systems that are compatible with human capabilities and limitations, ensuring that the right balance between humans and high automations is obtained. In particular, the project will assess neurophysiological signals, behavioural and performance data and subjective data to verify that the indexes are capable of assessing attention and stress, and to use these indexes to study the impact of highly automated systems on controllers, with a focus on transition between different levels of automation. Deep Blue is the Coordinator of the STRESS project and the Dissemination manager. In addition, Deep Blue is responsible for the: Future scenarios envisioning; Simulations planning and execution; and Automation guidelines generation	http://www.stressproject.eu

4.1.1.4 Major Infrastructure

Deep Blue premises are located in Rome. The office hosts 25 work stations and 4 meeting rooms. Remote servers and computing facilities are available for information sharing, data processing and storing. Additional tools such as tablets, cameras, video and audio-recorders are available to support field study activities and validation/demonstration activities. Deep Blue hosts a small library with books and materials about Human Factors, Safety and Security, Psychology, Cognitive Science, Automation, Data Analysis, Computer Science, Air Traffic Management, etc. and dedicated training material for its employees. Other on-line resources (e.g., access to on-line journals, platforms, e-learning modules, etc.) are available to support training on the job. During its long experience in the organization, conduction and analysis of validation and demonstration activities, Deep Blue developed methods and tools that help to obtain more reliable results in the shortest possible time, such as standardised tool for electronic questionnaires administration and analysis, as well an integrated framework for innovative and real time statistical data analyses. Electronic questionnaires support the whole SHAPE Eurocontrol package for Human Performance estimation and still leaves freedom for the definition of ad hoc surveys. The questionnaires are optimized for tablets, smartphone and normal computers and the data are collected and analysed in real-time. This guarantees us advantages like:

- High disposition to the compilation from the interviewed
- Low error rate
- Instantaneous availability of the results and possibility to prompt inquire the emerged aspects
- Possibility to dynamic conduct the RTS based on the results

Analysis of quantitative data such as system logs and human-system interactions is also conducted using a suite of tools developed by our analysts and integrated with the state of the art software for analysis and visualisation. Raw data is usually pre-processed and then stored in a database to facilitate the analysis.

4.1.2 UNIVERSITY OF STRATHCLYDE (UoS)

The University of Strathclyde has extensive experience of participating in and coordinating European Framework Projects. Strathclyde has a portfolio of over 200 projects across FP7 and H2020 and has participated in over 50 of these as project coordinator/sole beneficiary. Strathclyde currently has 76 Horizon 2020 projects with a value in excess of €25m. 26 of these have been awarded under the Marie Skłodowska-Curie scheme (13 as coordinator or single beneficiary): 4 RISE, 14 ITNs, 6 Individual Fellowships and 2 Researchers' Night. Strathclyde has a portfolio of 128 FP7 projects with an approximate value of €50m. 35 of these were awarded under People, 65 Cooperation, 13 Capacities and 6 under other schemes. Across FP7 and H2020 Strathclyde has involvement in 12 ERC projects and has collaborated with approximately 1500 partners in industry, academia and intermediary organisations from around the world.

The Department of Naval Architecture, Ocean and Marine Engineering (NAOME) at University of Strathclyde (UoS) is one of the largest Naval Architecture departments in Europe and possibly the largest academic research group in Europe in the marine sector with more than 130 researchers and PhD students addressing a wide range of aspects of ships and offshore structures in very close collaboration with the marine industries. The outcomes of research have contributed remarkably to innovation and advancement of technology, establishment and revision of conventions and rules of IMO, Government bodies and classification societies, improvement of safety, environment sustainability and efficient production and operation of ships. Strathclyde University, is the world's top institution in shipping safety research and one of the Key institutions in European waterborne transport research and has been involved in more 60 European projects in the capacities of Co-ordinators, technical co-ordinators and investigator partners. SAFEDOR, COMPASS, MAIDER, FLAGSHIP, RISPECT, SILENV, SEAHORSE, FAROS, EXCROSS, DIVEST are some of the safety related projects and directly linked to SAFEMODE project.

The Department's world leading research in Maritime Safety, Ship Design and Operations has led to the establishment in 2016 of the Maritime Safety Research Centre jointly funded to £2M by Royal Caribbean Cruise Lines (RCCL) and DNVGL to investigate all aspects of maritime safety; this can be seen as a testimony to the high-quality industry-focused research that UoS is carrying out. Finally, the department is currently constructing a full-mission bridge simulator in 2018 to be used for research into maritime safety and resilient ship operations. The Department hosted a number of international conferences related to maritime safety and human factors including Human performance at Sea Conference in 2010, HPAS 2010, MarineNoise and Vibration Conference in 2011, Marine Design Conference 'IMDC2012, Stability conference, STAB 2015 and SEAHORSE 2016

4.1.2.1 Key personnel

- **Dr Rafet Emek Kurt (M).** Dr Kurt is a Lecturer and PGT Recruitment Director in the Department. Dr Kurt's research interests lie in the field of human factors in maritime domain which includes design, optimisation, operation of ships, by considering the human factors, safety and risk at the core of the subject. Dr Kurt investigated the effects of noise and vibration on human performance and developed novel human response models for noise and vibration levels on-board ships. Dr Kurt's current research focuses of human factors related marine accidental learning with the help of fuzzy cognitive maps, resilience engineering concepts, maritime workarounds ("work as imagined" vs "work as done") and integrating human factors into Formal Safety Assessment (and risk-based design). Dr Kurt also attends various meetings (e.g. Maritime Safety Committee, Marine Environmental Protection Committee) at International Maritime Organisation (IMO). Dr Kurt has been involved in various research and KE projects such as; EU FP7 SILENV, EU FP7 EXCROSS, EU FP6 IMPROVE, EU FP7 SEAHORSE, IMO-NORAD SENSREC, EU LLP SHIPDIGEST, EU LLP BOATDIGEST.
- **Professor Osman Turan (M).** Prof Turan is one of world's leading experts on shipping safety, design for safety covering human factors. He has been involved in the forefront of the waterborne safety and contributed significantly to the development of safety related rules at various platforms including IMO. He has been involved in many maritime accident investigations using pioneering techniques to establish the reasons of the accidents including human factors and develop solutions

to eliminate/mitigate the accidents and safety critical conditions through design and operations. Prof Turan has been involved in more than 20 EU projects and was the co-ordinator of FP 5 Flowmart Project, and the technical co-ordinator of COMPASS project and the Co-ordinator of FP7 SEAHORSE project, which received the LR-RINA maritime safety award.

- **Beatriz Navas de Maya (F).** Miss Navas de Maya is a PhD researcher in the Naval Architecture, Ocean and Marine Engineering Department since October 2016 in the field of maritime safety, human factors and resilience engineering. Her research focuses on enhancing safety by addressing human factors, resilience engineering concepts, Fuzzy Cognitive Maps and the accident investigation data in an integrated manner. Miss Navas de Maya has also been involved in EU funded SEAHORSE project.

4.1.2.2 Publications

1. Navas de Maya, B., Kurt, R. E. & Turan, O. (2018) Application of fuzzy cognitive maps to investigate the contributors of maritime collision accidents 10 p
2. Abdushkour, H., Turan, O., Boulougouris, E. & Kurt, (R. E. 2018) Comparative review of collision avoidance systems in maritime and aviation (Accepted/In press) The 3rd International Symposium On Naval Architecture and Maritime (INT-NAM 2018). Istanbul: Yildiz Technical University, 13 p.
3. Kurt, R. E., Arslan, V., Comrie, E., Khalid, H. & Turan, O. (2016) SEAHORSE procedure improvement system 6th Conference on Design for Safety, 28/11/16 - 30/11/16 Hamburg, Germany.10 p
4. Osman Turan, Rafet Emek Kurt, Volkan Arslan, Sara Silvagni, Marco Ducci, Paul Liston, Jaan Maarten Schraagen, Ivy Fang, George Papadakis, 'Can We Learn from Aviation: Safety Enhancements in Transport by Achieving Human Orientated Resilient Shipping Environment'. TRA2016, Transportation Research Procedia, Volume 14, April 2016, Pages 1669–1678.
5. Volkan Arslan, Rafet Emek Kurt, Osman Turan, Louis De Wolff, 'Safety Culture Assessment and Implementation Framework to Enhance Maritime Safety', Transport Research Arena TRA2016, Transportation Research Procedia, Volume 14, 2016, Pages 3895-3904
6. Kurt, R. E., Khalid, H., Turan, O., Houben, M., Bos, J. & Helvacioğlu, I. H., 'Towards human-oriented norms: considering the effects of noise exposure on board ships' Jul 2016 In: Ocean Engineering. 120, p. 101-107 7 p.
7. SEAHORSE project: Dealing with maritime workarounds and developing smarter procedures. Kurt, R. E., Arslan, V., Turan, O., de Wolff, L., Wood, B., Arslan, O., Kececi, T., Winkelman, J. W., van Wijngaarden, M. & Papadakis, G. 3 Sep 2015 Safety and Reliability of Complex Engineered Systems - Proceedings of the 25th European Safety and Reliability Conference, ESREL 2015. p. 3811-3818 8 p. <https://doi.org/10.1201/b19094-499>
8. B. El-Ladan, O. Turan, 'Human reliability analysis—Taxonomy and praxes of human entropy boundary conditions for marine and offshore applications', Journal of Reliability Engineering and Systems Safety, Volume 98, Pages 43-54, 2012

4.1.2.3 Relevant Previous Projects

Name	Topic	Relevance	Reference
SEAHORSE FP7 Project	Enhancing maritime safety by focusing on human factors and resilience engineering	SEAHORSE is a leap forward towards shipping safety achieved through technology transfer from air transport to marine transport focusing on human factors problems in an innovative, integrated and multidisciplinary manner towards safer and more resilient shipping	http://seahorseproject.eu/

Name	Topic	Relevance	Reference
	principles	operations.(UoS)	
EXCROSS FP7 Project	Fertilization and synergies in different modes	The general target of EXCROSS is to facilitate an enhanced, cost effective and better managed safety research in all the different transportation modes. (UoS)	http://www.excross.eu
SilenV FP7 Project	Noise and Vibration effects	The SilenV proposes a holistic approach to study ship generated Noise & Vibration pollution and assess solutions to reduce emissions. (UoS)	http://www.silenv.eu/
SAFEDOR FP6 IP Project	Risk-Based regulatory framework for performance prediction	SAFEDOR treated safety as a design objective while establishing a Risk-Based regulatory framework that links performance prediction with risk assessment. (UoS)	http://www.safedor.org/
FAROS FP7 Project	Risk-based design incorporating the human factors.	In project FAROS, the rationalised nature of the Risk-Based Design will be used to integrate the human element into the ship safety framework and deliver ship concepts (ro-pax and tanker) that are safe, economic and “green”. (UoS)	http://cordis.europa.eu/projects/rcn/105337_en.html

4.1.2.4 Major Infrastructure

- A. *Full Mission Bridge Simulator*. TRANSAS 5000 full mission bridge simulator dedicated to research only. The simulator is being constructed and will be fully functional in January 2018. The NTPRO 5000 simulator R&D suite includes Model Wizard – a 3D database editing tool, Virtual Ship Yard – a ship hydrodynamics model development package, and Cardinal – a 3D current analysis and forecasting software as well as emission monitoring. The simulator can be used for various research studies, such as: Navigational Safety and Human Orientated Design Research, human – machine interaction, accident analysis, designing of rare events for generating solutions to navigational and human factors problems and specific design solutions.



Figure 13 Full Mission Bridge Simulator.

- B. *Kelvin Hydrodynamic Lab*. The Kelvin Hydrodynamics Lab tank provides excellent conditions for measuring the performance of surface ships and a wide variety of floating and underwater structures. Ship models used are up to 4m in length. High quality, single frequency waves and random sea states may be generated with wave heights over 0.5m. The motions of floating vessels and structures are measured using a state-of-the-art, real-time, non-contact infrared camera system.



Figure 14 Kelvin Hydrodynamics Lab

4.1.3 EUROCONTROL - EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

The European Organisation for the Safety of Air Navigation, EUROCONTROL, was founded in 1963. It is an intergovernmental organisation supporting its forty-one member states in the development, implementation and operation of a seamless, performance driven pan-European Air Traffic Management network. The main activities of EUROCONTROL are focused upon the coordination and planning of air traffic management across Europe. This involves working with air transport stakeholders from the national authorities, air navigation service providers, civil and military airspace users, airports, and other organizations. Its activities involve all gate-to-gate air navigation service operations: Network Management, controller training, regional control of airspace, safety-proven technologies and procedures, collection of air navigation charges, regulatory support functions and research. EUROCONTROL has a long history in safety and safety research, and during the past decade has been leading the development of Safety Management and Safety Culture in Europe, and supporting the implementation and improvement of safety in European States, as well as its promotion via the world class website Skybrary. EUROCONTROL also works with the FAA to develop and apply macro-models of safety in order to support the safe development of future infrastructure upgrade programmes such as SESAR in Europe and NextGen in the USA, including evaluation of the critical role of the human in aviation safety.

EUROCONTROL is a founding member of the SESAR Joint Undertaking and is actively engaged in the coordination of European research, and remains an active player in the development and monitoring of the ACARE Safety Research and Innovation Agenda (SRIA) via the EC-funded Project OPTICS (which EUROCONTROL led) and OPTICS2, and works on key aviation safety research projects such as Future Sky Safety, which has a strong Human Factors element, and leading edge projects such as CORUS and PODIUM, which are investigating how to safely integrate drones into airspace.

EUROCONTROL has more than thirty safety and human factors experts working on all aspect of safety, from research and design, to operational safety, and has access to most ATM organisations in Europe and to pan-European safety data. It has its own state-of-the-art simulation centre at Bretigny, a world-class safety training centre in Luxembourg, its own top performing operational centre in Maastricht, and a 24/7 Crisis Cell to help with and coordinate crises in European ATM. EUROCONTROL is the Organisation for the *Safety* of Air Navigation, and recognises that future safety must be informed by focused research tackling areas such as organisational safety, macro-safety models of the entire aviation system-of-systems, and the critical role of the human in aviation safety. It is fully committed to the research avenues in this proposal, which will ensure that the safety enjoyed today by the travelling public and by airspace users will extend & improve into the foreseeable future.

4.1.3.1 Key personnel

- **Barry Kirwan (M).** Barry Kirwan has degrees in Psychology, Human Factors and Human Reliability Assessment. He has worked in the nuclear, chemical, petrochemical, marine and air traffic sectors of industry, lectured at the University of Birmingham in Human Factors. He was formerly Head of Human Reliability at BNFL in the UK nuclear industry, and Head of Human Factors at NATS (UK). For the past eighteen years he has been working for EUROCONTROL, on various safety research areas, in particular safety culture, at the EUROCONTROL Experimental Centre in Bretigny, near Paris. He has published four Human Factors and Safety books and around 220 scientific articles, and is a visiting Professor of Human Reliability & Safety at Nottingham University in the UK. He initiated and led the European Safety Culture Programme for Air Traffic Management, dealing with more than thirty countries in Europe, for twelve years, as well as collaborating with the FAA in the US (as European chair of FAAEUROCONTROL Action Plan 15 on Safety Research) during the same time period. He was co-chair of ACARE (Advisory Council for Aviation Research in Europe) Working Group 4 (Safety & Security) for three years, as well as project manager and Coordinator for the EU-funded OPTICS project, and remains actively involved in the follow-on project OPTICS2. He is currently leading one of the Future Sky Safety projects on Human Organisational Factors, and supporting another on cockpit Human Factors. He

periodically advises UK rail and UK/US nuclear power industries on Human Reliability Assessment and Human Factors classification.

- **Andy KILNER (M)** Andy KILNER has spent over 20 years working in the field of human factors and safety in high risk safety critical industry and electronics. Andy started his career in Air Traffic Management with National Air Traffic Services in the UK before going on to work in the fields of conventional and nuclear defence, civil nuclear and transport. Working primarily in the domain of human factors, he managed the HF team at Sony, and Serco. In returning to air traffic management, Andy took up a post at EUROCONTROL and supported the European safety culture programme with surveys at AVINOR, Slovenia, NAV and ENAV. Andy was then re-organised into the SESAR programme and looked after safety research projects and the transversal area of human performance. Andy now continues to work in safety modelling and understanding Safety Risk in ATM. He is managing the Integrated Risk, or IRiS, approach to manage risk in ATM. IRiS is an emerging risk framework that ECTL is developing with the FAA; it is scheduled for a 2018 delivery and a tentative deployment in Europe.
- **Renée PELCHEN-MEDWED (F).** Renée Pelchen-Medwed has a Master's degree in Psychology from the Karl-Franzens University in Graz, Austria. As a scientific assistant at the university she worked with pilots in the field of special disorientation and with air traffic controllers on several topics concerning Human Factors and Safety. She works for Eurocontrol since 2003. For 6 years she worked as Human Factors and Validation expert in the Eurocontrol Center for Research, Development and Simulations (CRDS) in Budapest, Hungary. Since 2010 she works in Eurocontrol headquarters in Brussels mainly in the wide field of the Single European Sky ATM research (SESAR). In SESAR 1 she contributed to the development of the HP assessment methodology for SESAR and was then as well as now in SESAR 2020 responsible for leading and performing human performance assessments in various operational and technical SESAR projects. She is co-chairing the cooperative plan for Human Performance and Safety Research (CP1.7) a collaboration between FAA in the US and Eurocontrol in Europe.
- **Marta LLOBET LOPEZ (F).** Marta Llobet López has an Engineer degree from the School of Engineering in Barcelona (ETSEIB) and from the French Civil Aviation School in Toulouse (ENAC). Since 2008, she also has a master degree in Human Factors from the French University René Descartes-Paris V related to aeronautical systems conception. She has worked for more than 7 years as safety specialist in the ATM domain in Sofréavia - EgisAvia, performing safety assessments and developing safety cases, in particular for ADS-B (Automatic Dependent Surveillance – Broadcast) applications, providing in this way technical support to EUROCONTROL and the Civil French Aviation. Marta joined the Safety team of EUROCONTROL Experimental Centre (EEC) in March 2009 to work on the development of safety case for projects as Digital NOTAM and CASCADE. She started to work within the SESAR from the beginning of this research program, being involved in the development and maintenance of the SESAR Safety Reference Material. Within SESAR2020 she is currently responsible for leading and performing the safety assessment of Multiple Remote Tower project. For the last 5 years Marta has also been supporting the development and validation of safety risk models in ATM. She led the modelling aspects for a Risk Observatory being developed in project P4 of Future Sky Safety. Currently she is also working in the emerging EUROCONTROL risk management framework and the IRiS models.
- **Frederic ROOSELEER (M).** Frédéric Rooseleer is an Air Traffic Management (ATM) Expert with 17 years of professional experience in civil aviation, in which over 12 years in the field of ATM, holding a Master degree in aeronautical engineering. Among his duties in EUROCONTROL (The European Organisation for the Safety of Air Navigation), he is responsible for the RECAT-EU and Pairwise safety cases, and developed the safety case on RECAT-EU

proposal for optimising the wake turbulence separation minima, and supported operational deployments. He is a Member of the ICAO Wake Turbulence Study Group and has undertaken the work on the ICAO RECAT Technical proposal. He is also the technical lead of SESAR 2020 PJ02-02 solution for Enhanced Arrival Procedures, and is a teacher at the EUROCONTROL Institute for Air Navigation Services (IANS) of the Safety Assessment of Changes course.

- **Nicolas FOTA (M).** Octavian Nicolae has a PhD degree in Computer Engineering applied to Air Traffic Management (from the French LAAS). He has worked in nuclear, automotive and air traffic sectors of industry, lectured at Polytechnical University of Bucharest in Safety & Dependability applied to power plants. He was formerly Safety engineer at the Romanian nuclear power reactors design & development entity (CANDU technology), Safety consultant at IXI (GFI Informatique) and Safety team manager at EgisAvia (ATM department). For the past twelve years he has been working for EUROCONTROL, leading the safety assessments of new ATM developments ‘from concept to in-service’ operations. Currently performing safety assessment & assurance support within SESAR encompassing the concept & system design, validation exercises and Live Trials safety material in view of approval by relevant Regulatory bodies, development of the SESAR Safety Reference Material and working on various safety research areas, in particular agent-based dynamic risk modelling.
- **Brian Hickling (M)** has a degree in Biochemistry and is also a certified Systems Engineer. He first worked for Raytheon initially as a systems engineer and finally as a researcher and consultant for the Aviation Industry in the domain of Surveillance Systems and in Artificial Intelligence (for the DOD). Since 1989 he has worked for EUROCONTROL first in the area of Surveillance and Tracking systems and since 1999 in safety as an expert in risk modelling and safety assessment. He has been the author of scientific articles concerning surveillance systems, aviation safety analysis and human factors. He has been technically responsible for many EUROCONTROL projects including RASS, ASMT, the SAFLEARN (incident database), IRP and AIM (risk models) and has carried out safety assessments for SESAR and SESAR2020 projects. Brian has worked extensively with all forms of safety data from ANSP, Flight Planning and on-board recordings from Airlines. He has developed safety monitoring tools using surveillance and systems data (designer and manager of ASMT project) and was the author of the European Automated Safety Monitoring standards documentation. He was a driving force in the development of the SESAR ATM risk models based upon analysis of incident data (SAFLEARN/IRP/AIM/IRIS). He has been recently developed as well the technical specification for a Risk Observatory prototype being developed in FSS P4 Total Aviation Safety. He has also worked closely with suppliers of experimental software to specify, design, develop and test new tools both in the surveillance and safety domains.
- **David Martin Marrero (M)** holds a master’s degree in mathematics, a master in technologies and telecommunication systems (Signal processing) and has coursed some PhD studies in advanced ATM systems. He has worked as a researcher participating in air traffic management R&D projects in the Technical University of Madrid. During this period, he collaborated with INDRA in different Air Traffic Management projects especially in the scope of the SESAR programme. He also worked in the development of the tracking system AirCon2000 to include the data processing for multilateration and ADS-B together with the already existing radar processing. Moreover, he participated in the development of a safety assessment for the sectorless ATM concept together with the German Aerospace Centre (DLR) at the institute of flight guidance in Braunschweig, Germany. Later on, he worked for ENAIRE at the Canary Islands Control Centre at the ATS division managing the flow of safety reports delivered by the operational safety department and registering the corrective actions for the ATM incidents in the region. He joined EUROCONTROL in 2017 and since then he has worked in various drone related projects as Safety Assessment Specialist, at the EUROCONTROL Experimental Centre in Bretigny. Among

the different drone projects, he participates in CORUS building the concept of operations for the European UTM system and in PODIUM where several live trials are being conducted to demonstrate the maturity level of the U-Space services for different environments and drone use cases. Furthermore, David collaborates with EASA at the JARUS expert group developing safety material within the SORA scope for the safe integration of Unmanned Aircraft Systems (UAS) into airspace and at aerodromes.

4.1.3.2 Publications

1. Kirwan, B. (1994) A guide to practical human reliability assessment. London: Taylor & Francis.
2. Y. James Chang, Dennis Bley, Lawrence Criscione, Barry Kirwan, Ali Mosleh, Todd Madary, Rodney Nowell, Robert Richards, Emilie M. Roth, Scott Sieben, Antonios Zoulis. (2013). The SACADA Database for Human Reliability and Human Performance, Reliability Engineering & System Safety.
3. Krois, P. Armenis, D., Joly, R., Kirwan, B., Marrison, C., May, N., Piccione, D., and Schwarz, M. (2015) Toward a human performance standard of excellence in air traffic management. 18th International Symposium on Aviation Psychology (ISAP) Conference, 4-7 May, Dayton, Ohio.
4. Noort, M., Reader, T.W., Shorrock, S. and Kirwan, B. (2016) The relationship between national culture and safety culture: Implications for international safety culture assessments. Journal of Occupational and Organizational Psychology, 89, 515–538.
5. Edwards, T., Sharples, S., Kirwan, B. and Wilson (2016) Identifying Markers of Performance Decline in Air Traffic Controllers. In Human Factors in Transportation: Social and Technological Evolution Across Maritime, Road, Rail, and Aviation Domains” edited by Giuseppe Di Bucchianico, Andrea Vallicelli, Neville A. Stanton, and Steven J. Landry. Chapter 26, 367-384

4.1.3.3 Relevant Previous Projects

Name	Topic	Relevance	Reference
FUTURE SKY SAFETY (P6) Horizon 2020	Human Performance Envelope in the Cockpit	This project investigated how factors such as situation awareness, stress and workload affected human performance in both normal and challenging scenarios, in a full flight simulator and also in an advanced (touchscreen) cockpit.	https://www.futuresky-safety.eu/project-6/
FUTURE SKY SAFETY (P5) Horizon 2020	Harmonising safety culture across aviation segments	The safety culture ‘Stack’ concept is about harmonising safety culture across different companies in aviation at a single location (in this specific case, Luton Airport), and is about airlines, ground handling agencies, de-icers, air traffic controllers, etc., learning from each other for safety.	https://www.futuresky-safety.eu/project-5/
FUTURE SKY SAFETY (P4) Horizon 2020	Total System Risk Assessment	This project works to develop a prototype risk observatory to assess and monitor safety risks throughout the Total Aviation System and allow frequent update to the assessment of risks. The risk observatory will acquire, fuse and structure safety data (which can include data from normal operations) and translate it to actionable safety information.	https://www.futuresky-safety.eu/project-4/
IRiS	IRiS the	EUROCONTROL has worked with the FAA on	

	Integrated Risk Picture for Europe	modelling risk and addressing risks inherent in ATM. IRiS is a web based risk framework that hosts a set of barrier based safety models describing how risk evolves in ATM in a holistic way. The IRiS models describes barriers that mitigate ATM risk and uses ANSP incident data to understand how these barriers fail, and, how barriers ultimately prevent 'end events', i.e. how ATM adds success. When populated with local data, IRiS can provide a description of the actual risk an ANSP is exposed to, and how this risk is mitigated by the barriers it has in place, effectively baselining the safety in that organisation.	
Human Performance Standard of Excellence	Human Factors Guidance for Operations and Design	The HPSoE was developed in collaboration between European ANSPs and the FAA, and is now being further refined by CANSO, the global organisation of ANSPs. The approach has a five-level maturity model of Human Factors incident investigation as well as how to include Human Factors in design. The final version will be available in November 2018.	https://www.skybrary.aero/index.php/Human_Performance_Standard_of_Excellence_(HPSoE)
SACADA	Human Factors data classification in nuclear power plant simulators for safety	The Scenario Authoring, Characterization, and Debriefing Application (SACADA) database was developed to better understand human performance in challenging nuclear power plant scenarios, to inform both training for emergencies and risk models (human error quantification). The approach developed an advanced classification system for human performance.	https://www.sciencedirect.com/science/article/pii/S095183201300224X
TOKAI Human Performance Classification System	A standardised means of classifying human-related safety events in air traffic operations.	TOKAI has been developed by EUROCONTROL with its ANSPs and also in consultation with the FAA. Work is ongoing inside EUROCONTROL to develop a newer version which is more sensitive to Human Factors aspects, in order to increase learning potential from these incidents. This is also part of what is known as the Safety II initiative, looking not only at what went wrong, but what went right.	http://www.eurocontrol.int/services/tokai
SESAR PJ05	Remote Tower for Multiple Airports	The project proposes the development of a remotely provided aerodrome air traffic service by a "multiple" and/or "centre" setting. Those settings help to combine ATS services from various aerodromes in a centralized control room independent on airport location in order to make use of the valuable resource ATS provider more efficiently.	https://www.remote-tower.eu/

4.1.3.4 Major Infrastructure

EUROCONTROL has a major air traffic simulation centre in Bretigny France, where more than forty working positions can be simulated with pseudo-pilot interaction, as well as a tower simulator and a remote tower simulator, and an A320 cockpit simulator. There are also several other smaller ATC facilities used for

testing prototype systems. Any of these simulation facilities can be connected to each other, and also to external simulation facilities globally. It is therefore possible to connect a simulated air traffic control operations room with full scale flight simulators, for example.

The Human Factors team who support these simulations can measure a range of factors affecting performance, from simple debriefs and questionnaires for workload and situation awareness measurement, to more advanced methods including eye tracking and heart rate measurements. Recording systems are also in place for determining event severity, e.g. how close two aircraft came together in the case of a loss of standard separation.



Figure 15 Air traffic simulation centre in Bretigny France

4.1.4 STICHTING NATIONAAL LUCHT- EN RUIMTEVAARTLABORATORIUM

The Netherlands Aerospace Centre NLR is a leading international research centre for aerospace in the Netherlands. Supported by its multidisciplinary expertise and research facilities, NLR provides innovative and integral solutions for the complex challenges in the aerospace sector. NLR's activities span the full spectrum of Research Development Test & Evaluation. NLR thereby bridges the gap between research and practical applications, while working for both government and industry at home and abroad. NLR has more than 650 specialists with in-depth expertise in a range of areas within aviation. NLR has also extensive experience in EC funded projects (CleanSky, SESAR and others).

NLR's Aerospace Operations Safety Institute (NLR-AOSI) is a consultancy and research organisation that develops and applies world-class knowledge and expertise to improve air transport safety. NLR-AOSI supports worldwide all stakeholders in air transport to understand and resolve complex safety implications of the new technologies and operations necessary to accommodate growth in air transport. Amongst customers of NLR-AOSI are air navigation service providers, aviation authorities, airports and airlines. NLR-AOSI contributes to safety topics of national and international relevance to society. Therefore, NLR-AOSI actively participates in public debates on all Dutch and significant European Air Transport related incidents or accidents. Participation may range from providing relevant information and expert opinion to policymakers and the general public to detailed investigations of incidents and accidents. Knowledge is the fundament of the safety institute. Therefore, it is the ambition to maintain, apply and to strengthen this fundament. This will be done by further advancing existing and developing new methodologies, tools and techniques by allocating part of its income to R&D. NLR-AOSI is present in key national and international working groups and committees like JAA Joint Safety Strategy Initiative (JSSI), US Commercial Aviation Safety Team (CAST) and the European Advisory Committee of the Flight Safety Foundation, thereby strengthening its role in society and the sharing and development of knowledge.

NLR has a department that is fully dedicated to human factors research in aviation that will be involved in the proposed work: Training, Simulation and Operator Performance department. Relevant research topics include fatigue risk management, human-machine interaction design, human factors analysis and mitigation (including operator performance, mental workload, and fatigue/alertness). The department has extensive experience in evaluating operator/pilot performance and identifying and analysing the related human factors issues. For this, we have available an elaborate set of human factors tools and techniques such as actigraphy, bio-mathematical models, eyetracking, heart rate (variability), electroencephalography (EEG), standardized questionnaires and rating scales, surveys, interviews, (de)briefing, and video/audio recording. If required and available, simulator/aircraft parameters and pilot performance (flight data, reaction time, and errors) are also being included for our analyses.

4.1.4.1 Key personnel

- **Sybert Stroeve (M)** MSc Electrical Engineering, University of Twente, 1991, PhD Mechanical Engineering, Delft University of Technology, 1998. In his PhD research, a combination of methods from control theory, biomechanics and neural networks resulted in a new modelling approach for the control of muscles during movement and posture tasks. At the Foundation of Neural Networks, he did research as Post-doc on the integration of neural network techniques and symbolic artificial intelligence methods, applied to the automatic recognition of emotions, as well as research on synchronous firing in biological neural networks. He is a Senior Scientist at NLR's Aerospace Operations Safety Institute. His research interests include resilience, safety management, human performance modelling, organizational modelling and dynamic risk modelling for multi-agent environments. He applied these research lines in a range of safety assessment studies for air traffic management, including runway incursion risk, safety culture, safety management, resilience engineering, and en-route collision risk.
- **Ronald Verhoeven (M)** MSc Electrical Engineering, University of Twente, 1989. Verhoeven has been involved in a wide variety of research programs, in which he combined his long-term human factors experience with his acquired flight operational knowledge, in the field of HMI cockpit prototyping and ATM concept evaluation in the civil application domain. Currently he is active as

a Data Scientist at NLR's Aerospace Operations Safety Institute. His activities are focused on data gathering, cleaning and enrichment in the aeronautical domain using Machine Learning and Data Mining tools and technologies for analyse and visualisation purposes to support e.g. safety assessments studies for airports and predictive maintenance related projects.

- **Henk van Dijk (M)** holds a PhD degree in Cognitive Psychology from the University of Twente, the Netherlands in 2006. Henk is Senior R&D Engineer at NLR's Training, Simulation and Operator Performance department. Henk participated in European research projects like HILAS (Human Integration into the Lifecycle of Aviation Systems), an integrated project on human factors integration in which several human-in-the-loop simulations were performed; CAATS II, the refinement of the European Operational Concept Validation Methodology (E-OCVM); PPLANE (Personal Plane), an 'out-of-the-box' pioneering project on personal air transport systems, in which he was responsible for the set-up of an operational command and control centre; and ACROSS, (Advanced Cockpit for the Reduction of Stress and Workload), project aims to develop pioneering solutions to reduce pilots' peak workload and stress, supporting them when dealing with difficult situation. Henk was the project manager of a project called 'Autonomous Transport' for the Dutch Ministry of Infrastructure and Water Management. This study, together with TNO and MARIN, focused specifically on the cross-fertilisation of automation concepts and technologies across the transport modes automotive, waterborne and aviation. Currently Henk is the Technical Lead on EC/EASA's large-scale Evaluation of the Effectiveness of the new EU Flight Time Limitations.
- **Joris Field (M)** has an MSc in Human Factors from the University of Cranfield, UK. He is an R&D engineer at NLR in the Aerospace Operations Training, Simulation and Operator Performance department. He has over 20 years of experience in the aviation industry having started his career in Training & Simulation at Thales. Joris has been directly and extensively involved in a number of European research projects at NLR that are relevant to this project. In these projects he has worked closely with industry representatives from across Europe. The research projects focused on applying human factors to training design and development, such as CRISIS, to develop a training system for airport emergency teams; SUPRA, studying the effect of aircraft upsets on pilots and developing simulation and training to train flight crew to handle the effect; ACROSS, supporting the human factors analysis of unexpected situations. Joris was the Technical Lead of the Man4Gen project where he was particularly involved in the cognitive engineering analysis of pilot's performance. Together with the KLM, Joris has been developing a training program for pilots in Startle Effect Management on behalf of EASA. Currently Joris is developing training for Air Traffic Controllers for a new airfield in the Netherlands.

4.1.4.2 Publications

1. Stroeve S.H. Van Doorn B.A., Everdij M.H.C. Analysis of the roles of pilots and controllers in the resilience of air traffic management. *Safety Science* 76:215-227, 2015
2. Stroeve S.H., Blom H.A.P., Bakker G.J. Systemic accident risk assessment in air traffic by Monte Carlo simulation. *Safety Science* 47:238-249, 2009
3. Stroeve S.H., Som P., Van Doorn B.A., Bakker G.J. Strengthening air traffic safety management by moving from outcome-based towards risk-based evaluation of runway incursions. *Reliability Engineering & System Safety* 147:93-108, 2016
4. Merwe K van de, Dijk H van, Zon GDR. Eye movements as an indicator of situation awareness in a flight simulator experiment. *International Journal of Aviation Psychology*; 2012; 22(1): 78-95
5. Dijk H van, Merwe K van de, Zon R. A coherent impression of the pilots' situation awareness: studying relevant human factors tools. *International Journal of Aviation Psychology*; 2011; 21(4): 343-356

4.1.4.3 Relevant Previous Projects

Name	Description	Reference
FUTURE SKY SAFETY Horizon 2020	Future Sky Safety (FSS) is a joint research programme aiming at addressing the main aeronautical safety risk priority areas: Reducing risk of accidents; strengthening the capability to manage risks; building ultra-resilient systems; building ultra-resilient vehicles. NLR has led the overall programme. FSS-P4 “Total system risk assessment” works to develop a prototype risk observatory to assess and monitor safety risks throughout the Total Aviation System and allow frequent update to the assessment of risks. FSS-P4 addresses Theme 2 “Strengthening the capability to manage risks”, that conducts research on processes and technologies to enable the aviation system actors to achieve near-total control over the safety risk in the air transport system. FSS-P5 “Resolving the organisational accident” is to reduce the likelihood of organisational accidents in aviation via development and implementation of a Safe Performance System. FSS-P5 answers to Theme 3 “Building ultra-resilient systems and operators”, which aims at strengthening the resilience to deal with current and new risks of the humans and the organisations operating the air transport system.	https://www.futuresky-safety.eu
SESAR P16.06	As the technological pillar of Europe’s ambitious Single European Sky (SES) initiative, the SESAR Joint Undertaking is the mechanism which coordinates and concentrates all EU research and development (R&D) activities in ATM. NLR contributed to the development of the SESAR Safety Reference Material for Resilience Engineering and Dynamic Risk Modelling. Resilience Engineering attempts to understand all operational performance outcomes (positive and negative) and to use that to interpret everyday safety performance. A case study for Resilience Engineering was developed for aircraft surveillance applications system (ASAS) to enable airborne spacing (ASPA) for sequencing and merging. Dynamic Risk Modelling (DRM) refers to the class of modelling techniques that explicitly models the dynamic performance of operation (people, equipment, procedures, and environment) and their time-dependent interactions. A case study of agent-based DRM was developed for Conflicting ATC Clearances – and focussing on landing versus Line-up use case.	https://www.sesarju.eu
Man4Gen	This study addressed the need to prepare pilots of modern, highly automated, airliners to deal with unexpected events, and to recommend short-term changes to operational strategies or procedures, flight crew training, and aircraft systems technology in order to mitigate the threat of unexpected situations to aviation safety. The project carried out two phases of simulator experiments with line pilots in a total of fifty crews across four locations, an exploratory phase of experiments and an evaluation of the project recommendations. The experiments applied a combination of performance evaluation through behavioural marker evaluation of competencies, as well as checking crew performance against pre-defined criteria. Psycho-physiological measures (eyetracking, heart-rate, communication analysis) were applied as required for the different evaluation scenarios. The results from this study demonstrate that flight crew can be assisted in their handling of unexpected events in the short-term through applying competency based training for a variety of training scenarios to address key competencies, and the application of a structured risk assessment and decision making strategy.	
Startle Effect Management	This study investigated the effect of startle and surprise on flight crew following an unexpected event, and developed a training solution that can be used to help crews to manage the effects of startle. The results of the study	

Name	Description	Reference
	<p>showed that the response from the flight crew to the training session was positive. The feedback from the crew indicated that the training methods were accepted and have potential for them in the operation. The evaluation of the training from the KLM instructors similarly indicated that the training had a positive effect. By delivering the training in the operational setting of the airline's own simulators, with their own instructors, the evaluation demonstrated that this training technique could be accepted by the flight crew, and potentially could be introduced at the airline for a wider group of pilots</p>	

4.1.5 HUNGAROCONTROL MAGYAR LEGIFORGALMI SZOLGALAT ZARTKORUEN MUKODO RESZVENYTARSASAG

HungaroControl, the Hungarian air navigation service provider (ANSP), provides air navigation services in Hungarian airspace and - on a NATO assignment – in the upper airspace over Kosovo, trains air traffic control personnel and conducts air navigation research and development.

Besides forming partnership with ANSPs, universities and technology providers, as a member of the Frequentis SESAR Partners consortium, HungaroControl participates in the industrial research, validation and demonstration activities of SESAR 2020 as well. The consortium of Atos, HungaroControl and Frequentis aims to enhance cross-industry innovation by integrating different stakeholders in the ATM value chain. As an ANSP, HungaroControl can provide essential support to industry partners working on innovative solutions. The support includes ATM-centric expertise, real-life operating experience and the provision of simulation facilities.

HungaroControl's Research, Development and Simulation Department operates CRDS, a high capacity simulator platform with 34 controllers and 26 pilot working positions with high performance ACE compliant software for real-time simulation, advanced tools and applications, SYSCO and data link environment.

The Research, Development and Simulation Department has extensive expertise in designing real-time simulations related to aeronautical air-ground communication. Moreover, the team is able to work with both industrial and academic partners to develop knowledge-based products and services in order to facilitate progress in the areas of HMI design, data-link communication, safety and human factors.

The knowledge, platform and tools offered by the department can be used for the definition of experimental scenarios, verification and validation tasks related to the project. In addition, the experts will support the evaluation of system functionality by providing human factors expertise for the design of the questionnaires and the interviews. The outcome of the questionnaires and discussions will serve as input for the assessment of results of the validation.

4.1.5.1 Key personnel

- **Dr Dániel Rohács (M)** is the Head of the Research, Development and Simulation Department of HungaroControl since 2017 and also the Head of Department of Aeronautics, Naval Architecture and Railway Vehicles at BME, and Research Director of REA-Tech Ltd. active in air transportation related innovative R&D. He was a Doctoral Researcher at the EUROCONTROL Experimental Centre, followed doctoral studies at the Sorbonne University and Princeton University. He works on innovative operational concept development, advanced systems & tools & avionics in air transportation, as well as airspace integration, emission, safety and security related investigations. He is active in international conference organisation, took/takes part in several EU FP6, FP7, H2020 projects, and involved in SESAR lot 5 and lot 6. He was a manager of several EU projects. He is a member of UAVNET, EASN and ACARE WG1. He also completed the MIT Venture Mentoring Service Training Programme.
- **Gábor Papp (M)** holds a Master's degree in Business Administration and acquired extensive experience in Air Traffic Management. He has been working for HungaroControl since the inauguration of the CRDS simulator in 2011. As a former Simulation Specialist and Sales Manager he was responsible for organisational and project management tasks, established sales objectives, cooperated with other departments (marketing, legal, IT), built and maintained long-lasting customer relationships. Mr. Papp became the Head of the Simulation and Validation Unit under the Research, Development and Simulation Department in 2017 and is currently responsible for four simulators at HungaroControl, including CRDS. He monitors and reviews the unit's project activities, coordinates with other teams and creates new strategies.
- **Fanni Kling (F)** holds an MSc in Computational and Cognitive Neuroscience and a Bachelor's Degree in Psychology. She's been working at HungaroControl's Simulation and Validation Unit

for 2.5 years. As a Data Scientist and a former Human Factors Analyst, Ms. Fanni Kling provides human factors and data analysis support to Fast-Time and Real-Time Simulations, Passive and Active Shadow Mode validations. She's been involved in various international R&D projects, such as SESAR2020 PJ03, 05, 10 and supports national and international validations focusing on Cross-border Free Route Airspace, airspace resectorization and rTWR. She was recently involved in the preparation of the project proposal PRIUS for the CEF-SESAR-2018-1 U-space call. She also received a practical and hands-on training in Air Traffic Management, simulating ACC, APP and TWR environment with a duration of 1 year.

- **Katalin Nánai (F)** holds Master's degrees in Biology, Psychology and in Work and Organizational Psychology. Katalin has more than 8 years working experience within the aviation environment and submitted several psychology researches involving Pilots and Maintenance Engineers. As a Human Factors Analyst at HungaroControl she is responsible for identifying, considering and studying Human factor issues and benefits during an ATM project throughout its lifecycle. She supports SESAR PJ05-02 and 10-01b with human factor and validation expertise.
- **Viktor Horváth (M)** holds a Master's Degree in Electrical Engineering and a Bachelor's Degree in Electrical and Mechanical Engineer / Integrated Engineer. As his primary task he is responsible for developing various Human-Machine Interfaces allowing the clients' simulations to look and feel as close to reality as possible. With other colleagues in the technical group he is working keenly to maintain the fail-safe operation and general good mood of the CRDS simulation platform. He is closely involved in the validation simulation of PJ10-01b, R&D projects focusing on Human-Machine Interaction and Airspace resectorization.
- **Sandor G. Dobi (M)** holds an MSc in Transportation Engineering (achieved in 2018, specialization in Air Traffic Management, diploma thesis: Concept of a possible integrated Controller Working Position) from the Budapest University of Technology and Economics. He has been working as a Research and Development Specialist at HungaroControl Hungarian Air Navigation Services since 2017, first as an intern as part of his MSc studies, then as a UTM and drone expert mainly. His expertise covers the safe and harmonized integration of drones into national airspace with conventional airspace users (UTM market, drone legislation, U-space, drone and UTM business development opportunities, and creating articles). He takes part in EU funded project like PJ10-01b PROSA (2017-2019), H2020-2016-2 VLD1-10 Safe integration of Drone call's project USIS (2018-2020). He also took a major role in the planning, writing, coordination and submission of project PRIUS for the CEF-SESAR-2018-1 U-space call.

4.1.5.2 Publications

1. Bos, T., Zon, R., Furedi, E., Dudas, D. & Rohacs, D. (2017). A pilot study into bio-behavioural measurements on air traffic controllers in remote tower operations. H-Workload 2017: The First International Symposium on Human Mental Workload, Dublin Institute of Technology, Dublin, Ireland, June 28-30. doi:10.21427/D7ZH02,
2. Kling F., Papp G., Rohács D. Integrating Human Factors in Real-Time Simulations, Repüléstudományi Közlemények XXIX évf. 2017 No. 3., 233 – 242. o.
3. Szüllő, A., Seller, R., Rohacs, D., Renner, P. Multilateration based UAV detection and localization, 18th International radar Symposium, (IRS), 2017, June 28 – 30, , Prague, Czech Republic, IEEE, German Institute of Navigation (DGON), 2017, **ISSN:** 2155-5753, pp. – 1320 – 1329, INSPEC Accession Number: 17102234, **DOI:** [10.23919/IRS.2017.8008235](https://doi.org/10.23919/IRS.2017.8008235)
4. Nanaí, K. (2016). How safe is your change? Safety and validation workshop in Budapest. Aviation Psychology and Applied Human Factors, 6(1), 46.

4.1.5.3 Relevant Previous Projects

Name	Description	Reference
SESAR 2020 PJ.05-02	Remotely Provided Air Traffic Service for Multiple Aerodromes. The HF scope of the solution is to assess air traffic controllers' performance when providing Air Traffic Services to multiple aerodromes at the same time. Human-in-the loop simulations are applied at DLR and passive-shadow mode validation at HungaroControl to address aspects such as workload, situation awareness, acceptance of operating methods usability and trust. Safety Assessment is plays also a key part in the validation activities.	https://www.se-sarju.eu
SESAR 2020 PJ.10-01b	Flight Centric ATC. The HP Assessment of this solution focuses on identifying key aspects that are likely to change due to the Flight-Centric ATC concept, in which the aim is to dissolve sector boundaries and to have one controller in charge for certain number of flights to guide it through a large airspace. The solution uses human-in-the loop simulations to validate concepts with end-users at a V2 level.	https://www.se-sarju.eu
SESAR 2020 PJ.03-01a	Enhanced Guidance Assistance to Aircraft and vehicles on the Airport Surface Combined with Routing. The HF scope of the solution is to assess how air traffic controllers' performance is impacted by providing automatic guidance means to mobiles on the airport. In human-in-the-loop simulations "Follow the Greens" procedure will be tested based on Airfield Ground Lighting at Bretigny, EEC. Workload, situational awareness, task allocation between human and machine and trust in the system will be key aspects to focus on.	https://www.se-sarju.eu
USIS Horizon 2020	<p>USIS (H2020-2016-2 VLD1-10 Safe integration of Drone call). The main goal of project USIS to demonstrate and validate U-space Initial Services that will be provided by the UAS Traffic Management System (UTM System) to UAS, UAS operators and to relevant third parties like Civil Aviation Authorities, police and military forces etc. The Initial Services will be demonstrated in two countries (Hungary, France) with live operations in order to assess the provision of the services in any European country. In-flight services will be accessible either through mobile application or directly into the remote control of the UAV by the provision of public interfaces (APIs) The list of services going to be demonstrated is:</p> <ul style="list-style-type: none"> • e-Identification • e-Registration • Surveillance • Tracking • Scheduling • Dynamic airspace management <p>These services are capable to support all operations with a primary focus on BVLOS and E-VLOS operations like search and rescue missions, border surveillance, cross-border operations, parcel deliveries, point-to-point deliveries, agricultural surveys, privacy and security surveillance).</p>	https://ec.europa.eu/programmes/horizon2020/
Validation of CONOPS FAB CE P1	Validation of CONOPS (Concept of Operations) within the FAB CE P1 FRA Study Project (Connecting Europe Facility (CEF), 2014 CEF Transport Call"-implementation). The aim of the Cross-border Free Route Airspace Concept of Operations (CONOPS) validation exercises was to	http://www.fab-ce.eu

Name	Description	Reference
	simulate the FAB CE airspace and investigate what changes the FAB CE FRA would imply on the current fixed route network and the FRA within individual FAB CE Member State borders. Besides Fast-time Simulation human-in-the loop-simulation was applied to test different technics for conflict resolution close to the FIR boundary and assess the changes on human performance.	

4.1.5.4 Major Infrastructure

HungaroControl's Research, Development and Simulation Department operates Central Europe's largest advanced air navigation simulation facility. It provides real-time and fast-time simulation projects, training and consultancy services for airports, air navigation service providers, functional airspace blocks and other interested parties.

Real Time Simulator Platforms:

- A. CRDS. The Research, Development and Validation Department operates CRDS, a high capacity simulator platform which encompasses 34 controller and 27 pilot working positions with advanced ATM tools and applications, System Coordination (SYSCO) and Data-Link environment (Figure 16). The platform is used for validating new operational concepts with the contribution of air traffic controllers proficient in the measured airspace. In order to create realistic and high fidelity scenarios HungaroControl offers the clients the opportunity to use the HMI of their "home" ATM system reproduced by the Simulation Developer. The validation methodology is in line with the European Operational Concept Validation Methodology (E-OCVM). The results of the validation exercises are analysed by the Human Factors Analyst and Data Scientist. Human-in-the-loop parameters such as objective data (e.g. the number of coordination events, ATM tool usage, short term conflict alerts) and subjective feedback through generic and simulation-specific questionnaires are gathered during the simulation. This way, ATM experts and decision makers will be able to foresee potential changes in human performance and to prevent safety issues related to workload and situational awareness.



Figure 16. CRDS facility at HungaroControl

- B. Tower Simulator. HungaroControl owns a 180-degree Tower Simulator that consists of 5 LCD projectors, 180-degree view, representing the real life environment (see Fig. 2). It can simulate the tree specific controller role in the tower (ADC, GRC, TPC), a Supervisor position, with sophisticated voice-com system, and 6 pseudo pilot positions. All the major Hungarian airports are modelled in detail, with the typical airframes and ground vehicles as well. The infrastructure can be used for

civilian and also for military purposes, while the manufacturer can implement any new airports, be it real or artificial.



Figure 17. Tower Simulator at HungaroControl

- C. Cessna Cockpit Simulator. The Research, Development and Validation Department operates a Cessna C172 cockpit simulator with FNPT-I Qualification. The simulator provides full visual display for LHBP and LSZH airports with an up-to-date navigation database. The simulator is mainly used for training purposes.



Figure 18. Cessna Cockpit Simulator at HungaroControl

4.1.6 ECOLE NATIONALE DE L'AVIATION CIVILE

Ecole Nationale de l'Aviation Civile (ENAC) or French Civil Aviation University is a public institution under the supervision of the French Ministry of transport. Its mission is to provide ab-initio and further training for the executives and main players of the civil aviation world and do research in a variety of air transport related domains. ENAC offers a wide range of activities that are tailored to meet the requirements of the public and private sectors both in France and in other countries. Based in Toulouse, France, ENAC is one of the top universities in the world devoted to the aviation industry (about 2000 students for Ab-Initio Training and 4500 trainees for Continuing Education and training and more than 140 researchers).

Since 1959 ENAC was the place where research activities in air traffic management and aviation were carried out.

ENAC offers a favourable environment for training and research activities. On the same campus Pilots, Controllers, Engineers, Researchers on the more advanced techniques and academic disciplines are gathered.

Research and Innovation are keys to maintaining capabilities and competitiveness. ENAC has strong relations with industry, and SMEs for developing innovation. ENAC research road map is driven by the challenges of the coming years and decades. Sustainability, Performance, Safety and Security, globalisation are among the main goals of our research activities.

ENAC Research is organised in academic teams of research and a set of transverse programs on key transverse challenges. One of these transverse programs is focused on Safety and Security. Two platforms Aeronautical Computer Human Interaction Lab (ACHIL) and the UAS Flying Arena are used for the applied research. The ENAC academic teams are OPTIM (Applied Mathematics, Optimization and Automatics for Aeronautics), TELECOM (Signal Processing and Navigation, Electromagnetics and Antennas, Telecommunication Networks), DEVI (Statistics, Economics and Econometrics, data visualization), and LII (interactive computing laboratory). The transverse Research Programs include Environment and Safety-Security.

Research is also a matter of exchanges and synergies: ENAC Research collaborates with other research organizations in Europe and around the world.

ENAC has several industrial or laboratories research projects in the field of aeronautics and the partnerships include large companies such as Airbus, Thalès, and SME such as Deep Blue or others.... Partnerships are frequent with ISAE, Università di Sapienza, Gröningen University, Universitat Autònoma de Barcelona and many others.

4.1.6.1 Key personnel

- **Nadine Matton, (F)**, is associate professor at ENAC (Ecole Nationale de l'Aviation Civile) at the University of Toulouse. She defended a PhD in Psychology in 2008 at the University of Toulouse on the topic of cognitive abilities assessed during pilot selection and funded by ENAC. She held a 2-year postdoctoral position at ENAC in order to pursue the research initiated during her PhD. Since 2011 she is associate professor at ENAC on the topic of Human Factors. Her research interests are focused on selection and training in aeronautical contexts.
- **Géraud Granger, (M)**, is graduated in science computing at l'Ecole Polytechnique. He studied modelisation and resolution of conflict in air traffic control using a traffic simulator developed at the ENAC. He worked within Skysoft facility for the ASD Belgocontrol project. He has been working for DGAC to adapt and develop traffic simulation environment to improve working conditions for controllers and this in two different European projects, Erasmus and SESAR 4.7.2. He is currently working at the ENAC as a research engineer and participated in the building of the ACHIL simulation facilities.
- **Corinne Bieder (F)**, Head of Safety & Security Research Program, initially graduated as an engineer and completed her education with master degrees in both risk management & social sciences. She started her career doing research within Electricité de France on Human Reliability

Analysis in the nuclear industry. She then joined a small consulting company, Dédale, to work on a variety of human factors and safety projects in a variety of hazardous domains (aviation, energy, railways, hospitals...). In 2005, she joined Airbus successively holding jobs in the training and strategy departments to integrate the safety dimension to these activities and eventually in the safety department itself to develop the corporate safety strategy and communication. In 2016, she joined the research division of ENAC where she is Head of the Safety & Security research program. She also continues her transverse research activities on safety within the NeTWork think tank and the FonCSI (Foundation for an Industrial Safety Culture) Scientific Group. Her research is focused on the systemic aspects of Safety and Security, that is integrating all the dimensions -technological, human, organizational, regulatory, political, economic, cultural...- contributing to Safety and Security. Some of her recent research topics are around the proceduralization of Safety, what it takes (politically, socially, legally...) to live with uncertainty and risk communication.

- **Dr Jean-Paul Imbert (M)** graduated in Computer Science and Electronic Engineering at ENAC in 1993 and holds a Ph.D. in computer science, neuroscience and human factors with the subject: “Adapting supervisory visualization design to optimize transmission of categorized information by level of relevance”. He holds a position of research engineer in the ACHIL team at ENAC, a team dedicated to applied human system interaction and human factor research in Air Traffic Control and Cockpit operations. He has been involved in several SESAR project and is currently in charge of the flying test bed of ACHIL team, an aircraft modified and dedicated to research projects. His expertise covers the following topics: Adaptive automation, situation awareness, participatory design and User-Centered design; Multimodal interaction; Human perception studies; Cognitive and physical ergonomics; Human Factors in ATM.
- **Railane Benhacène (M)** is an Aeronautical Engineer with a specialisation in Human Factors for Aeronautics. Responsible for the program of research in HMI applied to Aeronautics at the French Civil Aviation School, (ENAC). His former experience included work at the CENA (Centre d’Etudes de la Navigation Aérienne) - where he was head of the ASTER Project. Work involved Designing a novel tool for Terminal Sectors’ control. Conducted yearly experimental campaigns – provided ControllerWorking Position HMI for the Gate to Gate project. Was later involved in the Acropole project to evaluate future solutions for Paris’ Region ATC, and shifting to electronic environment. He also led the evolution of Arrival Management tool for Paris Charles de Gaulle Airport, with a strong involvement of Air Traffic Controllers. His research interests are in the human centred design and HMI in particular. He has set up and is leading the ACHIL team to address the specific needs for applied research at ENAC and the installation of a dedicated research platform (see below) to explore, design and evaluate safety constrained critical HMIs in the aeronautical domain.

4.1.6.2 Publications

1. Imbert Jean-Paul., Hodgetts H.M., Parise R., Vachon F., Dehais F., & Tremblay S. Attentional costs and failures in air traffic control notifications, Ergonomics (2014)
2. Louise Giraudet, Jean-Paul Imbert, Sébastien Tremblay, Mickaël Causse, Inattentional Deafness in Simulated Air Traffic Control Tasks: What the eyes can reveal about what you hear Frontiers in neuroscience (submitted 2015)
3. Sara Maggi, Sara Irina Fabrikant, Christophe Hurter, Jean-Paul Imbert, How Do Display Design and User Characteristics Matter in Animated Visualizations? Cartographica (submitted 2015)
4. Pietro Aricò, Gianluca Borghini, Gianluca Di Flumeri, Alfredo Colosimo, Ilenia Graziani, Jean-Paul Imbert, Geraud Granger, Railane Benhacene, Michela Terenzi, Simone Pozzi, Fabio Babiloni. Reliability over time of EEG-based mental workload evaluation during Air Traffic Management (ATM) tasks EMBC 2015

5. Louise Giraudet, Jean-Paul Imbert, Sébastien Tremblay, Mickael Causse High rate of inattentive deafness in simulated air traffic control tasks AHFE 2015

4.1.6.3 Relevant Previous Projects

Name	Topic	Relevance	Reference
STRESS	Stress factors in Air Traffic Control	Safety issues due to higher automation and human factors impact, measurement and evaluation	https://www.sesarju.eu/
MOTO	Embodied Cognition in Remote Tower	Enhancing sense of presence in remote situation for ATC	http://www.moto-project.eu/
NINA	Neurometrics Indicators for ATM	Measure cognitive workload for ATC, prototype adaptive HMI based upon workload index	http://www.nina-wpe.eu
MoTa	Modern Taxiing	HMI for enhanced Airport traffic management and insertion of robots for Airplane movements	http://ihmaero.recherche.enac.fr/index.php?article3/mota-project-summary

4.1.6.4 Major Infrastructure

- A. ENAC- ACHIL Research Platform – Aeronautical Computer Human Interaction Lab. (<http://www.enac.fr/en/achil-aeronautical-computer-human-interaction>), has significant experience and scientific expertise in Human Factors for Aeronautics, as well as the management of an applied research platform (ACHIL) dedicated to research for innovative interaction in the field of aeronautics, be it for the population of Pilots or Air Traffic Controllers. This platform is funded (2 M€) by a joint National and Regional French funding for Research infrastructures and is co-administered by ENAC and the ISAE school.



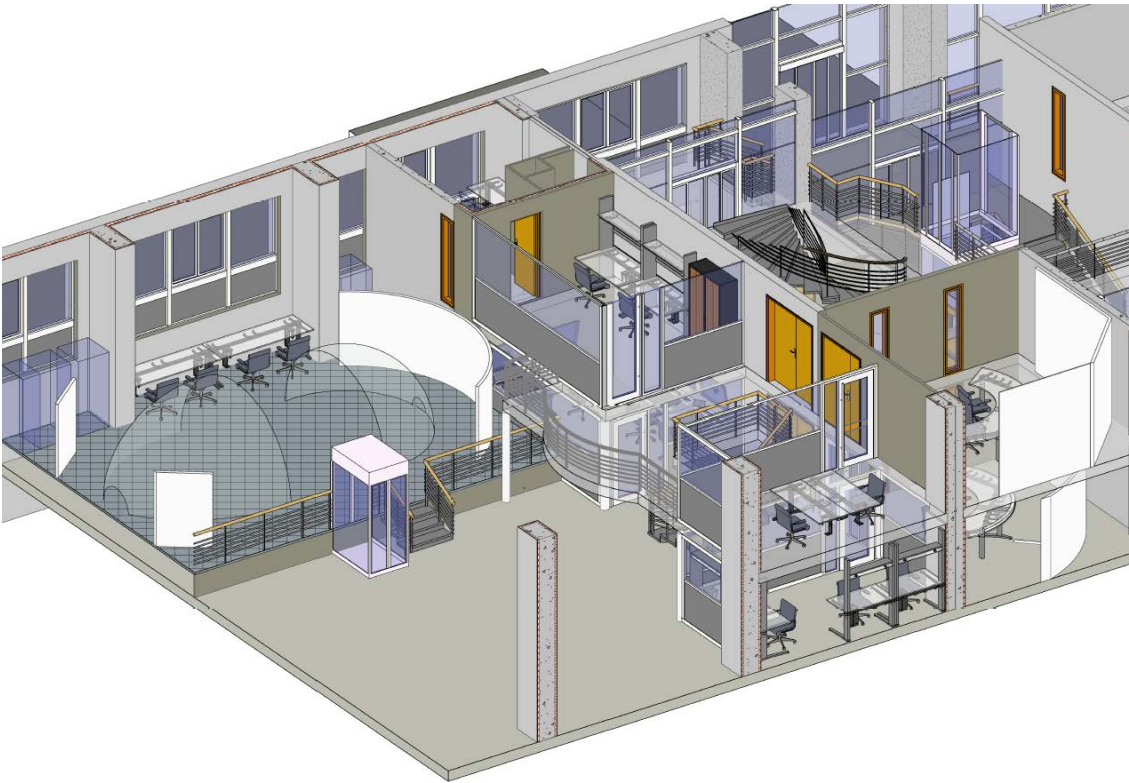


Figure 19 ACHIL Research Platform – Aeronautical Computer Human Interaction Lab

- B. **This platform dedicated to research on Human Factors and HMIs** is set up, shared with partner laboratories or industry, in order to explore new aeronautical concepts and prototypes and to analyze working methods and their evolutions. The ACHIL platform focuses on the analysis and design of operational systems (software, organizations) involving human operators (pilots, controllers, etc.). The field of application of the ACHIL platform is Aeronautics both on the ground and on board. Thus, perfectly in line with ENAC's missions and strategy, our research questions and issues stem from the needs expressed by the aeronautical sector (institutions, programs, industry). The work on this platform is intended to transpose on the applied fields of piloting or air traffic control the knowledge resulting from the academic work of the research teams of the ENAC. They aim in particular at supporting the work of the different aeronautical operators, (pilots, air traffic controllers), the human factors aspects and training, as well as the design of HMI and digital tools for future ATC and avionics systems. Moreover, the platform is a locus for the integration of transverse skills, such as those derived from algorithms, complexity measurement, telecommunications or economy. The objective is to create a place of integration and innovation that can take advantage of knowledge and technologies from different backgrounds.

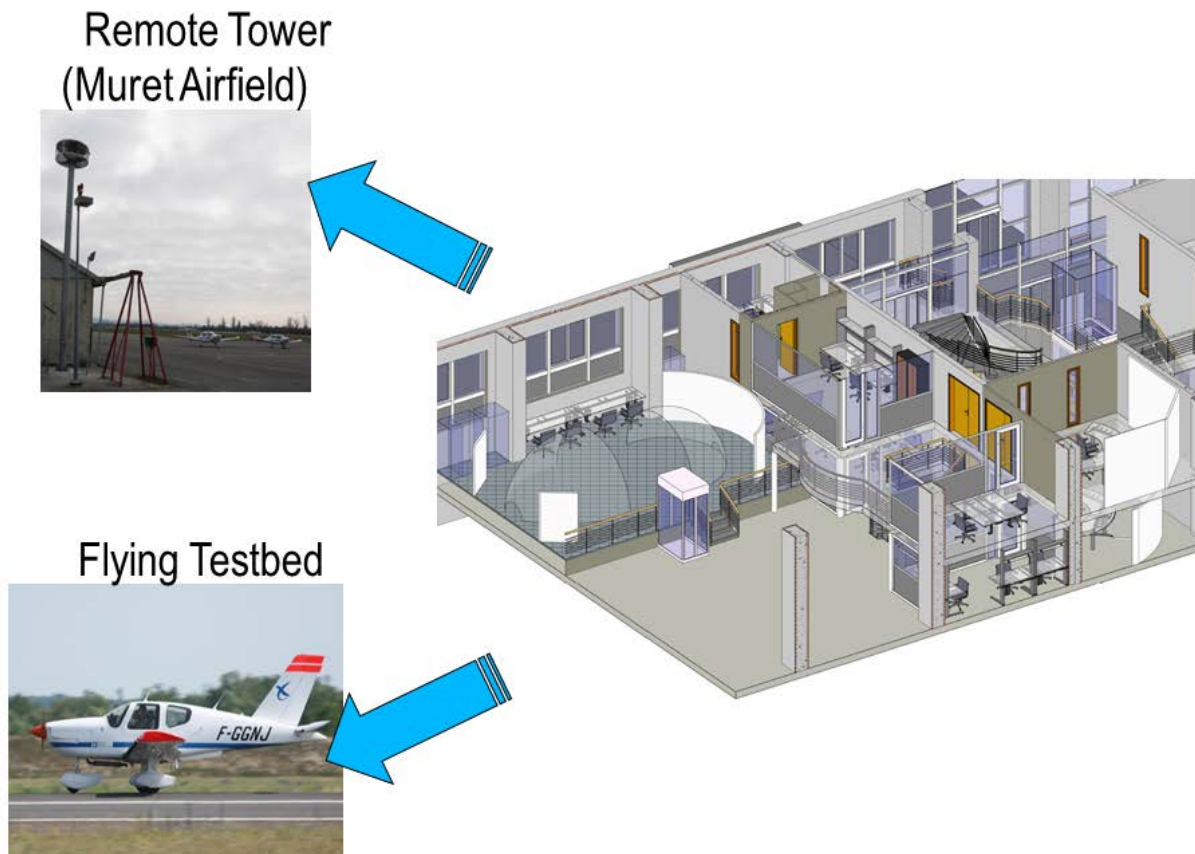


Figure 20 ACHIL Research Platform – Aeronautical Computer Human Interaction Lab

- C. Finally, a specific activity of prototyping is intended to support the training of aeronautical populations. The objective is multiple: to understand the learning mechanisms and the circumstances that maximize their effectiveness, and then to decline concepts in the tools themselves intended for the training of the pilots and controllers. Simulations and user centered design are widely used. Realism of the environment: the simulation tools used must allow the construction of a very realistic environment for operational experts (AMAN, TCAS, safety nets, aircraft models, etc.). Through its involvement in the aforementioned projects, the team has built an infrastructure of considerable computational capacity (100+ cores, 600+GB RAM, 40+ TB storage) and developed a sophisticated distributed architecture for data collection and indexing, as well as a variety of cutting edge data mining and retrieval algorithms. The team is therefore in excellent position to support a wide range of data collection, mining and indexing needs within research and innovation projects.

4.1.7 UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA

University of Rome Sapienza is the largest University of Rome. The laboratories of Industrial Neuroscience, headed by Prof. Fabio Babiloni have produced more than 400 published papers since 1985 on peer-reviewed, international scientific journals. All such publications are related to the recording and processing of biosignals (Electroencephalography -EEG, Electrocardiography - ECG, Galvanic Skin Response - GSR) in humans, that represents the core expertise of the laboratory. The research group of Prof. Fabio Babiloni has also been known internationally for its contribution to the advancement of neurophysiological signal processing and classification techniques, able to track, even in real time, the human mental and emotional states. The main experimental and industrial areas of application of such techniques are:

- Neuromarketing: Test the level of awareness and liking related to advertising stimuli or website.
- Customer Experience: Measuring the instinctive reactions to products, test of attention and emotion during Point of Sales experience, in front of product's positions on shelves or of POS communication ads.
- Monitoring Cognitive States in Operational Environments of high responsibility and stressed conditions (i.e.: helicopter and jet pilots, air traffic control operators, surgery trainees, car drivers).
- Neuroaesthetics: Test of beauty perception visiting Museums and looking to Fine Art Masterpieces.
- Medical Device Neuro Effects (i.e.: test of audio perception in patients with mono or bilateral cochlear implant).

4.1.7.1 Key personnel

- **Prof. Fabio Babiloni (M).** Prof. Fabio Babiloni is professor of Physiology at the Faculty of Medicine at the University of Rome "Sapienza". He is also full professor of Biomedical Engineering at the same University. He teaches "Physiology" at the students of the Medicine courses, "Industrial Neuroscience" to the students of BioEngineering course, "Neuroeconomy and neuromarketing" to the students of Psychology course and "Bioengineering" to the students of Biotechnology course. To July 2018 Prof. Fabio Babiloni has published 240 papers on peer-reviewed international scientific journals recognized on PUBMED, 250 peer-review conference papers and has a total impact factor of more than 400. His H index (Google scholar) is 63. Prof. Fabio Babiloni is Associate Editor of four international scientific journals: 1) IEEE Trans. On Neural System and Rehab. Engng, 2) IEEE Trans on Biomedical Engineering, 3) Computational Intelligence and Neuroscience, 4) International Journal of Bioelectromagnetism. Prof. Babiloni was the chairman of the NeuroMath Action including scientists from 25 countries in EU (2007-2011). Prof. Babiloni is the Chair of the Technical Committee for Biomedical Signal Processing of IEEE EMBS. His research interest is the in the area of the use of EEG and other neurophysiology signals for the assessment of the cerebral states of group of persons during their interaction (hyperscanning) and in working environment. He developed the area of the EEG recordings from multiple persons (called neuroelectric hyperscanning). He will lead the group working within the SAFEMODE project. Prof. Babiloni's list of publications could be retrieved through the PUBMED service hosted by the National Institute of Health (NIH) in USA at the following public link: <http://www.ncbi.nlm.nih.gov/pubmed/?term=Babiloni+F>
- **Dr. Gianluca Borghini (Male).** Dr. Borghini has a post-doctoral research fellow position at the Department of Molecular Medicine of the University of Rome "Sapienza". Gianluca received the PhD in Bioengineering and Master Degree in Electronic Engineering at the ALMA MATER STUDIUM University of Bologna, specializing his final studies on Biomedical Applications. Gianluca has been focusing his work on the objective assessment of mental states by integrating behavioral, subjective, and neurophysiological (EEG, ECG, EOG, GSR, Body Posture, Head Movements) measurements. Most of the studies have been conducted on professional personnel as military and commercial pilots, air traffic controllers, car drivers, and sky divers, and medical surgeons for the evaluation of their training level, mental workload, stress, mental fatigue, selective

attention, vigilance, and cognitive control behavior. In the 2011, he got the first position at the Flight Safety Course at the Italian Air Force Headquarter in Rome. Also, in the 2011 and 2016, he was rewarded with the prize “I Guidoniani” for the best research in the Aerospace Medicine during the national conference of Aeronautic and Aerospace Medicine (AIMAS). In the last 9 years, Gianluca has been involved in several National and International projects, and collaborations with partners like the Italian Air Force (Rome, Italy), Alitalia airline company (Fiumicino, Italy), Agusta-Westland (Yeovil, UK), ENAC (Toulouse, France), DLR (, Braunschweig, Germany), NUS (Singapore), Hangzhou Dianzi University (Hangzhou, China), University of Murcia (Murcia, Spain), University of Bologna (Bologna, Italy). As projects and collaborations, Gianluca has been involved in both military and civil projects like BrainShield, BrainTrained, STRESS, MOTO, MINIMA, SIMUSAFE, and SmokeFreeBrain. He is co-author of more than 20 scientific articles in peer-reviewed international journals, 1 patent, and more than 40 scientific contributions in peer-reviewed national and international conferences. In addition, he is guest associate editor of the international scientific journal "Frontiers on Human Neuroscience ", reviewer of several international journals, and part of the Advisory Board for H2020 European Commission projects. Ing. Gianluca Borghini is the team Leader of the “Cognitive Training and Workload” researches at BrainSigns Lab. The complete list of the published papers of dr. Borghini is available on PUBMED at the following public link:

<https://www.ncbi.nlm.nih.gov/pubmed/?term=gianluca+borghini>

- **Dr. Giulia Cartocci (F).** Dr. Cartocci obtained her Bachelor Degree in Biology and her Master Degree in Neurobiology with honors in 2007 and 2009 respectively at Sapienza University of Rome. In 2014 she obtained her PhD in Clinical Experimental Neuroscience, Auditory Pathology curriculum, at the same University. From 2015 Dr. Cartocci collaborates with BrainSigns and she is involved in the clinical application of the technological protocols for the acquisition of human biosignals (electroencephalogram mainly, beyond heart rate, skin conductance and eye-tracking) developed by BrainSigns, in particular aiming at measuring the approach/withdrawal motivation towards stimuli and the cognitive efforts related to the execution of particular tasks. Furthermore Dr. Cartocci, beyond the more specifically commercial application of neuromarketing, is interested in the study of the perception of public service announcements (against smoking in particular). Finally, Dr. Cartocci is involved in the phase of writing and submission of national and international research proposals (mainly in the framework of European Projects) and scientific publications concerning BrainSigns research topics (Clinical Trials, Neuromarketing and Neuroaesthetics). The complete list of the published papers of dr. Cartocci is available on PUBMED at the following public link: <https://www.ncbi.nlm.nih.gov/pubmed/?term=giulia+cartocci>
- **Dr. Pietro Aricò (M).** Dr. Aricò is research fellow at Department of Molecular Medicine, University of Rome “Sapienza”, under the direction of Prof. Babiloni. Pietro Aricò got a PhD in Bioengineering at the University of Bologna “Alma Mater Studiorum”, and a Master Degree in Biomedical Engineering at the University of Rome “Sapienza”. In particular, the research of Pietro Aricò has been focused on the integration of the technologies used in Brain Computer Interface systems in operational environments, in particular machine learning approaches. By using such technology, it is possible to classify particular components of the subject's biosignals in order to associate them with different mental states of the user or more in general human factor concepts, in particular attentional levels, training and mental workload. The expertise of Pietro Aricò, is focused on the analysis and processing of biosignals (Electroencephalography, Electrocardiogram, Galvanic Skin Response), with particular knowledge of different signal processing techniques (e.g. Wavelet analysis, Regressive algorithms, Independent Component Analysis, etc.). In addition, he has taken part at international collaborations with the International Institute of Neuroscience “SINAPSE” in Singapore. In addition, Dr. Pietro Aricò has a great expertise in programming online interfaces developed in Matlab environment (Mathworks), which allow the acquisition, processing of more biosignals and actuation of devices. He was also involved in several national

and international projects, such as “TOBI - Tools for Brain-Computer Interaction” (Integrated Project) and “SM4All - Smart hoMes for All” (STREP), funded by the European Commission on the 7th framework and the project “NINA - Neurometrics INDicators for ATM”, founded by SESAR JU. In the 2014 he was awarded by the prize “I Guidoniani” for the best research in the aerospace medicine during the Italian conference of Aeronautic and Aerospace Medicine. The present work of Pietro Aricò is focused on the evaluation of the mental workload and training assessment in operational environments, even in real time, in collaboration with different aerospace institutes, such as ENAC (Ecole Nationale de l'Aviation Civile), ENAV (Ente Nazionale Assistenza al Volo) and AgustaWestland-Finmeccanica Group. At present, he has been involved in four ongoing projects founded within the H2020 program: Stress, MOTO, Minima, and SmokeFreeBrain projects. He is co-author of more than 20 scientific articles in peer-reviewed international journals, 1 patent and more than 40 scientific contributions in peer-reviewed national and international conferences. In addition, he is editorial board member of the international scientific journal "Computational Intelligence and Neuroscience", and reviewer of several international journals. The complete list of the published papers of dr. Aricò is available on PUBMED at the following public link: <http://www.ncbi.nlm.nih.gov/pubmed/?term=Arico+P>.

- **Dr. Patrizia Cherubino (F).** Dr. Patrizia Cherubino achieved the Bachelor and the Master degree with honors in Economics and Business Administration at the University of Calabria in the 2006 and 2009, respectively. After the University, she attended a master in “Marketing Intelligence and Market Techniques for Public Administration (2010). In 2016 she obtained her PhD in Economics Management and Communication for Creativity at the “IULM University” in Milan, specializing her final studies on the Neuromarketing applications. Since 2010, Dr. Cherubino collaborates with BrainSigns srl, a spinoff of the Sapienza University of Rome, in the neuromarketing, research & innovation area. The main activity is focused around the generation and validation of biometrics tests for the evaluation of TV Commercial and consumer stimuli using EEG, HR and GSR signals. She participated in numerous projects related to the application of the neuroscience techniques for: i) the evaluation of the marketing stimuli, ii) the evaluation of efficacy of TV Commercial for several companies such as Telecom Spa, ENI Spa, Vodafone Spa, ISP, GfK Eurisko, iii) the recording of brain activity during real visits in a fine arts gallery (Neuroaesthetic study), iv) during the visit in a retail store (Neuroshopping), v) while people watching a political debate (Neuropolitics), vi) while people surf and interact with the web site (Web usability). Her expertise is focused on the analysis of biometric measurements (EEG, HR, GSR) of cognitive and emotional variables, and she is team leader of the Neuromarketing research in BrainSigns. Dr. Cherubino is also co-author of several publications on neuromarketing on peer reviewed scientific journals and co-author of a neuromarketing book. The complete list of the published papers of dr. Cherubino is available on PUBMED at the following public link: <https://www.ncbi.nlm.nih.gov/pubmed/?term=patrizia+cherubino>
- **Dr. Gianluca Di Flumeri (M)** Dr. Di Flumeri got his Master degree in Biomedical Engineering in 2014, and his Ph.D. degree *cum laude* in Morphogenesis and Tissue Engineering (Biophysics curriculum) in 2018, both at Sapienza University of Rome, the latter spending a 3-months-period at Institut Supérieur de l'Aéronautique et de l'Espace (ISAE SUPAERO) in Toulouse. He is currently a Research Fellow at the Department of Molecular Medicine of Sapienza University itself, under the direction of prof. Babiloni. His main research activity, on behalf of BrainSigns, is focused on acquisition and analysis of human biosignals (Electroencephalogram, Electrocardiogram, Galvanic Skin Response, Eye-Tracking), with the aim of investigating neurophysiological correlations with human cognitive phenomena. The result is the development of neurometrics of specific and relevant mental states, such as mental workload, vigilance, stress, and so on. He is particularly involved in using such a kind of neurometrics for Human Factor evaluation in operational environments (aviation, automotive, robot-assisted surgery), as well as in Neuromarketing field, for the evaluation of cognitive, emotional and motivational processes

evoked by external stimuli. Also, he has a great expertise in designing and programming Graphical User Interfaces (GUIs), developed in Matlab environment, in order to support the operators simplifying and optimizing the biosignals acquisition and processing phases. He contributed actively in several National and International research programs. The results of his research have been disseminated during several International Conferences of Bioengineering, and published on dozens of papers on peer-reviewed journals, on books and with one patent (please see <https://scholar.google.it/citations?user=XDqukj0AAAAJ> for further information). Also, he has been awarded by the Italian Sensory Science Society (SISS) with the “Young Researchers 2014” award, by the Italian Society of Aerospace Medicine (AIMAS) with the “I Guidoniani 2015” award, and by Fondazione Sapienza in 2017 with the “Premio Minerva” recognizing the forefront and the scientific relevance of his research activity.

4.1.7.2 Publications

1. Borghini, G., Aricò, P., Di Flumeri, G., Cartocci, G., Colosimo, A., Bonelli, S., Golfetti A., Imbert J.P., Granger G., Benhacene R., Pozzi S., and Babiloni F. (2017). EEG-based cognitive control behaviour assessment: an ecological study with professional air traffic controllers. *Scientific reports*, 7(1), 547.
2. Borghini G., Aricò P., Di Flumeri G., Colosimo A., Herrero Ezquerro M.T., Salinari S., Bezerianos A., Thakor N.V., and Babiloni F. (2017). A New Perspective for the Training Assessment: Machine-Learning-Based Neurometric for Augmented User’s Evaluation. *Frontiers in Neural Technology*, June 2017.
3. Aricò, P., Borghini, G., Di Flumeri, G., Bonelli, S., Golfetti, A., Graziani, I., Pozzi S., Imbert J.P., Granger G., Benhacene R., Schaefer, D., Pozzi S., and Babiloni F. (2017). Human factors and neurophysiological metrics in air traffic control: a critical review. *IEEE reviews in biomedical engineering*, 10, 250-263.
4. Borghini G., Aricò P., Di Flumeri G., and Babiloni F. (2017). *Industrial Neuroscience in Aviation: Evaluation of Mental States in Aviation Personnel*. Springer, March 2017.
5. Aricò P., Borghini G., Flumeri G., Sciaraffa N., Colosimo A., and Babiloni F. (2017). Passive BCI in Operational Environments: Insights, Recent Advances and Future trends. *IEEE Trans. Biomed. Eng.*, April 2017.

4.1.7.3 Relevant Previous Projects

Name	Description	Reference
MOTO SESAR H2020	MOTO – the embodied reMote Tower (SESAR H2020): ATM Human Performance research has been traditionally focused on two senses: sight and hearing. Remote tower operations make no exception, with many efforts and resources focused on acquisition of visual images, for instance by means of hi-resolution cameras (SESAR reques here). This situation is often understood by adopting traditional human information processing approaches, where human cognition is described as composed by the three phases of input acquisition-processing-action, with a clear and neat separation among them. MOTO will explore 3 research opportunities. The first one is to consider the role of all the human senses for tower operations. The approach of Embodied Cognition could be applied to achieve a full understanding on the use of other senses for controllers, i.e. one not deprived of important bodily sensations. The second one is that the Embodied Cognition approach also shows how the three phases of	http://www.moto-project.eu

Name	Description	Reference
	human cognition cannot be neatly divided, as decision-making is closely integrated with our perceptual capability and action possibilities. The embodied remote tower could potentially open up new possibilities to study (and reproduce, see point below) advanced forms of naturalistic decision-making, or attentional mechanism like the cocktail party effect. Third, the understanding of embodied aspects of ATM Human Performance is a pre-requisite to design effective multimodal input and output channels, thereby rethinking the current human-system interaction model. The end goal is to enhance human performance, by exploiting other channels than the already overloaded visual channel.	
MINIMA SESAR H2020	<p>Mitigating Negative Impacts of Monitoring high levels of Automation (SESAR H2020): Assigning tasks, formerly executed by human operators, to automation can increase the performance in many aspects of ATM. However, the absence of automation errors can often not be guaranteed. Consequently, a human operator is required to monitor the automation and to intervene in the rare cases of automation errors. It has been shown that this monitoring role of human operators results in negative effects like lack of attention, loss of situation awareness and – in the long term – skill degradation. This project will develop solutions to mitigate these effects. As an example a highly automated arrival management task in which the aircraft follow their predefined 4D-trajectories will be investigated. As neither the automatic detection and resolution of all conflicts nor the ability of all aircraft to follow their trajectories with the required precision can be guaranteed all the time, a human operator is needed to monitor and handle situations in which automation fails. New human-automation interaction design concepts for this task will be developed from scratch in three steps in this project: First, the task environment will be analysed to identify all the necessary tasks that can be assigned either to the human operator or the automation. Secondly, concept for different solutions will be developed considering the human performance envelope. This includes adaptive or adaptable automation with dynamic task distributions, tools to direct the operator attention, and suitable human-machine interfaces. In a third step, different human-automation design concepts will be evaluated. Identifying how to apply higher automation to complex systems while mitigating the negative effects of monitoring tasks will allow benefiting from performance increases of higher levels of automation while keeping the human operator performance on a high level to ensure safe operations.</p>	http://www.minima-project.eu
SIMUSAFE SESARH2020 0	<p>SIMUlator of Behavioural Aspects for SAFEr Transport (SESAR H2020): Road transport is known to be the most dangerous of all transport modes and poses a major societal challenge for EU. It has been claimed that 90% of road-traffic crashes are caused by driver error, being unsafe behaviour a significant factor in traffic accidents. Improving road safety means understanding the individual and collective behaviour of actors involved (drivers, two wheelers, pedestrians) and their interaction between themselves and safety-related systems and services. The goal of SIMUSAFE (SIMUlator of Behavioural Aspects for SAFEr Transport) following the FESTA-V model methodology is to develop realistic multi-agent behavioural models in a transit environment where researchers will be able to monitor and introduce changes in every aspect, gathering data not available in real world conditions. Driving simulators of several vehicles (cars, motorcycles, bicycles) and Virtual Reality (for pedestrians) will be used to simulate test environments. This will also enable the evaluation of scenarios which are not possible even with naturalistic driving (dangerous conditions, multiple monitored actors in</p>	www.simusafe.eu

Name	Description	Reference
	the same scene, under influence of substances). Data collected from simulations will be correlated with naturalistic driving tests, such that the simulation and model aspects are the closest possible to real world data. From the developed model and collected data, impacting factors causing an event (crash, near collision, infractions) from the environment and road users will be identified and quantified. Such knowledge will be the base for the development of more effective and pro-active measures for the prevention and mitigation of such factors, with subsequent impact in the safety devices market, regulations and driver education.	
NINA SESAR H2020	Neurometrics INDicators for Atm (SESAR H2020): NINA is a research project co-funded by SESAR, as part of its long term research programme. It aimed at developing a tool able to perform a real time assessment on a set of cognitive states of Air Traffic Controllers performing their job – such as mental workload intensity, type of attentional control and proficiency level gained during a training period. The tool uses an algorithm based on the analysis of 3 main neurophysiologic indexes: electrical brain activity, heart rate variability, eye blinking. As an integral part of the project, a study to show how the further development of similar kinds of tools could enhance aviation safety and efficiency was performed. This page briefly summarises the results of the study, presenting a proof-of-concept for an advanced system able to understand in real time the operator's psycho-physical state, to match it with the situation in which she is operating and to provide the best automated support accordingly.	http://www.nina-wpe.eu
STRESS SESAR 2020	Human Performance Neurometrics Toolbox for Highly Automated Systems Design (SESAR H2020). STRESS started from the analysis of the current expectations of ATM stakeholders towards automation. European research agenda is working to introduce higher levels of automation in air traffic control. In the future, a new generation of highly automated supporting technologies will be developed. They are expected to autonomously (or partially autonomously) manage tasks that are currently carried out by human operators and/or to support humans in making decisions that the operators will hardly be in a position to question. To address all these implications, the project selected as a theoretical framework for automation definition and classification the research carried out by different authors such as Sheridan, Parasuraman and Bainbridge. The main goal of the project is to generate guidelines to be followed to design future automated systems that are compatible with human capabilities and limitations, ensuring that the right balance between humans and high automations is obtained. In particular, the project will assess neurophysiological signals, behavioural and performance data and subjective data to verify that the indexes are capable of assessing attention and stress, and to use these indexes to study the impact of highly automated systems on controllers, with a focus on transition between different levels of automation.	http://www.stressproject.eu

4.1.7.4 Major Infrastructure

UNISAP unit has the knowledge generated across 20 years of work of professor Fabio Babiloni and his research group in the field of neuroelectrical signal processing related to the cognitive correlated of biosignals as certified by more than 400 papers on international peer-reviewed journals. Thus, the most significant infrastructure is the knowledge and experience gained across such decades in the capability to develop proper methodologies for data and multimodal analysis, and experimental protocols design in both controlled (i.e. Lab) and realistic settings (i.e. Aircraft Cockpit). In addition, prof. Babiloni's Lab has huge availability of high quality and reliable systems to gather participants' neurophysiological signals (e.g.

EBNeuro Be-Micro, Brain Product LiveAmp for EEG recording; Mindmedia Nexus 10, Shimmer 3+ for GSR and ECG recording). In addition, Virtual Reality devices are usually employed (e.g. HTC VIVE System and Unity-3D software) to simulate and run experiments to evaluate the sense of immersion, behaviour, and neurophysiological reaction of the user within VR environments. All such technologies will be used throughout the SAFEMODE project experiments.

4.1.8 ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS Centre for Research and Technology Hellas / Hellenic Institute of Transport (CERTH)

CERTH was founded in 2000 and it is a leading research centre in Greece conducting specialized basic and applied research and offering high quality services in several fields. It is a non-profit private status legal entity supervised by the General Secretariat for Research and Technology of the Ministry of Education and Religious Affairs. CERTH is listed among the top 20 EU institutions with the highest participation in competitive research grants. HIT is one of CERTH's five Institutes, devoted to the promotion and execution of transport research in Greece and beyond. HIT cooperates with local, private and public bodies and other institutions in Europe and internationally, and represents Greece in various International trade and scientific fora. Its main mission is to provide state-of-the-art research and create innovation in the field of transport at a national, European and international level covering issues relating to the operation, planning and development of infrastructure; standardization; economic analysis; vehicle technology; impact assessment of land, maritime, air, and multimodal transport services; training and education activities in related fields; dissemination of research activities; and representation of Greece in relevant scientific bodies.

4.1.8.1 Key personnel

- **Dr. Maria Boile (F)** is Associate Professor at the University of Piraeus and Research Director of the Transport Economics and Environment, Air and Maritime Transport Sector, at the Hellenic Institute for Transportation (HIT), Centre for Research and Technology Hellas (CERTH). Prior to joining HIT Dr. Boile served as an Associate Professor of Transportation in the Department of Civil and Environmental Engineering (CEE) at Rutgers University, U.S.; co-Director of the Freight and Maritime Program (FMP) at the Center for Advanced Infrastructure and Transportation (CAIT); and academic fellow in the Center for Supply Chain Management of the Rutgers School of Business. She has participated in over 70 sponsored research projects in the U.S., Europe and Latin America and has authored and co-authored over 170 technical articles. She is a member of the Board of Regents of the Eno Transportation Foundation and has served as an invited expert by the US Department of Transportation and the European Commission.
- **Dr. Maria Panou (F)** is currently holding a position as a Principal Researcher and Head of Department 'Vehicle & Driver – Transport Safety – Accessibility' at the Hellenic Institute of Transport of the Centre for Research and Technology Hellas. She has a PhD on Personalised ADAS warnings for drivers and infomobility services for travellers. Her main fields of expertise are smart innovative technologies for road safety and mobility in transport, ADAS warning algorithms, HMI and C-ITS applications, personalised infomobility services, transportation technologies for elderly and persons with special needs, innovative simulation training tools, ICT for all. She has participated in over 35 research projects (European and national), with strong experience in managerial and supervisory tasks as she has acted as Coordinator/technical manager in successful projects of the 6th & 7th FP, namely SAVE ME project (FP7-SST-234027) "System and actions for vehicles and transportation hubs to support disaster mitigation and evacuation" and TRAIN-ALL project (FP6-2005-031517). She has also coordinated the H2020 project IN LIFE (643442). She is acting as expert of research proposals evaluation for various entities, including the European Commission. She is a Member of the Editorial Board of the ETRR Journal (European Transport Research Review – An Open Access Journal) of ECTRI. Finally, she is the vice-President of the Hellenic Institute of electric vehicles.
- **Dr. Afroditi Anagnostopoulou (F)** is a Researcher at the CERTH/HIT, experienced in project management and transport economics overseeing the "Economic and Social Impacts of Transport Systems" laboratory. She holds a BSc in Management Science and Technology from the Athens University of Economics and Business (AUEB) and an MSc in Computer Science from the University College London (UCL). She has also received a PhD in Operations Research from the Department of Management Science and Technology of the AUEB. Dr. Anagnostopoulou has participated in several research projects of the FP7 and Horizon 2020. She is a member of the

“Hellenic Operational Research Society” and the “Economic Chamber of Greece”. She is listed in “Who's Who in the World” (2015, 2016), and her work has been published in international academic journals (including the first-tiered Transportation Science journal) and presented in more than 20 national and international conferences.

- **Mr. Eleftherios Sdoukopoulos (M)** was born in Larisa, Greece in 1984. He is a Dipl. Rural & Surveying Engineer, graduate of the Faculty of Engineering of the Aristotle University of Thessaloniki - AUTH (2008), and MSc Transport Engineer, after successfully completing in 2009 AUTH's Master Programme entitled ‘Design, Organization and Management of Transport Systems, ranking 1st in his class and receiving a certificate of excellence. Since 2014, he is also a PhD Candidate at the Department of Maritime Studies of the University of Piraeus, with his doctoral thesis focusing on port-hinterland relationships and interactions within the context of global supply chains. As part of his doctoral research, in 2018 he received a Fulbright Scholarship for conducting a short-term research at the University of Memphis in Tennessee, U.S. In 2010, he started working as an Associate Researcher at the Hellenic Institute of Transport and since then he has participated in 15 research projects and studies in total, funded under different European, regional and national programmes. His main research interests lie in the fields of maritime transport, design, management and operation of ports and marine terminals, port-city relationships and interactions as well as multi-modal port-hinterland systems. Within the aforementioned research fields, he has authored and co-authored 26 scientific papers in international journals, books and scientific conferences.
- **Ms. Evangelia Gaitanidou (F)** has a Diploma in Civil Engineering from the Aristotle's University of Thessaloniki, Greece, where she also obtained her MSc on “Planning, Organization and Management of Transportation Systems” and is currently a PhD Candidate in Transportation Safety with focus on Automation. She works in the Hellenic Institute of Transport since 2004, as a Researcher, head of the Vehicle Safety laboratory (2009-2012), the Clean Vehicles laboratory (2012-2014) and the Road Safety and Security laboratory (2014-present). She has so far participated in more than 20 EU funded projects in FP6, FP7 and in Horizon 2020 in most of which holding a significant role (assistant Coordinator/Technical Manager, Quality Manager, WP/Task leader). She has also had an active role in several National projects. She has about 30 publications in National and International peer reviewed Conferences and Journals, while, she is co-Editor of a book and co-author in 10 chapters in books. She has acted as Assistant Editor in the European Transport Research Review (ETRR) Journal (2009 – 2013) in which she still acts as a reviewer. She is rapporteur in 2 ECTRI Working Groups (Safety and Security). In 2018 she was also elected Vice-President of the Hellenic Institute of Transportation Engineers, for the period 2018-2020. Her main fields of interest lie in the areas of: Transportation Safety, Automated Driving, Resilience, Clean Vehicles, Sustainable Transport, ITS, Transportation of E&D, Mobility for All.
- **Mr. Aggelos Aggelakakis (M)** is a Dipl. Engineer of Planning and Regional Development, graduating in 2005 from the corresponding department of the University of Thessaly. In 2007, he acquired his MSc diploma on “Planning, Organization and Management of Transport Systems” from the Aristotle University of Thessaloniki (AUTH). Since March 2007 and for specified periods, he was a research associate at the Transport Engineering Laboratory of Aristotle University of Thessaloniki with participation in European and National Research Programmes. He has participated in many traffic studies in Greece and Cyprus in cooperation with private companies. He has been a research associate at Hellenic Institute of Transport since December 2013. His main fields of interest lie in the areas of: Urban Mobility, Sustainable Transport, Environment, Road Safety, Resilience, Transportation planning and Transport policy analysis.

4.1.8.2 Publications

1. Bekiaris, E., Wiethoff, M., Gaitanidou, E., (Eds.), “Infrastructure and Safety in a Collaborative World”, Springer [ISBN: 978-3-642-18371-3(hardcover) – ISBN: 978-3-642-18372-0 (online)], 2011.
2. Maria Panou, Phil Blythe, Evangelos Bekiaris, ‘Integrated safety & security for transportation hubs’, Road Safety in 4 Continents-RS4C, 28-30/2010, Abu Dhabi, UAE
3. Boile, M., Morrall T., Roland F., Sdoukopoulos E. (2012) Technology Gaps and Research Priorities to Support the EU Maritime Transport Policy. Transport Research Arena 2012 - Procedia-Social and Behavioral Sciences. Volume 48, p. 2433-2443
4. Laventhal W., Theofanis S., Boile M (2010) “Trends in Global Port Operations and Their Influence on Port Labor: Challenges and Implications for US East Coast Longshoremen” Journal of the Transportation Research Record Vol. 2166 pp. 37-43.
5. Sdoukopoulos L., M. Boile, E. Gagatsi (2011) “European Maritime Transport Policy and Research Priorities” Proceedings of the International Association of Maritime Economists (IAME) Conference, Santiago de Chile, October 2011.

4.1.8.3 Relevant Previous Projects

Name	Description	Reference
EU- PORTRAITs FP7	The EU-PORTRAITs (European Port Workers Training Scheme) project provided technical support to the European Ports Social Dialogue Committee aiming to examine the ‘map’ of the EU ports ‘human capital’ in relation to the sector’s current and future needs and requirements. It examined health and safety, training and qualification challenges in EU ports, with the involvement of the Social Dialogue committee.	http://euportraits.eu/index.php/programme
MARPOS FP7	The MARPOS (MARitime Policy Support) assisted the European Commission in the implementation of the European Union maritime transport policy objectives by utilising the results of past research work in the field of maritime transport and related expertise from the Transport sector. The project addressed the above issue by consolidating and synthesising the results of maritime transport research in the past FP5 and FP6, and part of the FP7.	https://cordis.europa.eu/result/rcn/55261_en.html
FUTURE FP7	FUTRE (Future Prospects on Transport Evolution and Innovation Challenges for the Competitiveness of Europe) aimed to examine the future challenges for the European transport sector and the incentives that had a considerable impact on the global demand and supply patterns in the passenger and freight transport. Within this framework, CERTH was responsible for the project coordination and participated in the development of future scenarios of supply and demand for the European transport sector as well as in the dissemination actions that aimed at different audiences and in the development of the communication strategy which defined a clear and concise message.	http://www.future.eu
EXCROSS FP7	EXCROSS (Exploiting safety results aCROSS transportation modes) CERTH/HIT has participated in the EC project EXCROSS ‘Exploiting safety results aCROSS transportation modes’. The aim was to enhance cross-fertilization and synergies between research initiatives dealing with safety in the different transport modes (e.g. aviation, maritime, rail, and road), reducing the fragmentation that exists in Europe between these initiatives.	www.excross.eu
IN SAFETY FP6	IN SAFETY (Implementation scenarios and further research priorities regarding forgiving and self-explaining roads) CERTH/HT was the Coordinator of the EC project IN SAFETY ‘Implementation scenarios and	http://www.stressproject.eu

Name	Description	Reference
	further research priorities regarding forgiving and self-explaining roads'. The aim was the use of intelligent, intuitive and cost-efficient combinations of new technologies and traditional infrastructure best practice applications, in order to enhance the forgiving and self-explanatory nature of roads.	

4.1.9 CETENA

CETENA S.p.A. - The Italian Ship Research Centre - is a company of the FINCANTIERI Group dedicated to research and consultancy in the naval and maritime field. CETENA has a staff of 80 and is based in Genova, with offices in Trieste, Castellammare, Palermo and a workshop in Riva Trigoso. Since its foundation in 1962, CETENA has been involved in national and international research activities and has carried out research and consultancy in close cooperation with shipbuilders, ship-owners, navies and universities.

CETENA's technical activities consist in numerical studies, simulations and measurements on board ships and in the company's laboratory. The competence areas are Hydrodynamics, Structures and Materials, Vibrations and Noise, Ship Vulnerability and Signatures, Ergonomics and Human Factors, Virtual Prototyping, Risk Analysis and Process Simulation. As a company focused on applied research and consultancy, CETENA's role in Italy is that of a link between the academic world and the world of shipbuilding and maritime operations, with a consolidated relationship with the Ministries of Transport, Industry and Research, and with the Italian Navy. CETENA is involved in international research activities and is a member of ITTC (International Towing Tank Conference), ISSC (International Ship and Offshore Structures Congress), ECMAR (European Cooperation in Maritime Research), CRS (Cooperative Research Ship).

Considering the Human Factors field, CETENA has been carrying out HF related activities for more than twenty years, both supporting Fincantieri design departments (dealing with basic, functional and detailed design activities) and shipyards. Dealing with ship design and construction, CETENA manages the full HF integration process; typical activities include selecting ergonomics and HFE guidelines, carrying out the assessment of ship general arrangement (including onboard flows analyses, habitability, usability, maintainability, evacuation studies and more), and finally conducting a verification campaign onboard during construction (including HF checklists compilation, illumination levels measurement and safety assessment).

4.1.9.1 Key personnel

- **Andrea Lommi (M).** Mr. Lommi is a senior engineer with almost 20 years experience in the maritime industry. Throughout his career he worked on Virtual Prototyping and Virtual Reality based simulations, ergonomics, light engineering, maintenance analysis and other related topics. Since 2010 he is CETENA reference person for Human Factors studies, supporting Fincantieri in the implementation of the HF integration plan (carrying out specific studies and assisting designers) and developing research activities on the subject. He was also a consultant for Italian, Indian and Navy in the definition and verification of the Complement for many Naval Units. In 2013 he was coordinator for EDA-funded project FODAI (Fatigue and Overload Detection and Advising Interface), dealing with stress detection by means of eye movements tracking and analysis. From 2016 to 2018 he was involved in a transfer of technology activity to Indian Navy and shipyards, delivering six editions of a training course on Human Factors in ship design.
- **Emilio De Angelis (M).** has been working for CETENA since 2008, initially focusing on topics including reduction of noise and vibration on board luxury yachts, structural design (specializing in finite element calculation and managing experimental campaigns of strain gauge measurements); with a previous background on maintenance (management, optimization of maintenance plans, definition and execution of experimental measurements), since 2010 he manages the Condition Based Maintenance (CBM) service (vibration measures aimed at more effective management of the ship maintenance) on-board all the latest Italian Navy units; in the same years he started working on on-board personnel safety and environmental issues, including topics like the assessment of health and safety risks, management of hazardous materials on board (Green Passport), pollutant emissions, noise radiated into the sea. Since 2015 he has been in charge of the Systems Engineering and Research Business Unit.

- **Giorgia Domenichelli (F).** Graduated in Architecture, Mrs Domenichelli has been working for CETENA since 2009, developing studies related to Human Factors and Ergonomics and supporting Fincantieri for the development of lighting-related activities. Her involvement is focused on lighting design, lighting engineering on different kinds of ships and comfort on board; in this framework, the most relevant activities she carried out include lighting design and functional lighting engineering, lighting analyses on operational compartments, support to the lighting designer, optimization of the lighting project and analysis with 3d lighting software simulator, lighting levels measurements on board and ergonomic studies.

4.1.9.2 Publications

1. Andrea Lommi, Pierpaolo Rube (2015) CREW – An effective approach to scheme of complement and workload estimation on military ships, 18th International Conference on Ships and Shipping Research (NAV 2015), Lecco: Politecnico of Milan, 10 p

4.1.9.3 Relevant Previous Projects

Name	Topic	Relevance	Reference
FODAI EDA Project	Fatigue and Overload detection through physiological monitoring and analysis	FODAI investigated the feasibility of a methodology for detecting excessive fatigue and workload for console operators. A very clear relationship between workload and pupillary diameter and eye blinks was identified, demonstrating the robustness of the methodology.	https://www.eda.europa.eu/
SilenV FP7 Project	Noise and Vibration effects	The SilenV proposes a holistic approach to study ship generated Noise & Vibration pollution and assess solutions to reduce emissions. (UoS)	http://www.silenv.eu/

4.1.9.4 Major Infrastructure

N.A.

4.1.10 ISTANBUL TEKNİK UNIVERSİTESİ

Founded in 1773 as the Imperial School of Naval Engineering during Ottoman Empire, Istanbul Technical University (ITU) is now one of the leading state universities in Turkey with approximately 32,000 students. The University offers 76 undergraduate and 140 graduate degree programs. ITU comprises 13 Faculties, 43 Departments, and 6 Graduate Institutes and Turkish Music Conservatory. ITU is a very long-established higher education institution and presents a powerful research base for scientists and for prospective researchers with its highly-developed research infrastructure. Providing technical education within a modern educational environment and strong academic staff, ITU is strongly identified with architectural and engineering education in Turkey. ITU is one of the leading research-intensive technical universities in Turkey. Research: Being Turkey's first technical university, ITU aims to create a new generation of technology and innovation to drive economic growth by conducting value-added and industrially applicable research. ITU's researchers carry out research in the fields of engineering, core sciences, earth/planetary sciences, arts and social sciences. Particular research areas, in which the ITU researchers pursue discoveries and implement projects, are materials science, nanotechnology, aeronautics, mechatronics, biotechnology, renewable energy, sustainable building systems and design. ITU is one of the leading research-intensive technical universities in Turkey. Regarding EU funded research; ITU currently has 21 projects from 6th Framework Programme, 47 projects from 7th Framework Programme, 3 projects from MEDA Programme, 2 projects from MINERVA Programme, 1 project from Leonardo Da Vinci Programme, 1 project from MATRA Programme, 1 project from Grundtvig Programme, 1 Project from DG TREN Fund, 1 Project from Youth in Action Programme, 1 project from Black Sea Cross Border Cooperation Programme, 2 Projects from Life Long Learning Programme, 7 projects from Erasmus Plus Programme, 1 project from IPA Capacity Building in the Field of Climate Change in Turkey Grant Scheme Programme, 15 projects from Horizon 2020 Programme. Besides, ITU is actively involved in wide range of national projects. In this respect, ITU has around 8000 projects funded by different national research programmes since 2003. ITU holds significant positions in a number of international institutions of academy. For instance, one of the three Turkish members of American Academy of Sciences, two of the three Turkish members of Russian Academy of Sciences and two of the three Turkish members of European Academy of Sciences are from ITU. Furthermore, the University has more than 130 international partnership agreements and is a member of various international networks such as European Association for International Education (EAIE), European University Association (EUA), International Association of Universities (IAU), Advanced Technology Higher Education Network (ATHENS), Black Sea University Network (BSUN), International Association of Universities (IAU), Community of Mediterranean Universities (CMU), and Top Industrial Managers for Europe (TIME). ITU has around 900 Erasmus Agreement with renowned universities around Europe. 11 International Dual Diploma Programs are being conducted at ITU. ITU is the only university with the largest number of International Dual Diploma Programs in Turkey. The contracted universities are State University of New York, Montana State University, Fashion Institute of Technology, Southern Illinois University, New Jersey Institute of Technology. Istanbul Technical University has an office called European Union Centre Research Office that gives information about EU Framework Programs and other EU Programs to the academic staff either by giving seminars, workshops ITU EU Centre Research Office works as a help desk office and gives technical guidance, information to the academic staff of ITU. ITU EU Centre Research Office has experts who have expertise in drafting and monitoring EU Programmes. ITU European Union Centre Research Office is one of the EURAXESS Service Centers in Europe. EURAXESS Service Centers were established to support foreign researchers in Turkey and to encourage Turkish researchers in the participation of the mobility programs of the European Union (EU), works in accordance with more than 200 other mobility centres currently established in the other member and associate countries of the EU. ITU adopts the principles set out in the European Charter for Researchers and in the Code of Conduct for the Recruitment of Researchers. ITU European Union Centre Research Office deals with work permits, residence permits of the foreign researchers who are working in EU Funded Research Programmes at Istanbul Technical University. The Maritime Faculty was established in 1884 at Istanbul as a part of the Naval Academy. In 1992, it is re-established as a 'Maritime Faculty' of Istanbul Technical University. The departments in ITUMF are Maritime Transportation and Management Engineering Department and Marine Engineering Department. ITUMF is still one of the leading maritime education, training and research institute by utilizing Full-mission Ship handling Simulator, training ships and many other simulators and labs at Turkey. Furthermore, ITUMF has international academic collaborations in its teaching and research activities. Simulator Laboratory/Centre provides visual education to students and to the maritime sector in

general by using several simulation models. ITUMF has a training, laboratory and research ships and a Maritime Safety at Sea Training Centre including swimming pool, fire training centre and lifeboat station.

4.1.10.1 Key personnel

- Assoc. Prof. Dr. Ozcan Arslan (M)** Assoc. Prof. Dr. Arslan worked on several types of tankers and he has still 'Oceangoing Master' license. He completed his MSc with 'Human Resources Management for Turkish Seafarers' thesis his and PhD with 'Strategic Management Modeling for Chemical Tanker Management' thesis in 2009 at ITU Maritime Transportation Engineering PhD program. He has taken part in the EU FP-7 Project: SEAHORSE as a member of ITU; Coordinated IAMU (International Association of Maritime Universities) Projects: - Improving Energy Efficiency of Ships Through Optimisation of Ship Operations between 2014-2015 and E-Maritime Medicine for seafarers, students and seamanship physicians between 2015-2016; Participated EU Leonardo Project: MARTEL and he participated in EU funded LLP Leonardo Da Vinci Project: Ship DIGEST on behalf of consulted company. He has several researches and publications about energy efficiency, safety management, transportation safety, strategic management, human factors, accident analysis, accident investigation and root cause analysis. He teaches, among others, 'Quality and Safety Management', 'Advanced Ship Management', 'Tanker Operations', 'Safety and Reliability in Ship Operations'. Also he is managing 20 Turkish Chemical Tanker companies' benchmarking meetings semi-annually in ITU Maritime faculty; collecting their ships' internal and external inspection results including MOC (Major oil companies), PSC, FSC and CDI continuously and analysing the non-conformities, near-misses and accidents from the database with the working group.
- Assist. Prof. Dr. Elif Bal Beşikçi (F)** Dr. Elif Bal Beşikçi is an oceangoing chief officer, who is an Assistant Professor at the Istanbul Technical University, Istanbul, Turkey. Ass. Prof. Dr. Bal Beşikçi is Vice Head of Department of Maritime Transportation Engineering Department in Maritime Faculty of Istanbul Technical University. In her Ph.D. thesis, she developed a decision support system (DSS) employing ANN-based fuel prediction model to be used on-board ships on a real time basis for energy efficient ship operations. Prior her Ph.D., she worked on chemical tanker ships as an oceangoing watchkeeping officer and chief officer positions. Dr. Bal Beşikçi was involved in the project named 'improving energy efficiency of ships through optimization of ship operations', funded by International Association of Maritime Universities (IAMU). Her research areas are: Maritime energy management and energy efficiency; Real-time decision support systems for energy efficient ship operations; Maritime safety and transportation; Human factor at sea
- Esma Uflaz (F)** Esma Uflaz works as a research assistant at ITU Maritime Faculty, department of Maritime Transportation and Management Engineering. After graduating from the Maritime Transportation and Management Engineering of Maritime Faculty, she got oceangoing watchkeeping officer license in 2011. Since then, she worked as a third officer, second officer at oil chemical and oil product tanker vessels for K Tankering and Shipmanagement Co. She worked different size and positioned at tankers. Promoted to the position of oceangoing chief officer in 2015. She continued her career on shoreside and worked as a Deck Superintendent for Thales Maritime Shipmanagement Company during one year. She has experience on ship inspections, audits, safety process and operations for tankers. She received MSc degrees in Maritime Transportation and Management Engineering from the ITU Maritime Faculty from 2015 to 2017 with a thesis on "Efficiency Analysis of ISM Forms and Procedures". She has been Phd student at ITU Maritime Faculty, department of Maritime Transportation and Management Engineering since 2018.
- Betul Pehlivan Essiz (F)** Betul Pehlivan Essiz is an oceangoing watchkeeping officer, who is an MSc degree student at the Maritime Faculty, Istanbul Technical University, Istanbul, Turkey. In her MSc thesis is to refresh information and knowledge of seafarers in health and safety issues on board to reduce negative health consequences to the individuals. Prior her master's degree student, she

worked on chemical tanker ships as an oceangoing watchkeeping officer positions. And she also worked at chemical tanker company's operational department as an operator position.

4.1.10.2 Publications

1. Kececi, T., Arslan, O. (2017) SHARE Technique: A Novel Approach to Root Cause Analysis of Ship Accidents, *Safety Science*, 96 (2017), 1-21.
2. Bal Besikci E., Arslan O., Turan O., Olcer, I.A., An artificial neural network based decision support system for energy efficient ship operations, *Computers & Operations Research*, Vol 66, pp:393-401
3. Bal Besikci E., Arslan O., Tavacioglu L., Prioritization of the Causal Factors of Fatigue in Seafarers and Measurement of Fatigue with the Application of the Lactate Test, *Safety Science*, Safety Science, Vol. 72, No. 46-54, 02/2015, ISSN: 0925-7535,
4. Arslan, O., Quantitative Evaluation of Precautions On Chemical Tanker Operations, *Process Safety and Environmental Protection* 2009. 87-2
5. Arslan, O., Turan, O., Analytical Investigation of Marine Casualties at the Strait of Istanbul with SWOT – AHP Method, *Maritime Policy & Management* 2009

4.1.10.3 Relevant Previous Projects

Name	Description	Reference
E-Maritime Medicine	E-Maritime Medicine for seafarers, students and seamanship physicians, IAMU (International Association of Maritime Universities) Project, (Project Partner, (May 2015-May 2016)	
SEAHORSE FP7	Seahorse (Safety Enhancement in transport by Achieving Human Orientated Resilient Shipping Environment): this project aimed to seek feasible and effective transfer of the successful safety concepts, such as resilience engineering and other tools adopted from the aeronautical industry to marine transport. SEAHORSE (Safety Enhancements in transport by Achieving Human Orientated Resilient Shipping Environment, Project Nr: 605639, EU 7. Frame Project, (November 2013 – 2017)	https://www.seahorseproject.eu
IAMU	Improving Energy Efficiency Of Ships Through Optimisation Of Ship Operations, IAMU (International Association of Maritime Universities) Project, (Project Coordinator, Started in May 2014, May 2015)	
SHIP-DIGEST	SHIP-DIGEST (Ship Dismantling Insight by Generating Environmental and Safety Training – EU Leonardo Project)– 2011 – 2013). Ship DIGEST's main aim and objective is to assist the Ship Dismantling industry by improving, through knowledge transfer, the various identified social and HSE issues by utilising innovative products, tools and vocational education and training (VET) from previous EU projects and from similar industries within the EU.	https://www.shipdigest.eu
MARTEL	MARTEL (Maritime Test for English Language - EU Leonardo Project, Project (Researcher – 2008, total 6 months). MarTEL has established a set of tests and standards transferring innovation from existing English language standards, the IMO Maritime English 3.17 model course and IMO's Standard Marine Communication Phrases (SMCP). The MarTEL	http://www.marstel.pro

Name	Description	Reference
	materials are all in-line with the latest STCW convention requirements.	

4.1.10.4 Major Infrastructure

İstanbul Technical University Simulators Center (ITUMF-SC) is in operation since 2001 and leader in training and development in Turkey. Over 15 years SC holds unique expertise in navigational safety.

- A. **Simulator Center** has full range of simulation options ranging from standalone desktop simulation to fully interactive, tug and large vessel simulations. Simulators Center has in recent years implemented organizational improvements aimed at optimizing and documenting work processes to ensure improved efficiency and that the organization is prepared for growth. SC has also expanded the activities in port engineering projects. Our research projects on Environmental Stress Model had been studied at Kobe University, have been taken into consideration for navigational risk assessment module of port and narrow waterway projects. Also SC researchers has newly developed a Navigational Risk Modelling and Assessment module named “NAVRISAS” for port, narrow waterways and open sea since 2015. Over 150 risk assessment projects completed in 11 years.



Figure 21 V-Step Tug Handling Simulator

SC consist of 8 simulation laboratories. These are:

- JMS Full Mission Bridge Simulator
- Transas Bridge Simulator
- V-Step Tug Handling Simulator
- Kongsberg Engine Room Simulator
- GMDSS Simulator
- Transas VTS Simulator
- Transas Cargo Handling Simulator
- Transas ECDIS Simulator



Figure 22 Transas Bridge Simulator

B. Full Mission Engine Room Simulator (ERS) To ensure optimum safety and efficiency at sea, extensive training for marine engineers is essential. At this insight, the Engine Room Simulator (ERS) is designed to provide the training students need, from basic to advanced level, and with special reference to the requirements of the STCW code. Simulation training, in a controlled environment, gives marine engineering students the opportunity to learn, experiment and interact with a variety of realistic situations that would be dangerous or expensive to recreate in real life. *The training objectives of Engine Room Simulator (ERS)* are (i) engine room equipment familiarization; (ii) system layout and flow diagrams; (iii) machinery control; (iv) control system; (v) automation, alarm and safety system; (vi) emission control and fuel economy management; (vii) energy management; (viii) emergency operations; (ix) watch-keeping and troubleshooting; (x) vessel resource management.

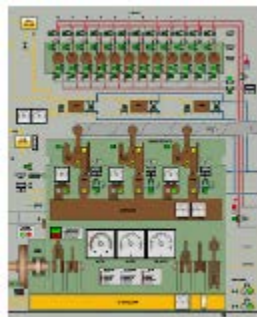


Figure 23 Diagrams of Full Mission Engine Room Simulator (ERS)

Full mission Engine Room Simulator in ITU Maritime Faculty is one of the most important education infrastructure with its unique characteristics and features for marine engineering students. Engine Room Simulator I (5th semester course) and Engine Room Simulator II (7th semester course) courses are conducted with using full mission ERS. In addition, Engine Room Simulator provides opportunity for planning and conducting variable special training courses like *Engine Room Resource Management Course*, *Advanced Marine Engines Maintenance and Trouble Shooting Course* and *Advanced Crew Competency Assessment Course*. Also, ERS presents researchers in ITU Maritime Faculty to study on marine engineering based safety, reliability, maintainability issues; crew based competency enhancement and assessment issues; and ship based emergency response management, crisis management, resource management issues.



Figure 24 Full Mission Engine Room Simulator (ERS)

4.1.11 CALMAC FERRIES LTD

Caledonian MacBrayne (Scottish Gaelic: Caledonian Mac a' Bhriuthainn), shortened to CalMac, is the major operator of passenger and vehicle ferries, and ferry services, between the mainland of Scotland and 22 of the major islands on Scotland's west coast. Since 2006 the company's official name has been CalMac Ferries Ltd. The CalMac fleet is the largest fleet of car and passenger ferries in the United Kingdom. With 31 units in operation (with another 2 under construction), the company provides lifeline services to 23 islands off the west coast of Scotland, as well as operating routes across the Firth of Clyde. CalMac vessels are owned by the asset holding company Caledonian Maritime Assets Limited, which is in turn wholly owned by the Scottish Government.

4.1.11.1 Key personnel

- **Mr Benjamin James Wood (M)** is the HSQE Innovation manager at CalMac ferries and is tasked with ensuring the continual development of the infrastructure and framework that the Directorate operates within. Ben has delivered numerous projects and initiatives aimed at developing the overall safety culture including incident management and sustainability software solutions to a passenger safety video emulating the successful concept utilised by aviation. Ben is a creative, agile, innovative and results-driven safety professional working within the global cruise and ferry sectors. Skilled and passionate in delivering enhancements to human behaviours and system performance in high risk domains. Experience gained include 10 years globally as a Navigation Officer with Carnival UK, Princess and Cunard together with 3 years in the Royal Naval Reserve. Project involvement at a European level and HSQ lead for a £1b successful contract bid. Ben has an ability to lead and influence others while displaying sound common sense and judgement in challenging operational and strategic environments. Demonstrates a clear understanding of the importance between the alignment of culture and strategy and the people, processes and systems that operate within. Specialities: Integrated Management Systems (ISO 9001, 14001, ISM) | Cultural Change & Behavioural Adaptation | Internal Audit | Stakeholder Management | Risk Management | Causal factors and taxonomies | Safety Performance & Analytics | Incident Investigation & Report Writing | Causal Factors | Project & Programme management | Client Relationships.
- **Miss Hannah Ward (F)** currently holds the position of Management Systems Specialist at CalMac Ferries and is an experienced Project manager who is PRINCE2 Foundation qualified. Hannah has gained extensive knowledge about the company, its customers, and its business requirements. She is able to demonstrate high levels of competency in the use of the majority of platforms deployed within the HSQE Directorate and is leading on the training and business change requirements for the Incident Management project that is currently being delivered at CalMac. Hannah is also competent in Process Mapping and assists in the continual improvement of the integrated management system.

4.1.11.2 Publications

1. Volkan Arslan, Rafet Emek Kurt, Osman Turan, Louis De Wolff, 'Safety Culture Assessment and Implementation Framework to Enhance Maritime Safety', Transport Research Arena TRA2016, Transportation Research Procedia, Volume 14, 2016, Pages 3895-3904
2. SEAHORSE project: Dealing with maritime workarounds and developing smarter procedures. Kurt, R. E., Arslan, V., Turan, O., de Wolff, L., Wood, B., Arslan, O., Kececi, T., Winkelman, J. W., van Wijngaarden, M. & Papadakis, G. 3 Sep 2015 Safety and Reliability of Complex Engineered Systems - Proceedings of the 25th European Safety and Reliability Conference, ESREL 2015. p. 3811-3818 8 p. <https://doi.org/10.1201/b19094-499>

4.1.11.3 Relevant Previous Projects

Name	Topic	Relevance	Reference
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Name	Topic	Relevance	Reference
SEAHORSE FP7 Project	Enhancing maritime safety by focusing on human factors and resilience engineering principles	SEAHORSE is a leap forward towards shipping safety achieved through technology transfer from air transport to marine transport focusing on human factors problems in an innovative, integrated and multidisciplinary manner towards safer and more resilient shipping operations.(UoS)	http://seahorseproject.eu/
MACS FP7 Project	Checklist Design for aviation	MACS – Airbus assisted checklist design for arrivals and departures	

4.1.11.4 Major Infrastructure



A. MV Glen Sannox (2019) – left CGI design and right launching of hull in 2017.



4.1.12 CHALMERS TEKNISKA HOEGSKOLA AB

Chalmers tekniska högskola (Chalmers University of Technology) was founded in 1829 following a donation by William Chalmers, director of the Swedish East India Company, and was transformed into an independent foundation in 1994. Chalmers has developed leading research in the areas of life sciences, materials science, information technology, micro-and nanotechnology, environmental sciences and energy. Chalmers' annual turnover is 3695 million SEK (appr. 383 million EUR), out of which 70 % is related to research. Around 60 % of the research funding is acquired in competition from external sources. Some 13 900 people, including 3258 employees (2955 FTEs), work and study in Chalmers' 13 departments. The university offers PhD and Licentiate programmes as well as MScEng, MArch, BEng and nautical programmes. There are 9502 students (FTE) in programmes leading to 1 335 Master's degrees annually. 1 111 students are involved in doctoral programs leading to about 270 PhD and Licentiate of Technology degrees each year. Chalmers has an extensive track record of engaging in EU funded research projects. In the Framework Programmes for Research and Innovation, Chalmers has participated in over 750 projects. On a continuous basis Chalmers is involved in approximately 150 EU-projects with an annual EU funding (2017) for research of 22 M€ In Horizon 2020, Chalmers is participating in 131 projects with a contract value of 74 M€ including 9 ERC grants, 30 MSCA grants (15 ITNs) and 26 projects in the Transport challenge. Chalmers is coordinator or single beneficiary of 28 Horizon 2020 projects, including the Graphene Flagship. Mechanics and Maritime Sciences (M2) consists of seven different divisions in mechanical engineering and maritime sciences. The department has Sweden's most comprehensive simulator centre for navigation and propulsion of ships as well as world-class laboratories in combustion engine technologies and wind tunnels. M2 carries out fundamental and applied research in all modes of transport, including increased security, energy efficiency and material optimization for sustainable technology solutions. The department strives continuously to establish close collaboration between academia, industry and society with a strong focus on utilization.

4.1.12.1 Key personnel

- **Scott MacKinnon (M)** is a Professor of Maritime Human Factors within the Division of Maritime Studies at Chalmers University. His research has four primary foci: (1) safety in marine and coastal occupations, (2) understanding the relationship between workload and performance, (3) impact of virtual and simulated environments upon knowledge acquisition and mobilization and (4) the impact of participatory ergonomics and human centered design within work environments. Dr. MacKinnon holds a PhD in Biomedical Engineering (Ergonomics) from the University of Cape Town.
- **Dr. Monica Lundh (F)** is currently senior lecturer at the of the Division of Maritime Operations at the Department of Mechanics and Maritime Sciences at Chalmers University of Technology, Sweden. She has a background in the maritime industry and is a Marine Engineer, served 11 years in the Swedish merchant fleet, of which the last five were as a qualified engineering officer. She is responsible for research in engine room ergonomics and safety, including changes in work performance brought about by technical developments on board. Dr. Lundh has also been involved in several EU projects with focus on user centered design and work place optimization. Her precious research also included evacuation of passenger ship using the perspective of operator's performance.

4.1.12.2 Publications

1. Norazahar, N. Khan, F., Veitch, B. and MacKinnon, S. (2017) Prioritizing safety critical human and organizational factors of evacuation operations of offshore installations in harsh environment, *Safety Science.*, 95, 171-181.
2. Musharraf, M., Smith, J., Khan, F., Veitch, B. and MacKinnon, S. (2016). Assessing offshore emergency evacuation behavior in a virtual environment using a Bayesian Network approach. *Reliability Engineering and System Safety*, Vol 152, pp. 28-37.

3. Musharraf, M., Smith, J., Khan, F., Veitch, B. and MacKinnon, S. (2016). Incorporating individual differences in human reliability analysis. *Journal of Safety Science*, <https://doi.org/10.1016/j.ssci.2017.07.010>.
4. Lundh, M., Mallam, S. and MacKinnon, S. (2016). A General Arrangements Visualization Approach to Improve Ships' Design and Optimize Operator Performance. COMPIT 2016 15th International Conference on Computer Applications and Information Technology in the Maritime Industries 9-11 May 2016, Lecce/Italy.
5. MacKinnon, S., Bradbury-Squires, D. and Button, D. (2016). Virtual reality-based training improves mustering performance. COMPIT 2016 15th International Conference on Computer Applications and Information Technology in the Maritime Industries 9-11 May 2016, Lecce/Italy.

4.1.12.3 Relevant Previous Projects

Name	Description	Reference
MUNIN FP7	MUNIN (Maritime Unmanned Navigation through Intelligence in Networks) - FP7 2012-2016. The overall goal of the MUNIN project originates from the vision of autonomous and unmanned vessels. Specifically, MUNIN aims to develop and verify a concept of an autonomous ship	http://www.unmanned-ship.org/munin/
EfficienSea2 H2020	EfficienSea2 - Horizon 2020 Ongoing to May, 2018. The overall aim of our EfficienSea2 project has been to create and implement innovative and smart solutions for efficient, safe and sustainable traffic at sea through improved connectivity for ships. Information exchange between ships and shore is unstable, costly and marked by old technology and non-standardised solutions. This increases the risk of accidents, inefficiency and administrative burdens. Also, incentives to comply with emission regulations are limited, which adversely impacts the environment. The need for operational solutions in the maritime domain is significant. CHALMERS has created and implemented innovative and smart solutions for efficient, safe and sustainable traffic at sea through improved connectivity for ships. EfficienSea2 is a demonstrator in the Arctic and Baltic Sea and the first generation of a coherent e-Navigation solution. Through global collaboration, use of open-source software and an explicit aim for standardised solutions, we will pave the way for a global roll-out of e-Navigation.	https://efficiensea2.org
Sea Traffic Management	Sea Traffic Management (Horizon 2020 - Ongoing to Dec., 2018) will overcome many of the challenges of communication and information sharing between stakeholders in the maritime transport industry. Sea Traffic Management connects and updates the maritime world in real time, with efficient information exchange. Through data exchange among selected parties such as ships, service providers and shipping companies, STM is creating a new paradigm for maritime information sharing offering tomorrow's digital infrastructure for shipping. It will create significant added value for the maritime transport chain, in particular for ship owners and cargo owners.	http://stmvalidation.eu
SEDNA Project Horizon 2020	SEDNA ("Safe maritime operations under extreme conditions: the Arctic case") is a research project that is developing an innovative and integrated risk-based approach to safe Arctic navigation, ship design and operation. As more of the Arctic waters become navigable due to global warming, ship traffic in the Arctic regions is increasing. However, there are significant operational challenges in the Arctic. As a result, recent years have seen a sharp rise in marine casualties.	https://www.sedna-project.eu

Name	Description	Reference
	SEDNA has a global consortium, with 13 partners from 6 different countries, including China, and will run for three years from June 2017.	

4.1.12.4 Major Infrastructure

Full Mission Bridge Simulator: The simulator consists of 3 TRANSAS bridges certified by DnV GL which are all connected to the **European Maritime Simulator Network (EMSN)**.

4.1.13 EMBRAER PORTUGAL SA

Embraer Portugal, S.A. (EMBRPT) is a holding company for aerospace related business. Its main business is as a TIER 1 supplier of aero-structures: mainly wings, empennages and flight control surfaces. EMBRPT also has an Embraer Engineering and Technology Center with focus on: Research and Development (in projects from TRL 2 to 6); Integrated Product Design (performing design and stress analysis activities); and Material Review Board activities for manufacturing support. Regarding R&D, it aims to support the industrial activities of the aero-structures plants of Embraer Portugal (e.g, industry 4.0, new materials and designs) and also exploit future research directions in Europe, aimed at 1) increasing connections with European networks of partners and suppliers and, 2) contribute to overall aviation safety increase. In that regard it, if focuses on themes related to cyber-physical systems, future automation and human centred problems. EMBRPT is a full subsidiary of Embraer S.A., with HQ in Brazil and from which it can draw expertise and know-how. Namely it will be able to use knowledge from senior Human Factors, Safety experts, Systems and pilots, among others, to support its participation in the project.

4.1.13.1 Key personnel

- **Dr. Ricardo Reis (M)** is Technical Leader at the Embraer Engineering and Technology Center in Portugal. He is an Aerospace Engineer with a Ph.D. in CFD and High Performance Computing. He coordinated and participated in several RD projects either National or European funded. These projects span from future aircraft concept design configurations to composite materials characterization, manufacturing and structures.
- **Eng. Marta Quintiães (F)** is a Product and Technology Development Engineer at the EETC-PT of Embraer Portugal, leading the R&D team and involved in technology prospecting activities. She holds an Aeronautical Engineering Master Degree in aircraft stability & control. With more than 10 years of professional experience, she has been participating in several R&D and product development projects both as researcher and managing large projects.

4.1.13.2 Publications

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4.1.13.3 Relevant Previous Projects

Name	Relevance	Reference
Future Sky Safety (P7)	Future Sky Safety is a full-fledged programme aimed at improving aviation safety in Europe. Embraer Portugal is participating in the P7 sub-project on Mitigating Risk of Fire, Smoke and Fumes, supporting the study of new structural composite materials under fire and in the P6 sub-project on Human Performance Envelope. (H2020)	http://www.futuresky.eu
newFACE	newFACE was a national funded project in Portugal, aimed at studying new aircraft concepts for the 2035 timeframe, driven by sustainability and user-centered design. It resulted in three new aircraft concepts, for regional and medium haul, an executive jet and an utility aircraft (QREN, Portuguese Funding).	http://newface.inegi.up.pt
FLEXCRAFT	FLEXCRAFT is a three year project, starting in 2016, to further develop key aspects of the UTILITY concept from newFACE. This concept includes features of remote piloted or optional piloted operation.	COMPETE 2020, Portuguese Funding
DIMA	DIMA (self-funded in cooperation with GMV). This project is being developed with GMV in Portugal for new avionics architectures using distributed modular avionics. EMBPT also contributed to the OPTICS 2 project as technical advisor.	

4.1.13.4 Major Infrastructure

EMBRPT can draw on expertise and facilities of the Embraer group.

4.1.14 FEDERAL STATE UNITARY ENTERPRISE THE CENTRAL AEROHYDRODYNAMIC INSTITUTE NAMED AFTER PROF. N.E. ZHUKOVSKY

Federal State Unitary Enterprise Central Aerohydrodynamic Institute named after prof. N.E. Zhukovsky (TsAGI), Moscow region, Russia, is a leading Russian aeronautics research center. During almost 100 years it has gained a unique experience of fundamental research and applied research on aerodynamics, hydrodynamics, aeroelasticity, flight dynamics, strength, acoustics, flight simulation, etc. TsAGI's test facilities include wind tunnels, propulsion system and compressor test facilities, static and dynamic strength labs, acoustic chambers, a fleet of flight simulators of different purposes and architecture. During its history, TsAGI has been developed new aerodynamic configurations, aircraft stability/controllability criteria, strength requirements, flight simulation technique and flight simulation requirements. TsAGI was a pioneer in theory of wing aerodynamics, strength, flutter, divergence and reversal of control, as well as other theories, applications and experimental studies. TsAGI participated, in total, in 40 R&D projects of FP6, FP7 and HORIZON 2020 (Clean Sky2 and SESAR2020) including such projects as HISAC, TELFONA, FLIRET, IDIHOM, DREAM, SARISTU, AFLONEXT, DESIREH, AGILE, TILDA, SUPRA, ARISTOTEL and others. The latter two projects were devoted to HF problems in particular.

4.1.14.1 Key personnel

- **Dr. Andrey Bushgens (M)** Dr. Bushgens graduated from Moscow State University in 1968 and took up posts of engineer, senior research scientist, head of section. At present he is a Deputy Director of Flight Dynamics and Control System Department of TsAGI. PhD (1975), Doctor of science degree (1996). All degrees were received in TsAGI. Areas of scientific interest: flight dynamics, control systems, flight simulation. The main results of his work in these areas are as follows: Motion equations for parachutes with correction for the additional air mass and analysis of parachute motion stability; Development of PSPK-102 flight simulator, which was initially used for Russian Shuttle "Buran" project, and now is widely used in multiple Russian and international projects; Development of trajectory manual control system and respective indication and navigation algorithms for instrumentation desk displays; Development of quasi-static model of aircraft-runway interaction to be used in on-ground flight simulation; Flight simulator training of test pilots and astronauts; Fundamental research in field of on-ground flight simulation and flight simulator motion systems. Dr. Bushgens is author of more than 70 publications and 20 inventions in field of flight dynamics and flight simulation. His name and results of his work is widely known within Russian aviation community and abroad.
- **Dr. Larisa Zaychik (F)** Dr. Zaychik graduated from Moscow Aviation Institute. Since 1978 she works at TsAGI as engineer, leading research engineer, head of section. Since 2102 she is a head of Flight Simulation Division of Flight Dynamics and Control System Department of TsAGI. PhD in field of aeronautical engineering (1988). Dr. Larisa Zaychik has large research experience in field of handling qualities and motion simulation, an author of 90 publications, 3 inventions and more than 100 technical reports. The main results of her work can be summarized as follows: Regularities of motion cues perception of their threshold and over-threshold values; Effect of motion system drive algorithms on motion cueing fidelity; Technique of on-ground handling qualities experiments; Handling quality criteria to assess optimum values of aircraft control sensitivity taking into account aircraft dynamics and inceptor feel system characteristics; Theoretical approach to estimate role of accelerations in piloting and methods to predict in-flight handling quality ratings; Criteria of motion simulation fidelity; Theoretical approach to assess biodynamical interaction in pilot-aircraft system; Pilot-aircraft modelling; Effect of manipulator feel system characteristics on pilot-aircraft interaction. Dr. Larisa Zaychik participated in projects SUPRA and ARISTOTEL of European FP7 and other international projects, attended many international conferences with presentations. Her name is well known within flight simulation community.

- **Dr. Yury Yashin (M).** Dr. Yashin works at TsAGI after his graduating from Kazan Aviation Institut. At present he is a leading research engineer of Flight Dynamics and Control System Department. He holds PhD in field of aeronautical engineering. The main directions of his work are as follows: On-ground flight simulator experiments to study aircraft stability, controllability and handling qualities with regard to human factor of flight simulation; Technique of on-ground simulation of aircraft flight modes including critical ones; Simulator-to-flight correlations, methods to predict in-flight HQR based on on-ground simulation results; Handling quality criteria and pilot modelling for various flight conditions; Ergonomics of human-machine interface, its effect on piloting and safety; Pilots interaction in different flight situations and for different types of control inceptors (wheel, passive and active sidesticks) and indications. Dr. Yury Yashin participated in experimental handling quality investigations of various aircraft types such as tailless airplane, airship, space shuttle “Buran”, modern fighters and civil aircrafts. He participated in projects SUPRA and ARISTOTEL of European FP7 and other international projects. Yury Yashin is author of 70 publications and inventions, technical papers. He is lecturer in Moscow Physics and Technology Institute giving a course “On-ground flight simulators and experimental technique”.
- **Yury Arkhangelsky (M).** Yury Arkhangelsky works at Flight Dynamics and Control System Department of TsAGI since 2015 after graduating from Moscow Aviation Institute and takes up post of an engineer. His scientific interest focuses on motion cueing problem, which is the main subject of his future PhD thesis. At the moment he concentrates on critical flight modes such as upset/stall and recovery, and software to control motion system. In addition to the main direction of his work, he conducts some research in area of aircraft and rotocraft handling qualities. Results of his work are stated in a number of technical reports and publications.

4.1.14.2 Publications

1. L.E.Zaichik, Y.P. Yashin, P.A. Desyatnik, V.S. Perebatov, H. Smaili, “Effect of Manipulator Feel System Characteristics on HQ of Aeroelastic Aircraft”, AIAA Atmospheric Flight Mechanics Conference, 19-22 August, Boston MA, 2013.
2. S.V. Kravchenko, B. Lee (The Boeing, USA), A.G. Bushgens, L.E. Zaichik, Y.P. Yashin, V.S. Perebatov, V.V. Rodchenko, (TsAGI) “Directional Handling Qualities of the Modern Airliners”, in *Joint Advanced Research and Technology Projects in Commercial Aviation. 20 Years of Collaboration between Russian and Boeing scientists (1992-2013)*, Moscow, Nauka 2013.
3. L.E.Zaichik, Y.P. Yashin, P.A. Desyatnik, V.S. Perebatov and K.N. Grinev, “Handling Quality of Aircraft Equipped with Sidesticks”, AIAA “Aviation – 2014”, Atlanta GA, June 16 – 20, 2014.
4. M.D. Pavel, M. Jump, P. Masarati, L.E. Zaichik, B. Dang-Vu, H. Smaili, G. Quaranta, O. Stroosma, D. Yilmaz, M. Johnes, M. Gennaretti, A. Ionita, “Practices to identify and prevent adverse aircraft-and-rotocraft-pilot couplings - A ground simulator perspective”, *Progress in Aerospace Sciences*, vol. 77, August 2015, pp.54-87.
5. S.A.E. Nooij, M. Wentink, H. Smaili, E.L. Groen, L.E. Zaichik, “Motion Simulation of Transport Aircraft in Extended Envelopes: Test Pilot Assessment”, *Journal of Guidance, Control, and Dynamics*, 2017, vol.40, No.4, pp.776-788.

4.1.14.3 Relevant Previous Projects

Name	Description	Reference
SUPRA FP7	SUPRA (Simulation of UPset Recovery in Aviation): developed advanced simulator models to reproduce extreme upset conditions (including aerodynamic stalls) of transport aircraft in ground-based flight simulators.	https://cordis.europa.eu/project/rcn/92296_it.html

Name	Description	Reference
ARISTOTEL	ARISTOTEL (Aircraft and Rotocraft Pilot Couplings – Tools and Techniques for Alleviation and Prevention) aimed to support the European endeavor to reduce the rate of aviation accidents by tackling the area of A/RPC suppression and prevention. The project developed advanced pilot and rotocraft/aircraft simulation models, including neuromuscular system dynamics, extended and improved the current criteria for A/RPC prediction.	http://www.aristotel-project.eu

4.1.14.4 Major Infrastructure

TsAGI has a fleet of flight simulators of different architecture, including a 6DoF Full Flight Simulator PSPK-102 with extended travel capabilities, flexible architecture to imitate all types of aircraft automation and flight information (flight displays, various formats of navigation displays, etc.); different types of control inceptors (column/wheels, sidesticks, center sticks, pedals) loaded with electrical loading system which allows variation of the feel system characteristics in a wide range.

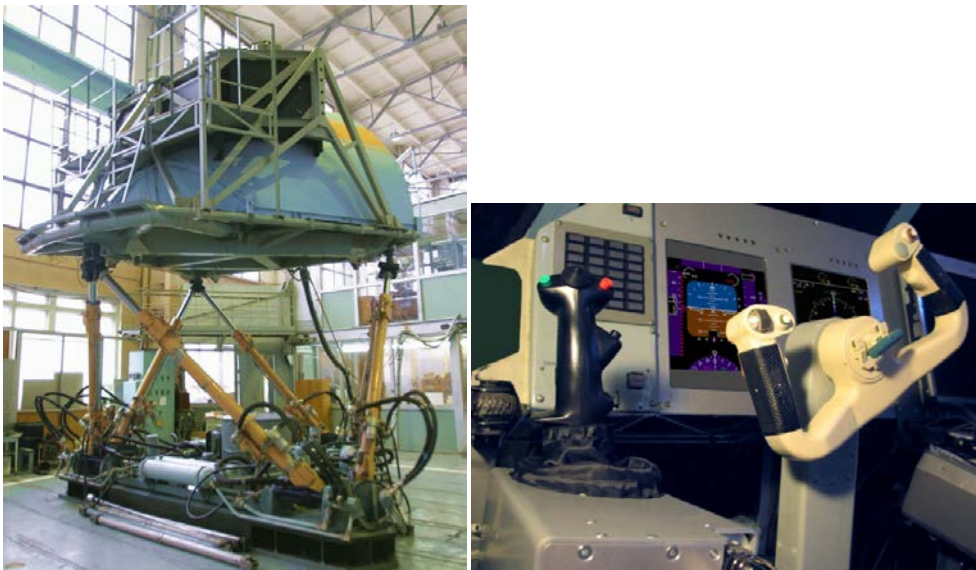


Figure 25 TsAGI fleet of flight simulators

The PSPK-102 flight simulator started operating in 1983 with studying handling qualities of Russian space-shuttle “Buran”. Since 1990 it is used for studying HQ of every transport aircraft developed in Russia, and for some methodological experiments, such as motion cues reproduction. The simulator was used also for experiments conducted under the contracts with DERA, UK (1997-2000) and The Boeing Commercial Airplanes, USA (2001-2008), as well as in some European FP projects (SUPRA, ARISTOTEL).

PSPK-102 flight simulator has a 6-DoF motion system of a synergistic type. The motion system consists of six actuators with hydrostatic bearings. The actuator's stroke is 1.8 m. The maximum values of displacement, velocity and acceleration in this motion system for each degree of freedom respectively are shown in Table below.

	Travel, <i>m, deg</i>	Velocity, <i>m/sec, deg/sec</i>	Acceleration, <i>m/sec², deg/sec²</i>
Surge	±1.75	1.5	7
Sway	±1.475	1.3	7

Heave	± 1.23	1.1	8
Roll	± 35.1	30	230
Pitch	± 37.8	30	230
Yaw	± 60	50	260

4.1.15 STATE RESEARCH INSTITUTE OF AVIATION SYSTEMS

State Research Institute of Aviation Systems (GosNIIAS) is one of the leading research organizations in the field of aeronautics in Russia. Established in 1946, the Institute conducts applied research and participates in the development of future aviation systems and their components, including algorithms and software development, integration and testing. Main GosNIIAS research technologies are all level system simulation (mathematical, hardware-in-the-loop, physical), full-scale testing, hardware-in-the-loop simulation system development, special-purpose computer technologies and hardware/software certification. GosNIIAS actively cooperates with foreign companies and organizations and since 2008 participates in research projects according to European Framework Programmes. As a partner, GosNIIAS has contributed to FP7 projects SCARLETT and ASHLEY developing application algorithms and software.

4.1.15.1 Key personnel

- **Nikolai Selvesiuk (M)** Deputy Director General. PhD in Engineering (2002), Doctor of Engineering (2006). Professional experience: Optical sensors, control systems, navigation and surveillance systems, mathematical modelling, data fusion algorithms.
- **Valentin Zlatomrezhev (M)** Head of laboratory, Indication and Training Systems Professional experience: Aircraft Systems mathematical modelling, Aircraft training device design, Aircraft prototyping, Human-machine interface.
- **Eugene Zybin (M)** Head of laboratory, Analytical Center of Aviation Technology Development Programs Support. PhD in Engineering (2003), Doctor of Engineering (2016). Professional experience: System integration and verification, aircraft safety and security, navigation and surveillance systems, mathematical modelling.
- **Andrey Nikanorov (M)** Lead engineer, Laboratory of Indication and Training systems. Professional experience: Human-Machine Interaction, Human Performance, Aircraft Systems mathematical modelling, Aircraft training device design, Aircraft prototyping, Flight Warning System.

4.1.15.2 Publications

1. Gabdrakhmanov A.Sh., Korsun O.N. (2017). The experimental research of the way acoustic noise influences speech characteristics. The European Proceedings of Social & Behavioural Sciences EPSBS. P. 113–120.
2. Korsun O.N., Poliev A.V. (2016). Automated definition of phonetically homogeneous sections of words in a natural language based on multiparameter optimization. Journal of Computer and Systems Sciences International. Vol. 55. No. 4. P. 609–618.
3. Evdokimenkov V.N., Krasil'shchikov M.N., Om M.H., Korsun O.N., Sebyakov G.G. (2017). Individually-adapted control and support of pilot's control actions based on neural network models. Procedia Computer Science "2th International Symposium Intelligent Systems, INTELS 2016". P. 126–134.
4. Vizilter Y., Rubis A., Vygolov O., Zheltov S. (2018) Vision-based change detection using comparative morphology. Intelligent Systems Reference Library. Vol. 135. P. 65–96.
5. Vizilter Yu.V., Gorbatshevich V.S., Vorotnikov A.V., Kostromov N.A. (2017). Real-time face identification via multi-convolutional neural network and boosted hashing forest. Deep Learning for Biometrics "Advances in Computer Vision and Pattern Recognition", Cham, Switzerland. C. 33-55

4.1.15.3 Relevant Previous Projects

Name	Description	Reference
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Name	Description	Reference
Virtual Prototyping of Aircraft MC-21	Virtual Prototyping of Aircraft MC-21 (Irkut Company) Russian single-aisle twinjet airliner: Mathematical models of all aircraft systems; Display Indication system; Virtual control panels; Operational station	
Flight Procedure Training Device	Research and Development of a Flight Procedure Training Device and Mathematical models for Sukhoi Superjet Aircraft (Russian project in cooperation with Thales).	
IL-96 M/T aircraft on-board equipment	<p>Research projects in the frame of the Russian Federal Research Program:</p> <ul style="list-style-type: none"> • Usage and interface of touch screens in cockpit • CAD for Control panel design • Eye Tracking researches <p>The IL-96 M/T aircraft on-board equipment was developed in the boundaries of GosNIIAS - Rockwell Collins (US) partnership.</p>	

4.1.15.4 Major Infrastructure

State Research Institute of Aviation Systems (GosNIIAS) is based in Moscow. Involved in this project department “Advanced systems and Integration of avionics” has more than 200 high qualified employees. GosNIIAS hosts 2 libraries and internal servers. In GosNIIAS there are various research benches for different kind of aircraft and different proposes. With reference to SAFEMODE, the most useful for research could be next benches and tools:

- Aircraft Cockpit Universal Prototyping Bench (picture)
- Microsoft HoloLens - a holographic computer and head-mounted display. (Augmented reality)
- HTC Vive – Virtual Reality head mounted display
- Eye-tracking system (see picture)

Based on long experience in designing HMI and avionics systems, GosNIIAS has developed methods and tools for avionics systems design (including cockpit). We also use ANSYS SCADE products for displays interface design.



Figure 26 Aircraft Cockpit Universal Prototyping Bench

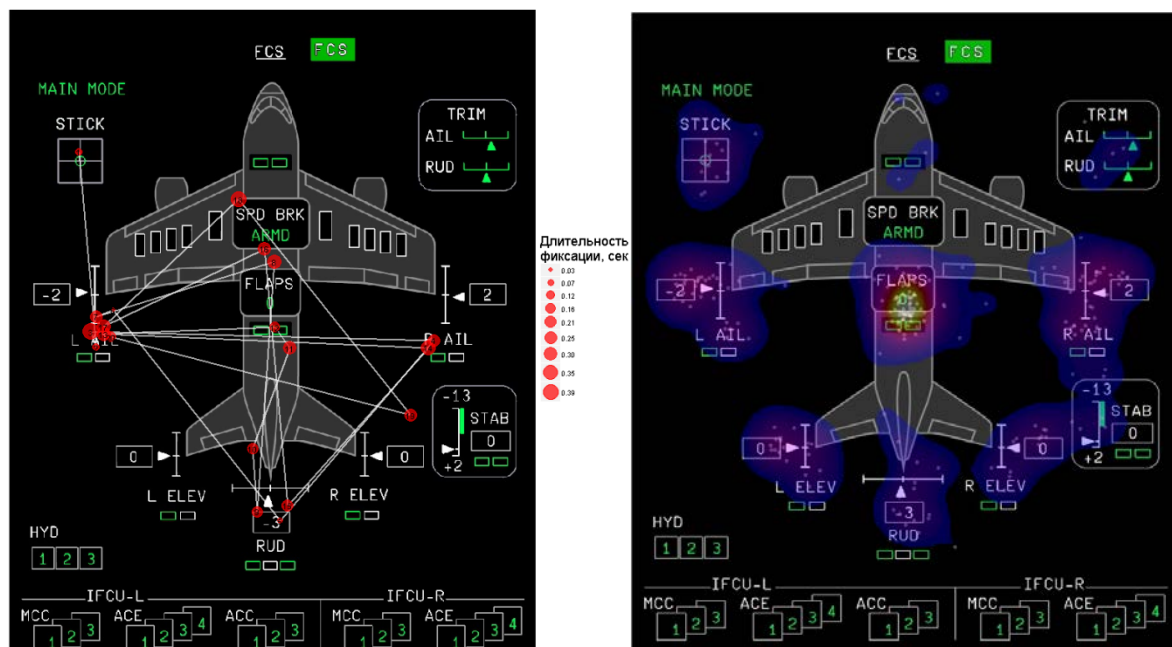


Figure 27 Eye tracking for Flight Controls System Synoptic Page

4.1.16 STATE EDUCATIONAL INSTITUTION OF HIGHER PROFESSIONAL EDUCATION MOSCOW AVIATION INSTITUTE STATE TECHNICAL UNIVERSITY

MAI is a world-known and biggest university in Russia in the field of aerospace training. Since the foundation of MAI (1930) more than 160 000 professionals have graduated. More than 70% of MAI graduates work for industry-based corporations. MAI holds the record among universities in the quantity of graduates who have become space and test pilots. There are 23 pilot-cosmonauts who spent more than 15 years performing space missions. The total number of alumni is 160 000. The total number of students including foreign students is 22 000. Faculty staff – 1800. The institute is engaged in all major partnership projects. It also cooperates with leading Russian and foreign industry-based corporations such as Comac, ENAC, Safran, BranMos aerospace, HAL, JSC, “United aircraft corporation”, Roscosmos and others. The highest priority scientific areas are: aviation systems; space and rocket systems; power systems; IT; new materials and manufacturing technologies; diversification of aerospace complex technology application. MAI technopark: R & D amount (1,5 billion dollars per year); Scientific and research laboratories and centers (140+); Student design bureau (5); Mission control center; Experimental plant; Airdrome; Business Development Center The major activity areas of MAI are the flight safety and human factors. In the frame of such activities a number of courses are given to the students:

- Man-machine systems
- Flight safety
- The investigation of flight accidents
- The methods of experimental investigation and facilities used for pilot-vehicle research.

The researches in these areas were carried out at MAI aeronautical school in its pilot-vehicle lab PVL for many years. The main aspects of the research are the fundamental regularities of pilot behavior, the methods for identification of pilot responses characteristics, the mathematical modeling of pilot behavior, the flight control system and its interfaces (display, manipulators) design with taking in to account the effectiveness of the piloting mission and flight safety. The MAI PVL had a number of contracts with different Russian industrial companies (MiG, Sukhoi, TSAGI, Flight research institute) and was involved in research programs of the Ministry of science and education, Academy of science Ministry of industry and trade. During the last 20 years, the lab has got a number of contracts with different foreign organizations. As an example, the contract with Wright lab (US Air Force) USA on investigation of pilot induced oscillations and development of criteria for its prediction, contract with ONERA (France) on development of workstation for experimental investigation of manual control tasks, contract with Aerospaciale (France) on study aircraft-pilot –coupling problem and its suppression for different Airbus airplanes, contract with AVIC China on PIO tendency investigation for the Chinese transport aircraft; the joined project with MIT (sponsored by Skolkovo) on human space exploration. The MAI part of research was dedicated to the development of the predictive display for the space docking mission with ISS. The development technique for the man-machine system design is applied now for the display and flight control system of the novel generation of spacecraft “Federation”. During the last 8 years the lab participated in flight safety studies of the novel Russian airplanes Sukhoi Superjet airplane, and MS-21. In 2009-2011 and in 2016-2017 the lab received mega grant from the Ministry of Science and Education on development of ground based simulator with stereoscopic visual system and novel helmet display providing the considerable improvement of the effectiveness of flight safety in different manual control tasks.

4.1.16.1 Key personnel

- **Prof. Aleksandr Efremov (M)** Prof. Efremov graduated from Moscow Aviation Institute (MAI) – engineer (1968), Ph.D. (1973), Doctor of science degree 1996. All degrees were received from MAI. Post Doc at Massachusetts Institute of Technology (1976 – 1977). Areas of scientific interest: Dynamics of flight and control, man-machine system, simulators, pilot behavior. Areas of teaching: Dynamics of flight, flight control system, man-machine system, simulators, flight safety. Experience: Engineer at MIG aircraft design company (1968) MAI aeronautical school faculty since 1971; Research fellow at MIT pilot-vehicle lab 1976-1977. The director of pilot vehicle lab of MAI since 1985. Head of dynamics of flight and control department since 1999. Dean of MAI Aeronautical School since 2007. Consultancy work: Consultancies in the form of short professional

courses. MIT (USA, 1991, 2009, 2011, 2012, 2013), ONERA (1993), NLR (Holland, 1995), Delft University (1995), Wright Patterson USAF (USA, 1993), FAI, BUAA (China, 2001, 2010, 2012), Mexican Polytechnic Institute (1998), ShenYang Aircraft Design and Research Institute, the P.R.China (2001), DLR (2007, 2009, Germany), Munich Tech University (2009). Professional esteem indicators: Honorary professor of Russian higher Education. European Engineering educator ING-PAED IGIP. The title “Professor of the year” (2018). Externally funded research grants and contract information: Russian Ministry of Higher Education and Science, Grant (2010-2012). Russian Ministry of Higher Education and Science, Grant (2013-2015). Scolkovo Foundation the Grant (2014-2015). Russian fund for basic research (2014-2016). Federal Research program of Russian Ministry of Science and Education (2014 – 2016). Contracts from different Russian organizations MiG, Suhoi, TSAGI, TSII MASH, Flight Research Ins, Irkut etc. Contracts for research from foreign organizations USAF (USA, 1994, 1996), ONERA (France, 1996) Aerospaciale (France, 1997), Aerospace Industry Co. (Poland, 1998), FAA (China, 2011-2014). Publications: The author of more then 240 papers and reports, 2 text books, 2 monographs. Membership of professional associations committees and societies: SAE-IEEE USA committee on Aerospace Guidance and Control systems (ACGSC) since 2000. NATO/RTO group on integration of the vehicle system 2003-2007. Member of International CEAS EURO GNS Technical Committee since 2010, Member of Editorial Board of the scientific journals – “Scientific notes of TSAGI”; “MAI Aerospace journal”; “MAI notes”, “Russian Aeronautics”

- **Dr. Mikhail Tiaglik (M)** Dr Tiaglik graduated from MAI in 2008 associate professor Ph. D received in 2011. Expert in head up and helmet mounted, display design, pilot psychophysiological characteristics, development of ground based simulators, had a flying experience as a civilian pilot. Lecturer in man machine system, manual control courses, the Head of flight practice for the MAI students. He participated in 12 projects on different aspects of man-machine system investigation, was responsible for the work on two megagrants dedicated to the development of simulators with stereoscopic visual system and helmet display
- **Dr. Yury V. Tiumentsev (M)** Dr. Tiumentsev graduated from Moscow aviation Institute (1971), Doctor of Sciences in System Analysis, Control, and Information Processing the Moscow Aviation Institute (National Research University). D.Sc. Thesis: “Neural network modeling of adaptive dynamic systems.” (2016). The area of scientific interest and teaching: flight mechanics and control; adaptive control; computer science; soft computing; artificial intelligence; artificial neural networks; computer-aided design; machine learning, artificial neural networks, adaptive systems, intelligent control, mathematical modeling and computer simulation of complex systems, advanced information technologies. Publications: the monograph titled “Neural network modeling of aircraft motion” (2016, in Russian), more than 130 articles, published in 1973–2017, related to research subjects mentioned above; about 50 reports on conferences (including international ones). Members of professional associations committees and societies: Vice-President of the Russian Neural Network Society, Vice-Chairman (Co-Chairman since 2002) of the Organizing and Program Committee of the Annual All-Russia (International, since 2015) Scientific and Engineering Conference “Neuroinformatics”, Chairman of the Special Tutorial Session “Modern Problems of the Neuroinformatics” at the “Neuroinformatics” Annual Conference associated with soft computing methods and their applications, A member of the Scientific Committee and a publication reviewer of the ICAISC (International Conference on Artificial Intelligence and Soft Computing) biennial conferences (since 2005), Publications reviewer for the International Joint Conference on Neural Networks (IJCNN), International Conference on Artificial Intelligence and Soft Computing (ICAISC), IEEE Symposium Series on Computational Intelligence (SSCI) (since 2006), Biologically Inspired Cognitive Architectures (BICA) Conference (since 2015) and for some, magazines including IEEE Transactions on Neural Networks and Learning Systems (since 2013), Journal of Artificial Intelligence and Soft Computing Research (since 2015), Russian, Aeronautics (since 2010); An expert of the Federal Target-Oriented Program "Research and development in the priority

areas of the scientific and technological complex of Russia for 2014-2020" (since 2015) carried out by the Ministry of Education and Science of the Russian Federation; Chief Editor of the "Adaptive and Intelligent Systems" Book Series issued by the "Fundamental Knowledge Laboratory" Publishers Moscow); Translator and editor of information publications ("Aircraft Engineering", "Astronautics and Rocket Dynamics", "Rocket Engineering and Space Technology", "Military Aviation, Rockets, and Space Technology" magazines) at the All-Russia Institute for Scientific and Engineering Information (VINITI); Book translator at the "Mir" Publishers (3 books); Book translator and editor for the "Adaptive and Intelligent Systems" Book Series at the Fundamental Knowledge Laboratory" Publishers (5 books).

4.1.16.2 Publications

1. Review of control models for human pilot behavior. Xu, S., Tan, W., Efremov, A.V., Sun, L., Qu, X. 2017 Annual Reviews in Control 44, c. 274-291
2. Pilot behavior modeling and its application to manual control tasks. Efremov, A.V., Tjaglik, M.S., Tiumentzev, U.V., Wenqian, T. 2016 IFAC-PapersOnLine 49(32), p. 159-164
3. The ways for improvement of agreement between in-flight and ground-based simulation for evaluation of handling qualities and pilot training. Efremov, A.V., Koshelenko, A.V., Tjaglik, M.S., Tjaglik, A.S. 29th Congress of the International Council of the Aeronautical Sciences, ICAS 2014
4. Encyclopedia "Systems and control", Efremov A.V. (coauthor), Springer, 2014
5. Adaptive gateway element based on a recurrent neurodynamical model characteristics. Prostop Yu.S., Tiumentsev Yu.V. // Advances in Neural Computation, Machine Learning, and Cognitive Research, Studies in Computational Intelligence Vol. 736, B. Kryzhanovsky et al. (eds.) – Springer Nature, 2018. – pp. 33–38. ISBN 978–3–319–66603–7

4.1.16.3 Relevant Previous Projects

Name	Description	Reference
Project WL-TR-96-3109 "INVESTIGATION OF PILOT INDUCED OSCILLATION TENDENCY AND PREDICTION CRITERIA DEVELOPMENT"	Investigation of pilot-induced oscillation tendency prediction criteria development. The project is a part of a contract given by US AF for the Russian organization – MAI, TSAGI, FRI on the investigation of PIO. In the frame of this project, MAI modified the optimal control model of pilot behavior for improvement of the agreement with the experimental results for the wide range of controlled element dynamics and develop the criteria for the aircraft flying qualities and pilot induced oscillation tendency predictions.	www.dtic.mil/get-tr-doc/pdf?AD=ADA322290
Project SPC-96-40-73 "DEVELOPMENT OF CRITERIA FOR PREDICTION OF HANDLING QUALITIES"	<i>There are analyzed the criteria used for flying qualities (FQ) prediction. The technique for evaluation of flying qualities by use the piloting rating was developed. There are defined the relation between pilot-rating and Flying qualities parameter. The ground based simulation was carried out for HAVE PIO data base of configurations. It allowed to modified criteria for prediction of flying qualities and PIO tendency in angular control tracking task. Except the other criterion for evaluation of flying qualities in refueling task was developed too. The both criteria demonstrated high potentialities in prediction of PIO and FQ.</i>	www.dtic.mil/get-tr-doc/pdf?AD=ADA333344

Name	Description	Reference
OF NEW GENERATION OF AIRCRAFT”		
STEREO SV 2009-2011	the mega grant received from Russian Ministry of science and education for the development of a ground based simulator with stereoscopic visual system. It was a joined project with MIG company. The main purpose of the simulator is the investigation of the different manual control tasks and piloting mission. In particular, such missions where the stereoscopic effect of the human perception influences considerably on the pilot’s actions (refueling, hovering task, last stage of landing (flare), docking of the spacecraft with the International Space Station etc.). The simulator was demonstrated at a number of international exhibitions; Mosaviashow, Paris, Bangalore).	
MNS-project 2016-2017	The mega grant received from the Russian Ministry of science and education for the development of a novel helmet-mounted pilot display system. The peculiarity of the developed system in the predictive information of the path motion generated on display and potentiality to extend the number of piloting tasks (landing, refueling, etc.) were the predictive path information that gives the improvement of accuracy up to 2 – 2.5 times and decreases pilot workload considerably.	

4.1.16.4 Major Infrastructure

The MAI PVL has three ground-based simulators. All of them have a computer generated visual system. One of them has 60deg angle of view, the second has collimator system with 120 deg. angle of view and the third (with stereoscopy visual system) – 180 deg. angle of view. The first and the second simulator have the motion system, which are used for investigations of motion cues effects on operators’ responses characteristics. The lab also has two workstations for the manual control area research.



Figure 28 Ground-based simulators, with 60deg angle of view (left) and 120 deg angle of view (right)



Figure 29 Flight Simulator with stereoscopy visual system – 180 deg angle of view (left) and two workstation for the manual control area research (right)

4.1.17 JOINT STOCK COMPANY INNOVATIVE TECHNOLOGIES CONCERN (JSC ITC)

JSC ITC is a part of the Dinamika group of companies (one of Russia's leaders in the development, manufacturing and after-sale support of flight simulators). JSC ITC is the enterprise, developing industrial robot based specialized flight simulators. Technical specialists of JSC ITC are studying the possibility to use alternative systems of motion of flight simulators in order to reduce their cost and increase availability for small flight training centers and schools. Another direction of development is the creation of unmanned aircraft (drones), in particular the type of tiltrotor aircraft. Several of the most experienced aviation specialists, doctors and candidates of technical Sciences, who passed the school of design and flight tests of the most modern and high-tech aircraft complexes, such as SSJ 100 Superjet, Space Shuttles and many others, are involved in the work for JSC ITC.

4.1.17.1 Key personnel

- **Dr. Dmitry Pochkaenko (M)** Dr. Pochkaenko is a chief designer of JSC ITC. As a member of the CSTS Dinamika in 2010 – 2013 he provided technical guidance on the development of such simulators as Ka-52 Full Mission Simulator SuperJet and SSJ-100 Full Flight Simulator (which is installed in the Training Center of the Ulyanovsk Higher Civil Aviation School). Currently he manages the Department of training systems of JSC ITC and the development of aircraft simulators based on the KUKA industrial robots.
- **Dr. Sergey Studnev (M)** Dr. Studnev is a leading project manager of JSC ITC. Having been working in TsAGI, he participated in the development of manual and automatic control systems of aircraft, including VKS Buran. Currently he coordinates the development and implementation of flight simulators based on the KUKA KR 1000 Titan industrial robot-manipulator.
- **Pavel Desyatnik (M)** Pavel Desyatnik graduated from Moscow Power Engineering Institute in 2004. He works at JSC ITC on a half-time basis since the moment of its foundation in 2014 and takes up the post of senior engineer. At present he concentrates on use of Robot KUKA KR 1000 Titan as a motion platform for studying critical flight modes such as upset/stall and recovery. Since his work is tightly connected with TsAGI, his scientific interest includes: Theoretical and experimental methods to study aircraft handling qualities of modern highly-augmented aircraft; Methods to optimize aircraft dynamic performance, control sensitivity, and manipulator feel system characteristics; Methods of on-ground flight simulations including effect of motion cues, cockpit drive algorithms, motion simulation fidelity. Pavel Desyatnik is an author of 20 papers in Russian and foreign scientific journals.

4.1.17.2 Publications

1. Andrey Bushgens, Dmitry Pochkaenko, «What is this KUKA thing?» FORUM Magazine, 01'(19) 2017, pp. 20-22 (in Russian);
2. Desyatnik, P.A., Zaichik, L.E., Yashin, Y.P. Providing optimum lateral static stability margin of highly augmented aircraft. 58th Israel Annual Conference on Aerospace Sciences, IACAS 2018. 2018-March, pp. 1615-1630.
3. Desyatnik, P.A. Optimization of directional handling qualities of highly augmented aircraft. *Aerospace MAI Journal*. 2017, Vol. 24, No. 1, c. pp. 83-95.
4. Desyatnik, P.A., Zaichik, L.E., Zhelonkin, V.I., Zhelonkin, M.V., Tkachenko, O.I., Yashin, Y.P. Effects of the flight simulator motion on the simulation fidelity of aircraft in refueling task. *Aerospace MAI Journal*. 2017, Vol. 24, No. 2, c. pp. 86-94.
5. Desyatnik, P. Criterion to select optimum values of aircraft lateral static stability margin in landing approach. *TsAGI Science Journal*. 2015, Vol. 46, No. 7, pp. 671-686.

4.1.17.3 Relevant Previous Projects

Name	Topic	Relevance	Reference
KUKA-INNOTECH	Study of the possibility of using the KUKA KR 1000 Titan industrial robot–manipulator as a flight simulator motion system	Pilots are usually taught and trained on hexapod systems before undertaking real training flights. The disadvantage of these systems is their price, ranging between 7 and 25 million euros, making them too expensive for smaller flying schools. A simulator mounted on an industrial robot would take these costs down to about one million euros. This cycle of the study of KUKA KR 1000 Titan industrial robot–manipulator with a test payload provided for the measurement of the basic characteristics that determine the quality of the robot based system of motion as a tool for simulation of linear and angular accelerations, namely the amplitude-phase frequency characteristics and nonlinearity aspects.	http://www.dinamika-avia.ru/mcenter/forum/detail.php?id=2950
KUKA-Pilot Simulator	Development of the flight simulator based on KUKA KR 1000 Titan industrial robot–manipulator	The general target of this investigation is to develop an enhanced, cost effective flight simulator that can be used for learning and training HF aspects for difficult flight situations, such as pilot behaviour in the stalling of the aircraft or a loss of spatial orientation.	http://www.dinamika-avia.ru/mcenter/forum/detail.php?id=2950

4.1.17.4 Major Infrastructure

The Department develops research flight simulators designed to study the features of the HF in the control of a plane or a helicopter in difficult flight conditions (at critical angles of attack, in the modes of refueling in the air, etc.). Currently, a flight simulator for investigation of pilot spatial disorientation medical aspects is being developed. Production of the first flight simulator of this type is scheduled for 2019.

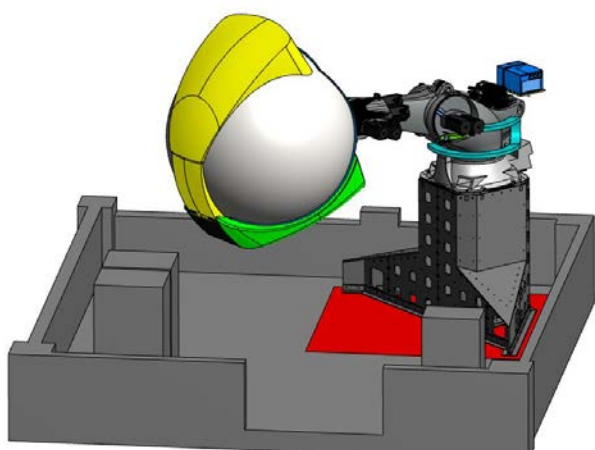


Figure 30 Department develops research flight simulators

The Department develops unmanned aircraft (drones), in particular the type of tiltrotor aircraft. Specialists of JSC ITC together with the Zhukovsky Central AeroHydrodynamic Institute continue researching the mockup of light tiltrotor aircraft. This advanced aircraft combines the advantages of a helicopter (the possibility of vertical take-off and landing) and an aircraft (speed, range and flight duration). It is designed for monitoring

of the underlying surface, solving transport problems. The UAV is capable of being based on unarmed small sites and can be used in various industries in the future. The experiments were carried out under a government contract with the Ministry of Industry and Trade of Russia using TsAGI's low-speed wind tunnel. Scientists studied the aerodynamic characteristics of the mockup with modified controls for the cruising, take-off and landing configurations of the wing and empennage. The research was aimed at improving effectiveness of the controls.

4.1.18 MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY (STATE UNIVERSITY)

4.1.18.1 Key personnel

- **Maxim KUDROV (M)** graduated from Moscow Institute of Physics and Technology (MIPT) in 2007 and obtained his PhD in Physics and Mathematics from MIPT (2010). He is the Dean of Department of Aeromechanics and Flight Engineering in MIPT and docent of Chair for General physics in MIPT. Maxim Kudrov is a specialist in the field of multiphase flow, aerodynamics. Under the leadership of the dean, more than 20 research projects were carried out, the faculty participated in 4 international projects. The development of the flight safety school at the Faculty of Aeromechanics and Flight Engineering in MIPT is one of the most demanded and interested task.

4.1.18.2 Publications

1. V.V. Vyshinsky, M.A. Kudrov, K.A. Zudov. **Flight safety in airport vicinity with mountainous landscape.** APACM Thematic Conference & IACM Special Interest Conference COMPSAFE 2014 Computational Engineering and Science for Safety and Environmental Problems 13-16 April 2014/Sendai International Center, Sendai, Japan 11F-2, p. 768-771.
2. V.V. Vyshinsky, K.A. Zudov, M.A. Kudrov, Yu.S. Mikhaylov. **Aerodynamic characteristics of an aircraft during take-off and landing at mountain airport conditions.** International Forum of Leading Aerospace Universities. Aerospace University of the Future. 22-24 May 2014. Berlin Papers, pp. 85-93.
3. V.V. Vyshinsky, K.A. Zudov, M.A. Kudrov. **Flight safety in airport vicinity with mountainous landscape.** International Forum of Leading Aerospace Universities. Aerospace University of the Future. 22-24 May 2014. Berlin Papers, pp. 94-98.
4. V.V. Vyshinsky, M.A. Kudrov, K.A. Zudov. **Physical Processes in the Atmosphere Acting on the Turbulent Background and Flight Safety.** APACM Thematic Conference & IACM Special Interest Conference COMPSAFE 2014 Computational Engineering and Science for Safety and Environmental Problems 13-16 April 2014/Sendai International Center, Sendai, Japan 11F-4, p. 776.

4.1.18.3 Relevant Previous Projects

No previous international projects connected to the subject of this proposal.

4.1.18.4 Major Infrastructure

- A. **Supercomputers** with different capacities, up to 83,14 TFLOPS
- B. Number of CPUs / cores - 448/3584
- C. Nodes: 224 (2xXeon E5-2690 2.9 GHz 64 GB RAM)
- D. Network: Infiniband QDR / Gigabit Ethernet

4.1.19 DE MONTFORT UNIVERSITY

De Montfort University (DMU) is a leading research-oriented university in the UK with approximately 21,300 students, 2,950 staff, and an annual income in the region of £181 million. Based in Leicester, in the heart of England, DMU offers the perfect combination of award-winning teaching and world-class facilities. DMU has been recognised as a university ranked Gold under the Teaching Excellence Framework (TEF). The award provides recognition of the outstanding teaching and learning on offer at DMU and the extraordinary impact it has on the students. DMU is renowned for the quality and breadth of its research, with much done in conjunction with industry partners. DMU's growing reputation for research which benefits society has been confirmed with the publication of the REF 2014 results. Almost

60% of DMU's research activities were judged to be world-leading or internationally excellent in the REF, the UK-wide initiative to assess the quality of research in UK universities. For the second year running the university has been named as one of the 150 best young universities in the world by Times Higher Education. DMU was also named among the top 50 institutions in the world formed between 1986 and 1999. DMU has a long established track record in the successful delivery of multi stakeholder research and commercial projects, to date DMU has participated in more than 40 FP7 and H2020 projects. In the area of aeronautics DMU research team has a unique expertise in aerodynamics, flight dynamics and flight simulation of critical flight regimes in extended flight envelope characterised by onset of separated flow conditions. Data from experimental and computational predictions in combination with the developed principles of phenomenological aerodynamic modelling are used for simulation of Loss-of-Control In flight (LOC-I) situations. DMU was leading the work package in the EU FP7 research project SUPRA ('Simulation of Upset Recovery in Aviation'). The developed aerodynamic model SUPRA is now effectively used on the centrifuge based flight simulator DESDEMONA at TNO, The Netherlands for training pilots to prevent and recover from upsets. Recently, collaboration with AMST Systemtechnik GmbH, Austria, DMU has developed all-configuration aerodynamic model with extended flight envelope for new AIRFOX UPRT flight simulator, which is dedicated for LOC-I pilot training. To support research activities in the area of critical flight regimes has been established in 2012 a joint research group in "Nonlinear Flight Dynamics" between DMU and TsAGI.

4.1.19.1 Key personnel

- **Prof. Mikhail Goman (M)** is a recognized expert in nonlinear flight dynamics and unsteady aerodynamics modelling at high incidence flight conditions. During his career in TsAGI (1972-2002) he was involved in a number of national and international projects with investigation of high angles of attack flight dynamics, for example, the well-known Cobra maneuver. He has significantly contributed to computational methods for nonlinear flight dynamics and phenomenological modelling of unsteady aerodynamics at high angles of attack (known as 'Goman-Khrabrov model'). He was awarded Zhukovsky Gold medal (the highest aeronautical award established in Russia in 1922). In 1997-2000 he was awarded DERA, UK Research Fellowship, and since 2000 he is Professor at the Faculty of Technology at DMU. He was leading the development of extended aerodynamic model SUPRA in the EU FP7 research project of the same name. This followed by the next collaborative project with AMST Systemtechnik, Austria for the development of all-configuration extended envelope aerodynamic model for AIRFOX UPRT flight simulator. Prof. Goman is involved in international collaboration activities and consultancies with many aeronautical research centers and institutions.
- **Dr. Nikolay Abramov (M)** has graduated from the Moscow Institute of Physics and Technology (MPhT), Faculty of Aeromechanics and Flight Technology in 1998. He received Ph.D. degree in aerospace engineering from DMU in 2005. His special research interests are focused on phenomenological modelling of unsteady nonlinear aerodynamics at high incidence flight and identification of aerodynamic models from wind tunnel and flight tests data. His contribution in this area is reflected in many AIAA and RAeS publications. He was a key developer of the SUPRA model and the new all-configuration extended aerodynamic model for a transport aircraft installed on the AIRFOX UPRT flight simulator designed and built by AMST Systemtechnik, Austria.
- **Mr. Mohamed Sereez (M)** has completed his PhD research project at DMU under supervision of Prof Mikhail Goman and has already submitted his PhD Thesis "Prediction of Aircraft Aerodynamic Characteristics in Extended Flight Envelope using CFD Methods". As a teaching assistant he was involved in a research-informed undergraduate teaching of Mechanical Engineering students, supervising the Final Year Research projects in CFD aerodynamics prediction for extended flight envelope. After completion of the PhD course he continues connection with DMU in a role of post doc research fellow.

- **Mr. Vladimir Birukov (M)** is a high rank test pilot, having experience in piloting LOC-I critical conditions on different types of transport aircraft. He participated in the EU FP7 research project SUPRA and significantly contributed in tuning of the key SUPRA model parameters, which allowed successful validation of the SUPRA model in extended flight envelope with engagement of many test and line pilots. Vladimir Birukov will be involved in the SAFEMODE project as a visiting expert at DMU.

4.1.19.2 Publications

1. M. Goman and A. Khrabrov. "State-space representation of aerodynamic characteristics of an aircraft at high angles of attack", Journal of Aircraft, Vol. 31, No. 5 (1994), pp. 1109-1115. <https://doi.org/10.2514/3.46618>
2. N. Abramov, M. Goman, and A. Khrabrov (2004) "Aircraft Dynamics at High Incidence Flight with Account of Unsteady Aerodynamic Effects", AIAA Atmospheric Flight Mechanics Conference and Exhibit, Guidance, Navigation, and Control and Co-located Conferences, <https://doi.org/10.2514/6.2004-5274>
3. N. Abramov, M. Goman, A. Khrabrov, E. Kolesnikov, L. Fucke, B. Soemarwoto, and H. Smaili (2012) "Pushing Ahead - SUPRA Airplane Model for Upset Recovery", AIAA Modeling and Simulation Technologies Conference, Guidance, Navigation, and Control and Co-located Conferences. <https://doi.org/10.2514/6.2012-4631>
4. J. Pattinson, M. H. Lowenberg, and M. G. Goman (2013) "Multi-Degree-of-Freedom Wind-Tunnel Maneuver Rig for Dynamic Simulation and Aerodynamic Model Identification", Journal of Aircraft, Vol. 50, No. 2 (2013), pp. 551-566. <https://doi.org/10.2514/1.C031924>
5. Sereez, M., Abramov, N. and Goman, M.G. (2018) "Impact of Ground Effect on Airplane Lateral Directional Stability during Take-Off and Landing". Open Journal of Fluid Dynamics, 1-14. <https://doi.org/10.4236/ojfd.2018.81001>

4.1.19.3 Relevant Previous Projects

Name	Description	Reference
The EU FP7 research project	<i>Simulation of UPset Recovery in Aviation" (SUPRA)", (2009-2012)</i>	http://www.supra.aero/
CSIR-NAL, India	<i>"Synthetic Aerodynamic Model for GTA aircraft in Extended Flight Envelope" (2013)</i>	
CSIR-NAL, India	<i>"Flight Envelope Expansion for GTA aircraft Using Active Control Approach" (2014-2015)</i>	
AMST Systemtechnik GmbH, Austria	<i>"All-configurations Flight Simulation Model in Extended Envelope for Transport Airplane" (2015-2018).</i>	

4.1.19.4 Major Infrastructure

- A. Spatial disorientation (SD) is one of the major causes of aircraft accidents especially during LOC-I and serious upsets. The available at DMU flight simulator AIRFOX DISO¹ can be used for investigation of pilot's behavioral reaction to various safety critical situations caused by LOC-I, external environmental effects and internal system failures. It can be also used for training pilots for recognition of SD and building awareness during SD situations.



Figure 31 AirFox DISO flight simulator.

B. AMST AIRFOX UPRT Flight Simulator.

Close collaboration with AMST Systemtechnik, Austria, a partner in the SAFEMODE consortium, in the development of all-configuration extended envelope flight simulation model for a transport aircraft allows us to use modifications of this flight simulation model, adapted to the objectives of the SAFEMODE project, on the AIRFOX UPRT flight simulator.

C. Joint Research Group in the area of “Nonlinear Flight Dynamics” with TsAGI.

DMU has a well-established collaboration with TsAGI, another partner in the SAFEMODE consortium. This allows us to coordinate our activities with possible access to TsAGI’s experimental facilities. DMU with TsAGI jointly developed a unique “**Computational Framework for Nonlinear Flight Dynamics**”,

which will be used in the project for systematic validation of the developed flight simulation models for use in the WP6. DMU has powerful workstations for nonlinear flight dynamics investigation and CFD simulations of aerodynamic characteristics in extended flight envelope.

4.1.20 NATIONAL TECHNICAL UNIVERSITY OF ATHENS – NTUA

The National Technical University (NTUA) is the oldest and most prestigious educational institution of Greece in the field of technology, and has continuously contributed to the country's scientific, technical and economic development since its foundation in 1836. The School's scientific staff and post-graduate researchers conduct teaching and related educational activities and research work assisted by post-graduate students and a considerable number of external collaborators. The amount and the high standards of this research are proven by the numerous publications in International Scientific Journals and Proceedings of International Conferences, as well as by the prominent place of NTUA among all European Universities, due to the increasing number of research projects financed by the EU and other Greek and foreign organizations of the public and the private sector. The establishment of the Laboratory for Maritime Transport (LMT) was officially approved by the NTUA Senate in May 2006. Since 1989, LMT functioned as a research and educational unit within the School of Naval Architecture and Marine Engineering (NA&ME), known as 'NTUA Maritime Transport'. Following Greece's rich maritime tradition, LMT is active in practically all areas of maritime transport R&D and provides a link to educational activities by being fully active in the School's undergraduate and post-graduate educational programs. NTUA-LMT has substantial experience in the design, development and simulation of maritime and intermodal transport, marine environmental protection, safety and human factors analysis, risk analysis, cost-benefit analysis, financial analysis, optimisation of logistical systems, lifecycle cost analysis, business process modelling, and dissemination activities. LMT has completed or is involved in projects in areas such as technology, management, economics, logistics, telematics, human-related aspects, environment, and safety. It has also been involved in projects and studies with a substantial policy analysis element. Research projects in which NTUA-LMT participated include EC DG-TREN and DG-RTD projects ATOMOS, THAMES, ATOMOS II, SAFECO, SAFECO II, DISC, DISC II, PROSIT, ATOMOS IV, ADVANCES, THEMES, EVIMAR, TRAPIST, INTEGRATION, MARQUAL, MTCP, OSH, EU-MOP, FLAGSHIP, CHINOS and MOSES. NTUA-LMT has been the Coordinator of the Concerted Action on Shortsea Shipping (project SSS-CA), an FP4 DG-TREN umbrella project overseeing European R&D in Shortsea Shipping, ports, maritime logistics and intermodal transport, and in which 14 European countries participated (1995 to 2000). NTUA-LMT has also coordinated the FP6 DG-RTD project EUMOP on oil spill response (2005-2008). Among other projects undertaken by NTUA-LMT include the one from Det Norske Veritas (DNV) on effective bulk transport (with an emphasis on green logistics), and from the Hellenic Chamber of Shipping on ship air emissions. Apart from issues related to shipping operations, the LMT also examines issues related to the human factor (i.e., seafarers & passengers on board) for both routine and emergency situations. Research conducted by the Maritime Risk Group (MRG – a unit operating within the NTUA-LMT) highlighted the high impact of the human factor on reliability and resilience engineering. The MRG has significant experience in Human Centred Design (HCD), Non-Technical Skills (NTS), and issues related to stress and fatigue. Recent projects related to this call for proposals include, CyClaDes (Crew Centred Design & Operations for Ships and Ships systems) and SAFEPEC (Innovative, risk-based inspection for a smarter and safer waterborne industry).

4.1.20.1 Key personnel

- **Dr Nikolaos P. Ventikos (M)** is an Associate Professor in the Laboratory for Maritime Transport at the School of Naval Architecture and Marine Engineering (NA&ME) of the National Technical University of Athens (NTUA), Greece. He is also the Head of the Maritime Risk Group (MRG). His expertise, relevant to this project, is in marine safety; risk analysis/assessment and risk engineering; human factors and human reliability; Crew-Centred design; lifecycle analysis and design; resilience engineering; technology assessment; aspects of salvage engineering (e.g., oil removal from ships in distress, or wrecks, and preliminary analysis/feasibility of wreck removal); maritime security; ship recycling; maritime sustainability; safety analysis; data mining and statistical, probabilistic and risk modelling. During his presence at NTUA, he has participated in several major research projects in the areas of fleet/ship generated pollution, environmental protection and antipollution operations, marine safety, maritime transport and systems, marine salvage, safety analysis and technology assessment. He has coordinated the project of Green Footprint of Maritime Transport (Envishipping) and has also participated in and coordinated (during its last administrative phase) the Supporting EU's Freight Transport Logistics Action Plan on Green Corridors Issues (SuperGreen) project. Dr

Ventikos was awarded the G.P. Livanos Grand Prize on Environmental Issues sponsored by the Hellenic Nautical Chamber (2000), his Ph.D. dissertation was nominee for the Environmental Award sponsored by the Union of Greek Shipowners (2002) and he is an active faculty member of the Laboratory for Maritime Transport of NTUA, which was awarded the Lloyd's List Greek Shipping Award for the Piraeus International Centre (2008) and the Lloyd's List Greek Shipping Award on Achievement in Safety or Environmental Protection (2010). He has published significant parts of his work in peer reviewed journals and he has given over 100 presentations and lectures at various international scientific conferences and symposia with topics relevant to his expertise.

- **Konstantinos Louzis (M)** has a Master in Naval Architecture and Marine Engineering from the School of Naval Architecture and Marine Engineering (NA&ME) of the National Technical University of Athens (NTUA), Greece. He is currently a PhD Candidate at the Laboratory for Maritime Transport of the same school in the scientific areas of risk analysis/assessment, marine safety, and life-cycle risk management. He is a member of the Maritime Risk Group (MRG) research group. Konstantinos Louzis is a member of the Technical Chamber of Greece and the Hellenic Institute of Marine Technology (HIMT). Konstantinos Louzis' expertise, relevant to this project, is in marine safety; risk analysis/assessment and risk engineering; maritime accident investigation and modelling; human factors and human reliability; resilience engineering; technology assessment; aspects of salvage engineering (e.g., oil removal from ships in distress, or wrecks, and preliminary analysis/feasibility of wreck removal); safety analysis; data mining and statistical, probabilistic and risk modelling; ship design. During his presence at NTUA, he has participated in several major research projects. He has also participated in various studies (e.g., development of GIS Maps and Spatial Analysis for the marine pollution from the M/T Agia Zoni II, and a study on discharge facilities for oil recovered at sea for the European Maritime Safety Agency - EMSA). He has published parts of his work in the following peer reviewed journals: Journal of Human and Ecological Risk, Journal of Risk Analysis and Crisis Response, Frontiers in Marine Science and Ocean Engineering. He has participated as a speaker at various international scientific conferences with topics relevant to his expertise.
- **Eirini-Asimina Stamatopoulou (F)** Eirini Stamatopoulou is a Phd Candidate and member of the Laboratory for Maritime Transport in the School of Naval Architecture and Marine Engineering at the National Technical University of Athens (NTUA), Greece. She holds a diploma in Naval Architecture & Marine Engineering. After she graduated, she has worked as freelancer engineer. Eirini's work focusses on win-win solutions to reinforce the effectiveness, productivity and safety of shipping operations, while minimizing the risk and the environmental impact. Since 2012, she is member of Laboratory for Maritime Transport as a Phd Student. At NTUA, she has participated in several research projects with respect to shipping sustainability (air emissions), safety and optimization. Her expertise consist of maritime transports, logistics, environmental protection, port operations, maritime safety and security. Eirini's work in above areas of interest has been published in proceedings of international conferences and referred Journals (e.g. Transport Research Part D, Transport & Environment). She is also the co-author of a book Chapter. Eirini is a member of Technical Chamber of Greece.
- **Alexandros Koimtzoglou (M)** has a Master in Naval Architecture and Marine Engineering from the School of Naval Architecture and Marine Engineering (NA&ME) of the National Technical University of Athens (NTUA), Greece and he holds a Master in Business Administration (MBA) in Shipping from the ALBA Graduate Business School. Furthermore, he is a member of the Maritime Risk Group (MRG) research group. His expertise, relevant to this project, is in marine safety; risk analysis/assessment and risk engineering; maritime accident investigation and modelling; human factors; resilience engineering; technology assessment; salvage engineering (e.g., wreck removal studies); safety analysis; statistical, probabilistic and risk modelling and ship design. During his presence at NTUA, he has participated in several major research projects in the areas of marine

safety, maritime transport and systems, ship design, safety analysis and technology assessment. and he has also compiled various naval engineering studies (i.e., trim and stability booklets, inclining experiments, wreck removal operations). Alexandros Koimtzoglou is a member of the Technical Chamber of Greece, the Hellenic Institute of Marine Technology (HIMT) and the Society of Naval Architects and Marine Engineers (SNAME). He has published parts of his work in the following peer reviewed journals: Journal of Human and Ecological Risk, Journal of Risk Analysis and Crisis Response, Frontiers in Marine Science and Ocean Engineering. He has participated as a speaker at various international scientific conferences with topics relevant to his expertise.

- **Sotiralis Panagiotis (M)** holds a university degree in Naval Architecture & Marine Engineering from the School of Naval Architecture and Marine Engineering (NA&ME) of the National Technical University of Athens (NTUA), Greece. He has a Master's Degree in Techno-Economic Systems (MBA) from National Technical University of Athens (School of Electrical and Computer Engineering) - University of Piraeus (Department of Industrial Management and Technology). He is currently a PhD candidate at the Laboratory for Maritime Transport, of the same school in the scientific areas of dynamic risk analysis/assessment and maritime safety. He is a member of the Maritime Risk Group (MRG) research group. His expertise, relevant to this project, is in maritime safety; dynamic risk analysis/assessment and risk engineering; human factors; human reliability and engineering; resilience engineering; statistical modelling and optimisation of the operational and environmental performance of different types of ships. He has participated in several major research projects and has also published parts of his work in peer reviewed journals and has participated as a speaker at various international scientific conferences with topics relevant to his expertise.

4.1.20.2 Publications

1. Sotiralis P. Ventikos N.P., Hamann R., Golyshev P., Teixeira A.P. (2016), Incorporation of human factors into ship collision risk models focusing on human centred design aspects, *Reliability Engineering and System Safety*, 156: 210–227.
2. Ventikos, N.P., Giannopoulos, I.F., (2013). Assessing the Consequences from Marine Accidents: Introduction to a Risk Acceptance Criterion for Greece. *Human and Ecological Risk Assessment*. 19, 699–722. doi:10.1080/10807039.2012.691398
3. Ventikos N.P., Louzis K., Koimtzoglou A. (2013), The Shipwrecks in Greece are Going Fuzzy: A Study for the Potential of Oil Pollution from Shipwrecks in Greek Waters, *Human and Ecological Risk Assessment: an International Journal*, 19 (3): 462-491.
4. Ventikos, N.P., Lykos, G. V., Padouva, I.I., (2014). How to achieve an effective behavioral-based safety plan: the analysis of an attitude questionnaire for the maritime industry. *WMU Journal of Maritime Affairs*. 13, 207–230. doi:10.1007/s13437-014-0061-1
5. Ventikos, N.P., Lykos, G.V., Sotiralis, P., (2015). Study on near misses in the framework of enhancing maritime safety with the focus placed on Crew-Centered Design, in: *Book of Maritime Technology*. Piraeus, Greece, pp. 101–113.

4.1.20.3 Relevant Previous Projects

Name	Topic	Relevance
SAFEPEC	Innovative risk-based tools for ship safety inspection (FP7-TRANSPORT-2013-MOVE-1, 2014-	The SAFEPEC project aims to promote proactive safety and develop a ‘unified risk-based framework’ built upon the analysis of historical data of casualties, near miss cases, deficiencies and non-conformities that are detected by various types of inspections. Another outcome of the project is a software prototype that enables the interoperability and coherent interpretation of those data

Name	Topic	Relevance
	2017)	sources; and can contribute to the early detection of failure, either in the ship structure or its equipment. Workshops and other engagement activities will be organised to collect the stakeholder views about the products developed during the project. Based on the feedback obtained along these events, a set of recommendations for proactive ship inspection policy will be elaborated.
CYCLADES	Human element factors in shipping safety (FP7 Project, 2013-2016)	The CyClaDes project is designed to promote the increased impact of the human element in shipping across the design and operational lifecycle. The project focuses on all the key steps in the lifecycle; the stakeholders; where the barriers to human element integration occur; and how to best locate, produce, disseminate, and apply human element knowledge within the overall context of shipping. The advantage is realized by supporting the integration of the human element in the design and operational life-cycle from appreciation, to concept, to design, to application, to evaluation and approval, to maintenance.
LEANWIND	Logistic Efficiencies and Naval architecture for Wind Installations with Novel Developments (FP7 Project, 2013-2017)	The offshore wind industry has not yet applied lean principles to the logistical operations of the wind farm in all stages of the lifecycle as proposed by the LEANWIND project. "Lean" principles were originally developed by Toyota to optimize the processes of manufacturing industries; these principles of optimization and efficiency have subsequently been adopted by many other industries to remove wasteful stages and streamline processes.
SHOPERA	Energy Efficient Safe SHip OPERAtion FP7 Project, Transport/ FP7-SST-2013-RTD-1/ Activity 7.2.4 Improving Safety and Security. (2012-2015)	The project SHOPERA addresses several challenges by looking holistically at integrated ship design and operational environments and implementing multi-objective optimisation procedures to optimise a ship's powering while ensuring safe ship operation; but at the same time seeking the right balance between the ship's efficiency and economy, safety and greenness. Upon completion, SHOPERA will submit key results to IMO for consideration in the rule making process.
LRF-NTUA Centre of Excellence		An initiative funded by the Lloyd's Register Foundation (LRF), which examined emissions from shipping in a holistic manner, addressed design, construction and operational aspects with the aim to provide insight into potential solutions

4.1.20.4 Major Infrastructure

Based on its experience in relevant research projects, NTUA has various models for risk analysis and human factor focusing in maritime industry. Furthermore, NTUA has specialised Actigraphs, which have been used in experiments for measuring seafarer fatigue.

4.1.21 WORLD MARITIME UNIVERSITY

Established by an IMO Assembly Resolution on 4 July 1983, WMU is a centre of excellence for postgraduate maritime education, with the aim to further enhance the objectives and goals of IMO and IMO member states around the world through education, research, and capacity building to ensure safe, secure, and efficient shipping on clean oceans. WMU is truly an organization by and for the international maritime community.

The World Maritime University (WMU) in Malmö, Sweden is a postgraduate maritime university. WMU delivers MSc and PhD programmes in Maritime Affairs, with specialisations in the following areas: maritime law and policy, maritime safety and environmental administration and management, maritime education and training, shipping management, port management, marine environment and ocean management, and international maritime transport and logistics.

Overall, WMU:

- Contributes to maritime capacity building and the development of effective policies for the global maritime community
- Helps build a sustainable world through maritime education and research
- Educates future global maritime leaders, experts and professionals
- Provides a forum for international collaboration on maritime transportation
- Support IMO capacity-building strategy

4.1.21.1 Key personnel

- **Dr Raphael Baumler (M)** is an Associate Professor at World Maritime University since 2010. Attached to Maritime Safety and Environment Administration department, he also works with Maritime Energy Management departments. He also teaches in Dalian Maritime University in Maritime Safety and Environment Management. Raphael Baumler is member of the Maritime Risk and System Safety (MaRiSa) Research Group. Primarily educated as a dual officer, Dr. Raphael Baumler worked on various types of ships. He spent more than 20 years in a seafaring career, including seven years as Master on a large container ship. He also worked as Staff Captain on cruise ship, and he completed various assignments as junior officer and engineer on board container ships, ferry, VLCC and offshore supply vessels. Raphael Baumler holds a Master degree in Crisis Management and a Ph.D. in Risk Management from France. His work approach elaborates on system theory and complexity thinking. His main academic work focuses on human element in shipping and protection of the marine environment. Combining academic skills (MSc. and Ph.D.) and vocational experience (Master Mariner and Marine Engineer), he connects practice and theory to analyse shipping complexity and particularly the human element. Expert for IMO Marine Environment Division, Raphael Baumler conducted consultancies and lead projects related to international instruments such MARPOL Annex VI, Ballast Water Management Convention, and Hong Kong Convention on ship recycling. He also supports IMO Technical Cooperation Division to promote the development of national maritime policy. Finally, he prepared IMO submissions on demand and publishes in academic journals.
- **Associate Professor Momoko Kitada (F)** joined WMU in 2011 and is Secretariat of the WMU Women's Association (WMUWA). She leads WMU's collaboration efforts with the IMO in terms of women's integration in the maritime sector. Momoko Kitada is a former seafarer and her research interests lie in gender and diversity issues in shipping, in particular, women seafarers and seafarers' families in terms of identities and welfare issues. She teaches subjects in Maritime Education and Training (MET), including cultural issues, knowledge management, assessment methodology, and contemporary labour issues. Momoko's research expands to the human element and social aspects in maritime energy management as well as capacity building for sustainable development. She also teaches research methodology and study skills for MSc students. The major publications are "Maritime Women: Global Leadership"(2015, Springer); "Risk management no shinzui [The

Essence of Risk Management]”(2017, Seizando); and “Trends and Challenges in Maritime Energy Management” (2018, Springer).

- **Dr Jens-Uwe Schröder-Hinrichs (M)** Professor (Maritime Administration), Director of Research, Head of Maritime Safety and Environmental Administration (MSEA). Jens-Uwe Schröder-Hinrichs graduated from the University of Rostock, Germany with a M.Sc. equivalent degree in Maritime Transport Engineering (Dipl.-Ing.) in 1995. In 2003 he completed his Ph.D. (Dr.-Ing.) in Safety Science at the University of Wuppertal, Germany with a thesis about causes of maritime casualties and underlying factors. Former officer, he holds an unlimited Master Mariner Licence (Kapitän AG). After finishing his seafaring career, he joined the classification society Germanischer Lloyd, working in the head office in Hamburg, Germany. In October 2000 he joined the World Maritime University (WMU), Malmö, Sweden. As far as research activities are concerned, Dr. Schröder-Hinrichs is the Head of the Maritime Risk and System Safety (MaRiSa) Research Group, a group which he set up in 2009. Dr. Schröder-Hinrichs is Associate Editor of the WMU Journal of Maritime Affairs which is jointly published with Springer Verlag. He is involved with the Journal since its beginning in 2002 and was its Editor from 2006 - 2017. He is also a Co-Editor of the WMU book series, WMU Studies in Maritime Affairs, jointly published with Springer Verlag. Dr. Schröder-Hinrichs is and was an advisor to maritime administrations on issues related to maritime risk and safety as well as the implementation and enforcement of maritime safety regulations. He is an Audit Team Leader in the IMO Member State Audit Scheme. In addition, Dr. Schröder-Hinrichs is a member of the Nautical Institute (Member of the Council) and the German Ship Master and Officer Association.
- **Prof. Laura Carballo Piñeiro (F)** Prior to joining WMU Professor Carballo worked at the Universities of Vigo and Santiago de Compostela in Spain, where she developed her expertise in private international law, international litigation, international insolvency and maritime law. Holding a PhD in civil procedure law and a PhD in private international law, she practiced as a lawyer and has worked as a deputy judge in Spain. Fellow of the Alexander von Humboldt Foundation, she specialized in international maritime labour law. She has been visiting fellow at the Max Planck Institute for Comparative and Private International Law, Columbia Law School, the Institute of European and Comparative Law at Oxford University and UNCITRAL, and she has taught in a number of institutions in Europe and Latin America such as the Hague Academy of International Law, the Universities of Antioquia and Medellín in Colombia and the Central University of Venezuela. Her main area of research at WMU is international maritime labour law, in particular maritime employment, living and working conditions, occupational safety and health, seafarers' identity documents, collective relations, and corporate social responsibility.

4.1.21.2 Publications

1. Kitada M., Baldauf M., Mannov A., Svendsen P.A., Baumler R., Schröder-Hinrichs J.U., Dalaklis D., Fonseca T., Xiaoning S., and Lagdami K. (2018). Command of Vessels in the Era of Digitalization. Proceedings of 9th International Conference on Applied Human Factors and Ergonomics. 21-25 July 2018
2. Schröder-Hinrichs, J.-U., Graziano, A., Kataria, A., & Praetorius, G. (2017). TRACEr-MAR: Technique for the retrospective & predictive analysis of cognitive errors adapted to the maritime domain. WMU Papers in Ocean and Maritime Affairs No. 1. Malmö: World Maritime University (DOI: 10.21677/pmoa.20170630).
3. Kataria, A., Praetorius, G., Schröder-Hinrichs, J.-U., Baldauf, M. (2015). Making the case for Crew-Centered Design (CCD) in merchant shipping. Proceedings 19th Triennial Congress of the IEA, Melbourne 9 - 14 August 2015

4. Praetorius, G., Kataria, A., Petersen, E.S., Schröder-Hinrichs, J.-U., Baldauf, M., & Kähler, N. (2015). Increased Awareness for Maritime Human Factors through e-learning in Crew-centered Design. *Procedia Manufacturing*, 3, 2824-2831 (DOI: 10.1016/j.promfg.2015.07.762)
5. IMO (2010). Study on human and organizational factors by WMU. SUB-COMMITTEE ON FLAG STATE IMPLEMENTATION. FSI 19/INF.15. IMO: London

4.1.21.3 Relevant Previous Projects

NAME	TOPIC	DESCRIPTION
OPENRISK	Open-Source tools for regional risk assessments for improved European preparedness and response at sea (EC / DG ECHO 2017-2019)	This project aims to: -build on regional risk assessment projects focusing on Preparedness and Response that have been carried out during the recent years in EU waters; -make sure that the outcomes of these processes will be utilised fully by creating an inter-regional plan and European dialogue on these maritime risk assessment initiatives in order to exchange experiences from such regional initiatives, compile a best practices report, and prepare for joint next steps. – take first steps in developing an openly available, based on open source software and other open access material and fully transparent method toolbox for risk assessments useful for the preparedness and response community
MAREC/ SAMRISK	Inter-Organizational coordination of mass rescue operations in complex environments (Norwegian Government 2018-2020)	Increasing the knowledge on how the emergency response system integrates a broad range of actors with varied background such as volunteers in a large-scale emergency operation.
CYCLADES	Human element factors in shipping safety (FP7 Project, 2013-2016)	The CyClaDes project is designed to promote the increased impact of the human element in shipping across the design and operational lifecycle. The project focuses on all the key steps in the lifecycle; the stakeholders; where the barriers to human element integration occur; and how to best locate, produce, disseminate, and apply human element knowledge within the overall context of shipping. The advantage is realized by supporting the integration of the human element in the design and operational life-cycle from appreciation, to concept, to design, to application, to evaluation and approval, to maintenance.
SAFEPEC	Innovative risk-based tools for ship safety inspection (FP7-TRANSPORT-2013-MOVE-1, 2014-2017)	The SAFEPEC project aims to promote proactive safety and develop a ‘unified risk-based framework’ built upon the analysis of historical data of casualties, near miss cases, deficiencies and non-conformities that are detected by various types of inspections. Another outcome of the project is a software prototype that enables the interoperability and coherent interpretation of those data sources; and can contribute to the early detection of failure, either in the ship structure or its equipment. Workshops and other engagement activities will be organised to collect the stakeholder views about the products developed during the project. Based on the feedback obtained along these events, a set of recommendations for proactive ship inspection policy will be elaborated

PROMERC	Non-military protection measures for merchant shipping against piracy - Capability Project or Coordination and Support Action (EC EC/7th Framework Programme 2014-2016)	To reduce the vulnerability of EU merchant fleets and maritime supply lines to criminal abduction and extortion and thereby reduce risk to mariners, shipping & the environment while also reducing costs.
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4.1.21.4 Major Infrastructure

WMU is equipped with simulators (engine, bridge and safety/security) dedicated to research.

4.1.22 AIRBUS OPERATIONS SAS

Airbus is a global pioneer in the aerospace industry, operating in the commercial aircraft, helicopters, defence and space sectors. The Company is a leader in designing, manufacturing and delivering aerospace products, services and solutions to customers on a worldwide scale. The Company operates under a unique brand: Airbus, which stands for internationalisation, innovation and integration. Every part of the business contributes to the brand equity – and every part benefits from it. All worldwide market activities across commercial aircraft, helicopters, defence and space businesses as well as any future core business entities operate under the same Airbus brand. As the largest aeronautics and space company in Europe and a worldwide leader, Airbus Commercial is at the forefront of the aviation industry, building the most innovative commercial aircraft and consistently capturing about half of all commercial airliner orders. Thanks to its deep understanding of changing market needs, customer focus and technological innovation, Airbus helps airlines grow and people connect. Its comprehensive product line comprises highly successful families of aircraft, from the single-aisle A320 Family to the double-deck A380. Over the last 45 years, Airbus has built a reputation on reacting to market demands, developing and evolving its products to meet the needs of customers and the wider world. As such, technological innovation has been at the core of Airbus' strategy since its creation. Human Factors & Ergonomics is deeply rooted in AIRBUS design. During the past 20 years AIRBUS developed specific HF&E competence and knowledge in the frame of Aircraft design and operations. These activities encompass the whole Aircraft lifecycle (R&T, development and in-service) to ensure the adequate design is set to allow the users to perform the required task in a safe, efficient and easy way. Developed on-board solution required collaboration with Air Traffic Management, Airport, Airlines, thus ensuring a continuous and global efficient solution wrt identified Human Factors issues. Airbus developed strong methodologies and tools, covering aspects of Human factors as diverse as Psychology / Cognitive Ergonomics, Physiological / Physical / Neuro-Physiological Ergonomics and Linguistics, and answering both Airworthiness certification and Airbus internal standards requirements. Airbus improves continuously its expertise in considering new means for increasing pertinence and efficiency in design (proactivity) and is interested to confront its view and knowledge with external partners to first cross-fertilize concepts and technologies across Aviation and Maritime fields, and to work together. Beyond the expertise on wake vortex risk modelling and severity assessment developed in its different aircraft programs, Airbus has been involved in a number of R&T projects on the subject (S-WAKE, FLYSAFE, CREDOS...) and has been leading a network of excellence (WAKENET3-Europe). Airbus is also involved in the ICAO Wake Turbulence Steering Group (WTSG) and providing support to the Eurocontrol Wake Vortex Task Force (WVTF) to elaborate a Recategorization of wake turbulence separations.

4.1.22.1 Key personnel

- **Sonja Biede-Straussberger (F)** is a Human Factors specialist at Airbus Human Factors & Ergonomics department. In 2006, she received a doctoral degree in psychology conducting a multi-faceted psychophysiological study on monotony in air traffic controllers and was involved in a multidisciplinary research project on authority sharing in ATM. Since 2008 she is responsible for managing Airbus' Human Factors contribution to SESAR and was involved in the design and validation of various SESAR concepts as well as the definition of the SESAR Human Performance Assessment Process. Amongst the technical projects covered where the design of a Wake Vortex Prediction System, airborne spacing concepts, and 4D operations as well as airborne improvements for approach and airport operations.
- **Christine Bézard (F)** joined Airbus in 2001 as System Safety Engineer, after 10 years as Safety specialist in various industries including Nuclear power, automotive and Space

systems. Within Airbus, she has an extensive experience in Safety (risk management, architecture) on all Aircraft programs, from R&T, Aircraft development, to in-service support. In 2006 she graduated in Human Factors from Paris Descartes University (DU). Since 2014, she is leading AIRBUS commercial Aircraft Human Factors & Ergonomics team, specialized in cockpit design. The team is composed of 20 Human Factors specialists and experts (Psychologists, Physiologists, Neurophysiologists, Linguists) actively engaged in cockpit user-centred design, thus ensuring Aircraft Safety and operability. Since more than 20 years, Human Factors is a core competence and a key methodological and operational actor within Airbus design office.

- **Sebastian Kauertz (M)** is a wake vortex specialist with a PhD in aeronautical engineering from the RWTH Aachen in Germany. He has over 15 years of professional experience on the topic of wake turbulence with regard to wake vortex physics, wake encounter modelling & simulation and wake encounter flight test evaluation & analysis. He participated to several research projects linked to wake turbulence, such as the EC sponsored CREDOS project, SESAR projects 9.11 and 6.8.1 and SESAR2020 solution PJ02.01. He furthermore contributed to Wake Turbulence Safety Assessments for the A350 and A330NEO aircraft to support definition of the applicable wake turbulence separation minima for these aircraft.

4.1.22.2 Publications

1. Straussberger, S. and Reuzeau, F. (2011) A Cockpit Point of View on Human Factors for a Changing ATM Environment, SAE Int. J. Aerosp. 4(2):1341-1349, 2011, doi:10.4271/2011-01-2709.
2. Henry, J., Bach, C. and Biede, S. (2015). A framework for designing authority and responsibility into complex sociotechnical systems. Paper presented at the 5th International Conference on Application and Theory of Automation in Command and Control Systems, Toulouse.
3. Bach, C. & Biede, S. (2016). Assessing Needs from a Human Factors perspective when designing complex systems. Proceedings of the 32rd Meeting of the European Association for Aviation Psychology.
4. Biede, S., Lebas, J. & Petit, E. (2018, in press). Challenges of Early Identification of Human Factors Impacts for new Concepts of Operations: An example for the Airborne View on Commercial Formation Flight Operations. In M. Schwarz, J. Lasry, G. N. Schnücker, H. Becherstorfer (Eds.) Proceedings of the 33rd Conference of the European Association for Aviation Psychology. Groningen, Netherlands: European Association for Aviation Psychology.
5. Kauertz, S., Holzäpfel, F. and Kladetzke, J., "Wake Vortex Encounter Risk Assessment for Crosswind Departures", AIAA Journal of Aircraft Vol. 49, No. 1, 2012.

4.1.22.3 Relevant Previous Projects

Name	Relevance
SESAR1 project 9.11	SESAR2020 solution PJ02.01 "Wake Turbulence Separation Optimization" is developing updated wake turbulence separation requirements for approach and departure operations, taking into account individual aircraft pairings as well as weather parameters. Airbus contributes to a concept area dealing with Wake Risk Monitoring by using on-board aircraft data to reliably identify in-service wake turbulence encounters.
SESAR2020 solution	"Wake Turbulence Separation Optimization" is developing updated wake turbulence separation requirements for approach and departure operations, taking into account

PJ02.01	individual aircraft pairings as well as weather parameters. Airbus contributes to a concept area dealing with Wake Risk Monitoring by using on-board aircraft data to reliably identify in-service wake turbulence encounters.
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4.1.22.4 Major Infrastructure

Different kind of Flight Simulators are owned and used by Airbus in its Toulouse facilities (and around the world in various Customer Service office). These installations are ranging from simple laptop interface to full in motion simulator. Aim is to be able to assess new functionalities (human/machine interface, system, ...) or to train internal or external pilots prior to flight or in the frame of qualification or may be related to other various topics.

In particular, simulators have always been of interest regarding the validation of evolving ways of working of an aircraft crew: workload assessment related to a given procedure, efficiency of a new alerting system, design of an information interface, etc. To support these activities, a dedicated fixed based R&T simulator for aircraft cockpit (MOSART) is existing that enables the practical assessment of evolution vs a current configuration.

Even if this simulator is currently not planned to be used within the frame of the SAFEMODE proposal, it enables Airbus to have experience and knowledge on many interface design evolution, integration and validation, especially in the frame of human factors.

4.1.23 AP&A

AP&A was established in 1988 and provides expert technical, operational and commercial services to leading shipowners, shipmanagers and offshore clients worldwide.

The company offers crew and high quality manpower for projects on board vessels. These cover officers and ratings, Masters to Messmen, as well as welders, fitters, electricians, carpenters, project managers and Supervisors of different nationalities.

AP&A follow all regional and international seafaring guidelines and adopt best practices and standards for their personnel. The company is involved with selection, accreditation, training and welfare of seafarers and technicians.

The company employs highly qualified and experienced office staff for managing the seagoing workforce. These include naval architects, marine engineers as well as specialised crew and HR managers and travel teams. AP&A is heavily involved with the installation and maintenance of 'Green Technologies' in the maritime sector, including scrubbers and ballast water treatment systems.

4.1.23.1 Key personnel

Andreas Papadakis

Managing Director and founder of AP&A. Previously, he was Technical Manager and New Building Supervisor at leading Greek shipping companies. Andreas is a graduate of Newcastle University with a BSc in Marine Engineering. He is also Vice President and founding member of the Hellenic Engineers Society of Great Britain.

George Papadakis

George is a Director of AP&A, responsible for Contracts and Procurement management for AP&A's projects and new business. He works with leading shipowners and managers and with major clients in the offshore sectors. He was involved in the FP7 SEAHORSE project.

George helped establish AP&A as a leading Integrator for Green Technologies over the last few years. Prior to AP&A he was International Account Director at M&C Saatchi, developing marketing and advertising strategies for a host of major brands.

George graduated from Balliol College, Oxford University with MA Language and Literature.

George Maghioros

George Maghioros has worked in the Greek maritime industry for 36 years. His roles include Superintendent Engineer, Technical Director and consultant surveyor for major shipping companies and has acquired considerable experience in all fields of Technical operations. George is a graduate from Newcastle Upon Tyne University of Marine Engineering with Master's Degree and Bachelor of Science in Naval Architecture and Shipbuilding.

Konstantina Papoulia

Konstantina graduated from Southampton Solent University with an MSC in 'International Maritime Studies- Ship and Shipping Management'. She joined AP&A in 2015 and is responsible for Human Resources in the AP&A Crewing Department. Her role includes the selection of AP&A seafarers, the processing of their documentation and certificates and their mobilisation. She is responsible for supplying seafarers to leading cruise ship companies including Royal Caribbean and Carnival Group as well as leading vessel operators in Greece such as Chartworld, Primera and All Oceans.

4.1.23.2 Publications

1. Osman Turan, Rafet Emek Kurt, Volkan Arslan, Sara Silvagni, Marco Ducci, Paul Liston, Jaan Maarten Schraagen, Ivy Fang, George Papadakis, 'Can We Learn from Aviation: Safety Enhancements in Transport by Achieving Human Orientated Resilient Shipping Environment'. TRA2016, Transportation Research Procedia, Volume 14, April 2016, Pages 1669–1678.
2. SEAHORSE project: Dealing with maritime workarounds and developing smarter procedures. Kurt, R. E., Arslan, V., Turan, O., de Wolff, L., Wood, B., Arslan, O., Kececi, T., Winkelman, J. W., van Wijngaarden, M. & Papadakis, G. 3 Sep 2015 Safety and Reliability of Complex Engineered Systems - Proceedings of the 25th European Safety and Reliability Conference, ESREL 2015. p. 3811-3818 8 p. <https://doi.org/10.1201/b19094-499>

4.1.23.3 Relevant Previous Projects

Sister company AP&A UK participated in Seahorse Project and relevant outputs were implemented.

NAME	TOPIC	RELEVANCE	REFERENCE
SEAHORSE <i>FP7 Project</i>	Enhancing maritime safety by focusing on human factors and resilience engineering principles	SEAHORSE is a leap forward towards shipping safety achieved through technology transfer from air transport to marine transport focusing on human factors problems in an innovative, integrated and multidisciplinary manner towards safer and more resilient shipping operations.(UoS)	http://seahorseproject.eu/

Currently AP&A is involved in MarEd project funded by the European Commission under the framework of Erasmus+ Programme KA2 Strategic Partnerships for Vocational Education and Training (VET) as a Development of Innovation is coordinated by Maritime Faculty of **Istanbul Technical University**.

The MarEd consortium consists of the partners; **University of Strathclyde** situated in Glasgow - UK, **Turk Loydu**, headquarter located in Tuzla – Istanbul, **A.P.&A. Limited** located in Glyfada, Greece, **CALMAC Ferries** from Gourock-UK, **Orka Informatics** located in Istanbul.

The project MarEd mainly aims to define all energy efficiency gaps in the shipping industry and create a distance learning module to train staff.

4.1.23.4 Major Infrastructure

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4.1.24 RYANAIR DESIGNATED ACTIVITY COMPANY

Ryanair is Europe's Number 1 airline, carrying over 130m customers p.a. on more than 2,000 daily flights from 86 bases, connecting 215 destinations in 37 countries on a fleet of 450 Boeing 737 aircraft. With over 200 Boeing 737's on order, Ryanair will continue growing its fleet to 600 aircraft, carrying 200m customers p.a. by FY24. Ryanair has a team of more than 13,000 highly skilled aviation professionals delivering an industry leading 33-year safety record. In 2017, Ryanair became the first European airline to have carried over 1 billion customers. Ryanair's focused Corporate Safety Strategy and robust Safety Management System, which includes OFDM capture rates over 99%, empowers its industry leading safety policy, promotion, assurance and risk management.

4.1.24.1 Key personnel

- **Choorah Singh (M)** was appointed as Deputy Director Operations Control at Ryanair in October 2009. He previously held roles as Navigational Technical Services Manager and Flight Operations IT Manager within the Ryanair Ops Control department and prior to this experience he worked in various departments in Ryanair from Commercial to IT since 2001. In his current portfolio, he is responsible for the day-to-day management of Ryanair's Operations Control Centre (OCC) in Dublin which controls and supervises the Ryanair flight schedule. Functions within the OCC include Flight Watch, Crew Control, Ground Ops Control, Flightplanning and Nav Services. Choorah is also responsible for Ryanair's Air Traffic Management (ATM) related activities with the European Commission and Eurocontrol. He is also a member of other Single European Sky institutions such as the SESAR Joint Undertaking, SESAR Deployment Manager, Network Management Board, Industry Consultation Body and the Eurocontrol Agency Advisory Board.
- **Captain Martin Timmons (M)** Ryanair's Deputy Director of Safety and Security.
- **Captain Andrew Elbert (M)** Ryanair's Regional Base.
- **Captain Andrew Carroll (M)** Ryanair's Flight Safety Officer.

4.1.24.2 Publications

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4.1.24.3 Relevant Previous Projects

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4.1.24.4 Major Infrastructure

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4.1.25 PANEPISTIMIO PATRON

Applied Mechanics Laboratory, University of Patras (AML/UPAT) is in operation since 1980. It is part of the Department of Mechanical Engineering and Aeronautics, University of Patras (UPAT). AML/UPAT deals mainly with the general field of materials and structures giving emphasis in the science, the technology and the applications of composite materials (organic, ceramic and metal matrix), monolithic ceramics and plastics. AML/UPAT has extensive experience in the field of aeronautics and surface transport via participation in research projects dealing with intermodality between surface and air transport modes, safety and security of transport systems. Educational activities include eighteen formal courses offered at undergraduate and graduate level dealing with the mechanics, analysis and design of composite materials and advanced structures, non-destructive techniques, wave propagation and scattering theory, anisotropic elasticity, etc. Qualified graduates may enrol in the PhD four-year program also offered by the Laboratory. AML is internationally recognized for its contribution in the respective fields through books, lectures, research papers, conferences, professional society activities and research co-operation within the frame of financially supported projects, both by national and international Institutions, mainly by the EU. UPAT/AML has in its permanent staff 5 university professors and 9 PhD holders (working in the field of Composite Material, Structural Dynamics, Non-Destructive Testing and Numerical Methods) and 6 technicians and support staff. Currently, 25 Engineers and PhD students are working in the Lab. (8 out of them are females). As part of its continued growth, UPAT/AML is continually looking for exceptional people to join its staff. During the last 10 years 18 PhD theses have been completed in the general field of Mechanics of Composite Materials, Structural Dynamics and SHM & Non-Destructive Inspection of Materials and Structures. Its highly trained and internationally experienced team of engineers, led by the professors and PhD holders of the laboratory offers a wide range of services on developing and prototyping innovative ideas and technologies, maintaining a high readiness level to deliver novel solutions and tools to the global market. AML/UPAT is accredited by the National Accreditation System S.A (ESYD) in the fields of EN17025 (mechanical tests at ambient and elevated temperatures), EN17020 (transport of dangerous goods (2005), EN 17020: certified for the application of EN 62446 (Minimum requirements for the documentation, operation mode testing and inspection of Photovoltaic systems connected to the grid and its normative references HD 60364)(2011) and EN 17020: responsible entity for the application of the EU regulation in Greece, for the testing of seat belts, bumpers and seats for school buses, (2014). AML/UPAT has participated in more than 40 European collaborative projects the last 15 years. University of Patras is also Core member partner participating AIRFRAME ITD of Clean Sky 2.

4.1.25.1 Key personnel

- **Professor Vassilis Kostopoulos (M)**, Director of the Applied Mechanics Lab, in the Dpt. of Mechanical Engineering & Aeronautics, University of Patras. He has a 28 years' experience in the field of composite and aerospace structures, more than 140 journal publications, more than 180 conference presentations, 6 books in the field of composites, 7 patents and has extensive experience in research projects having participated in more than 35 European and more than 10 large national projects. For the last 5 years he holds the position of national delegate of Greece in the Advisory Council for Aerospace Research in Europe (ACARE). His research interests lie in the fields of Design, Analysis and Optimization of Composite Structures, Non-Destructive Inspection & Evaluation of Engineering Structures, Structural Health Monitoring, Nano-augmentation, Nano-engineering and Nano-design of structural composite materials, Fracture and Fatigue of Composites Materials and Structures, Blast behaviour of Structures, Anisotropic Elasticity, Anisotropic Damage Theory, Wave Propagation and Scattering in Continuous Media, Non-Linear Acoustics. He has been the main Supervisor of 21 completed PhD theses. During the project he will assist with his expertise in cross border security and interoperability issues.
- **Assistant Professor Theodoros Loutas (M)**, Assistant Professor in the Dpt. of Mechanical Engineering and Aeronautics of the University of Patras. Dr. Loutas received his Ph.D. with honours in 2007 from the same department as well as his diploma in 2002. His research interests lie in the fields of Structural Health and Condition Monitoring with techniques such as linear and nonlinear ultrasound with guided waves, acoustic emission, acousto-ultrasonics. He is also interested in the diagnostics and prognostics of rotating machinery and equipment, advanced signal processing techniques (time-frequency, time-scale transforms, etc.) as well as the mechanics and the mechanical

behaviour of advanced materials (metals, composites, nano-composites). He has 30 publications in peer-reviewed international journals in these fields and more than 35 conference presentations. During the project he will assist with his expertise in profiling mechanism and UI design and development.

- **Dr. A. Kotzakolios (M)** PhD Mechanical Engineering (2011). His PhD was in the field of blast response simulation of composites aircraft structures. Since 2006 he has been working in the field of design & analysis of advanced structures for various applications (aeronautics, space, automotive and marine). He has been involved in various EU projects dealing with novel approaches in design for aerospace structures. He has extensive experience in certification processes for aerospace applications and in modelling and simulation of complex engineering systems.

4.1.25.2 Publications

1. D.E. Vlachos and V. Kostopoulos. " FANTASSY project: Future Aircraft design following the carrier-pod concept as an enabler for co-modal seamless Transport, passenger Safety and environmental sustainability", 3rd AirTN forum on Enabling and promising technologies for achieving the goals of Europe's Vision Flightpath 2050, September 2013, Cranfield University, UK.
2. D.E. Vlachos, V. Kostopoulos, "A Carrier-pod Aircraft Configuration for the Air Transport System beyond 2050", 7th European Aeronautics Days, (AERODAYS 2015), October 2015, London, England.
3. T. Kotzakolios, D. Vlachos and V. Kostopoulos, Explicit Blast Hardening of both metallic and composite Fuselage Aircraft Structures, International Journal of Computer Aided Engineering and Technology
4. V. Kostopoulos, Y.P. Markopoulos, G. Giannopoulos and D.E. Vlachos, Crashworthiness Study of Composite Motorcycle Safety Helmet, Composites Part B, Vol. 33, 2002, pp. 99-107.
5. T. Kotzakolios, D. Vlachos and V. Kostopoulos, Blast Response of Metal Composite Laminate Fuselage Structures Using Finite Element Modeling, Composite Structures, 93 (2), (2011), pp. 665-681.

4.1.25.3 Relevant Previous Projects

Name	Topic	Relevance
EXTREME	H2020-EU.3.4. - SOCIETAL CHALLENGES - Smart, Green And Integrated Transport	The aim of the EXTREME project is to develop novel material characterisation methods and in-situ measurement techniques, material models and simulation methods for the design and manufacture aerospace composite structures under EXTREME dynamic loadings leading to a significant reduction of weight, design and certification cost while increasing safety of aircraft.
CompInnova	H2020-EU.1.2.1. - FET Open	To develop a revolutionary automated multipurpose and multifunctional Vortex robot that it will carry for the first time ultrasonic Phased Array (PA) and Infrared Thermography (IRT) equipment for inspecting metallic and composite aircraft structures respectively, as well as a novel repairing system for the inspected damaged components. Aim of this achievement is to drastically improve the quality of maintenance procedures and reduce significantly its time and cost. Eventually, such an approach is expected to bring multiple breakthroughs from the aircraft design level to maintenance, repair and certification standards. The breakthrough that is aimed to be achieved, within CompInnova, can potentially contribute to the development of new technologies, applications, standards, as well as certification procedures.
FLY-BAG2	FP7- TRANSPORT	FLY-BAG2 aim is to develop innovative solutions based on novel lightweight materials and structural concepts for the mitigation of the

		effects of an on-board blast and improve aircraft survivability . Direct strengthening of the airplane structure is not a viable solution since it would clearly result in thicker skins and a weight penalty; moreover, the related costs could not be justified in the majority of the commercial routes. Instead, the proposed blast mitigation and retrofitting solutions will be developed to be easily implemented on existing aircrafts.
ADHER	FP6- AEROSPACE	The ADHER R and D project will improve Health and Usage Monitoring Systems (HUMS) performances in 3 directions : 1) Include simultaneous Oil Debris Monitoring (ODM) and Vibrations monitoring, using available ODM and Vibrations sensors 2) Analyse new physical models for ODM and Vibrations characteristics of helicopter rotating parts (gearboxes, bearings, etc.) to calibrate ageing effects and progressive emergence of failures 3) Conceive and validate innovative software dedicated to Auto-Adaptive Diagnosis / Prognosis of rotating parts potential failures for helicopters. Based on Self-Learning Algorithms, this software will analyse helicopters fleet data and their time evolution. New physical models and Automatically Learned functional relationships will improve links between sensor recorded features, helicopter usage, and regime characteristics . The project main goal is to enable "fleet scale" health monitoring, with robust failure diagnosis / prognosis, relying on multi-sensors monitoring, and automated software analysis of sensor recorded data. This will reduce false alarms rates and maintenance costs, and increase operational aircraft availability , enabling efficient scheduling of preventive maintenance.
WASIS	FP7- TRANSPORT	Aeronautics is a key asset for the future of Europe, but nowadays the industry has to face the challenge of "More Affordable, Safer, Cleaner and Quieter" while at the same time accounting for a demand that will triple over the next 20 years. WASIS project aims to rise to this challenge with the development of a composite fuselage structure based on the lattice stiffening concept, optimizing geometrical and mass properties of transition zones of fuselage structural joints. Project overall concept is focused on simultaneous meeting environmental demands and rising safety coupled with design and manufacturing cost-efficiency improvement. Furthermore, the structure will also be developed to better withstand worst situation loadings, assessing safety through the large adoption of simulation and virtual testing from the very first design stages . Developed innovative fuselage section design will be merged with high-productive filament winding technology to reduce manufacturing costs and time, and samples will be manufactured in order to prove how the different concepts fit together. Complete testing of the samples will be applied to prove the wafer approach. As a result of this project integrated approach – sufficient fuselage weight savings, manufacturing cost/time efficiency and safety increasing are to be achieved.

4.1.25.4 Major Infrastructure

With respect to the specifically interesting equipment suitable for the developments within the proposed activity, in the following the available facilities at AML/UPAT are analytically presented.

- 15 workstations operating independently or in a cluster
- More than 10 PC Workstations of various configurations also available as a cluster
- The following CAD Software are available: CATIA v5, SolidWorks, SIEMENS NX, Rhinoceros.

- For Structural Analysis the following FEA Packages are used: SIEMENS NX, FEMAP, MSC Patran/Nastran/Sinda, MSC Thermica, LS-DYNA, ESA-Comp, FEMB, ModeFRONTIER, NX Nastran.
- For Multi-physics Analysis the following FEA packages are used: ANSYS, ABAQUS, ThermXL, ESATAN/ESARAD etc

AML/UPAT maintains an extensive Technical Library with up-to-date information and reports on topics of composite materials and structures. In addition, it has academic access to all major scientific journals and reporting houses in fields relevant to spacecraft materials and structures. Testing and characterization unit is accredited under EN1702. An indicative list of resources at AML/UPAT is given below:

- 2 INSTRON Hydraulic Universal Testing Machines (Maximum capacity, $\pm 25\text{kN}$ and $\pm 250\text{kN}$, Maximum frequency for fatigue testing 100 Hz), Equipped with Video Extensometer and 1200 °C oven and extensometer.
- 1 MAYES Hydraulic Universal Testing Machine (Maximum capacity, 100kN), equipped with conditioning chamber with temperature and humidity control
- DIC system
- 2 Photron FASTCAM SA4 High Speed Cameras
- Mathis-Instruments TCI-Thermal Conductivity Analyser The system has broad testing capabilities (0 to 100 W/mK) across a wide range of temperatures (-50° to 200°C).
- Environmental chamber 600X600X600, up to 95% R.H. control
- ROKIT 3DISON AEP 3D printer using PC, PEEK, ULTEM 9085
- STRATASYS uPrint SE Plus 3D Printer using ABSplus
- STRATASYS Fortus 380mc using FDM Nylon 12CF (carbon fiber), ULTEM resins and ST-130 soluble material for sacrificial composite tooling
- In – house built drop tower test rig (1,5 m height, up to 10 kg mass)
- LNG delivery closed loop system for low temperature chamber cooling
- Two stage freezer unit for sub-ambient testing
- INSTRON CEAST 9340 drop tower machine (1,1 m height, up to 37.5 kg mass)
- Gas gun (1,5 m muzzle length, 1/2" projectile dia., 150 m/s muzzle velocity, 1 kJ projectile energy)
- Gas gun (3 m muzzle length, 60 mm projectile dia., 350 m/s muzzle velocity, 6 kJ projectile energy)
- Non-Destructive Inspection using Ultrasonic Systems, A, C and D-Scan (Tank Size 1200X800X800 mm)
- 4-channel Acoustic Emission system PCI-2 from Physical Acoustics Corporation
- Micron Optics 2-channel Optical Sensing Interrogator SM130 for FBG strain sensors
- Thermal Analysis system comprising the following units: Thermal Mechanical Analyzer (TMA) 943, Mechanical Analyzer (DMA) Q800 - TA Instruments, Differential Scanning Calorimeter (DSC) Q100 - TA Instruments, Liquid Nitrogen Cooling Accessory (LNCA)

4.1.26 RAIL SAFETY AND STANDARDS BOARD LIMITED (RSSB)

The railway is a complex system with multiple interfaces delivered by many different organisations. At RSSB (www.rssb.co.uk) we bring these organisations together to make collective decisions in the United Kingdom. We help the rail industry carry out research, understand risk, set standards and improve performance. And we provide a constant point of reference in a changing environment. RSSB are an independent body, working with our members to drive improvements in the British rail system. RSSB members include all the GB Passenger and Freight Train Operators, Infrastructure Managers and companies including Abellio, Siemens, Hitachi and Network Rail. At the core of RSSB are teams of technical specialists, which cover disciplines including Human Factors, Risk Assessment, Railway Engineering, Railway Operations, Sustainability and Health & Wellbeing. These specialists support the GB rail industry to develop and manage National and European Standards and also undertake research. In addition to working on European Research projects, RSSB manages a research programme funded by the UK Department for Transport, where about £10m is invested each year in a varied research and development programme. We support rail in the areas of safety, standards, knowledge, innovation and in a wide range of cross-industry schemes requiring our knowledge and independence. Our work involves close collaboration, but as technical experts we are also able to step back and provide an informed view. Because we can see both the big picture and the detail, we are able to furnish the industry with the information and tools it needs to continuously improve, enabling the rail industry to deliver increased capacity, reduced carbon, lower costs and improved customer satisfaction. We are owned by the industry but are non-profit making, and independent of any commercial interests. We span the whole system, including our membership infrastructure companies, train and freight operators, rolling stock owners and suppliers to the industry. At RSSB we deliver a wide range of toolkits, standards, models and knowledge to improve the business of operating and engineering the railway system, and we develop the people that make it work. This knowledge and skills are applied to address issues in today's railway, and to inform the strategy for tomorrow's railway. RSSB actively supports the development of the European research and innovation agenda, participates in related fora, and looks to collaborative European research as a key input to its work. This work would be undertaken by RSSB's human factors team. The team is currently made up of 14 specialists, who structure their work around 6 key human factors themes: New technology and new ways of working; Human factors learning from operational experience and safety culture; Fatigue, Health and Wellbeing; Customer experience; Competence and skills development; Standards. RSSB also gathers and shares knowledge with rail stakeholders on all issues and topics that can have an impact on the transport sector, be they of an engineering, technological and scientific nature, linked to wider socio-economic developments, or rail operations and human factors related. To that purpose, RSSB's R&D department delivers research projects for the rail industry, and its knowledge services team conducts knowledge searches for its members; the findings are hosted on an interactive web-based sharing platform called SPARK.

4.1.26.1 Key personnel

- **Huw Gibson (M).** Huw Gibson is acting Head of Human Factors at RSSB. Huw is responsible for specifying, costing, implementing and managing a range of human factors work with particular focus on human reliability assessment, train driver performance, new technologies and incident investigation. A key research interest is the collection and application of human reliability data to safety decision making. I have been responsible for the development of the CORE-DATA database of human error probabilities and the development of Railway Action Reliability Assessment and Controller Action Reliability Assessment. I was also part of the team which developed Nuclear Action Reliability Assessment, now used in the UK Nuclear Industry with the agreement of the UK Office of Nuclear Regulation. In the railway context, I have supported the consideration of human reliability on topics including: ERTMS transitions, automatic selective train door operations, train driver on-train camera monitoring systems for dispatch, track possessions, defective on-train equipment, visual inspection of train axles, driver signal observation and driver station stopping tasks. I have also been responsible for the development of the Human Factors elements of the GB National incident reporting system. Huw is a Fellow of the Chartered Institute of Ergonomics and Human Factors, has a Ph.D. from the University of Birmingham ("Communication Failures in Air Traffic Control", University of Birmingham 2002) and an MSc (Eng.) in Work Design and Ergonomics (University of Birmingham, 1992).

- **Philippa Murphy (F).** Philippa Murphy is a Principal Human Factors Specialist working for RSSB. She has spent the majority of her career in the rail sector working on various human factors and behavioural safety projects and research for Railtrack, Network Rail and as a freelance consultant. Her areas of expertise at RSSB are accident investigation and classification of human factors data, Non-Technical Skills training, development and integration, and improving operational decision making. Philippa has also worked in the Environmental and Risk Consultancy ERM.
- **Anisha Tailor (F).** Anisha is a Senior Human Factors Specialist at RSSB with a BSc in Psychology and Masters in Health Psychology. Before joining RSSB in 2017 Anisha worked as a human factors specialist for the UK's Transport Research Laboratory, bringing experience in road safety and human performance to the project. Anisha has experience in risk assessments for railway route knowledge and has been involved in a range of studies which have investigated human performance in the road driving and railway contexts. Wider organisational factors have also been considered through work on fatigue, decision making in degraded modes and the provision of human factors support to front line managers.
- **Margaret Adams (F).** Margaret is an experienced railway professional who has worked in the UK rail industry for over 15 years and is currently the European Programmes Manager for Rail Safety and Standards Board (RSSB). For several years, Margaret was the Engineering Research Manager responsible for delivering Energy, Rolling Stock and Infrastructure research projects including European Framework Programmes such as PantoTRAIN and Gaderos. Margaret now works full time on the H2020 and Shift2Rail programmes, developing partnerships, forming consortiums for the Horizon 2020 / Shift2Rail Programmes and delivering European Programmes on behalf of RSSB. Before joining RSSB she was Director of a project consultancy, and delivered a range of projects and programmes for rail, Government and industry clients. She is a member of the Association of Project Managers (MAPM). Margaret's education includes a degree of BA (Hons) in Psychology and Philosophy, MEng degree in Engineering (ongoing).

4.1.26.2 Publications

1. Gibson, W.H. et al (2017) 'The Role of Human Factors in Supporting Safety Learning from Railway Incidents' 27th International Railway Safety Council, Hong Kong.
2. Gibson, W.H., Mills, A., Dennis, C. and Carpenter, S. (2013) 'Development of the incident Factor Classification System' in 45th ESReDA Seminar on Dynamic Learning from Incidents and Accidents, Bridging the Gap between Safety Recommendations and Learning, Porto, Portugal
3. Gibson, W.H., Mills, A., Smith, S. and Kirwan, K. (2013) 'Railway Action Reliability Assessment, a railway-specific approach to human error quantification' in Rail Human Factors: Supporting reliability, safety and cost reduction pp. 671–676.
4. Gibson, W.H. et al (2011) 'Tailoring the HEART technique for application in the rail industry' ESREL 2011, Troyes, France.
5. Kirwan, B., Gibson, W.H. and Hickling, B. (2008) 'Human error data collection as a precursor to the development of a human reliability assessment capability in air traffic management' Reliability Engineering & System Safety 93(2) pp. 217-233.

4.1.26.3 Relevant Previous Projects

Name	Topic	Relevance	Reference
Development of the Incident Factor Classification System (T994)	This project involved the design and implementation of a national database for the classification and analysis of the human factors causes of railway incidents. The user requirements, human factors taxonomies and software were developed and implemented for the project. The database has been populated with industry data and the data have been used to inform national and European strategy on signals passed at danger, train driver rote knowledge and fatigue		https://www.sparkrail.org/Pages/SparkWelcome.aspx .
Development of a human error quantification technique for use in the railway industry (T270)	The objective of the project was to produce a railway-specific human reliability assessment (HRA) tool to enable HRA to be carried out more efficiently, more accurately, and with more consistency within the rail industry. The work was supported by a technical expert from EUROCONTROL. The approach, Railway Accident Reliability Assessment, has been used in railway safety assessments in areas including Emergency Plans, Maintenance Procedures and Train Cab design.		www.sparkrail.org/Page/SparkWelcome.aspx .
Research into the Human Factors causes of SPADs (T1128)	This study completed in 2018 and investigated the systems and human performance causes of one of the most critical railway incidents, a signal passed at danger. The research funding came from the UK Department for Transport and results from the study are being implemented in the GB rail industry. The study analysed and classified the underlying causes of the incidents, reviewed the causes in their organisational context and identified areas for strategic intervention related to human performance and systems causes (competence, equipment design, fatigue). The work integrated risk and human factors safety data and was complemented by a national survey on culture in relation to SPAD incidents.		https://www.sparkrail.org/Pages/SparkWelcome.aspx .
Evaluating the use of on-train driver only operation (passenger) monitors during station departures (T1059)	This study investigated a specific train driver task using safety database and human reliability assessment approaches. These were supplemented with simulator studies assessing driver performance for the safety critical scenarios. The work has fed in to changes to National Standards for the design of in-cab CCTV systems to be used by train drivers.		www.sparkrail.org/Page/SparkWelcome.aspx
Achieving a step change in route knowledge management (T1108)	Route knowledge forms part of train driver competence, as defined in European legislation. This project used mixed methods of incident data analysis, field data and risk assessment to develop a new approach to competence development. The approach was used in live trials at three train operating companies. The approach is now being implemented in the GB rail industry through a change to the national route knowledge standard.		https://www.sparkrail.org/Pages/SparkWelcome.aspx

4.1.26.4 Major Infrastructure

RSSB premises are located in London, including workstations, meeting rooms, a canteen and area for visitors to work in. RSSB runs the national Safety Management Information System from these offices. As RSSB is a member organisation, we can draw on their resources in terms of access to train simulators, test sites and railway staff.

4.1.27 UNIVERSITEIT VAN AMSTERDAM

The University of Amsterdam (UvA) was established in 1642 and is the largest university in the Netherlands. UvA is a member of the League of European Research Universities (LERU) and one of the top research universities in Europe. Its alumni include more than a dozen ministers in Dutch governments and two Nobel Prize laureates. UvA is the highest ranked Dutch University in the recently published QS ranking. It has extensive experience leading and participating in national and international projects and programs. The project will be hosted by the Amsterdam Business School (ABS). ABS consists of around 110 faculties, around 30 PhD students, and around 40 support staff. The School is and has been involved in many national and EU-funded projects, and collaborates with a large number of research groups, nationally and internationally. At graduate level, it offers teaching programs in Accounting, Finance, Business with business analytics and data science being overarching themes. It furthermore has a substantial post-graduate education portfolio. Research within the school is grouped in three main themes: Business Analytics & Data Science; Corporate Governance; and Entrepreneurship. Especially relevant for this project is the business analytics/data science theme, where a strong alliance with the Science Faculty has been formed, both in education and research.

4.1.27.1 Key personnel

- **Prof. dr. Evangelos Kanoulas (M)** is professor of Text Analytics and Information Retrieval for Business at the University of Amsterdam. He holds a joint appointment between the Amsterdam Business School (20%) and the Informatics Institute (80%). His expertise lies in the fields of information retrieval, natural language understanding, and text mining. In the past he worked as a research scientist in two of the leading companies in search technology, Google and Microsoft. In 2010 Kanoulas was awarded the Marie Curie Fellowship to work as a postdoctoral research scientist at the University of Sheffield, UK, while in 2018 he was awarded with the prestigious NWO VIDI grant (800K EUR) to conduct research in user-human conversations for retrieving information in large scale databases. Kanoulas has extensively published his work in top-tier conferences in the field, including KDD, SIGIR, CIKM, AACL, VLDB, WWW, WSDM. He has written over 60 peer-reviewed journal articles and conference papers, which have received over 1900 citations to this date. He has served as a conference chair for the ACM ICTIR in 2017, and as a program chair for the CLEF in 2014. Since 2007 together with others he has proposed and organised numerous search benchmark exercises under the umbrella of the Text Retrieval Conference (TREC), funded by the US National Institute of Standards and Technology, all of which led to large-scale testing collections to foster research and development in information retrieval. Since 2014 he is a member of the steering committee of CLEF, the European counterpart of TREC.

4.1.27.2 Publications

1. Thijs Scheepers, Evangelos Kanoulas and Efstratios Gavves. “Improving Word Embedding Compositionality using Lexicographic Definitions”. In Proceedings of the 2018 World Wide Web Conference (WWW '18).
2. Shangsong Liang, Xiangliang Zhang, Zhaochun Ren and Evangelos Kanoulas. “Dynamic Embeddings for User Profiling in Twitter”. In Proceedings of ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD-2018), 2018.
3. Ilias Koutsakis, Evangelos Kanoulas, George Tsatsaronis and Eamonn Maguire. Classy: A visual analytics environment for supervised text classification and model evaluation. In Proceedings of the 26th ACM International Conference on Conference on Information and Knowledge Management (CIKM '17). ACM, New York, NY, USA.
4. Shangsong Liang, Emine Yilmaz, Evangelos Kanoulas, “Collaboratively Tracking Interests for User Clustering in Streams of Short Texts”, ACM Transactions on Knowledge and Data Engineering (TKDE), 2018.
5. Christophe Van Gysel, Maarten de Rijke, Evangelos Kanoulas, “Neural Vector Spaces for Unsupervised Information Retrieval”, ACM Transactions on Information Systems (TOIS), 2018.

4.1.27.3 Relevant Previous Projects

Name	Topic	Relevance	Reference
CONTRO-CURATOR COMMIT Project	Identifying controversial topic on the web and summarizing opinions around these topics.	The general goal of CONTROCURATOR was to process large volumes of natural language and assign semantics to it to classify pieces of text as controversial or not using methods that allow the collaboration of humans and machines. SAFEMODE also targets at analysing large safety databases of natural language reports to identify event scenarios and classify them to human factors.	http://controcurator.org/
ACCURAT FP7 Project	Analysing and evaluating comparable corpora for under resourced areas of machine translation.	The general goal of ACCURAT was to gather multi-lingual corpora that allow the development of effective machine translation techniques. SAFEMODE collects textual data for near-misses, incidents and accidents, which often consists of multi-lingual, either within the same report, but also across reports. Machine translation techniques will be useful to integrate all data.	http://www accurat-project.eu/
NOMAD FP7 Project	Identifying arguments in favour or against a statement in a textual corpus of user-generated text obtained from a variety of sources on the Web and summarizing these arguments.	The general purpose of NOMAD was to process large volumes of user generated content and classify them but also summarize them around important topics for which people argue about. Similarly, SAFEMODE also targets at analysing large safety databases of user (employees) generated reports to identify event scenarios and classify them to human factors. User generated text share certain characteristics, such as the use of abbreviations, noisy language, misspellings, etc.	http://www nomad-project.eu/
BIAS Amsterdam Academic Alliance Project	Identify Bias and Engagement in Political Social Media	The general goal of BIAS was to process large volumes of user generated and curated data natural language and assign semantics to it to classify pieces of text as biased or not. SAFEMODE also targets at analysing large safety databases of user (employees) generated reports to identify event scenarios and classify them to human factors.	

4.1.27.4 Major Infrastructure

ILPS – the research group of Prof. Kanoulas, owns a cluster with close to 1000 cores, 60 GPUs, 2,000Tb storage, 10Tb main memory. Further, ABS has direct access to the Dutch national compute infrastructure maintained by SurfSARA, from which it obtains several million compute hours per year for its experimental work.

4.1.28 WÄRTSILÄ

Wärtsilä is a global leader in smart technologies and complete lifecycle solutions for the marine and energy markets. By emphasising sustainable innovation, total efficiency and data analytics, Wärtsilä maximises the environmental and economic performance of the vessels and power plants of its customers. In 2018, Wärtsilä's net sales totalled EUR 5.2 billion with approximately 19,000 employees. The company has operations in over 200 locations in more than 80 countries around the world. Wärtsilä is listed on Nasdaq Helsinki. Further Wärtsilä is a world leader in marine technology. With an extensive portfolio of innovative and integrated products and solutions, Wärtsilä delivers efficiency, reliability, flexibility, and environmental sustainability to enhance the business of its customers. As our industry enters a new era of innovation and unprecedented efficiency, Wärtsilä is using high levels of connectivity and digitalisation to bring value and optimisation to all marine applications. In so doing, it is leading the industry's transformation towards a smart marine ecosystem.

4.1.28.1 Key personnel

tbc

4.1.28.2 Publications

tbc

4.1.28.3 Relevant Previous Projects

tbc

4.1.28.4 Major Infrastructure

tbc

4.1.29 ARCHIPELAGO PHILIPPINE FERRIES CORPORATION

Archipelago Philippine Ferries Corporation (“APFC” or “Archipelago”) was founded to provide a vital maritime link between the Philippines’ 7,107 islands. Since its incorporation in 2002, it has become a trusted shipping company that owns and operates the Philippines’ first and only catamaran Roll-on/Roll-off (“Ro-Ro”) ferry, as well as modernized ports and terminals in the eastern, western and central sea corridor. In support of the government’s Strong Republic Nautical Highway Project, and to facilitate the economical movement of people and goods, APFC offers safe, fast and convenient ferry service to the islands using state-of-the-art Ro-Ro vessels. These new vessels are the first ferries designed specifically for Philippine water conditions. APFC’s ferries operate under the brand name, FastCat. The vessels are of mid-speed Ropax/Ro-Ro vessels built for freight vehicle transport along with passenger accommodations. It offers safe, fast and convenient ferry transport service to the Filipino market and eventually its neighbouring countries with its investment of thirty (30) brand-new, custom crafted Ro-Ro vessels with world-class amenities that are fully compliant with international standards for lifesaving, firefighting, and damage-stability. Each vessel is designed with 275 to 325 passenger capacities and can accommodate 32 to 38 light cars and 8 to 12 cargo trucks. It travels at 16.5 knots or 29 kilometres per hour, faster than most Ro-Ro vessels, and is proudly, the first of its kind in the country. APFC’s reflecting program is slated to be completed by 2020. Further details available in www.fastcat.com.ph

4.1.29.1 Key personnel

- **Mr. Christopher S. Pastrana (M)** is the President & CEO of Archipelago Philippine Ferries Corporation. He is responsible for leadership of the Board and for the efficient organization and conduct of the Board’s functioning. He saw a way to contribute to the transportation industry and to the improvement of inter-island connectivity in general. As the Philippine economy continues to grow, the need for efficient inter-island transport system is crucial more than ever to facilitate business, agriculture and tourism. He thought of the need for a modernization program and help the industry through innovation by providing brand new vessels that would be more suitable to the Philippine market and would offer the safety, comfort and convenience every Filipino so deserves. He raised the bar and become the game changer in the maritime industry in the Philippines, transforming not only the ferry industry but also enhancing the overall passenger experience. He formed a strategic alliance with JAM Liner and Philtranco Bus companies to serve as a major “feeder” for the RoRo (Bus as rolling cargo and passengers) and this partnership also provides synchronized ticketing system and aligned trip schedules, thus ensuring seamless connectivity in areas where they operate. Also, passengers and goods can now be transported efficiently from their point of origin to their point of destination on a nationwide scale. Delays, waiting and travel time are reduced. He is currently the President of the Philippine Interisland Shipping Association and sits in the board of MARINA.
- **Mr. Dennise C. Trajano (M)** is the Chairman of the Board of Archipelago Philippine Ferries Corporation (APFC). He is also a Managing Director in JAM Group/Dyip Co. and QRS. Mr. Trajano is a Civil Engineering graduate from the University of Sto. Tomas.
- **Mr. Christopher S. Pastrana (M)** President & CEO, has around 30 years of business and management experience in water transportation. He founded APFC and its success could be attributable to his solid leadership. As a major player in water transportation industry, he represents APFC in many water transport international and national organizations and symposiums. Mr. Pastrana graduated from the University of the Philippines, Los Banos with a degree in Agricultural Business. He also obtained a Masters of Entrepreneurship from Asian Institute of Management.
- **Mrs. Mary Ann I. Pastrana (F)** Executive Vice President – Treasurer. She is the Treasurer of APFC since 2002. She is responsible for running and overseeing the treasury operations of APFC. Concurrent to her role in APFC, she holds the same position in CAPP Group of Companies. Prior to founding APFC, she held treasury and finance positions in Prudential Customs Brokerage and Chon-Lin Corporation. Ms. Pastrana graduated from the University of the Philippines, Los Banos in 1989 with degree in Nutrition and passed the Nutrition Licensure Examination on the same year. She holds Post – Diploma Course in Executive Maritime Management for the World Maritime University in 2016 and is the current Vice President of Women in Maritime.

- **Atty. Ricky G. Ty (M)** VP-Legal, has around 17 years of involvement in Maritime Training and Education. He's an experienced lawyer in maritime litigation. Concurrent with holding a position in APFC, he is also the Vice President of HR & Admin. Atty. Ty graduated from University of Sto. Tomas with a degree in Political Science. He later on obtained Bachelors of Law degree from Lyceum of the Philippines.
- **Mr. Danilo C. Trajano (M)** Director of APFC. He is also the Vice-Chairman of JAM Liner, Inc. Mr. Trajano is a Civil Engineer by profession.
- **Mr. Edwin L. Gardiola (M)** Director of APFC. He is also the Chairman of JAM Liner, Inc. Mr. Gardiola is a Civil Engineer by profession.

4.1.29.2 Publications

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4.1.29.3 Relevant Previous Projects

Name	Relevance	Reference
Philippine Nautical Highway System	Philippine Nautical Highway System: the Road Roll-on/Roll-off Terminal System (RRTS) or simply the RoRo System, is an integrated network of highway and vehicular ferry routes which forms the backbone of a nationwide vehicle transport system in the Philippines.	
FASTCAT project	FASTCAT project: catamaran roll on-Roll off ships were specifically designed for climate conditions of the Philippine seas to deliver safe and efficient integrated transport system. ships also has a double hull with 10 watertight compartments, no ballast tanks for stable buoyancy, and a fire security system and a navigation and control systems.	
Modernisation of Philippine Ports	Modernisation of Philippine Ports: APFC has been involved in the modernization of Philippine ports in the east and west sea corridor	

4.1.29.4 Major Infrastructure

APFC offers safe, fast and convenient ferry transport service to the Filipino market and eventually its neighbouring countries with its investment of thirty (30) brand-new, custom crafted Ro-Ro vessels with world-class amenities that are fully compliant with international standards for lifesaving, firefighting, and damage-stability

4.1.30 INSTITUT TEKNOLOGI SEPULUH NOPEMBER

Institut Teknologi Sepuluh Nopember (ITS) is located in Surabaya, a second largest industrial city in Indonesia. ITS belongs to the five (5) best overall university, and the second best university in the disciplines of science and technology in Indonesia. In the year of 2017 ITS has been awarded by the Ministry of Research Technology and Higher Education (MoRTHE), Republic of Indonesia, as the first rank national university with innovative science and technology achievements. ITS is acknowledged as the hub to some 37 universities in the eastern part of Indonesia, with the centre of excellences in marine technology, human settlement and energy. ITS comprises of 10 faculties with 39 departments of various discipline of science and engineering studies, with overall student body of some 21,000 students ranging from undergraduate, master degree and doctorate degree programmes. ITS is very active in conducting researches, both financed by national grants as well as international grants with a large number of international partners. In this respect ITS has achieved an acknowledgement as the second rank of Indonesian research institution in Scopus-indexed scientific publication speed. Faculty of Marine Technology (FMT) is one among 10 faculties under ITS, specialising in the organisation of higher education in marine technology since its establishment in 1960. The total student body of FMT is around 1,800 students, divided into four departments, namely Department of Naval Architecture (DoNA), Department of Marine Engineering (DoME), Department of Ocean Engineering (DoE), and Department of Marine Transport Engineering (DoMTE). FMT has played an important role in the development human resources and infrastructures of marine technology all over Indonesia. For this reason the Indonesian government by the end of 1980s has built a facility widely known as Indonesian Hydrodynamics Laboratory (IHL) within ITS campus, now run by the Agency for the Assessment and Application of Technology, Republic of Indonesia. In addition to this, by 2006 the Ministry of Industry (MoI), Republic of Indonesia, has built a facility called the National Ship Design and Engineering Center (NaSDEC) for ITS. FMT-ITS has worked closely with various international partners. The most recent one is with University of Strathclyde (UoS) in the research collaboration on Sustainable Vessel for Indonesia (SUVESIN), financially assisted by the British Council Newton Fund programme through the Institutional Links Grants 2016-2018. Department of Marine Transportation Engineering is the first department in this field in Indonesia. It was established in 2011, and it was initially started as one of four fields of expertise under the Department of Naval Architecture in 1993. The Department has a vast network in the Indonesian maritime industry, especially in shipping and port industries and governmental authorities. The department was involved in drafting of the Indonesian Shipping Act 2008, Maritime Highway Policy. Various studies in the field of shipping, port management and logistics from major partners domestic and abroad have been and are being undertaken. Few of the partners are a.o. World Bank, Ministry of Transportation, Ministry of Ocean Affairs and Fishery, STC Rotterdam, Erasmus University Rotterdam, Sembawang Shipyard (Singapore), Pertamina (state-owned oil and gas company), PELNI, ASDP, Samudera Indoensia, Meratus Shipping (shipping companies), PELINDO I-IV, TPS, Terminal Teluk Lamong (port companies). The department is involved in initiating similar department on few universities in eastern Indonesia, University of Hasanudin (Makassar) and University of Pattimura (Ambon). An array of research in the areas of shipping policy, conceptual designs of ports and terminals, intelligent marine transportation systems have been conducted intensively in collaboration with industrial partners.

4.1.30.1 Key personnel

- **Professor Eko Budi Djatmiko (M)** is a lecturer and superintendent of the Offshore Hydrodynamics Laboratory at the DoE of FMT-ITS. He completed his undergraduate degree from the Faculty of Shipbuilding & Engineering ITS in 1983. Pursued further studies at the Department of Naval Architecture & Ocean Engineering (NAOE), Glasgow University, Scotland, earned his MSc degree in 1988 and PhD degree in 1992 after submitting the thesis entitled “Hydro-Structural Studies of SWATH Type Vessels”. Upon his return to ITS in 1993 Prof Djatmiko has been engaged with various studies, researches and professional services related to design, hydrodynamics and structural analyses of ship and ocean structures. He has also held responsibilities in a number of university management, ranging from Head of DoE-ITS in 1993-1999, Head of ITS Marine Research Center in 2000-2003, Deputy Dean FMT-ITS for Student Affairs in 2003-2007, ITS Vice Rector for Cooperation Affairs in 2007-2011, Dean of FMT-ITS in 2011-2015, and Chairman of ITS Sustainable Island Development Initiatives (SIDI) in 2014-now. His achievements as a professional ocean engineer may be shown by some of the following activities. Member of the Team for Ship

Stability Evaluation, an assignment by the Ministry of Transportation (MoT) – Republic of Indonesia (RI). Team Leader for the Design Review and Verification of the Belanak FPSO, an assignment by the Ministry of Energy and Mineral Resources (MoEMR) – RI in collaboration with ConocoPhillips Indonesia Inc Ltd. Team Leader for the Design Review and Verification of the West Seno TLP, an assignment by MoEMR – RI in collaboration with Unocal Makassar Ltd. Member of the Technical Committee of Indonesian Bureau of Classification (BKI). Member of the Independent Team on Oil & Gas Safety Monitoring, assignment by the MoEMR – RI. Member of the Preparatory Team for the Procurement of 3,500 Fishing Vessels, an assignment by the Ministry of Marine Affairs and Fisheries (MoMAF) – RI. Team Leader for the Roadmap Development on the Implementation of LNG as Alternative Fuel for National Marine Transportation, an assignment jointly given by the MoEMR and MoT – RI.

- **Dr.-Ing. Setyo Nugroho (M)** is a lecturer of the Department of Marine Transportation Engineering of the Institut Teknologi Sepuluh Nopember (ITS) where he leads the Laboratory of Marine Transport Telematics. He pursued his bachelor and master degrees from the Delft University of Technology/ TU Delft (The Netherlands) -finished in 1993-, and his doctorate degree from the Technical University of Berlin/ TU Berlin (Germany) -finished in 2005-, both in the field of Marine Transportation. He was the Vice Dean of the Faculty of Marine Technology, at the Institut Teknologi Sepuluh Nopember (ITS), Surabaya. He worked at Wijsmuller Engineering, Ijmuiden, The Netherlands, immediately after the MSC graduation from TU Delft. Then he worked for Meratus Shipping between 1994-1997, in Surabaya, where he was responsible for the operations of general cargo and container ships, chartering, agency and projects. His fields of interest are shipping, intelligent transportation systems (ITS) and artificial intelligence. He filed his Case-Based Stowage Planning System (CaseStow) at the German and European Patent Offices, in 2004 and 2005. His stowage planning software, iStow, has been certified by Indonesian Classification Society (BKI) and is in the process of similar certification by IACS members, o.a. ClassNK and RINA. He conducts research in the areas of stowage planning, application of ITS for safety and productivity enhancement of both merchant and traditional shipping. He is also one of the co-founders of the Sustainable Island Development Initiatives (SIDDI). He coordinates a multidisciplinary research to enhance the quality of life of remote islands in a sustainable way.
- **Dr. Tri Achmadi (M)** is a lecturer and has been assigned as the Head of the Dept. of Marine Transportation Engineering, Faculty of Marine Technology (FMT), Institut Teknologi Sepuluh Nopember (ITS) 2011– 2019. He completed his Bachelor Degree from the Dept. of Naval Architecture, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember (ITS), Surabaya in 1987. Upon his completion of his undergraduate study, he continued to a higher degree education at the Dept. of Marine Technology, the University of Newcastle Upon Tyne, UK– finished his Doctoral Degree in 1992. His dissertation entitled “An Integrated Design and Evaluation Model for Inter-island Transportation in Indonesia”. His professional achievements: In the field of marine transport development and capacity building of institutions in Indonesia, since 2002, he has been involved in many consultation works in collaboration with international experts. Most of the projects were funded by international institutions, such as: The World Bank Group, Development Bank of Germany - KfW (Kredit Kreditanstalt für Wiederaufbau), ISL (Institute of Shipping Economics and Logistics, Bremen, Germany), USAID-Washington DC, GHD PTY. LTD. (Australian Consulting Company, head office: Canberra), and ADB (Asian Development Bank). In shipping and Port business and development, he has been involved in many State-owned enterprises in Indonesia, such as: Pertamina, PLN, Pelni, ASDP, Port Corporations as well as with privately-owned shipping and port companies. In 2014-2019, he was assigned as a member of advisory board under the Ministry of Transportation (MoT), in which he responsible for marine transport public policy analysis such as marine transport pricing policy, Subsidy, Safety Measures Analysis at national level etc. In 2008, he was one of the team member to develop the “Indonesia Shipping Law” known as “Undang–Undang Pelayaran” No:17/2008, which is still applicable up to present. Beside his busy activities in the

government and marine transport industry, he teaches several subjects at under-and-post graduate school. His field of interest includes optimization techniques in decision making process for marine transport planning, conceptual ship design, maritime economics, maritime logistics, and regional economics.

- **Shanty, ST., MT (F)** has been working as a lecturer in the major of the State Maritime Polytechnic of Samarinda since 2005, became secretary of department in 2008-20012, and head of department in 2012-2016. Since 2006, she has been involved in a consultation work in collaboration with Department of Industry and Commerce, At present, the East Kalimantan Province aims to review and to improve the traditional shipping industry. She has been actively involved in an array of research and capacity building activities of the traditional shipping. Shanty is also a research student in the Doctorate program of the Department of Marine Transportation Engineering of the Institute Technology Sepuluh Nopember (ITS). She completed her undergraduate degree from the Faculty of Shipbuilding and Engineering at the Hasanuddin University in 2001. Pursued her Msc degree at the Department of Marine Transportation Engineering of the Institute Technology Sepuluh Nopember (ITS) and finished in 2004. Her fields of interest are shipping, port and transportation. She conducts research in the area of marine safety of the domestic merchant shipping.

4.1.30.2 Publications

1. E.B. Djatmiko, Murdjito & M.B. Zaman (2015), Safety of Oil and Gas Industry from Academic Perspective, Forum Group Discussion on Oil & Gas Safety, Directorate General of Oil & Gas, Ministry of Energy and Mineral Resources, Surabaya, Indonesia, August 2015
2. E.B. Djatmiko & Murdjito (2017), Safety Aspect in Marine Transportation for the Distribution of Fuel Oil to the Remote Small Islands, Forum Group Discussion on National Oil and Gas Distribution, Oil and Gas Downstream Management Agency, Surabaya, Indonesia, October 2017
3. S. Nugroho, M.B. Zaman, E.B. Djatmiko, Murdjito, W. Busse, Information Connectivity As A Primary Instrument To Enhance Transport Connectivity, International Journal of Marine Engineering Innovation and Research, Vol. 2(2), Mar. 2018. 98-101 (pISSN: 2541-5972, eISSN: 2548-1479)
4. Murdjito, M.P. Rosari & E.B. Djatmiko (2018), Analysis on the Critical Conditions of Side-by-Side Offloading Operation Between SSP Type-FPSO and Shuttle Tanker, Applied Mechanics and Materials, Vol. 874, pp. 53-63, January 2018
5. S. Nugroho, F. Zulkarnaen, J.F. Arizal, "Intelligent Transportation System Architecture to Address Challenges of the Traditional Shipping Operations (PELRA)", Journal of Engineering of Applied Sciences, 13(8), 2114-2119, 2018, ISSN 1816949X

4.1.30.3 Relevant Previous Projects

NAME	TOPIC	RELEVANCE	REFERENCE
HOLTEKAMP ARCH BRIDGE TRANSPORT	Analysis on the safety of sea transportation the Holtekamp Arch Bridge (weight 1800 ton) from Surabaya to Jayapura (distance of 1885 sea miles)	Evaluating the management of human resources and transportation means to assure the safety of marine transportation	Collaboration between ITS and PT Pembangunan Perumahan (Civil Engineering Company) to meet the demand of Ministry of Civil Works Period: 2017 – 2018
SUVESIN	Designing Safe, Green	The study is aimed at	Research Collaboration

	and Sustainable Vessels for Indonesian Coastal Transport and Fishing Operation	implementing alternative material (bamboo laminate) in the building of traditional cargo and fishing vessels to enhance the sustainability aspect with green environment perspective. This is supported by sound vessel design to assure the safety in operation.	between ITS and University of Strathclyde under the financial assistance of Newton Institutional Links Grant, British Council, UK Period: 2016 – 2018 www.suvesin.com/suvesin/
MONITORING AND SMART CONTROL FOR MARINE TRANSPORTATION	Development of monitoring and smart control system installed on seagoing vessels to enhance the management quality in marine transport.	Enhancing marine transportation safety with the aids of monitoring and smart control system	Incentive on Applied Research, financially assisted by the Ministry of Research Technology and Higher Education, Republic of Indonesia Period: 2009 – 2012
OFFSHORE OIL & GAS SAFETY AUDIT	Periodical audit conducted to various oil & gas companies operated in Indonesia to assure the high safety codes and standard is satisfied	Encourage the human resources and management in oil & gas companies to continuously make a great effort in achieving the highest level of safety	Assignment from the Directorate General of Oil & Gas, Ministry of Energy and Mineral Resources through the Independent Team of Oil and Gas Safety Controllers Period: ongoing since 2003
NATIONAL MARINE TRANSPORTATION SAFETY	Periodical evaluation and recommendation to enhance national marine transportation safety	Provide recommendation to enhance national marine transportation safety through improvement of human resource as operators, shipping management, and ship design as well as infrastructures	Assignment from the Directorate General of Sea Transportation and National Transportation Safety Committee, Ministry of Transport Period: ongoing since 1990

4.1.30.4 Major Infrastructure

A. National Ship Design and Engineering Center (NaSDEC)

The National Ship Design and Engineering Center (NaSDEC) is managed by ITS, established in 2006 in collaboration with the Ministry of Industry. The main aims of NaSDEC establishment is:

- Supporting the improvement and the competitiveness of national shipbuilding industry products in the international market by developing innovative and efficient ship product designs.
- Become an agency of organizing structured, systematic and organized activities nationally to support the availability of the products of ship design and engineering development that are able to compete in the national and international markets in terms of quality, cost and time of delivery.
- Enhancing the existing national potential to produce design and engineering of ships that are able to compete in the national and international markets from the aspect of quality, cost and time of delivery.
- Become an agency of technology transfer and technology dissemination in the field of ship design and engineering nationally.



Figure 32 The National Ship Design and Engineering Center (NaSDEC)

B. Indonesian Hydrodynamics Laboratory (IHL)

The Indonesian Hydrodynamics Laboratory (IHL) is located at ITS campus in Surabaya, Indonesia. The laboratory accommodates three main facilities. The first facility is a towing tank sized 234.5 x 11.0 x 5.5 m (length x breadth x water depth), capable of running model tests on 4 m upto 9 m long ship model at maximum speed of 9 m/sec, equipped with a wave maker to generate regular and random waves. The second facility is manoeuvring and ocean engineering basin with the tank dimensions (excl. harbour): a) Deep part 60 m x 35 m, max water depth 2.5 m, b) Pit part 5 m x 5 m, max water depth 9.5 m, c) Shallow part 45 m x 35 m, max water depth 1.25 m. This is equipped with main and sub carriage: Manned, max acceleration 0.8 m/s², max speed 2 m/s. Capable of testing model of floating or fixed structures of any kind, size depending on water depth and wave condition, from 0.2 m buoy model to 4 m long ship model. A hydraulically driven snake type wave maker capable of generating regular or irregular waves with period of 0.5 – 3 seconds with direction in deep part between 0° and 90°, 180° and 270°; in shallow part between 0° and 180°; with significant wave height up to 0.3 m. The third facility is a vertical closed recirculating type water channel, operated with variable speed and pressure of 0.2 ~ 2 bar absolute, capable to accommodate the test of marine propeller with a maximum diameter of 300 mm.

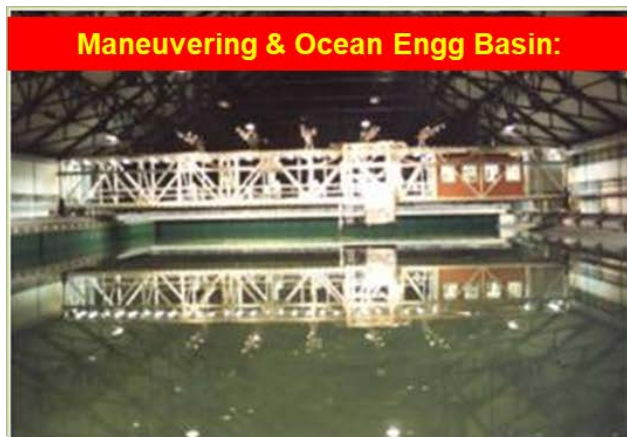


Figure 33 Indonesian Hydrodynamics Laboratory (IHL)

4.1.31 ROLLS-ROYCE MARINE AS

Rolls-Royce has a world leading range of capabilities in the marine market, encompassing vessel design, the integration of complex systems and the supply and support of power and propulsion equipment. We are leaders in mission-critical systems for offshore oil and gas rigs, offshore, merchant and naval vessels. Today the Rolls-Royce marine product range is one of the broadest in the world. 70 of the world's maritime forces and over 30,000 commercial vessels use our equipment. Our global support network underpins all activities and continues to expand with 50 centers in 28 countries with more planned. We provide a range of capabilities and expertise for offshore vessels and oil and gas platforms, merchant vessels and naval surface ships, with support provided by our global service network. We are active both in exploration/production and supply/service sectors, supplying systems that range from facilitating seismic research to keeping a rig safely in position. Our UT-Design vessels are an industry benchmark – over 650 are now in service or in build. Advanced designs that benefit from the integration of new technologies required for successful exploration and operation in deeper and more hostile waters. Equipment and systems are supplied for vessels that range from luxury yachts and cruise ships to ferries and tugs. We continue to expand our range of innovative and efficient cargo vessel designs, and lead the sector in environmentally friendly LNG propulsion solutions. Our experience in naval propulsion spans over 50 years for both surface ships and submarines. We have developed the MT30, the world's most powerful marine gas turbine at sea, powering the U.S. Navy's monohull Littoral Combat Ship, and also selected by Korea and the UK for future naval programs.

- Rolls-Royce pioneers cutting-edge technologies that deliver the cleanest, safest and most competitive solutions to meet our planet's vital power needs.
- Rolls-Royce has customers in more than 150 countries, comprising more than 400 airlines and leasing customers, 160 armed forces, 4,000 marine customers including 70 navies, and more than 5,000 power and nuclear customers.
- Annual underlying revenue was £15 billion in 2017, around half of which came from the provision of aftermarket services. The firm and announced order book stood at £78.5 billion at the end of December 2017.
- In 2017, Rolls-Royce invested £1.4 billion on research and development. We also support a global network of 31 University Technology Centres, which position Rolls-Royce engineers at the forefront of scientific research.
- Rolls-Royce employs 55,000 people in 50 countries. More than 19,400 of these are engineers.
- The Group has a strong commitment to apprentice and graduate recruitment and to further developing employee skills. In 2017 we recruited 313 graduates and 339 apprentices through our worldwide training programs.

4.1.31.1 Key personnel

- **Dr Frøy Birte Bjørneseth (F)** is currently working at Rolls-Royce Marine AS as a principal engineer within the field of human factors and control centres, mainly within bridge environment (Rolls-Royce Unified Bridge) and engine control rooms. Specialist within human machine interaction and human factors within the maritime domain. Main tasks: to ensure and maintain good usability and human factors of current and future Rolls-Royce products. PhD thesis: Assessing the Effectiveness of Using Direct Gesture Interaction in a Safety-Critical Maritime Application. The outcome gave interesting findings. The thesis was successfully defended the 26th of October 2010. Title awarded: Dr. Phil. HMI and HF within the maritime domain. Have thorough experience with quality assurance processes (PILM) and running projects of various sizes. Have successfully obtained funding from external sources (Norwegian Research Council) and has experience in writing research applications. Has also experienced "life at sea" through observation studies on board various vessels, studying on board operational environment during several types of operations. In addition: - Certified High Performance Culture facilitator; - Media training; - Team leader training. Main areas: Team leader Software GUI, Rolls-Royce Unified Bridge, Control Centre (Bridge/ECR) ergonomics, Research within Human Factors and Human Machine Interaction, Product development (consoles, levers, operator chairs, software), Graphical design/Interaction design of software applications, User testing and user interviews, User experience QA, Experimental research study

designs. Specialties: Human Machine Interaction, Human Factors, Usability Studies, Human Error, Cognitive load assessment, user centred design process, operator interviews and field studies. Dr. Bjørneseth is also holding a position as an Associate Professor within Human Factors at the Norwegian University of Science and Technology (NTNU)

4.1.31.2 Publications

1. Frøy Birte Bjørneseth, Mark Dunlop, Eva Hornecker (2012) Assessing the Effectiveness of Direct Gesture Interaction for a Safety Critical Maritime Application, International Journal of Human-Computer Studies June 19, 2012, Elsevier
2. Frøy Birte Bjørneseth, Mark Dunlop, Jann Peter Strand (2008) Dynamic Positioning Systems – Usability and Interaction Styles, ACM, NordiCHI (Achieved the Euan Minto prize for best student paper in Information and Computing Sciences dept.) October 2008
3. Frøy Birte Bjørneseth, Mark Dunlop, Eva Hornecker (2010) Assessing the Effectiveness of Multi-Touch Interfaces for DP Operation, Human Performance at Sea Conference (Honourable mention in best student paper awards) June 2010
4. Frøy Birte Bjørneseth, Sathiyakumar Renganayagalu, Mark Dunlop, Eva Hornecker, Sashidharan Komandur (2012) Towards an Experimental Design Framework for Evaluation of Dynamic Workload and Situational Awareness in Safety Critical Maritime Settings, Proceeding BCS-HCI '12 Proceedings of the 26th Annual BCS Interaction Specialist Group Conference on People and Computers Pages 309-314 September 2012
5. Frøy Birte Bjørneseth, Mark Dunlop, Loraine Clarke, Sashidharan Komandur (2014). Towards an Understanding of Operator Focus using Eye-tracking in Safety-Critical Maritime Settings, Human Factors in Ship Design and Operation, Conference, Royal Institution of Naval Architects, www.rina.org.uk February 26, 2014

4.1.31.3 Relevant Previous Projects

Name	Topic	Relevance	Reference
ROLLS-ROYCE UNIFIED BRIDGE	Complete redesign of the ship bridge environment using a human centered design process.	Ensure and maintain ergonomics, human factors and user experience for the Rolls-Royce Unified Bridge concept. Participated since project start-up including assessments, evaluations and several iterations of prototype development.	https://www.rolls-royce.com/innovation/unified-bridge.aspx#overview https://www.rolls-royce.com/innovation/unified-bridge.aspx#solution
ROLLS-ROYCE UNIFIED GRAPHICAL EXPRESSION	Complete redesign of all control applications within RRM	Developing a unified graphical expression/unified look and feel for all Rolls-Royce maritime applications. Resulting in a style guide for building graphical user interfaces.	Application example: https://www.rolls-royce.com/products-and-services/marine/product-finder/automation-and-control/control-centres-and-bridge-system/bridge-control.aspx#/
INCREASING SAFETY OF DEMANDING	To increase safety of demanding offshore	To increase safety of demanding offshore operations through focusing on usability and the human factor (HF) propose many challenges. The research community is small, however by adding	

G OFFSHORE OPERATIO NS THOUGH USABILITY	operations through focusing on usability and the human factor	focus from industry to this area by actually considering the operator's work situation and provide supportive solutions, one has come many steps closer to a safer safety critical operation. When developing solutions that reduce the human error rate, the equipment must be tested and statistical measurements from the tests compared.
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4.1.31.4 Major Infrastructure

The regional training center in Europe is located in Aalesund, Norway. The training center is located at the Norwegian Maritime Competence Centre (NMK) only 5 kilometers outside Aalesund city center. The training center caters to the training needs of regional customers, as part of the global network of Rolls-Royce training centers, that provides customers with access to world class facilities and internationally accredited qualifications. Supported by a team of experienced training specialists and advanced training facilities, the center is well equipped to provide a suite of standard and tailored training courses, based on bespoke customer requirements. As technology advances, your personnel need to be equipped to meet the challenges of operation and maintaining your systems safely and efficiently. The training center is the ideal location for crew training, to ensure you get the best economic and environmental value out of your equipment and systems. Actual sized training equipment including advanced simulators and various products, are available to enable practical training. Hands-on training will help to provide your crew members and technical team with the latest updates and knowledge on maintenance and operational skills. Rolls-Royce Marine is a tenant in the Norwegian Maritime Competence Center. Norwegian Maritime Competence Center has become a great success for both the marine and maritime sectors and has spurred great ripple effects for the town of Ålesund and the entire Møre coastal region. The commercial clusters in Sunnmøre has proven that competence cooperation between businesses, and between businesses and academia, creates innovation and further growth. Norwegian Maritime Competence Center is a part of Campus Ålesund and its objective is to be one of Norway's most important meeting places for competence and development. The Aalesund branch of NTNU (Norwegian University for Technology and Science) is located across the street however with the maritime institutes located in the NMCC building. A further development and extension of the NMCC is a central part of the vision to make the NMCC into a world leading maritime center. Norwegian Maritime Competence Center has today a total area of 39 000 square meters and several of the most important players of the maritime cluster resides within its area. Amongst others Rolls -Royce has situated its Technological Training Center within the building. In the NMCC there are several simulators and Offshore Simulator Center has the worlds most advanced offshore simulator as a very eye-catching part of the main entrance area. The simulators can be connected together for the simulation training of the complete crew, as well as connecting several ships together for integrated and advanced operations.



Figure 34 360 degree simulator 1: 360 degrees ship bridge simulator with traditional consoles.
Functions: Dynamic positioning, propulsion control, visualisation, several different scenarios, anchor handling equipment, navigation etc.



Figure 35 Anchor handling and seismic operations training simulators



Figure 36 360 degree simulator 2, to be launched: New 360 Unified Bridge simulator with all integrated bridge system.



Figure 37 Virtual ship intelligence lab



Figure 38 Workshop

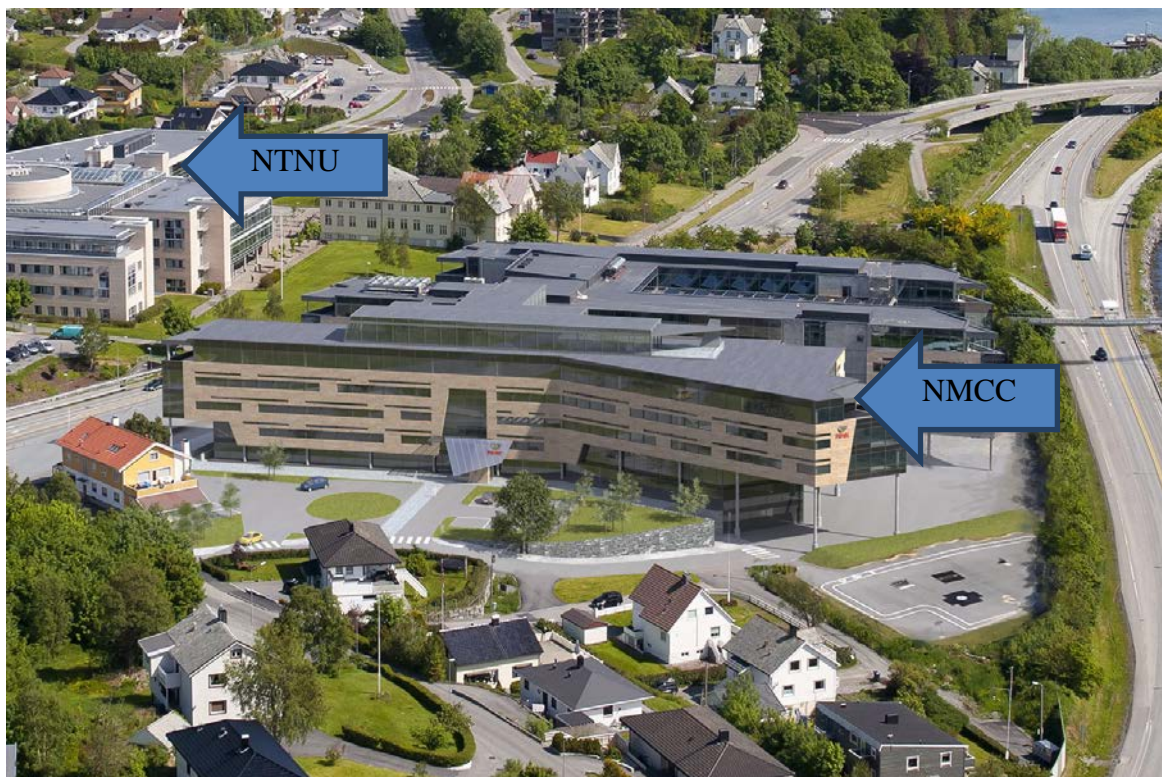


Figure 39 NMK on the top 10 list of technology leaders The Norwegian Maritime Competence Center is ranked No. 6 in Lloyd's prestigious list of the world's leading technology leaders.

4.1.32 WUHAN UNIVERSITY OF TECHNOLOGY (WUT)

Wuhan University of Technology (WUT) is one of the leading Chinese universities accredited by the Ministry of Education, China and one of the universities constructed in priority by the “State 211 Project” for Chinese higher education institutions. Currently, WUT has about 5,570 staff members including 650 professors, 3 academicians of China Academy of Engineering and 3 academicians of China Academy of Science. It has over 36,000 undergraduates, 16,000 postgraduates and 327 international students. In the recent research assessment, WUT was top 5% amongst Chinese universities in the disciplines such as Naval Architecture, Marine Engineering and Transportation Engineering. WUT ranked top 400 according to Times Higher Education’s World University Rankings 2014. Inheriting the history and culture of the former three universities, WUT insists on the guiding principle of “take the students cultivation as our essence, and take academic development as our priority”, while with the practice of over 60 years in student’s education, WUT has forged the spirit of the university as “Sound in Morality, Broad in Learning and Pursuing Excellence”. It has become the lofty ideal and core value of WUT to build an excellent university that provides an excellent education to lead its students to a fulfilled life with wisdom and responsibility, winning worldwide recognition and admiration. The WTS Center, as a national engineering research hub, has a long history of delivering research and training programmes in design and operation of maritime and engineering systems, including inland waterway vessels. WTS Center has an annual external research income of €4m. WTS Center is well equipped with traffic simulation and testing facilities, such as maritime simulation platforms, ship bridge simulator, engine room simulator, and a Key Laboratory for structural tests/analysis, as well as various software tools for both research and training purposes. It has strong connections with many industrial and regulatory organisations such as China Ocean Shipping Company (COSCO) and China Maritime Safety Administration (MSA). The National Engineering Research Center for Water Transport Safety (WTS Center) led by Prof. Xinping Yan at WUT, as a national engineering research center sponsored by the Ministry of Science and Technology, China, has 50 academic staff and more than 50 PhD researchers. WTS Center has had a long history of delivering research and training programmes in operation and management of water transport systems. Since 2000s, WTS Center has produced more than 100 PhD and 500 MSc completions. WTS Center has completed more than 200 external and internal research projects including the National Basic Research Program of China, the National High Technology Research and Development Program of China, NSFC and Key Technologies R&D Program of China. Over the past few years, WTS Center has an annual research income of approximately £3 million which is derived from competitively gained external funding entities. WTS Center is well equipped with traffic simulation facilities such as vehicle driving simulator, ship bridge simulator and engine room simulator as well as various software tools for both research and training purposes. It has strong connections with many industrial and regulatory organisations such as China Ocean Shipping Company (COSCO) and China Maritime Safety Administration (MSA). Meanwhile, WTS Center has established cooperative relations for students exchange and scientific research with more than 30 foreign universities and research institutions from UK, USA, Norway, France, Portugal, Finland and the Netherlands, etc. and undertaken several international joint projects including two funded by the FP7 Marie Curie scheme.

4.1.32.1 Key personnel

- **Professor Xinping Yan (M)** is Chair Professor in Transportation Engineering of Wuhan University of Technology and Director of National Engineering Research Center for Water Transport Safety, China. He received his BSc and MSc in Marine Mechanical Engineering from Wuhan University of Water Transportation Engineering, China in 1982 and 1987, respectively, and his PhD in Mechanical Engineering from Xi’an Jiaotong University, China in 1997. He is Chairman of Water Transport Committee of China ITS Association, Member of Technical Committee of CCS, Editorial Member of Journal of Maritime Environment, Editor-in-Chief of Journal of Transport Information and Safety.

Prof. Yan's research interests include marine system design and control, condition monitoring and fault diagnosis, tribology and its industrial application, intelligent transport system, etc. with remarkable financial support from Natural Science Foundation of China (NSFC), Ministry of Transport, China, Ministry of Science and Technology, China, etc. Prof. Yan's publications include 5 research monographs and textbooks, over 300 journal/conference papers including 150 SCI/EI cited papers. In the area of condition monitoring and fault diagnosis of large transportation systems, Professor Yan was awarded more than ten research prizes including the State Technological Invention Award in 2012. He was awarded the Distinguished Visiting Fellowship from the Royal Academy of Engineering, UK in 2014.

- **Professor Di Zhang (M)** is Professor and Associate Director of National Engineering Research Center for Water Transport Safety, Wuhan University of Technology, China. He received his BSc in Navigation Technology, MSc in Traffic Information Engineering & Control and PhD in Vehicle Operation Engineering from Wuhan University of Technology in 2005, 2008 and 2011 respectively. With the financial support from the China Scholarship Council, he was a full time researcher at Liverpool John Moores University (LJMU), from October 2010 to September 2011. Dr. Zhang's major research interests include risk assessment and decision science applied in marine systems. He has authored 5 book chapters, 30 refereed journal papers and over 50 refereed conference papers. He is associate fellow of Royal Institute of Navigation (AFRIN).
- **Associate Professor Zhe Mao (F)** is Associate Professor of National Engineering Research Center for Water Transport Safety, Wuhan University of Technology, China. She received his BSc & MSc in Computer Science, and PhD in Intelligent Transportation Engineering in 1998, 2006 and 2009 respectively. With the financial support from the FP7 Marie Curie IRSES of European Union (Project No: 612546), she was a full time researcher at University of Gothenburg (GU), from March 2017 to March 2018. Dr. Mao's major research interests include risk assessment and accident analysis applied in marine systems.

4.1.32.2 Publications

1. Wan C., Yang Z., Zhang D., Yan X., and Fan S. (2018). "Resilience in transportation systems: a systematic review and future directions", *Transport Reviews*, 38:4, 479-498.
2. Yan X., Wan C., Zhang D., Yang Z. (2017). "Safety management of waterway congestions under dynamic risk conditions—A case study of the Yangtze River". *Applied Soft Computing*, 59: pp. 115-128.
3. Zhou T., Wu C., Zhang J., Zhang D. (2017). "Incorporating CREAM and MCS into fault tree analysis of LNG carrier spill accidents". *Safety Science*, 96, 183-191.
4. Fu, S., Zhang, D., Montewka, J., Yan, X., & Zio, E. (2016). "Towards a probabilistic model for predicting ship besetting in ice in Arctic waters". *Reliability Engineering & System Safety*, 155, 124-136.
5. Liu K., Zhang J., Yan X., Liu Y., Zhang D., Hu W. (2016). "Safety assessment for inland waterway transportation with an extended fuzzy TOPSIS". *Proceedings of the Institution of Mechanical Engineers, Part O : Journal of Risk and Reliability*. Vol. 230, 3: pp. 323-333.

4.1.32.3 Relevant Previous Projects

Name	Topic	Relevance	Reference
REFERENCE FP7 Project	Research Network on Flexible Risk Assessment and Decision	The overall aim of REFERENCE is to bring together an international team of researchers, with a wide variety of skills in order to develop a formal safety assessment framework with appropriate support models for application to marine, oil and gas, supply chain management,	http://cordis.europa.eu/project/rcn/104833_en.html

	Science	nuclear and transport areas. (WUT)	
RESET H2020 Project	Reliability and Safety Engineering and Technology for large maritime engineering systems	RESET covers the fundamental study of reliability and safety, as well as applications in different maritime systems such as offshore installations, ships, offshore wind farms, and other Made-To-Order (MTO) systems.	https://etmjwang.wixsite.com/eu-reset

4.1.32.4 Major Infrastructure

A. Navigational simulator Navi-Trainer Professional 4000 (NTPRO 4000)

The Navigational simulator Navi-Trainer Professional 4000 (NTPRO 4000) enables simulator training and certification of watch officers, chief officers, captains and pilots serving on commercial and fishing ships with the gross tonnage of 500 tons and more. This complies with requirements of IMO STCW 78/95 Convention and Model Courses 7.01, 7.03 as well as number of specific tasks beyond the Convention.

Figure 40 NTPRO 4000 simulator is compliant with ‘Class A, (B, C) NAV’ as per Det Norske Veritas



classification.

B. Electroencephalography (EEG) technology

The Electroencephalography system is successfully used to record signals originating from the brain for research purposes. It provides (a) 40-channel EEG produced by Natus in the United States that can record EEG signals, giving support for variable quantification based on EEG spectral features; (b) the portable physiological recorder and supporting software can be used to collect and analyse indicators such as breathing, skin electricity and body temperature. The device can be applied to investigate the relationship between different shipping conditions and human performance.



Figure 41 Electroencephalography (EEG) technology

4.1.33 TUI AIRWAYS (UK)

TUI Airways has been voted the ‘World’s Best Leisure Airline’ at the World Airline Awards for five years running. Our state-of-the-art 787 Dreamliners have transformed long haul flying for our customers and crews. With 6 million holidaymakers – we’re the UK’s leading travel brand. With 12,500 employees – from travel agents to flight crew, engineers to back office colleagues. We operate and provide world leading holidays to 80+ destinations in 30 countries around the world. The parent company TUI AG group of airlines have over 150 airplanes. TUI Airways, in the UK, operate 60+ airplanes across the B787, B767, B757 and B737 aircraft types. TUI Airways has a mature Safety and Risk management system.

4.1.33.1 Key Personnel

- **Dimuthu Adikari** – Aviation Safety Manager TUI Airways and Safety Analytics Manager – TUI Group; with 10 years of experience in Aviation Safety working for TUI within Safety and Risk Management. A Member of the Safety & Accident Investigation Centre - Strategic Advisory Board, Cranfield University [2018]
Academic Qualifications
 MSc Air Transport Management – Cranfield University
 BEng (Hons) Aerospace Design Engineering – Kingston University, London
Professional Qualifications
 Challenge 24 – Leadership Training, The Collaboration Company [2017]
 Leading People, Institute of Risk Management [2016]
 UK National Aviation Security Training Programme, Department for Transport [2013]
 Member of the Royal Aeronautical Society [since 2006]
- **Captain Andrew Lauretani**, B787 pilot and Flight Safety Officer. Andrew has 32 years commercial and military flying experience. Currently, a B787 pilot and Flight Safety Officer with TUI Airways Flight Safety team with 4 years’ experience of Safety Management Systems (SMS) including incident investigation and flight data management (FDM). A former B767, B757 and B737 pilot and graduate of the RAF Central Flying School.
- **First Officer Phil Luxton** – B787 pilot, TUI Flight Data Technical Pilot and Flight Safety Officer with 12 years SMS and FDM experience and a former RAF Tornado Pilot
- **Captain Aneel Quraishy** – B737 / B787 Pilot, TUI Flight Safety Officer with 13 years SMS and FDM experience and qualified in Accident Investigation for Airline Management (Cranfield University).
- **Captain Martin Goddard** – B737 / B787 Pilot, TUI Flight Safety Officer 10 years SMS and FDM experience
- **Captain Adam Cavey** – B737 pilot and TUI Flight Safety Officer with 2 years SMS and FDM experience.
 Flight Data Analysis: 1 x Flight Data Analysis (as required)
 Training Personnel: 2 x TREs (as required)
 Line Pilots: 1 x Pilot (as required)

4.1.33.2 Publications

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4.1.33.3 Relevant Previous Projects

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4.1.33.4 Major Infrastructure

TUI Airways has resources commensurate with requirement to hold a UK AOC airline operation. It has a mature SMS within a Safety, Compliance and AOC Directorate within TUI Airways. This can provide personnel and flight data management resources for the purposes of the normal operations and to this project.

4.1.34 BEEBI CONSULTING

BeeBI Consulting provides professional services in software, design, data analysis and management, Business Intelligence Systems, CRM - customer relationship management, marketing consulting and training with different global clients in 3 different countries spanning across 6 different industries. Different client industries include; Retail, Telecommunications, Finance and Banking, Shipping and Logistics, Insurance, Automotive. BeeBI Consulting as a member of Interaktif Group company, is up-to-date with latest technologies and maintains its Research and Development efforts to offer corporate business solutions that are among the best solutions in the future. Using a mix of our highly experienced consultants and skilled developers who are proficient with lower cost, we are able to provide "quality-guaranteed" results on-time and on-budget for all our clients. We conduct business with prominent brands and specializes in coming up with practical solutions and putting them in action.

4.1.34.1 Key personnel

- **Ali Demiral (M)** is a Business Intelligence Systems Architect with 12+ years of experience in the BIS industry. Having occupied roles in both ETL and Front End (Reporting) teams, he has a multitude of DWH experience within TELCO, Retail, Auditing, Manufacturing, Supply Chain, Airlines, E-Commerce organizations and corporations. His ability to effectively architect, scope, assess, and implement products such as MicroStrategy has received peer recognition in multiple occasions. Some of the projects that he took part as a Technical Architect, had awarded at EuroCis Retail Trade Show and Turkcell Mobile Technology awards. He has also had "Certificate of Appreciation" regarding the projects that he has finalized at the customer Adidas World of Global IT – GERMANY. He has implemented Architectural BIS solutions across different regions and countries such as Canada, Denmark, Germany, Turkey with key accounts such as adidas, Maersk Line, Turkcell, Vodafone. He is the founder of BeeBI Consulting and keep having Project Management roles at several key projects.
- **Okan Tubek (M)** started his career as an Electronics Engineer at Neta Elektronik A.Ş., which produces digital satellite receivers for his business life. Airties Wireless Communication Inc., which produces wireless ADSL modems. Arge Engineer; He worked as a Data Analyst, Business and Data Services Manager, Software and Analysis Services Director for Directcomm., also he worked as a research assistant at Maltepe University. Now he continues to work as founder of Interaktif Group, which provides services in software, data analysis, design applications and marketing consultancy fields. Within the scope of the Interaktif Group, Interasate, Trustdata, Interesting Things, Interesting Academy, Supercode, pCRM brands, and many other brands and patents. He has acquired entrepreneurial experiences in different sectors. He produces services for various sectors such as Medicine, Health, Entertainment, Automotive, Logistics, Clothing, Food, Education; development of web / pc / mobile based software development, hardware development, CRM and automation systems, interactive mobile, gaming, social media and event marketing applications with the expert team, data mining studies, database based marketing strategies, customer relationship management and loyalty applications development and development issues.
- **Gulay Unal (F)** is a Software Developer with 6+ years of experience in IT department. She is currently working in Interaktif Group for last 2 years. She works as full stack software specialist. She is working on these websites developed for Mercedes-Benz, it provides convenience to the user in data entry, reporting, related calculations, graphics and so on. Technologies she uses C#, ASP.NET, .NET Framework, ADO.NET, Entity Framework, LINQ to Sql, EF Code-First, VCF, XML, Json, MVC, HTML5, Css, Bootstrap, JQuery, AJAX, Javascript, react.js, Ms-Sql, T-Sql
- **Shivanshu Maheshwari (M)** is a Technical Lead with 4+ years of experience in IT industry. He has done his Master Thesis based on International Project Management, Integration Management, Business in Engineering, Intelligent Systems and He works as a Technical Management Lead. He had an active role to support the Project Management Office at adidas Headquarter for planning, execution and completion of global IT projects. He also involved in requirements gathering and analysis for upgrading PPM tool for adidas PMO. He worked on waterfall and hybrid methodology with Rules for Adidas Project (RAP) 3.0 framework of adidas project management. He has full

understanding of Waterfall and Agile project driving methodologies and fully skilled on the technologies; JIRA, Confluence, Kanban, MS Project and MS Office.

- **Elif Veyses (F)** is a Business and Data Analyst with 2+ years of experience in CRM projects. She currently works in Interaktif Group. Some of her projects are marketing datamart, basket analysis, segmentation, data mining, reporting. Technologies she uses R, Rstudio, T-Sql, Ms-Sql, SPSS, MS-Office.

4.1.34.1 Publications

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4.1.1.3. Relevant Previous Projects

Name	Topic	Relevance	Reference
Maersk BI Reporting Project	BI Reporting System for Maersk Line Shipments	Maersk Line BI Reporting Platform gives Maersk to follow the shipment costs and compare with the market data by visualizing the data at dashboard platforms that relevant users can access with any mobile devices.	Maersk Line Headquarter - Denmark
Adidas Global BI Reporting Platform	Reporting Platform for adidas costing and Lifecycle Management Team	Material Lifecycle Management reporting platform helps adidas to see the sustainability of their products and the materials that are used in their products. BI Reporting platform enables their users to do their analysis irrelevant of the locations. The solution is provided to adidas worldwide offices.	Adidas Headquarter - Germany
TCO Project	Gives the information about Mercedes-Benz Vans	TCO application is helps the customer about their van profits' and the details. TCO app also compare MB-Vans with the competitors brand service fees.	Mercedes-Benz - Turkey
CRM Project	Customer management systems	The system is developed to facilitate customer management	Mercedes-Benz - Turkey
Data Quality Project	Clean data	Developed for clean the data warehouse from bad data and keep it up to date	Boyner-Turkey
Automotive Branding Projects	In terms of management	Includes projects that meet the needs of the automotive industry.	Mercedes-Benz - Turkey

4.1.34.2 Major Infrastructure

Amazon based 18 servers, 2 local data analysis servers are hold by BeeBI Consulting to provide its IT services. These servers can be used for SAFEMODE for initial testing and development of its tools. BeeBI Consulting is mainly located in Berlin. As BeeBI Consulting is a member of Interaktif Grup Company, the company group also holds 3 more offices in Chicago IL-USA (90m²), in Gebze - Turkey (80 m²), Istanbul-Turkey (200m²). BeeBI Consulting has access to many offices across European cities as well as USA via well-known shared office provider company WeWork

(<https://www.wework.com>). In case of need, it will be possible to utilise one of these offices for project meetings and workshops.

4.2 Third parties involved in the project (including use of third party resources)

The beneficiaries must base their contracts/subcontracts according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA). Beneficiaries that are ‘contracting authorities’ or ‘contracting entities’ (within the meaning of the EU public procurement Directives 2004/18/EC and 2004/17/EC or any EU legislation that replaces these Directives) must moreover comply with the applicable national law on public procurement.

4.2.1 1 - DEEP BLUE SRL

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
Does the participant envisage that part of its work is performed by linked third parties ²	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	Y
<p><i>The European Aviation Safety Agency (EASA) will ensure alignment and coordination of the SAFEMODE activities with the Data4Safety initiative, validating the data analysis performed by the project from the perspective of the Data4Safety dataset. EASA will also contribute to the risk model activities, providing expertise to connect risk-models with the EPAS catalogue of top risks. EASA will supporting the drafting of policy notes and recommendations, ensuring their coherency with the regulatory framework and approach, providing feedback on the applicability, expected benefits and impact assessment of the recommendations.</i></p> <p><i>This cooperation will be an inkind contribution against payment (art.11) carried out not on the premises of the beneficiary.</i></p> <p><i>The total EASA Effort will be 200 h/year, 600h in total, i.e. 4.3 PM, at a cost of 120 EUR/hour (inclusive of indirect costs). To perform the above, EASA will carry out 2 travels per year, for a total of 6 missions, 800 EUR per travel.</i></p> <p><i>Total PC costs : 72 000 EUR</i></p> <p><i>Total ODC: 4800</i></p> <p><i>Tot costs: 76 800</i></p> <p>At the time of the Grant Agreement preparation, the draft contract among EASA and the coordinator is under discussion. It will be finalised, agreed and signed during the first 6 months of the project.</p>	
Does the participant envisage that part of the work is performed by International Partners ³ (Article 14a of the General Model Grant Agreement)?	N

² A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

³ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.2 2 - University of Strathclyde (UoS)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁴	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁵ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁴ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁵ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.3 3 - EUROCONTROL - EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁶	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁷ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁶ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁷ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.4 4 - STICHTING NATIONAAL LUCHT- EN RUIMTEVAARTLABORATORIUM

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁸	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁸ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁹ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.5 5 - HUNGAROCONTROL MAGYAR LEGIFORGALMI SZOLGALAT ZARTKORUEN MUKODO RESZVENYTARSASAG

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ¹⁰	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ¹¹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

¹⁰ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

¹¹ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.6 6 - ECOLE NATIONALE DE L AVIATION CIVILE

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ¹²	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ¹³ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

¹² A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

¹³ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.7 7 - UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ¹⁴	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ¹⁵ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

¹⁴ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

¹⁵ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.8 8 - ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ¹⁶	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ¹⁷ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

¹⁶ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

¹⁷ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.9 9 - CETENA (CET)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ¹⁸	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ¹⁹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

¹⁸ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

¹⁹ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.10 10 - ISTANBUL TEKNİK UNIVERSİTESİ

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ²⁰	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ²¹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

²⁰ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

²¹ ‘International Partner’ is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.11 11 - CALMAC FERRIES LTD

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ²²	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ²³ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

²² A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

²³ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.12 12 - CHALMERS TEKNISKA HOEGSKOLA AB

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ²⁴	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ²⁵ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

²⁴ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

²⁵ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.13 13 - EMBRAER PORTUGAL SA

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ²⁶	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ²⁷ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

²⁶ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

²⁷ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.14 14 - FEDERAL STATE UNITARY ENTERPRISE THE CENTRAL AEROHYDRODYNAMIC INSTITUTE NAMED AFTER PROF. N.E. ZHUKOVSKY

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ²⁸	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ²⁹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

²⁸ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

²⁹ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.15 15 - STATE RESEARCH INSTITUTE OF AVIATION SYSTEMS

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ³⁰	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ³¹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

³⁰ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

³¹ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

**4.2.16 16 - STATE EDUCATIONAL INSTITUTION OF HIGHER PROFESSIONAL EDUCATION
MOSCOW AVIATION INSTITUTE STATE TECHNICAL UNIVERSITY**

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ³²	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ³³ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

³² A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

³³ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.17 17 - JOINT STOCK COMPANY INNOVATIVE TECHNOLOGIES CONCERN

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ³⁴	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ³⁵ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

³⁴ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

³⁵ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.18 18 - MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY (STATE UNIVERSITY)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ³⁶	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ³⁷ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

³⁶ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

³⁷ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.19 19 - DE MONTFORT UNIVERSITY

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y
<p>€30.000,00 subcontract. Details below:</p> <ul style="list-style-type: none"> - Airfox UPRT flight simulator – €18,400: hire of AMST Systemtechnik GmbH Airfox Flight Simulator and UPRT (Upset Prevention and Recovery Trainer), 40 hours at ca. 460€/per hour. - Programmer - €4,850: programmer for the installation of DMU Flight Simulation models and development of required interfaces, ca. 32 hours at €150/hour. - Test pilot - €6,750: validation of Flight Simulation models for a transport airplane and a long-range business-jet. Execution of the forward-looking scenarios and the case Studies in WP6. ca. 30 hours at €225/hour. 	
Does the participant envisage that part of its work is performed by linked third parties ³⁸	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ³⁹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

³⁸ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

³⁹ ‘International Partner’ is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.20 20 - NATIONAL TECHNICAL UNIVERSITY OF ATHENS – NTUA

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁴⁰	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁴¹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁴⁰ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁴¹ ‘International Partner’ is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.21 21 - WORLD MARITIME UNIVERSITY

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁴²	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁴³ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁴² A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁴³ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.22 22 – AIRBUS OPERATIONS SAS

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁴⁴	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁴⁵ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁴⁴ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁴⁵ ‘International Partner’ is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.23 23 – AP&A

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁴⁶	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁴⁷ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁴⁶ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁴⁷ ‘International Partner’ is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.24 24 - RYANAIR DESIGNATED ACTIVITY COMPANY

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁴⁸	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁴⁹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁴⁸ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁴⁹ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.25 25 - PANEPISTIMIO PATRON

No third parties involved.

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁵⁰	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁵¹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁵⁰ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁵¹ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.26 26 - RAIL SAFETY AND STANDARDS BOARD LIMITED (RSSB)

No third parties involved.

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁵²	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁵³ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁵² A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁵³ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.27 27 - UNIVERSITEIT VAN AMSTERDAM

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁵⁴	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁵⁵ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁵⁴ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁵⁵ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.28 28 - WÄRTSILÄ

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁵⁶	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁵⁷ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁵⁶ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁵⁷ ‘International Partner’ is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.29 29 - ARCHIPELAGO PHILIPPINE FERRIES CORPORATION

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁵⁸	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁵⁹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁵⁸ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁵⁹ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.30 30 - INSTITUT TEKNOLOGI SEPULUH NOPEMBER

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁶⁰	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁶¹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁶⁰ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁶¹ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.31 31 - ROLLS-ROYCE MARINE AS

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁶²	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁶³ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁶² A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁶³ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.32 32 - WUHAN UNIVERSITY OF TECHNOLOGY (WUT)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁶⁴	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁶⁵ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁶⁴ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁶⁵ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.33 33 - TUI Airways (UK)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁶⁶	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i> <i>Only potential use of externally provided Simulators (if required)?</i>	
Does the participant envisage that part of the work is performed by International Partners ⁶⁷ (Article 14a of the General Model Grant Agreement)?	N

⁶⁶ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁶⁷ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

4.2.34 34 - BEEBI CONSULTING

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
<i>If yes, please describe and justify the tasks to be subcontracted</i>	
Does the participant envisage that part of its work is performed by linked third parties ⁶⁸	N
<i>If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party</i>	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
<i>If yes, please describe the third party and their contributions</i>	
Does the participant envisage that part of the work is performed by International Partners ⁶⁹ (Article 14a of the General Model Grant Agreement)?	N
<i>If yes, please describe the International Partner(s) and their contributions</i>	

⁶⁸ A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the [Model Grant Agreement](#)).

⁶⁹ 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

External Stakeholders Group

#	Name	Country
1	EUROPEAN AVIATION SAFETY AGENCY	Germany
2	EUROPEAN MARITIME SAFETY AGENCY	Portugal
3	AIRDOLOMITI	Italy
4	AUSTRO CONTROL	Austria
5	BEŞİKTAŞ LİKİD TAŞIMACILIK	Turkey
6	BULATSA	Bulgaria
7	CENTRO STUDI S.T.A.S.A	Italy
8	CHINA CLASSIFICATION SOCIETY	China
9	CHIRP Maritime	United Kingdom
10	COLLABORATIVE INNOVATION CENTER FOR SMART RIVER, MINISTRY OF TRANSPORT	China
11	DiGIFeMa	Italy
12	DIRECTORATE GENERAL OF SEA TRANSPORT, MINISTRY OF TRANSPORTATION	Indonesia
13	DITAŞ	Turkey
14	EAGLESTAR MARINE HOLDINGS	Malaysia
15	EUROUSC ITALIA	Italy
16	GEDEN LINES	Turkey
17	GISBIR	Turkey
18	HANGZHOU DIANZI UNIVERSITY	China
19	KAMAN SHIP MANAGEMENT	Turkey
20	LLOYD'S REGISTER	United Kingdom
21	LONDON LUTON AIRPORT	United Kingdom
22	MARIN	Netherlands
23	MARITIME AND COASTGUARD AGENCY	United Kingdom
24	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	United States of America
25	MASTERS AND MATES ASSOCIATION OF THE PHILIPPINES INC.	Philippines
26	MEMORIAL UNIVERSITY	Canada
27	MINERVA MARINE INC.	Greece
28	NETJETS TRANSPORTES AÉREOS	Portugal
29	OPTIMUM SHIP SERVICES LTD	Greece

#	Name	Country
30	PT. DHARMA LAUTAN UTAMA	Indonesia
31	R&D CENTER OF CHINA OCEAN SHIPPING (GROUP)	China
32	ROYAL CARIBBEAN CRUISES LTD.	United States of America
33	STENA LINE	Sweden
34	TRANSPORT MALTA	Malta
35	TURK LOYDU	Turkey
36	U.A.E. GENERAL CIVIL AVIATION AUTHORITY	United Arab Emirates
37	UVS INTERNATIONAL	France
38	V.SHIPS UK	United Kingdom
39	ZENITH GEMİ İŞLETMECİLİĞİ	Turkey

5 Ethics and Security

5.1 Ethics

5.1.1 Overview

SAFEMODE aims to deliver HF-based risk models which designers and risk assessors can use on a daily basis for their activities. The Consortium does not envisage any ethical or data privacy issues to be arisen in relation to data collection as well as Consortium dissemination activities (e.g. workshops within WP8, webinars, online, etc.). Any activities involving and engaging people outside the Consortium abide to European and national guidelines with considerable focus on recent General Data Protection Regulation (GDPR).

This section will briefly touch upon key concepts about ethical and responsible data sharing and other surrounding aspects through open platforms/ spaces/ ecosystems as well as responsible data and information re-use (i.e. as this a primary benefit of Open Data Initiatives). Personal, project and partner related responsibility is behind data re-use. Responsible use and re-use of Open Data and research entails ensuring participants' rights to consent, privacy and security along all process (i.e. collection, analysis, storage, presentation, and re-use), whilst ensuring data openness and transparency. (Responsible Data Forum).

5.1.2 Target user groups

The main user groups targeted are professionals working in the aviation and maritime domain (e.g. members of industry and government, academicians, researchers, etc.). Engaged stakeholders will have the competence to understand written and oral informed consent information. Informed consent templates will be prepared within WP1 Task 1.3 (Social, Ethical, Legal, Privacy issues identification and monitoring). In addition, the policies and mandates set for the Open Data repository (SHIELD) will abide to respective EU guidelines. Evaluators will receive solely anonymised and coded information. Any recorded data will be available only in anonymised format. Participants who will consent for video recording (e.g. during workshops and events) will provide respective written consent.

It is necessary to mention that evaluation and pilot activities that are directly relevant to the project will be implemented by participants. On the other hand, stakeholders will be involved in the collection of feedback and opinions, including communication and dissemination efforts. Therefore, the terms stakeholders and participants are used interchangeable within this section. Such data collection will provide a solid foundation for building the SHIELD's main entry points as well as enhancing its growth by putting the mechanisms in place for a resilient ecosystem of researchers and interested stakeholders.

5.1.3 SAFEMODE and ethical considerations

Involvement of human participants is ethical and information will be provided at each stage of involvement for all phases they will be part of. Involvement of stakeholders is central in SAFEMODE project. These activities and the overall ethical conduct of the project will be supervised by the Internal Ethics Committee (as described in Section 5.1.8).

The description below will present the ethical issues that may arise during SAFEMODE and the actions and countermeasures the consortium will undertake to eliminate or reduce at minimum the potential risks on human fundamental rights and freedoms.

The SAFEMODE research activities will be compliant with the principles of dignity, freedom, equality, solidarity, citizens' rights and justice by complying with all the ethical principles and the applicable national, EU and international laws.

In particular, The SAFEMODE Consortium will ensure the ethical and legal compliance with current regulations, in particular:

- the EU Charter of Fundamental Rights (art. 7 and 8);
- the European Convention for the Protection of Human Rights and Fundamental Freedoms (art. 8);
- the General Data Protection Regulation - GDPR (Regulation (EU) 2016/679) in force since May 2018 complementing previous legislations such as: the Data Protection Directive (1995/46/EC) and

the Directive on Privacy and Electronic Communications (2002/58/EC), the CoE Convention No. 108 for the Protection of Individuals with regard to Automatic Processing of Personal Data (1981);

In concrete, according to the EC Ethical Self-Assessment Checklist, the ethical issues that have to be discussed and properly addressed in the SAFEMODE project are:

- SAFEMODE involves the participation of human subjects in ‘experiments’ and data collection activities, including collection of neurophysiological parameters.
- SAFEMODE involves the collection of personal data of front-end operators and staff of the end-user organisations through field observation, interviews as primary data.
- In addition, personal data may come from the secondary data—surveys, company video recordings, system logs, internal documents, etc.—provided by end user organisations.
- SAFEMODE involves non-EU partners from China, Indonesia, Philippines, Russia, Turkey and personal data might be imported from non-EU to EU (and NOT vice-versa). Non-EU countries will be required to comply with the legal and ethical requirements for participation in EU research and H2020 guidelines.
- As in every project that collects and analyses personal data and relevant business data, potential misuse of the research results are possible.

Moreover, SAFEMODE “experimental” approach in WP5 and WP6, might require the use of behaviour observations and recording, possibly including the use of video and audio recording and recording of pilots and marine crew operators with cockpit and working positions interactions during work activities (e.g., system logs) and neuro-physiological data collections.

In the following sub-sections, we will discuss the main open issues highlighted by the EC Ethical Self-Assessment Checklist.

5.1.4 Participant recruitment protocol

5.1.4.1 General approach

The SAFEMODE consortium will deal with the involvement of employees of the end-user organisation by complying with the legal and ethical requirements for participation in EU research and H2020 guidelines.

In particular, **SAFEMODE will aim to ensure respect for people and human dignity, fair distribution of research benefits and burden and protecting the values, rights and interests of the research participants.**

Moreover, for each of the research elements, which contain user studies or involve participants in the trials and testing, the necessary ethics approvals (if required) and the free and fully informed consent of the research participants will be obtained. Following the general principle of ethical research, all ethnographic observations, focus groups and structured interviews will be strictly limited to volunteers, mainly employees of partners’ organisations.

SAFEMODE research will NOT include children, adults unable to give informed consent, nor vulnerable individuals/groups.

The procedure for volunteers will strictly adhere to the conditions below:

1. Every volunteer has the right to remain anonymous;
2. Every volunteer will have his or her data protected as stated in the National Data Protection legislation.
3. All data released by the eventual volunteers participating to the project results evaluation brings a duty of confidentiality;
4. Every volunteer’s free and informed consent is required also while doing interviews, ethnographic observation, non-invasive experimentation, neurophysiological data collection, and accessing personal data records. The purpose of informed consent is to empower individuals to make a voluntary informed decision about whether or not to participate in the research based on knowledge of its purposes, procedures and outcomes and therefore no volunteers that are minors and with reduced autonomy or vulnerability will be involved;

5. Every volunteer will also have the right to know who will benefit from his or her participation to the experiment and, if they so wish, to receive information of any potential commercial exploitation of the research that involves their participation;
6. Participants will be informed in their own language about the purpose of the research, the vehicles for dissemination of the results and people, organisations and stakeholders involved in the research, and also about data treatment and handling (session 5.1.5).
7. Volunteers willing to be informed on results of the research will be timely updated with the outcomes of the study;
8. Volunteers will also be informed of the appropriate insurance cover that are in place, if applicable;
9. It will be clearly explained to the volunteers that they can withdraw from the project at any time;
10. The data will be collected in a way that the researcher will not impose any of their own bias on the data itself.
11. Fair involvement, equal opportunities and equal treatment among people with different socio-cultural background (e.g. *gender, nationality, religion, age*, etc.) will be guaranteed.

This study will use different methodologies: interviews, questionnaires, focus groups, ethnographic observation, system logs of users' interaction with the system, physiological data, video-tapes compilation for its later analysis.

The informed consent documents for each different study will be drafted during the first stages of the project, following the templates uploaded in Annex. As stated above, the consortium partners will be made aware of the necessity to obtain an **entirely voluntary and free consent** of each and single individual participating in the research. In order to achieve a high standard and harmonised informed consent procedure in the SAFEMODE project, Internal Ethics Committee will collaborate with the field trials partners and the end-users.

Moreover, DBL, as project coordinator and member of the Internal Ethics Committee (Session 5.1.8), will coordinate and lead the interaction between the front-end operators, on the one hand, and the field trial partners and end users, on the other hand, regarding the neurophysiological data collection, field observations, interviews, focus groups and questionnaires. This decision of having only one SAFEMODE partner responsible for the collaboration and communication with the front-end operators and staff was due to guarantee the fully and free consent and to avoid pressure on them.

SAFEMODE will obtain a written consent from all research participants. All participants will be informed about the research and about the consequences of their participations. They will receive information about the methods, the timeframe and the environment in which their data will be studied. The individuals will have a contact point (a responsible authority within their organisation) in case they need to receive additional information regarding their participation. The participants will be informed about the opt out procedure.

The information sheets, accompanying the informed consent form, are written in a language and in terms fully understandable to the participant. The sheets will describe the aims, methods and implications of the research, the nature of the participation and any benefits, risks or discomfort that might be involved. The information sheet will explicitly state that participation is voluntary and that anyone has the right to refuse to participate and to withdraw their participation, samples or data at any time — without any consequences. Only when the research participant fully understood the information sheet and in a context in which the participant cannot reasonably be pressured to give consent, consent will be considered valid.

Human Resources Department of the end-user will send an email to all employees/a group of employees (based on the purposes of the study), providing the necessary information regarding the project and the information to participate in the research activities. In the email, there will be a link to a dedicated website where the employees will be able to read the complete information sheet, the SAFEMODE activities and a short registration form. Only the employees who will register (providing their consent, through the “opt-in” consent method) and therefore are willing to participate in the SAFEMODE activities, will be further contacted for the studies, questionnaires or field trials. The participants can withdraw their consent at any time without providing any reason, by confidently contacting Dr. Alessandra Tedeschi, from DBL.

5.1.4.2 *Experiment collecting neurophysiological parameters*

Ethical and legal issues are always a delicate matter for a study that involves users and especially when collecting neuro-physiological information from cerebral and cardiac data in healthy persons such as the proposed study. When it comes to technology and data sharing in general where personal data obtain a special meaning, there exist obvious public concerns: the difficulty of respecting privacy and confidentiality when third parties have a strong interest in getting access to electronically recorded and stored personal health data, or the difficulty in ensuring the security of shared personal monitoring data.

In addition to the already mentioned regulation (Session 5.1.3) the study will consider also the “International eHealth Code of Ethics” endorsed by the Internet Healthcare Coalition in 2000 established the nature of e-health information, products and services.

Other reference document to be used by the Ethical committee that can support in the correct management of experiments collecting neurophysiological data, are:

- Ethical Guidelines for Good Research Practice
- Code of Human Research Ethics
- MRS Code of Conduct and related guidelines
- UNESCO Ethical Guidelines for International Comparative Social Science Research in the framework of MOST
- University of Toronto Social Sciences and Humanities Research Ethics Board (SSH REB) Guidelines for Ethical Conduct in Participant Observation
- Lives report on e-health

The Consortium will conform to the rules and legislation here listed considering the test to be performed. Specific example for collecting neurophysiological data will be drafted during the first stages of the project, following the templates uploaded in Annex.

The members of the SAFEMODE project consortium will follow the national legislation and the non-EU countries will be asked to comply with the legal and ethical requirements for participation in EU research and H2020 guidelines.

5.1.4.3 *Mitigation Measures to avoid Staff Coercion*

SAFEMODE mainly entails data collection activities with staff members from relevant end users' organisations. This group of subjects is potentially exposed to the risk of coercive involvement by their employers. This risk will be mitigated during the recruitment process. Contacts will not be direct but will require the involvement of an internal contact person which will take care of involving relevant individuals. Therefore, prior to the recruiting will began, this person will be informed by the research team that:

1. Participation of staff in the study is entirely voluntary,
2. That participating individuals must not obtain any occupational advantage (e.g. retribution) over staff members that do not volunteer for research;
3. That no penalty on the job or any other negative consequence must apply to non-participating subjects.
4. That points 1, 2 and 3 needs to be communicated to the relevant candidates when contacting them.

The consent form will be sent to all potential research participants by the Human Resources departments in their respective organisations. In the consent form the selected employees will be informed about SAFEMODE, about the operational procedures of the tests, and about the ethical principles and applicable international, EU and national law considered while drafting the forms. In drafting these documents, the Human Resources departments will ensure respect for people and for human dignity, fair distribution of research benefits and burden and protecting the values, rights and interests of the research participants. The informed consent form provided to the participants will be written in a language and in terms fully understandable to them. The Human Resources departments will opt for the language of the contract of the selected participants.

Furthermore, whenever feasible the research team will make an effort to avoid the involvement of a recruiting contact person who may be in the worker's chain of command. In addition, during the data

collection activities (e.g., interviews, focus groups, observations, etc.), the line manager of the staff involved will not be present.

Observations of staff at work may be carried out in the context of the project. Such observations will be limited to the staff that will be directly observable by the researcher, i.e. the research team will not make use nor introduce equipment revealing employee's location and/or behaviour in order to ensure compliance with Article 16 of "Recommendation CM/Rec(2015)5 of the Committee of Ministers to Member States on the processing of personal data in the context of employment".

Besides, in case of withdrawal or refusal to take part in the study, the SAFEMODE research team involved in data collection activities (e.g., representatives of DBL, EUROCONTROL, University of Strathclyde, University of Amsterdam, Università la Sapienza, etc.) will not inform the employer organisation. The participating staff will be informed in the informed consent form about the fact that whether she/he participates in the study or not will not be communicated to their employer.

Finally, we will take appropriate measures to properly communicate results of the research in order to avoid that 'negative' findings highlighting the potential safety issues of an organisation or department can have a bad effect on workers' groups or on the overall work environment. All data will be presented in an aggregated way and completely anonymised, answers or behaviours from single employees or specific groups of employees will not be recognisable – there will be several internal screenings before releasing a report, in order to guarantee that the identity and the confidentiality of the participants will not be at risk and the research results will be firstly discussed with the data collection activities participants to ensure proper understanding and obtain preliminary feedback.

5.1.5 Data Handling and Privacy Procedures

Questionnaires, interviews, audio/video recordings or field observations will be subjected to current European regulations on matters of data handling and privacy (GDPR, Regulation (EU) 2016/679). The research outcomes will always be reported without contravening the right to privacy and data protection, in particular:

1. The SAFEMODE Consortium will store and analyse data that have been collected just after the experiment participants gave their Informed Consent to take part to the specific data collection activity. All the participants have been duly informed of the objectives of the data collection and of their duties and rights in support to the SAFEMODE research activity (as described in Section 5.1.4)
2. The SAFEMODE consortium is committed to guarantee full anonymity of data. Full anonymity refers to the removal of information that could lead to an individual being identified, either on the basis of the removed information or this combined with other information. The project will not collect nor store personal data that could lead to an individual being identified, such as names, telephone numbers, bank statements, security numbers, etc. The project will collect basic biographical data, e.g., age, sex, background and position in the organisation; however, this data will be collected and stored as fully anonymous data—it will not be associated to personal, including neurophysiological, data. The identifiable personal information will be always stored separately from these data. Data presented in publications or to employers will use aggregated data only, in which individuals cannot be identified. Pictures, videos and audios will be recorded just after the signature of a detailed Information Sheet and Consent Form. Also, for videos and images, participants' faces will be covered with a masking filter to prevent identification. For audio files, no name of participant, facilities, and companies will appear on audio files. Audio filters that distort voices will also be applied. The audios and videos will be not used for any different purposes, nor disclosed to any third party and will be destroyed 2 years after the end of the project.
3. Should full anonymization not be feasible, the project will recur to pseudo-anonymization. Pseudo-anonymization will eventually apply to on-line surveys with staff (if required). This survey will ask the participants to leave their e-mail addresses if they wish to be contacted by the researchers for a follow up interview. E-mail addresses will be stored separately from the data by authorised people from the SAFEMODE Consortium (i.e., representatives from DBL), to avoid the names and data being linked to the data-files.
4. The data collected in these studies will be hosted on the web space from DBL, which is hosted at www.deepblueservices.eu. All servers are located in Italy, hence Italian data protection law applies,

which is one of the toughest in Europe. Current state-of-the-art security is guaranteed by the web space provider Aruba. The data will be stored in a safe and secure way and only a restricted number of people from DBL (Dr. Alessandra Tedeschi, Dr. Simone Pozzi, Dr. Daniele Ruscio) have access to the raw data.

5. Data will consist of digital or/and paper data. Digital data will be stored on hard disks disconnected from the network, which will be stored in secured drawers; and/or on secured servers, with defined protocol that limit access to authorized personnel. Paper data will be stored in secured drawers with limited access to authorized personnel.
6. Data access will be limited to SAFEMODE authorised staff only, and only within the spatial and temporal limits agreed with the participants to the data collection activities and in no case beyond what is prescribed by the current legislation.
7. A previous authorisation from the participant will be needed when anonymity requirements are technically or operationally unfeasible.
8. Data will not be modified or falsified.
9. Data will be destroyed two years past the termination of the project. Paper data will be physically destroyed. Digital data will be overwritten to ensure that they are effectively scrambled and remain inaccessible.
10. Ad-hoc measures to avoid unforeseen data usage or disclosure, including mosaic effect (i.e. obtaining participant identification by merging multiple sources) will be designed and implemented.

5.1.5.1 Data Protection Authorities

The applicant's team will dully follow the national guidelines set by the data protection authority at each partner country site for Data Controllers/Officers according to Data Protection recent EU guidelines. Additionally, they must respect and abide to national legislation. In particular:

1. They must collect personal data fairly and lawfully.
2. They must process only the data which are necessary for one or more specified purposes.
3. They must make sure that they keep data accurate and up to date.
4. They must retain data only for as long as is deemed necessary for the collection and process thereof (i.e. only relevant to feedback/opinions).
5. For data process purposes, the Controller must choose employees with relevant professional qualifications providing sufficient guarantees in terms of technical expertise and personal integrity to ensure such confidentiality.
6. The Controller must implement appropriate organisational and technical measures to secure data and protect them against accidental or unlawful destruction, accidental loss, alteration, unauthorised disclosure or access as well as any other form of unlawful processing.
7. If the data processing is carried out on behalf of the Controller, by a person not dependent upon him, the relevant assignment must necessarily be in writing.
8. The Controller must respect the data subject's rights to information, access and objection.
9. They must meet their obligations vis-a -vis the DPA (notification, granting of permit).
10. They must be kept informed on any Decisions, Directives or Recommendations issued by the DPA that may be important to them.

If an Ethics application is required, it will be submitted and only when it is approved, data collection will happen. A confirmation letter will be issued and communicated to the applicant.

In conclusion, the relevant ethical aspects have been analysed in this section. They are related to any activities involving stakeholders/ participants during the lifetime of the project.

5.1.5.2 Secondary Data Access and Management

In specific cases, just if needed for research purposes, the SAFEMODE consortium will also use data-sets previously collected by the end users or other third party organisations. In these cases, (actually not foreseen in the project planning), the SAFEMODE partners will obtain these data-sets directly from the organisations and/or researchers that are in charge of managing the data-sets. These data-sets will be made available to the SAFEMODE partners for scientific research purposes, only when and if such an action is legally compliant

with the national legislation, obtaining all the authorizations and permissions needed, including individuals' consent for secondary use if needed. Moreover, only after signing a data agreement that regulates the terms and the conditions of the use of such data, the end-user will share the data sets with SAFEMODE partners.

5.1.5.3 Privacy of SAFEMODE as a data-openness communication platform

SAFEMODE will serve as an Open Data Repository for analysing Human Factors, contextual elements and typical scenarios. It performs so with due respect for all gathered data. Hence, verbatim extracts will be shared only if the participant has agreed and wishes to do so. Furthermore, verbatim data require ethics approval has been obtained by the relevant body where respective views and opinions were collected. In any other case, these data will be stored separately from identification information and be securely protected by relevant mechanisms.

5.1.5.4 Incidental Findings Policy

SAFEMODE will have also an Incidental Finding project policy. Incidental Findings (IFs) are an issue of increasing importance to consider in research with human subjects. In the context of SAFEMODE, IFs refer to any unexpected finding that:

- results from the data collection activities conducted in the project, especially the data collection with front end operators, namely neurophysiological data, interviews, focus group, and observations;
- is not related to the object of the research;
- concern instances that, based on the researcher knowledge and judgment, are evidently illegal or potentially critical for aviation and maritime safety and security.
- abnormal health findings, such as, irregular neurophysiological parameters, potential Hypertension, Obesity, Diabetes, Forgetfulness, Disorientation and depression, or other illness may be discovered.

IFs identified in the context of the project will be reported to the relevant authority or to the responsible organisational role, namely, law enforcement agencies and/or management.

Health-related IFs have potentially serious implications for a medical health, psychological well-being, employment, and insurance coverage. In case of Health-related IFs, the researchers will contact with experts who will increase the tests in order to obtain a proper diagnosis. Then unexpected abnormal findings will be properly communicated to the research participant and other designated parties with the backrest of a qualified Physician and/or Psychologist in order to be able to answer the questions about the finding's clinical implications, possible interventions and long-term consequences. Dedicated statements informing the participants involved in the research activities regarding incidental finding policy will be included in the Consent Form.

5.1.6 Research involving non-EU countries

Data will be just imported from non-EU countries to EU countries, e.g., data collected in Israel at ELTA premises will be shared with other consortium members to be analysed.

Data collected at non-EU partners' premises may include: personal data of staff involved in the experiments according to what described in Section 5.1.4, results of the experiments, some secondary data about staff and/or end-users' organisational procedures and /or technical aspects.

All the data collection activities in non-EU countries will be carried out in accordance to the national legislative framework and specific permission from each national relevant Authority will be obtained. Moreover, ethical standards and guidelines of Horizon2020 will be rigorously applied, regardless of the Country in which the research is carried out.

In particular, data collection will comply with the SAFEMODE Ethical and Data Protection Guidelines described in deliverable D1.2 Social, Ethical, Legal, Privacy issues identification and monitoring.

Vice versa no sensitive or personal data will be transferred from EU to non-EU countries. Data transfers outside the EU will occur only after the completion of data analysis, which will occur in the EU, under the responsibility of the relevant EU partner. Therefore, data will be transferred outside the EU only in an

aggregated form, i.e. in the form of results, with no link to the names or other identifiers of the original individuals.

5.1.7 Potential misuse of research results

The SAFEMODE consortium will try to avoid the misuse of the research results. In particular, the SAFEMODE partners will favour a correct and rightful use of the results of the research, as well as of the knowledge of the techniques and theories applied, they will avoid any negative repercussion against the public reputation of each partner and of any other involved entity or individual and an improper exploitation of research results for obtaining commercial and business advantages, personal profits and any other kind of unlawful application of the research results.

Main mitigation measures to avoid the potential misuse of research results, both from partners of the Consortium and from external malicious actors will be: monitor the accesses to data and the researcher actions on data, define and implement policy access based on least privilege, protect data from outsiders.

Multiple security mechanisms and technologies will ensure protection from malevolent/criminal/terrorist abuse. The DBL server (deepblueservices.eu) software architecture includes a governance layer equipped by a customizable Access Control Module able to verify user's permissions and monitoring all his activities.

Users can access to the system after a successful login based on username and password. The continuous monitoring of the end-user work-session will provide to the administrator periodic report and real time notifications about faults, abnormal traffics, borderline or potentially dangerous situations. User role and permissions will be checked before to access to the analysis services and before to perform complex query to retrieve sensitive and relevant information from the knowledge base.

The hosting provider Aruba applies standard security policy and technologies, such as firewall and proxy mechanisms to protect the system from bot-nets and cyber-attacks. The policies to react to cyber-attacks will be set-up by DBL according to the risk assessment will be performed before the deployment.

In addition to that, strict procedures will be defined for publication of research results, any publication of final or intermediate results must comply with the following statements:

1. Everyone who participated in the collection of data will be acknowledged in the acknowledgements section of the publication, either individually or collectively. Co-authorship of publications will be determined and agreed based on standard academic conventions.
2. Sensitive information will only be presented to competent, responsible and scientifically sound audiences;
3. Political and socio-economic concerns must be carefully considered in presenting the results as any opinion expressed could affect the public opinion feelings about safety n aviation and maritime transport.

The table below summarizes main risks and proposed control mechanisms.

Risks	Control mechanism
Unauthorised access to data. Probability: Low Consequence: High	State of the art security mechanisms: - hosting provider Aruba applies standard security policy and technologies, such as firewall and proxy mechanisms, - DBL server software architecture includes a governance layer equipped by a customizable Access Control Module to verify user's permissions and monitoring all his activities, - Continuous monitoring of the end-user work-session to notify in real time about faults, abnormal traffics, borderline or potentially dangerous situations.
Use of research for obtaining commercial and business advantages,	- Monitor the accesses to data and the researcher actions on data, - Define and implement policy access based on least privilege, protect data

personal profits and any other kind of unlawful application. Probability: Low Consequence: Medium	from outsiders. - Continuous monitoring of the end-user work-session to notify in real time about faults, abnormal traffics, borderline or potentially dangerous situations, - Strict procedures defined for publication of research results.
Dissemination of sensitive information. Probability: Low Consequence: Medium	Strict procedures defined for dissemination, with approval by all the WP leaders: - Sensitive information only presented to competent, responsible and scientifically sound audiences, - Political and socio-economic concerns are carefully considered in presenting the results to the general public.

5.1.8 SAFEMODE Ethical Continuous Monitoring

A dedicated deliverable *D1.2 Social, Ethical, Legal, Privacy issues identification and monitoring* in WP1 will provide more detailed information on Ethics, Privacy and Confidentiality and the procedures that should be implemented: informed consent and human participants' recruitment, data collection, storage, access, sharing policies when third countries are concerned, protection, retention and destruction and confirmation, national and international/EU legislation. D1.2 will be a 'live' document being updated according to project needs and emergent Ethics requirements and it will have the final versions at M36 with deliverable *D1.3 Social, Ethical, Legal, Privacy issues identification and monitoring (final)*.

The SAFEMODE Internal Ethics Committee will be composed by representatives with legal expertise from the SAFEMODE Consortium will review and constantly monitor all the Ethical procedures in the project, particularly related to experiment conduction. A continuous ethical monitoring by the Internal Ethics Committee will be implemented to assess the execution of the different EC Ethical Requirements within the project in compliance with H2020 Ethical Standards and Guidelines. Moreover, the Internal Ethics Committee will review and formally approve SAFEMODE procedures for data collection, storage, access, sharing policies, protection, retention and destruction and will monitor the correct implementation of these procedures during the entire lifetime of the project. The members of the Internal Ethics Committee will be identified by M4 of the project and their CVs will be attached to D1.2. This continuous monitoring of ethical issues and procedures, privacy and data handling will be carried on by different organisations with different roles thus ensuring the compliance with rules and a more responsible and coherent exploitation of any kind of research results. If needed, when organising an empirical study, the partners in charge will submit it for scrutiny to the competent Ethics Committee and copies of the requests and the consequent authorizations will be attached to relevant deliverables.

To support the Internal Ethics Committee, an External Expert in Ethics, Privacy and Data protection, Dr. Yung Shin Van Der Syde, from the Centre for IT & IP Law at the KU Leuven (CV attached to D1.2), will be involved in project activities. The External Expert will periodically review and approve all the SAFEMODE documentations and procedures about Ethics, Privacy and Data Protection in order to ensure compliancy with current Regulations.

All the SAFEMODE researchers involved in empirical studies and Data Collection Activities will be trained about Social, Ethical, Legal, Privacy issues and about current regulations. In any case, each partner shall be responsible for ensuring its own compliance with all laws and regulations applicable to its activities. Such laws include, but are not limited to, those in respect of rights of privacy and intellectual property. The partners in charge of the empirical studies will provide detailed information on privacy/confidentiality and the procedures that will be implemented for data collection, storage, access, sharing policies especially when third countries are concerned, protection, retention and destruction and confirmation that they comply with national and international/EU legislation. This information will be submitted to the Internal Ethics Committee for an internal approval. Copies of ethical approvals and/or notifications for collecting and/or processing the personal data, if requested by national law, as well as copies of examples of informed consent forms and information sheets will be prepared within WP1 and included in D1.2 will be attached to the first version of D1.2 delivered at the end of Month 4. These will be in language and terms understandable to the participants. Example of Consent Forms and Information Sheets for different kind of data collection activities are provided as Annexes. By M4 the D1.2, defining the ethical procedures, will be submitted to the EC with attached both the authorization from the SAFEMODE Internal Ethics Committee and the

certificates/notifications issued/submitted to the competent National Data Protection Authorities, if requested by law. Only the non-relevant activities (interviews, data collection, experiments) will be implemented before the submission of the ethical deliverable D1.2.

If new data are collected, detailed information on the informed consent procedures created will be provided to the Internal Ethics Committee beforehand. Copies of the request and of the consequent approval will be attached to D1.3, delivered at the end of the project.

5.2 Security⁷⁰

Please indicate if your project will involve:

- activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

⁷⁰ See article 37 of the [Model Grant Agreement](#). . For more information on the classification of Information, please refer to the Horizon 2020 guidance: https://ec.europa.eu/research/participants/data/ref/h2020/other/hi/secur/h2020-hi-guide-classif_en.pdf.

ESTIMATED BUDGET FOR THE ACTION

	Estimated eligible ¹ costs (per budget category)										EU contribution			Additional information		
	A. Direct personnel costs				B. Direct costs of subcontracting	[C. Direct costs of fin. support]	D. Other direct costs		E. Indirect costs ²	Total costs	Reimbursement rate %	Maximum EU contribution ³	Maximum grant amount ⁴	Information for indirect costs	Information for auditors	Other information:
	A.1 Employees (or equivalent)		A.4 SME owners without salary				D.1 Travel	D.5 Costs of internally invoiced goods and services						Estimated costs of in-kind contributions not used on premises	Declaration of costs under Point D.4	Estimated costs of beneficiaries/ linked third parties not receiving funding/ international partners
A.2 Natural persons under direct contract		A.5 Beneficiaries that are natural persons without salary		D.2 Equipment												
A.3 Seconded persons				D.3 Other goods and services												
	[A.6 Personnel for providing access to research infrastructure]						[D.4 Costs of large research infrastructure]									
Form of costs ⁶	Actual	Unit ⁷	Unit ⁸		Actual	Actual	Actual	Unit ⁹	Flat-rate ¹⁰							
									25%							
	a	Total b	No hours	Total c	d	[e]	f	Total g	h = 0,25 x (a +b+c+f+g +[i1] ¹³ + [i2] ¹³ -n)	j = a+b+c+d +[e]+f+g+h +[i1]+[i2]	k	l	m	n	Yes/No	
1. DEEP BLUE	695 500.00	0.00	0.00	0.00	0.00	0.00	78 000.00	0.00	174 175.00	947 675.00	100.00	947 675.00	947 673.50	76 800.00	No	n/a
2. USTRAT	690 000.00	0.00	0.00	0.00	0.00	0.00	80 000.00	0.00	192 500.00	962 500.00	100.00	962 500.00	962 500.00	0.00	No	n/a
3. EUROCONTROL ¹⁴	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1 211 656.25
4. NLR	396 000.00	0.00	0.00	0.00	0.00	0.00	30 000.00	0.00	106 500.00	532 500.00	100.00	532 500.00	532 500.00	0.00	No	n/a
5. HUNGAROCONTROL	195 088.00	0.00	0.00	0.00	0.00	0.00	68 342.00	0.00	65 857.50	329 287.50	100.00	329 287.50	329 287.50	0.00	No	n/a
6. ENAC	216 000.00	0.00	0.00	0.00	0.00	0.00	23 000.00	0.00	59 750.00	298 750.00	100.00	298 750.00	298 750.00	0.00	No	n/a
7. UniSap	270 000.00	0.00	0.00	0.00	0.00	0.00	10 000.00	0.00	70 000.00	350 000.00	100.00	350 000.00	350 000.00	0.00	No	n/a
8. CERTH	150 000.00	0.00	0.00	0.00	0.00	0.00	16 000.00	0.00	41 500.00	207 500.00	100.00	207 500.00	207 500.00	0.00	No	n/a
9. CETENA	183 750.00	0.00	0.00	0.00	0.00	0.00	18 000.00	0.00	50 437.50	252 187.50	100.00	252 187.50	252 187.50	0.00	No	n/a
10. ITU	108 650.00	0.00	0.00	0.00	0.00	0.00	20 000.00	0.00	32 162.50	160 812.50	100.00	160 812.50	160 812.50	0.00	No	n/a
11. CalMac	148 000.00	0.00	0.00	0.00	0.00	0.00	21 000.00	0.00	42 250.00	211 250.00	100.00	211 250.00	211 250.00	0.00	No	n/a
12. CHALMERS	302 500.00	0.00	0.00	0.00	0.00	0.00	22 000.00	0.00	81 125.00	405 625.00	100.00	405 625.00	405 625.00	0.00	No	n/a
13. EMBPT	77 963.00	0.00	0.00	0.00	0.00	0.00	12 000.00	0.00	22 490.75	112 453.75	100.00	112 453.75	112 453.75	0.00	No	n/a
14. TsAGI ¹⁴	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	997 500.00
15. GosNIIAS ¹⁴	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	322 500.00
16. MAI ¹⁴	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	283 750.00
17. Innotch ¹⁴	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	239 500.00
18. MIPT ¹⁴	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	154 625.00
19. DMU	109 475.00	0.00	0.00	0.00	30 000.00	0.00	28 000.00	0.00	34 368.75	201 843.75	100.00	201 843.75	201 813.75	0.00	No	n/a
20. NTUA	168 000.00	0.00	0.00	0.00	0.00	0.00	21 000.00	0.00	47 250.00	236 250.00	100.00	236 250.00	236 250.00	0.00	No	n/a
21. WMU	178 750.00	0.00	0.00	0.00	0.00	0.00	26 000.00	0.00	51 187.50	255 937.50	100.00	255 937.50	255 937.50	0.00	No	n/a
22. AIRBUS	89 600.00	0.00	0.00	0.00	0.00	0.00	15 000.00	0.00	26 150.00	130 750.00	100.00	130 750.00	130 750.00	0.00	No	n/a
23. APA	53 675.00	0.00	0.00	0.00	0.00	0.00	17 000.00	0.00	17 668.75	88 343.75	100.00	88 343.75	88 343.75	0.00	No	n/a
24. RYANAIR	80 000.00	0.00	0.00	0.00	0.00	0.00	8 500.00	0.00	22 125.00	110 625.00	100.00	110 625.00	110 625.00	0.00	No	n/a
25. UPATRAS	56 250.00	0.00	0.00	0.00	0.00	0.00	7 000.00	0.00	15 812.50	79 062.50	100.00	79 062.50	79 062.50	0.00	No	n/a
26. RSSB	82 500.00	0.00	0.00	0.00	0.00	0.00	7 500.00	0.00	22 500.00	112 500.00	100.00	112 500.00	112 500.00	0.00	No	n/a
27. UVA	147 000.00	0.00	0.00	0.00	0.00	0.00	13 150.00	0.00	40 037.50	200 187.50	100.00	200 187.50	200 187.50	0.00	No	n/a
28. Wartsila NL	132 312.15	0.00	0.00	0.00	0.00	0.00	25 000.50	0.00	39 328.16	196 640.81	100.00	196 640.81	196 640.81	0.00	No	n/a
29. APFC	34 500.00	0.00	0.00	0.00	0.00	0.00	13 500.00	0.00	12 000.00	60 000.00	100.00	60 000.00	60 000.00	0.00	No	n/a
30. INSTITEKNO	36 000.00	0.00	0.00	0.00	0.00	0.00	12 000.00	0.00	12 000.00	60 000.00	100.00	60 000.00	60 000.00	0.00	No	n/a
31. ROLLS-ROYCE MAR	200 600.00	0.00	0.00	0.00	0.00	0.00	17 500.00	0.00	54 525.00	272 625.00	100.00	272 625.00	272 625.00	0.00	No	n/a
32. WUT ¹⁴	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	485 000.00

ESTIMATED BUDGET FOR THE ACTION

	Estimated eligible ¹ costs (per budget category)										EU contribution			Additional information		
	A. Direct personnel costs				B. Direct costs of subcontracting	<i>[C. Direct costs of fin. support]</i>	D. Other direct costs		E. Indirect costs ²	Total costs	Reimbursement rate %	Maximum EU contribution ³	Maximum grant amount ⁴	Information for indirect costs	Information for auditors	Other information:
	A.1 Employees (or equivalent)		A.4 SME owners without salary				D.1 Travel	D.5 Costs of internally invoiced goods and services						Estimated costs of in-kind contributions not used on premises	Declaration of costs under Point D.4	Estimated costs of beneficiaries/ linked third parties not receiving funding/ international partners
A.2 Natural persons under direct contract		A.5 Beneficiaries that are natural persons without salary		D.2 Equipment												
A.3 Seconded persons				D.3 Other goods and services												
<i>[A.6 Personnel for providing access to research infrastructure]</i>				<i>[D.4 Costs of large research infrastructure]</i>												
Form of costs ⁶	Actual	Unit ⁷	Unit ⁸		Actual	Actual	Actual	Unit ⁹	Flat-rate ¹⁰							
									25%							
	a	Total b	No hours	Total c	d	<i>[e]</i>	f	Total g	h = 0,25 x (a +b+c+f+g + <i>[i1]</i> ¹³ + <i>[i2]</i> ¹³ -n)	j = a+b+c+d + <i>[e]</i> +f+g+h + <i>[i1]</i> + <i>[i2]</i>	k	l	m	n	Yes/No	
33. TUI Airways ltd	78 655.00	0.00	0.00	0.00	0.00	0.00	8 000.00	0.00	21 663.75	108 318.75	100.00	108 318.75	108 318.75	0.00	No	n/a
34. BeeBI	70 400.00	0.00	0.00	0.00	0.00	0.00	13 500.00	0.00	20 975.00	104 875.00	100.00	104 875.00	104 875.00	0.00	No	n/a
Total consortium	4 951 168.15	0.00		0.00	30 000.00	0.00	630 992.50	0.00	1 376 340.16	6 988 500.81		6 988 500.81	6 988 469.31			3 694 531.25

¹ See Article 6 for the eligibility conditions.

² Indirect costs already covered by an operating grant (received under any EU or Euratom funding programme; see Article 6.5.(b)) are ineligible under the GA. Therefore, a beneficiary/linked third party that receives an operating grant during the action's duration cannot declare indirect costs for the year(s)/reporting period(s) covered by the operating grant, unless it can demonstrate that the operating grant does not cover any costs of the action (see Article 6.2.E).

³ This is the theoretical amount of EU contribution that the system calculates automatically (by multiplying all the budgeted costs by the reimbursement rate). This theoretical amount is capped by the 'maximum grant amount' (that the Agency decided to grant for the action) (see Article 5.1).

⁴ The 'maximum grant amount' is the maximum grant amount decided by the Agency. It normally corresponds to the requested grant, but may be lower.

⁵ Depending on its type, this specific cost category will or will not cover indirect costs. Specific unit costs that include indirect costs are: costs for energy efficiency measures in buildings, access costs for providing trans-national access to research infrastructure and costs for clinical studies.

⁶ See Article 5 for the forms of costs.

⁷ Unit : hours worked on the action; costs per unit (hourly rate) : calculated according to the beneficiary's usual accounting practice.

⁸ See Annex 2a 'Additional information on the estimated budget' for the details (costs per hour (hourly rate)).

⁹ Unit and costs per unit : calculated according to the beneficiary's usual accounting practices.

¹⁰ Flat rate : 25% of eligible direct costs, from which are excluded: direct costs of subcontracting, costs of in-kind contributions not used on premises, direct costs of financial support, and unit costs declared under budget category F if they include indirect costs (see Article 6.2.E).

¹¹ See Annex 2a 'Additional information on the estimated budget' for the details (units, costs per unit).

¹² See Annex 2a 'Additional information on the estimated budget' for the details (units, costs per unit, estimated number of units, etc).

¹³ Only specific unit costs that do not include indirect costs.

¹⁴ See Article 9 for beneficiaries not receiving funding.

¹⁵ Only for linked third parties that receive funding.

ANNEX 2a**ADDITIONAL INFORMATION ON THE ESTIMATED BUDGET**

- Instructions and footnotes in blue will not appear in the text generated by the IT system (since they are internal instructions only).
- For options [in square brackets]: the applicable option will be chosen by the IT system. Options not chosen will automatically not appear.
- For fields in [grey in square brackets] (even if they are part of an option as specified in the previous item): IT system will enter the appropriate data.

⚠ Transitory period: Until SyGMA fully supports Annex 2a, you must prepare it manually (using this template by choosing and deleting the options/entering the appropriate data).
 For the 'unit cost tables': either fill them out manually or use currently existing tables from Annex 1 or the proposal.
 The document can then be uploaded in SyGMA and attached to the grant agreement.

Unit cost for SME owners/natural beneficiaries without salary**1. Costs for a [SME owner//beneficiary that is a natural person] not receiving a salary**

Units: hours worked on the action

Amount per unit ('hourly rate'): calculated according to the following formula:

{the monthly living allowance for researchers in MSCA-IF actions / 143 hours}
 multiplied by
 {country-specific correction coefficient of the country where the beneficiary is established}

The monthly living allowance and the country-specific correction coefficients are set out in the Work Programme (section 3 MSCA) in force at the time of the call:

- for calls *before* Work Programme 2018-2020:
 - for the monthly living allowance: **EUR 4 650**
 - for the country-specific correction coefficients: see Work Programme 2014-2015 and Work Programme 2016-2017 (available on the [Participant Portal Reference Documents](#) page)
- for calls *under* Work Programme 2018-2020:
 - for the monthly living allowance: **EUR 4 880**
 - for the country-specific correction coefficients: see Work Programme 2018-2020 (available on the [Participant Portal Reference Documents](#) page)

[additional OPTION for beneficiaries/linked third parties that have opted to use the unit cost (in the proposal/with an amendment): For the following beneficiaries/linked third parties, the amounts per unit (hourly rate) are fixed as follows:

- beneficiary/linked third party [short name]: EUR [insert amount]
 - beneficiary/linked third party [short name]: EUR [insert amount]
- [same for other beneficiaries/linked third parties, if necessary]]

Estimated number of units: see Annex 2

Energy efficiency measures unit cost

2. Costs for energy efficiency measures in buildings

Unit: m² of eligible ‘conditioned’ (i.e. built or refurbished) floor area

Amount per unit*: see (for each beneficiary/linked third party and BEST table) the ‘unit cost table’ attached

* Amount calculated as follows:
{EUR 0.1 x estimated total kWh saved per m² per year x 10}

Estimated number of units: see (for each beneficiary/linked third party and BEST table) the ‘unit cost table’ attached

Unit cost table (energy efficiency measures unit cost)¹

Short name beneficiary/linked third party	BEST No	Amount per unit	Estimated No of units	Total unit cost (cost per unit x estimated no of units)

¹ Data from the ‘building energy specification table (BEST)’ that is part of the proposal and Annex 1.

Research infrastructure unit cost

3. Access costs for providing trans-national access to research infrastructure

Units²: see (for each access provider and installation) the ‘unit cost table’ attached

Amount per unit^{*}: see (for each access provider and installation) the ‘unit cost table’ attached

* Amount calculated as follows:

$$\frac{\text{average annual total access cost to the installation (over past two years}^3\text{)}}{\text{average annual total quantity of access to the installation (over past two years}^4\text{)}}$$

Estimated number of units: see (for each access provider and installation) the ‘unit cost table’ attached

Unit cost table (access to research infrastructure unit cost)⁵

Short name access provider	Short name infrastru cture	Installation		Unit of access	Amount per unit	Estimated No of units	Total unit cost (cost per unit x estimated no of units)
		No	Short name				

Clinical studies unit cost

4. Costs for clinical studies

Units: patients/subjects that participate in the clinical study

Amount per unit^{*}: see (for each sequence (if any), clinical study and beneficiary/linked third party) the ‘unit cost table’ attached

* Amount calculated, for the cost components of each task, as follows:

For **personnel costs**:

For personnel costs of doctors: ‘average hourly cost for doctors’, i.e.:

{certified or auditable total personnel costs for doctors for year N-1

{ 1720 * number of full-time-equivalent for doctors for year N-1 }

multiplied by

estimated number of hours to be worked by doctors for the task (per participant)}

For personnel costs of other medical personnel: ‘average hourly cost for other medical personnel’, i.e.:

{certified or auditable total personnel costs for other medical personnel for year N-1

{ 1720 * number of full-time-equivalent for other medical personnel for year N-1 }

² Unit of access (e.g. beam hours, weeks of access, sample analysis) fixed by the access provider in proposal.

³ In exceptional and duly justified cases, the Commission/Agency may agree to a different reference period.

⁴ In exceptional and duly justified cases, the Commission/Agency may agree to a different reference period.

⁵ Data from the ‘table on estimated costs/quantity of access to be provided’ that is part of the proposal and Annex 1.

H2020 Templates: Annex 2a (Additional information on the estimated budget)

multiplied by
estimated number of hours to be worked by other medical personnel for the task (per participant)}

For personnel costs of technical personnel: 'average hourly cost for technical personnel', i.e.:

$$\frac{\{\text{certified or auditable total personnel costs for technical personnel for year N-1}\}}{\{1720 * \text{number of full-time-equivalent for technical personnel for year N-1}\}}$$

multiplied by
estimated number of hours to be worked by technical personnel for the task (per participant)}

'total personnel costs' means actual salaries + actual social security contributions + actual taxes and other costs included in the remuneration, provided they arise from national law or the employment contract/equivalent appointing act

For **consumables**:

For each cost item: 'average price of the consumable', i.e.:

$$\frac{\{\{\text{certified or auditable total costs of purchase of the consumable in year N-1}\}}{\text{total number of items purchased in year N-1}\}}$$

multiplied by
estimated number of items to be used for the task (per participant)}

'total costs of purchase of the consumable' means total value of the supply contracts (including related duties, taxes and charges such as non-deductible VAT) concluded by the beneficiary for the consumable delivered in year N-1, provided the contracts were awarded according to the principle of best value- for-money and without any conflict of interests

For **medical equipment**:

For each cost item: 'average cost of depreciation and directly related services per unit of use', i.e.:

$$\frac{\{\{\text{certified or auditable total depreciation costs in year N-1} + \text{certified or auditable total costs of purchase of services in year N-1 for the category of equipment concerned}\}}{\text{total capacity in year N-1}}$$

multiplied by
estimated number of units of use of the equipment for the task (per participant)}

'total depreciation costs' means total depreciation allowances as recorded in the beneficiary's accounts of year N-1 for the category of equipment concerned, provided the equipment was purchased according to the principle of best value for money and without any conflict of interests + total costs of renting or leasing contracts (including related duties, taxes and charges such as non-deductible VAT) in year N-1 for the category of equipment concerned, provided they do not exceed the depreciation costs of similar equipment and do not include finance fees

For **services**:

For each cost item: 'average cost of the service per study participant', i.e.:

$$\frac{\{\text{certified or auditable total costs of purchase of the service in year N-1}\}}{\text{total number of patients or subjects included in the clinical studies for which the service was delivered in year N-1}\}}$$

'total costs of purchase of the service' means total value of the contracts concluded by the beneficiary (including related duties, taxes and charges such as non-deductible VAT) for the specific service delivered in year N-1 for the conduct of clinical studies, provided the contracts were awarded according to the principle of best value for money and without any conflict of interests

For **indirect costs**:

$$\{\{\{\text{cost component 'personnel costs'} + \text{cost component 'consumables'} + \text{cost component 'medical equipment'}\}\}$$

minus

$$\{\text{costs of in-kind contributions provided by third parties which are not used on the beneficiary's premises} + \text{costs of providing financial support to third parties (if any)}\}$$

multiplied by

$$25\% \}$$

H2020 Templates: Annex 2a (Additional information on the estimated budget)

The estimation of the resources to be used must be done on the basis of the study protocol and must be the same for all beneficiaries/linked third parties/third parties involved.

The year N-1 to be used is the last closed financial year at the time of submission of the grant application.

Estimated number of units: see (for each clinical study and beneficiary/linked third party) the 'unit cost table' attached

Unit cost table: clinical studies unit cost⁶

Task, Direct cost categories	Resource per patient	Costs year N-1 Beneficiary 1 [short name]	Costs year N-1 Linked third party 1a [short name]	Costs year N-1 Beneficiary 2 [short name]	Costs year N-1 Linked third party 2a [short name]	Costs year N-1 Third party giving in-kind contributions 1 [short name]
Sequence No. 1						
Task No. 1 Blood sample						
(a) Personnel costs:						
- Doctors	n/a					
- Other Medical Personnel	Phlebotomy (nurse), 10 minutes	8,33 EUR	11,59 EUR	10,30 EUR	11,00 EUR	9,49 EUR
- Technical Personnel	Sample Processing (lab technician), 15 minutes	9,51 EUR	15,68 EUR	14,60 EUR	15,23 EUR	10,78 EUR
(b) Costs of consumables:	Syringe	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
	Cannula	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
	Blood container	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
(c) Costs of medical equipment:	Use of -80° deep freezer, 60 days	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
	Use of centrifuge, 15 minutes	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
(d) Costs of services	Cleaning of XXX	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
(e) Indirect costs (25% flat-rate)		XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
Task No. 2						
...						
Amount per unit (unit cost sequence 1):		XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
Sequence No. 2						
Task No. 1						

⁶ Same table as in proposal and Annex 1.

H2020 Templates: Annex 2a (Additional information on the estimated budget)

XXX						
(a) Personnel costs:						
- Doctors	XXX	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
- Other Medical Personnel	XXX	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
- Technical Personnel	XXX	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
(b) Costs of consumables:	XXX	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
	XXX	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
	XXX	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
(c) Costs of medical equipment:	XXX	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
	XXX	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
(d) Costs of services	XXX	XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
(e) Indirect costs (25% flat-rate)		XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
Task No. 2						
...						
Amount per unit (unit cost sequence 2):		XX EUR	XX EUR	XX EUR	XX EUR	XX EUR
...						
Amount per unit (unit cost entire study):		XX EUR	XX EUR	XX EUR	XX EUR	XX EUR

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITY OF STRATHCLYDE (USTRAT), established in Richmond Street 16, GLASGOW G1 1XQ, United Kingdom, VAT number: GB261339762, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('2')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

EUROCONTROL - EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION (EUROCONTROL), established in Rue de la Fusée 96, BRUXELLES 1130, Belgium, VAT number: not applicable, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('3')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

STICHTING NATIONAAL LUCHT- EN RUIMTEVAARTLABORATORIUM (NLR), established in Anthony Fokkerweg 2, AMSTERDAM 1059CM, Netherlands, VAT number: NL002760551B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('4')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

HUNGAROCONTROL MAGYAR LEGIFORGALMISZOLGALAT ZARTKORUEN MUKODO RESZVENYTARSASAG (HUNGAROCONTROL), established in IGLO UTCA 33 35, BUDAPEST 1185, Hungary, VAT number: HU13851325, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('5')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL and the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

ECOLE NATIONALE DE L AVIATION CIVILE (ENAC), established in AVENUE EDOUARD BELIN 7, TOULOUSE 31400, France, VAT number: FR57193112562, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('6')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA (UniSap), established in Piazzale Aldo Moro 5, ROMA 00185, Italy, VAT number: IT02133771002, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('7')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (CERTH), established in CHARILAOU THERMI ROAD 6 KM, THERMI THESSALONIKI 57001, Greece, VAT number: EL099785242, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('8')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

CETENA S.p.A. Centro per gli Studi di Tecnica Navale (CETENA), established in via Ippolito D'Aste 5, Genova 16121, Italy, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('9')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

ISTANBUL TEKNİK UNIVERSİTESİ (ITU), established in AYAZAGA KAMPUSU, MASLAK ISTANBUL 34469, Turkey, VAT number: TR4810549377, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('10')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

CALMAC FERRIES LTD (CalMac), established in The Ferry Terminal, GOUROCK PA19 1QP, United Kingdom, VAT number: GB889051388, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('11')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

CHALMERS TEKNISKA HOEGSKOLA AB (CHALMERS), established in -, GOETEBORG 41296, Sweden, VAT number: SE556479559801, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('12')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

EMBRAER PORTUGAL SA (EMBPT), established in PARQUE DA INDUSTRIA AERONAUTICA DE EVORA - LOTE A- HERDADE DE PINHEIRO E CASA BRANCA, EVORA 7005 797, Portugal, VAT number: PT508607035, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('13')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL and the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

FEDERAL STATE UNITARY ENTERPRISE THE CENTRAL AEROHYDRODYNAMIC INSTITUTE NAMED AFTER PROF. N.E. ZHUKOVSKY (TsAGI), established in Zhukovsky str 1, ZHUKOVSKY 140180, Russian Federation, VAT number: RU5013009056, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('14')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

STATE RESEARCH INSTITUTE OF AVIATION SYSTEMS (GosNIIAS), established in victorenko, MOSCOW 125319, Russian Federation, VAT number: RU7714037739, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('15')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

STATE EDUCATIONAL INSTITUTION OF HIGHER PROFESSIONAL EDUCATION MOSCOW AVIATION INSTITUTE STATE TECHNICAL UNIVERSITY (MAI), established in Volokolamskoe Shosse 4, MOSKVA 125993, Russian Federation, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('16')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

KONSERN INNOVATIONNYE TEKHNologii (Innoteh), established in CHKALOV STREET 44, BUILDING 4, ROOM 3, ZHUKOVSKY 140181, Russian Federation, VAT number: RU5040121113, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('17')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY (STATE UNIVERSITY) (MIPT), established in KERCHENSKAYA STREET 1 A KOR 1, MOSCOW 117303, Russian Federation, VAT number: RU5008006211, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('18')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

DE MONTFORT UNIVERSITY (DMU), established in THE GATEWAY, LEICESTER LE1 9BH, United Kingdom, VAT number: GB806661135, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('19')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

NATIONAL TECHNICAL UNIVERSITY OF ATHENS - NTUA (NTUA), established in HEROON POLYTECHNIOU 9 ZOGRAPHOU CAMPUS, ATHINA 15780, Greece, VAT number: EL099793475, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('20')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

WORLD MARITIME UNIVERSITY (WMU), established in FISKHAMNSGATAN 1, MALMO 211 18, Sweden, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('21')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

AIRBUS OPERATIONS SAS (AIRBUS), established in ROUTE DE BAYONNE 316, TOULOUSE 31060, France, VAT number: FR13420916918, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('22')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

ANDREAS PAPADAKIS NAUTILIAKES KAI EMPORIKES EPICHEIRISEIS MONOPROSOPI ETAIREIA PERIORISMENHS EFTHINIS (APA), established in 3, XANTHOU STREET, BONA VISTA PLAZA, GLYFADA ATHENS 16674, Greece, VAT number: EL095736650, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('23')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

RYANAIR DESIGNATED ACTIVITY COMPANY (RYANAIR), established in RYANAIR DUBLIN OFFICE AIRSIDE BUSINESS PARK, SWORDS DUBLIN, Ireland, VAT number: IE4749148U, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('24')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

PANEPISTIMIO PATRON (UPATRAS), established in UNIVERSITY CAMPUS RIO PATRAS, RIO PATRAS 265 04, Greece, VAT number: EL998219694, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('25')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

RAIL SAFETY AND STANDARDS BOARD LIMITED (RSSB), established in THE HELICON 1 SOUTH PLACE, LONDON EC2M 2RB, United Kingdom, VAT number: GB899092068, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('26')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITEIT VAN AMSTERDAM (UVA), established in SPUI 21, AMSTERDAM 1012WX, Netherlands, VAT number: NL003240782B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('27')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

WAERTSILA NETHERLANDS B.V. (Wartsila NL), established in Hanzelaan 95, Zwolle 8000GB, Netherlands, VAT number: NL001449679B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('28')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

ARCHIPELAGO PHILIPPINE FERRIES CORPORATION (APFC), established in 6TH FLOOR UNIOIL CENTER BUILDING COMMERCE AVENUE C ACACIA MADRIGAL BUSINESS PARK BRGY AYALA ALABANG, MUNTINLUPA 1781, Philippines, VAT number: PH223662279, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('29')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (INSTITEKNO), established in KAMPUS ITS SUKOLILO KEPUTIH - SUKOLILO, SURABAYA 60111, Indonesia, VAT number: ID003438348606000, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('30')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

ROLLS-ROYCE MARINE AS (ROLLS-ROYCE MAR), established in BORGUNDVEGEN 340, ALESUND 6009, Norway, VAT number: NO980371379MVA, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('31')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

Wuhan University of Technology (WUT), established in Luoshi Road 122, Wuhan 430070, China (People's Republic of), VAT number: CN420111724685906, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('32')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

TUI AIRWAYS LIMITED (TUI Airways Ltd), established in WIGMORE HOUSE, WIGMORE LANE, LUTON LU2 9TN, United Kingdom, VAT number: GB490212079, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('33')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

DEMIRAL ALI (BeeBI), established in ALTE JAKOBSTRASSE 49, BERLIN 10179, Germany, VAT number: DE313122620, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('34')

in Grant Agreement No 814961 ('the Agreement')

between DEEP BLUE SRL **and** the Innovation and Networks Executive Agency (INEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation (SAFEMODE)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

FINANCIAL STATEMENT FOR [BENEFICIARY [name]/ LINKED THIRD PARTY [name]] FOR REPORTING PERIOD [reporting period]

	Eligible ¹ costs (per budget category)													Receipts	EU contribution			Additional information	
	A. Direct personnel costs			B. Direct costs of subcontracting	[C. Direct costs of fin. support]	D. Other direct costs			E. Indirect costs ²	[F. Costs of ...]		Total costs	Receipts	Reimburse ment rate %	Maximum EU contribution ³	Requested EU contribution	Information for indirect costs :		
	A.1 Employees (or equivalent)	A.2 Natural persons under direct contract	A.3 Seconded persons [A.6 Personnel for providing access to research infrastructure]	A.4 SME owners without salary	A.5 Beneficiaries that are natural persons without salary	[C.1 Financial support]	[C.2 Prizes]	D.1 Travel	[D.4 Costs of large research infrastructure]	D.5 Costs of internally invoiced goods and services	[F.1 Costs of ...]	[F.2 Costs of ...]		Receipts of the action, to be reported in the last reporting period, according to Article 5.3.3				Costs of in-kind contributions not used on premises	
Form of costs ⁴		Actual	Unit	Unit	Actual	Actual	Actual	Actual	Unit	Flat-rate ⁵	Unit	[Unit][Lump sum]							
										25%									
	a	Total b	No hours	Total c	d	[e]	f	[g]	Total h	i=0,25 x (a+b+c+f+[g] + h+ [j 1] ⁶ +[j2] ⁶ -p)	No units	Total [j1]	Total [j2]	k = a+b+c+d+[e] +f+ [g] +h+ i + [j1] +[j2]	l	m	n	o	p
[short name beneficiary/linked third party]																			

The beneficiary/linked third party hereby confirms that:
The information provided is complete, reliable and true.
The costs declared are eligible (see Article 6).
The costs can be substantiated by adequate records and supporting documentation that will be produced upon request or in the context of checks, reviews, audits and investigations (see Articles 17, 18 and 22).
For the last reporting period: that all the receipts have been declared (see Article 5.3.3).

❗ Please declare all eligible costs, even if they exceed the amounts indicated in the estimated budget (see Annex 2). Only amounts that were declared in your individual financial statements can be taken into account lateron, in order to replace other costs that are found to be ineligible.

¹ See Article 6 for the eligibility conditions

² The indirect costs claimed must be free of any amounts covered by an operating grant (received under any EU or Euratom funding programme; see Article 6.2.E). If you have received an operating grant during this reporting period, you cannot claim indirect costs unless you can demonstrate that the operating grant does not cover any costs of the action.

³ This is the *theoretical* amount of EU contribution that the system calculates automatically (by multiplying the reimbursement rate by the total costs declared). The amount you request (in the column 'requested EU contribution') may be less,

⁴ See Article 5 for the forms of costs

⁵ Flat rate : 25% of eligible direct costs, from which are excluded: direct costs of subcontracting, costs of in-kind contributions not used on premises, direct costs of financial support, and unit costs declared under budget category F if they include indirect costs (see Article 6.2.E)

⁶ Only specific unit costs that do not include indirect costs

ANNEX 5

MODEL FOR THE CERTIFICATE ON THE FINANCIAL STATEMENTS

- For options [*in italics in square brackets*]: choose the applicable option. Options not chosen should be deleted.
- For fields in [grey in square brackets]: enter the appropriate data

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TERMS OF REFERENCE FOR AN INDEPENDENT REPORT OF FACTUAL FINDINGS ON COSTS DECLARED UNDER A GRANT AGREEMENT FINANCED UNDER THE HORIZON 2020 RESEARCH FRAMEWORK PROGRAMME

INDEPENDENT REPORT OF FACTUAL FINDINGS ON COSTS DECLARED UNDER A GRANT AGREEMENT FINANCED UNDER THE HORIZON 2020 RESEARCH FRAMEWORK PROGRAMME

Terms of Reference for an Independent Report of Factual Findings on costs declared under a Grant Agreement financed under the Horizon 2020 Research and Innovation Framework Programme

This document sets out the ‘**Terms of Reference (ToR)**’ under which

[OPTION 1: [insert name of the beneficiary] (*‘the Beneficiary’*)] [OPTION 2: [insert name of the linked third party] (*‘the Linked Third Party’*), third party linked to the Beneficiary [insert name of the beneficiary] (*‘the Beneficiary’*)]

agrees to engage

[insert legal name of the auditor] (*‘the Auditor’*)

to produce an independent report of factual findings (*‘the Report’*) concerning the Financial Statement(s)¹ drawn up by the [Beneficiary] [Linked Third Party] for the Horizon 2020 grant agreement [insert number of the grant agreement, title of the action, acronym and duration from/to] (*‘the Agreement’*), and

to issue a Certificate on the Financial Statements’ (*‘CFS’*) referred to in Article 20.4 of the Agreement based on the compulsory reporting template stipulated by the Commission.

The Agreement has been concluded under the Horizon 2020 Research and Innovation Framework Programme (H2020) between the Beneficiary and [OPTION 1: *the European Union, represented by the European Commission (‘the Commission’)*][OPTION 2: *the European Atomic Energy Community (Euratom,) represented by the European Commission (‘the Commission’)*][OPTION 3: *the [Research Executive Agency (REA)] [European Research Council Executive Agency (ERCEA)] [Innovation and Networks Executive Agency (INEA)] [Executive Agency for Small and Medium-sized Enterprises (EASME)] (‘the Agency’), under the powers delegated by the European Commission (‘the Commission’).*]

The [Commission] [Agency] is mentioned as a signatory of the Agreement with the Beneficiary only. The [European Union][Euratom][Agency] is not a party to this engagement.

1.1 Subject of the engagement

The coordinator must submit to the [Commission][Agency] the final report within 60 days following the end of the last reporting period which should include, amongst other documents, a CFS for each beneficiary and for each linked third party that requests a total contribution of EUR 325 000 or more, as reimbursement of actual costs and unit costs calculated on the basis of its usual cost accounting practices (see Article 20.4 of the Agreement). The CFS must cover all reporting periods of the beneficiary or linked third party indicated above.

The Beneficiary must submit to the coordinator the CFS for itself and for its linked third party(ies), if the CFS must be included in the final report according to Article 20.4 of the Agreement.

The CFS is composed of two separate documents:

- The Terms of Reference (*‘the ToR’*) to be signed by the [Beneficiary] [Linked Third Party] and the Auditor;

¹ By which costs under the Agreement are declared (see template ‘Model Financial Statements’ in Annex 4 to the Grant Agreement).

- The Auditor's Independent Report of Factual Findings ('the Report') to be issued on the Auditor's letterhead, dated, stamped and signed by the Auditor (or the competent public officer) which includes the agreed-upon procedures ('the Procedures') to be performed by the Auditor, and the standard factual findings ('the Findings') to be confirmed by the Auditor.

If the CFS must be included in the final report according to Article 20.4 of the Agreement, the request for payment of the balance relating to the Agreement cannot be made without the CFS. However, the payment for reimbursement of costs covered by the CFS does not preclude the Commission [Agency,] the European Anti-Fraud Office and the European Court of Auditors from carrying out checks, reviews, audits and investigations in accordance with Article 22 of the Agreement.

1.2 Responsibilities

The [Beneficiary] [Linked Third Party]:

- must draw up the Financial Statement(s) for the action financed by the Agreement in compliance with the obligations under the Agreement. The Financial Statement(s) must be drawn up according to the [Beneficiary's] [Linked Third Party's] accounting and book-keeping system and the underlying accounts and records;
- must send the Financial Statement(s) to the Auditor;
- is responsible and liable for the accuracy of the Financial Statement(s);
- is responsible for the completeness and accuracy of the information provided to enable the Auditor to carry out the Procedures. It must provide the Auditor with a written representation letter supporting these statements. The written representation letter must state the period covered by the statements and must be dated;
- accepts that the Auditor cannot carry out the Procedures unless it is given full access to the [Beneficiary's] [Linked Third Party's] staff and accounting as well as any other relevant records and documentation.

The Auditor:

- [Option 1 by default: is qualified to carry out statutory audits of accounting documents in accordance with Directive 2006/43/EC of the European Parliament and of the Council of 17 May 2006 on statutory audits of annual accounts and consolidated accounts, amending Council Directives 78/660/EEC and 83/349/EEC and repealing Council Directive 84/253/EEC or similar national regulations].
- [Option 2 if the Beneficiary or Linked Third Party has an independent Public Officer: is a competent and independent Public Officer for which the relevant national authorities have established the legal capacity to audit the Beneficiary].
- [Option 3 if the Beneficiary or Linked Third Party is an international organisation: is an [internal] [external] auditor in accordance with the internal financial regulations and procedures of the international organisation].

The Auditor:

- must be independent from the Beneficiary [and the Linked Third Party], in particular, it must not have been involved in preparing the [Beneficiary's] [Linked Third Party's] Financial Statement(s);
- must plan work so that the Procedures may be carried out and the Findings may be assessed;
- must adhere to the Procedures laid down and the compulsory report format;
- must carry out the engagement in accordance with this ToR;
- must document matters which are important to support the Report;
- must base its Report on the evidence gathered;
- must submit the Report to the [Beneficiary] [Linked Third Party].

The Commission sets out the Procedures to be carried out by the Auditor. The Auditor is not responsible for their suitability or pertinence. As this engagement is not an assurance engagement, the Auditor does not provide an audit opinion or a statement of assurance.

1.3 Applicable Standards

The Auditor must comply with these Terms of Reference and with²:

- the International Standard on Related Services ('ISRS') 4400 *Engagements to perform Agreed-upon Procedures regarding Financial Information* as issued by the International Auditing and Assurance Standards Board (IAASB);
- the *Code of Ethics for Professional Accountants* issued by the International Ethics Standards Board for Accountants (IESBA). Although ISRS 4400 states that independence is not a requirement for engagements to carry out agreed-upon procedures, the [Commission]/[Agency] requires that the Auditor also complies with the Code's independence requirements.

The Auditor's Report must state that there is no conflict of interests in establishing this Report between the Auditor and the Beneficiary *[and the Linked Third Party]*, and must specify - if the service is invoiced - the total fee paid to the Auditor for providing the Report.

1.4 Reporting

The Report must be written in the language of the Agreement (see Article 20.7).

Under Article 22 of the Agreement, the Commission[, the Agency], the European Anti-Fraud Office and the Court of Auditors have the right to audit any work that is carried out under the action and for which costs are declared from [the European Union] [Euratom] budget. This includes work related to this engagement. The Auditor must provide access to all working papers (e.g. recalculation of hourly rates, verification of the time declared for the action) related to this assignment if the Commission [, the Agency], the European Anti-Fraud Office or the European Court of Auditors requests them.

1.5 Timing

The Report must be provided by [dd Month yyyy].

1.6 Other terms

[The [Beneficiary] [Linked Third Party] and the Auditor can use this section to agree other specific terms, such as the Auditor's fees, liability, applicable law, etc. Those specific terms must not contradict the terms specified above.]

[legal name of the Auditor]	[legal name of the [Beneficiary]/[Linked Third Party]]
[name & function of authorised representative]	[name & function of authorised representative]
[dd Month yyyy]	[dd Month yyyy]
Signature of the Auditor	Signature of the [Beneficiary]/[Linked Third Party]

² Supreme Audit Institutions applying INTOSAI-standards may carry out the Procedures according to the corresponding International Standards of Supreme Audit Institutions and code of ethics issued by INTOSAI instead of the International Standard on Related Services ('ISRS') 4400 and the Code of Ethics for Professional Accountants issued by the IAASB and the IESBA.

**Independent Report of Factual Findings on costs declared
under Horizon 2020 Research and Innovation Framework Programme**

(To be printed on the Auditor's letterhead)

To
[name of contact person(s)], [Position]
[[Beneficiary's] [Linked Third Party's] name]
[Address]
[dd Month yyyy]

Dear [Name of contact person(s)],

As agreed under the terms of reference dated [dd Month yyyy]

with [OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')],

we

[name of the auditor] ('the Auditor'),
established at
[full address/city/state/province/country],
represented by
[name and function of an authorised representative],

have carried out the procedures agreed with you regarding the costs declared in the Financial Statement(s)³ of the [Beneficiary] [Linked Third Party] concerning the grant agreement [insert grant agreement reference: number, title of the action and acronym] ('the Agreement'),

with a total cost declared of
[total amount] EUR,

and a total of actual costs and unit costs calculated in accordance with the [Beneficiary's] [Linked Third Party's] usual cost accounting practices' declared of

[sum of total actual costs and total direct personnel costs declared as unit costs calculated in accordance with the [Beneficiary's] [Linked Third Party's] usual cost accounting practices] EUR

and **hereby provide our Independent Report of Factual Findings ('the Report')** using the compulsory report format agreed with you.

The Report

Our engagement was carried out in accordance with the terms of reference ('the ToR') appended to this Report. The Report includes the agreed-upon procedures ('the Procedures') carried out and the standard factual findings ('the Findings') examined.

³ By which the Beneficiary declares costs under the Agreement (see template 'Model Financial Statement' in Annex 4 to the Agreement).

The Procedures were carried out solely to assist the [Commission] [Agency] in evaluating whether the [Beneficiary's] [Linked Third Party's] costs in the accompanying Financial Statement(s) were declared in accordance with the Agreement. The [Commission] [Agency] draws its own conclusions from the Report and any additional information it may require.

The scope of the Procedures was defined by the Commission. Therefore, the Auditor is not responsible for their suitability or pertinence. Since the Procedures carried out constitute neither an audit nor a review made in accordance with International Standards on Auditing or International Standards on Review Engagements, the Auditor does not give a statement of assurance on the Financial Statements.

Had the Auditor carried out additional procedures or an audit of the [Beneficiary's] [Linked Third Party's] Financial Statements in accordance with International Standards on Auditing or International Standards on Review Engagements, other matters might have come to its attention and would have been included in the Report.

Not applicable Findings

We examined the Financial Statement(s) stated above and considered the following Findings not applicable:

Explanation (to be removed from the Report):

If a Finding was not applicable, it must be marked as 'N.A.' ('Not applicable') in the corresponding row on the right-hand column of the table and means that the Finding did not have to be corroborated by the Auditor and the related Procedure(s) did not have to be carried out.

The reasons of the non-application of a certain Finding must be obvious i.e.

- i) if no cost was declared under a certain category then the related Finding(s) and Procedure(s) are not applicable;*
- ii) if the condition set to apply certain Procedure(s) are not met the related Finding(s) and those Procedure(s) are not applicable. For instance, for 'beneficiaries with accounts established in a currency other than euro' the Procedure and Finding related to 'beneficiaries with accounts established in euro' are not applicable. Similarly, if no additional remuneration is paid, the related Finding(s) and Procedure(s) for additional remuneration are not applicable.*

List here all Findings considered not applicable for the present engagement and explain the reasons of the non-applicability.

....

Exceptions

Apart from the exceptions listed below, the [Beneficiary] [Linked Third Party] provided the Auditor all the documentation and accounting information needed by the Auditor to carry out the requested Procedures and evaluate the Findings.

Explanation (to be removed from the Report):

- If the Auditor was not able to successfully complete a procedure requested, it must be marked as 'E' ('Exception') in the corresponding row on the right-hand column of the table. The reason such as the inability to reconcile key information or the unavailability of data that prevents the Auditor from carrying out the Procedure must be indicated below.*
- If the Auditor cannot corroborate a standard finding after having carried out the corresponding procedure, it must also be marked as 'E' ('Exception') and, where possible, the reasons why the Finding was not fulfilled and its possible impact must be explained here below.*

List here any exceptions and add any information on the cause and possible consequences of each exception, if known. If the exception is quantifiable, include the corresponding amount.

....

**Example (to be removed from the Report):**

1. *The Beneficiary was unable to substantiate the Finding number 1 on ... because*
2. *Finding number 30 was not fulfilled because the methodology used by the Beneficiary to calculate unit costs was different from the one approved by the Commission. The differences were as follows: ...*
3. *After carrying out the agreed procedures to confirm the Finding number 31, the Auditor found a difference of _____ EUR. The difference can be explained by ...*

Further Remarks

In addition to reporting on the results of the specific procedures carried out, the Auditor would like to make the following general remarks:

Example (to be removed from the Report):

1. *Regarding Finding number 8 the conditions for additional remuneration were considered as fulfilled because ...*
2. *In order to be able to confirm the Finding number 15 we carried out the following additional procedures:*

Use of this Report

This Report may be used only for the purpose described in the above objective. It was prepared solely for the confidential use of the [Beneficiary] [Linked Third Party] and the [Commission] [Agency], and only to be submitted to the [Commission] [Agency] in connection with the requirements set out in Article 20.4 of the Agreement. The Report may not be used by the [Beneficiary] [Linked Third Party] or by the [Commission] [Agency] for any other purpose, nor may it be distributed to any other parties. The [Commission] [Agency] may only disclose the Report to authorised parties, in particular to the European Anti-Fraud Office (OLAF) and the European Court of Auditors.

This Report relates only to the Financial Statement(s) submitted to the [Commission] [Agency] by the [Beneficiary] [Linked Third Party] for the Agreement. Therefore, it does not extend to any other of the [Beneficiary's] [Linked Third Party's] Financial Statement(s).

There was no conflict of interest⁴ between the Auditor and the Beneficiary [and Linked Third Party] in establishing this Report. The total fee paid to the Auditor for providing the Report was EUR [] (including EUR [] of deductible VAT).

We look forward to discussing our Report with you and would be pleased to provide any further information or assistance.

[legal name of the Auditor]

[name and function of an authorised representative]

[dd Month yyyy]

Signature of the Auditor

⁴ A conflict of interest arises when the Auditor's objectivity to establish the certificate is compromised in fact or in appearance when the Auditor for instance:

- was involved in the preparation of the Financial Statements;
- stands to benefit directly should the certificate be accepted;
- has a close relationship with any person representing the beneficiary;
- is a director, trustee or partner of the beneficiary; or
- is in any other situation that compromises his or her independence or ability to establish the certificate impartially.

Agreed-upon procedures to be performed and standard factual findings to be confirmed by the Auditor

The European Commission reserves the right to i) provide the auditor with additional guidance regarding the procedures to be followed or the facts to be ascertained and the way in which to present them (this may include sample coverage and findings) or to ii) change the procedures, by notifying the Beneficiary in writing. The procedures carried out by the auditor to confirm the standard factual finding are listed in the table below.

If this certificate relates to a Linked Third Party, any reference here below to ‘the Beneficiary’ is to be considered as a reference to ‘the Linked Third Party’.

The ‘result’ column has three different options: ‘C’, ‘E’ and ‘N.A.’:

- ‘C’ stands for ‘confirmed’ and means that the auditor can confirm the ‘standard factual finding’ and, therefore, there is no exception to be reported.
- ‘E’ stands for ‘exception’ and means that the Auditor carried out the procedures but cannot confirm the ‘standard factual finding’, or that the Auditor was not able to carry out a specific procedure (e.g. because it was impossible to reconcile key information or data were unavailable),
- ‘N.A.’ stands for ‘not applicable’ and means that the Finding did not have to be examined by the Auditor and the related Procedure(s) did not have to be carried out. The reasons of the non-application of a certain Finding must be obvious i.e. i) if no cost was declared under a certain category then the related Finding(s) and Procedure(s) are not applicable; ii) if the condition set to apply certain Procedure(s) are not met then the related Finding(s) and Procedure(s) are not applicable. For instance, for ‘beneficiaries with accounts established in a currency other than the euro’ the Procedure related to ‘beneficiaries with accounts established in euro’ is not applicable. Similarly, if no additional remuneration is paid, the related Finding(s) and Procedure(s) for additional remuneration are not applicable.

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
A	ACTUAL PERSONNEL COSTS AND UNIT COSTS CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICE		
	<p>The Auditor draws a sample of persons whose costs were declared in the Financial Statement(s) to carry out the procedures indicated in the consecutive points of this section A.</p> <p><i>(The sample should be selected randomly so that it is representative. Full coverage is required if there are fewer than 10 people (including employees, natural persons working under a direct contract and personnel seconded by a third party), otherwise the sample should have a minimum of 10 people, or 10% of the total, whichever number is the highest)</i></p> <p>The Auditor sampled [] people out of the total of [] people.</p>		

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
A.1	<p>PERSONNEL COSTS</p> <p><u>For the persons included in the sample and working under an employment contract or equivalent act (general procedures for individual actual personnel costs and personnel costs declared as unit costs)</u></p> <p>To confirm standard factual findings 1-5 listed in the next column, the Auditor reviewed following information/documents provided by the Beneficiary:</p> <ul style="list-style-type: none"> ○ a list of the persons included in the sample indicating the period(s) during which they worked for the action, their position (classification or category) and type of contract; ○ the payslips of the employees included in the sample; ○ reconciliation of the personnel costs declared in the Financial Statement(s) with the accounting system (project accounting and general ledger) and payroll system; ○ information concerning the employment status and employment conditions of personnel included in the sample, in particular their employment contracts or equivalent; ○ the Beneficiary's usual policy regarding payroll matters (e.g. salary policy, overtime policy, variable pay); ○ applicable national law on taxes, labour and social security and ○ any other document that supports the personnel costs declared. <p>The Auditor also verified the eligibility of all components of the retribution (see Article 6 GA) and recalculated the personnel costs for employees included in the sample.</p>	1) The employees were i) directly hired by the Beneficiary in accordance with its national legislation, ii) under the Beneficiary's sole technical supervision and responsibility and iii) remunerated in accordance with the Beneficiary's usual practices.	
		2) Personnel costs were recorded in the Beneficiary's accounts/payroll system.	
		3) Costs were adequately supported and reconciled with the accounts and payroll records.	
		4) Personnel costs did not contain any ineligible elements.	
		5) There were no discrepancies between the personnel costs charged to the action and the costs recalculated by the Auditor.	
	<p><i>Further procedures if 'additional remuneration' is paid</i></p> <p>To confirm standard factual findings 6-9 listed in the next column, the Auditor:</p> <ul style="list-style-type: none"> ○ reviewed relevant documents provided by the Beneficiary (legal form, legal/statutory 	6) The Beneficiary paying "additional remuneration" was a non-profit legal entity.	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	<p>obligations, the Beneficiary's usual policy on additional remuneration, criteria used for its calculation, the Beneficiary's usual remuneration practice for projects funded under national funding schemes...);</p> <ul style="list-style-type: none"> recalculated the amount of additional remuneration eligible for the action based on the supporting documents received (full-time or part-time work, exclusive or non-exclusive dedication to the action, usual remuneration paid for projects funded by national schemes) to arrive at the applicable FTE/year and pro-rata rate (see data collected in the course of carrying out the procedures under A.2 'Productive hours' and A.4 'Time recording system'). <p><i>'ADDITIONAL REMUNERATION' MEANS ANY PART OF THE REMUNERATION WHICH EXCEEDS WHAT THE PERSON WOULD BE PAID FOR TIME WORKED IN PROJECTS FUNDED BY NATIONAL SCHEMES.</i></p> <p><i>IF ANY PART OF THE REMUNERATION PAID TO THE EMPLOYEE QUALIFIES AS "ADDITIONAL REMUNERATION" AND IS ELIGIBLE UNDER THE PROVISIONS OF ARTICLE 6.2.A.1, THIS CAN BE CHARGED AS ELIGIBLE COST TO THE ACTION UP TO THE FOLLOWING AMOUNT:</i></p> <p>(A) <i>IF THE PERSON WORKS FULL TIME AND EXCLUSIVELY ON THE ACTION DURING THE FULL YEAR: UP TO EUR 8 000/YEAR;</i></p> <p>(B) <i>IF THE PERSON WORKS EXCLUSIVELY ON THE ACTION BUT NOT FULL-TIME OR NOT FOR THE FULL YEAR: UP TO THE CORRESPONDING PRO-RATA AMOUNT OF EUR 8 000, OR</i></p> <p>(C) <i>IF THE PERSON DOES NOT WORK EXCLUSIVELY ON THE ACTION: UP TO A PRO-RATA AMOUNT CALCULATED IN ACCORDANCE TO ARTICLE 6.2.A.1.</i></p>	<p>7) The amount of additional remuneration paid corresponded to the Beneficiary's usual remuneration practices and was consistently paid whenever the same kind of work or expertise was required.</p>	
		<p>8) The criteria used to calculate the additional remuneration were objective and generally applied by the Beneficiary regardless of the source of funding used.</p>	
		<p>9) The amount of additional remuneration included in the personnel costs charged to the action was capped at EUR 8,000 per FTE/year (up to the equivalent pro-rata amount if the person did not work on the action full-time during the year or did not work exclusively on the action).</p>	
	<p><i>Additional procedures in case "unit costs calculated by the Beneficiary in accordance with its usual cost accounting practices" is applied:</i></p> <p>Apart from carrying out the procedures indicated above to confirm standard factual findings 1-5 and, if applicable, also 6-9, the Auditor carried out following procedures to confirm standard</p>	<p>10) The personnel costs included in the Financial Statement were calculated in accordance with the Beneficiary's usual cost accounting practice. This methodology was consistently</p>	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	<p>factual findings 10-13 listed in the next column:</p> <ul style="list-style-type: none"> obtained a description of the Beneficiary's usual cost accounting practice to calculate unit costs; reviewed whether the Beneficiary's usual cost accounting practice was applied for the Financial Statements subject of the present CFS; verified the employees included in the sample were charged under the correct category (in accordance with the criteria used by the Beneficiary to establish personnel categories) by reviewing the contract/HR-record or analytical accounting records; verified that there is no difference between the total amount of personnel costs used in calculating the cost per unit and the total amount of personnel costs recorded in the statutory accounts; verified whether actual personnel costs were adjusted on the basis of budgeted or estimated elements and, if so, verified whether those elements used are actually relevant for the calculation, objective and supported by documents. 	used in all H2020 actions.	
		11) The employees were charged under the correct category.	
		12) Total personnel costs used in calculating the unit costs were consistent with the expenses recorded in the statutory accounts.	
		13) Any estimated or budgeted element used by the Beneficiary in its unit-cost calculation were relevant for calculating personnel costs and corresponded to objective and verifiable information.	
	<p><u>For natural persons included in the sample and working with the Beneficiary under a direct contract other than an employment contract, such as consultants (no subcontractors).</u></p> <p>To confirm standard factual findings 14-17 listed in the next column the Auditor reviewed following information/documents provided by the Beneficiary:</p> <ul style="list-style-type: none"> the contracts, especially the cost, contract duration, work description, place of work, ownership of the results and reporting obligations to the Beneficiary; the employment conditions of staff in the same category to compare costs and; any other document that supports the costs declared and its registration (e.g. invoices, accounting records, etc.). 	14) The natural persons worked under conditions similar to those of an employee, in particular regarding the way the work is organised, the tasks that are performed and the premises where they are performed.	
		15) The results of work carried out belong to the Beneficiary, or, if not, the Beneficiary has obtained all necessary rights to fulfil its obligations as if those	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
		results were generated by itself.	
		16) Their costs were not significantly different from those for staff who performed similar tasks under an employment contract with the Beneficiary.	
		17) The costs were supported by audit evidence and registered in the accounts.	
	<u>For personnel seconded by a third party and included in the sample (not subcontractors)</u> To confirm standard factual findings 18-21 listed in the next column, the Auditor reviewed following information/documents provided by the Beneficiary: <ul style="list-style-type: none"> ○ their secondment contract(s) notably regarding costs, duration, work description, place of work and ownership of the results; ○ if there is reimbursement by the Beneficiary to the third party for the resource made available (in-kind contribution against payment): any documentation that supports the costs declared (e.g. contract, invoice, bank payment, and proof of registration in its accounting/payroll, etc.) and reconciliation of the Financial Statement(s) with the accounting system (project accounting and general ledger) as well as any proof that the amount invoiced by the third party did not include any profit; ○ if there is no reimbursement by the Beneficiary to the third party for the resource made available (in-kind contribution free of charge): a proof of the actual cost borne by the Third Party for the resource made available free of charge to the Beneficiary such as a statement of costs incurred by the Third Party and proof of the registration in the Third Party's accounting/payroll; 	18) Seconded personnel reported to the Beneficiary and worked on the Beneficiary's premises (unless otherwise agreed with the Beneficiary).	
		19) The results of work carried out belong to the Beneficiary, or, if not, the Beneficiary has obtained all necessary rights to fulfil its obligations as if those results were generated by itself..	
		<i>If personnel is seconded against payment:</i> 20) The costs declared were supported with documentation and recorded in the	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	<ul style="list-style-type: none"> any other document that supports the costs declared (e.g. invoices, etc.). 	Beneficiary's accounts. The third party did not include any profit.	
		<i>If personnel is seconded free of charge:</i> 21) The costs declared did not exceed the third party's cost as recorded in the accounts of the third party and were supported with documentation.	
A.2	PRODUCTIVE HOURS To confirm standard factual findings 22-27 listed in the next column, the Auditor reviewed relevant documents, especially national legislation, labour agreements and contracts and time records of the persons included in the sample, to verify that: <ul style="list-style-type: none"> the annual productive hours applied were calculated in accordance with one of the methods described below, the full-time equivalent (FTEs) ratios for employees not working full-time were correctly calculated. If the Beneficiary applied method B, the auditor verified that the correctness in which the total number of hours worked was calculated and that the contracts specified the annual workable hours. If the Beneficiary applied method C, the auditor verified that the 'annual productive hours' applied when calculating the hourly rate were equivalent to at least 90 % of the 'standard annual workable hours'. The Auditor can only do this if the calculation of the standard annual workable	22) The Beneficiary applied method [choose one option and delete the others] [A: 1720 hours] [B: the 'total number of hours worked'] [C: 'standard annual productive hours' used correspond to usual accounting practices]	
		23) Productive hours were calculated annually.	
		24) For employees not working full-time the full-time equivalent (FTE) ratio was correctly applied.	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	<p>hours can be supported by records, such as national legislation, labour agreements, and contracts.</p> <p><i>BENEFICIARY'S PRODUCTIVE HOURS' FOR PERSONS WORKING FULL TIME SHALL BE ONE OF THE FOLLOWING METHODS:</i></p> <p><i>A. 1720 ANNUAL PRODUCTIVE HOURS (PRO-RATA FOR PERSONS NOT WORKING FULL-TIME)</i></p> <p><i>B. THE TOTAL NUMBER OF HOURS WORKED BY THE PERSON FOR THE BENEFICIARY IN THE YEAR (THIS METHOD IS ALSO REFERRED TO AS 'TOTAL NUMBER OF HOURS WORKED' IN THE NEXT COLUMN). THE CALCULATION OF THE TOTAL NUMBER OF HOURS WORKED WAS DONE AS FOLLOWS: ANNUAL WORKABLE HOURS OF THE PERSON ACCORDING TO THE EMPLOYMENT CONTRACT, APPLICABLE LABOUR AGREEMENT OR NATIONAL LAW PLUS OVERTIME WORKED MINUS ABSENCES (SUCH AS SICK LEAVE OR SPECIAL LEAVE).</i></p> <p><i>C. THE STANDARD NUMBER OF ANNUAL HOURS GENERALLY APPLIED BY THE BENEFICIARY FOR ITS PERSONNEL IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICES (THIS METHOD IS ALSO REFERRED TO AS 'STANDARD ANNUAL PRODUCTIVE HOURS' IN THE NEXT COLUMN). THIS NUMBER MUST BE AT LEAST 90% OF THE STANDARD ANNUAL WORKABLE HOURS.</i></p> <p><i>'ANNUAL WORKABLE HOURS' MEANS THE PERIOD DURING WHICH THE PERSONNEL MUST BE WORKING, AT THE EMPLOYER'S DISPOSAL AND CARRYING OUT HIS/HER ACTIVITY OR DUTIES UNDER THE EMPLOYMENT CONTRACT, APPLICABLE COLLECTIVE LABOUR AGREEMENT OR NATIONAL WORKING TIME LEGISLATION.</i></p>	<p><i>If the Beneficiary applied method B.</i></p> <p>25) The calculation of the number of 'annual workable hours', overtime and absences was verifiable based on the documents provided by the Beneficiary.</p> <p>25.1) The Beneficiary calculates the hourly rates per full financial year following procedure A.3 (method B is not allowed for beneficiaries calculating hourly rates per month).</p> <p><i>If the Beneficiary applied method C.</i></p> <p>26) The calculation of the number of 'standard annual workable hours' was verifiable based on the documents provided by the Beneficiary.</p>	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
		27) The 'annual productive hours' used for calculating the hourly rate were consistent with the usual cost accounting practices of the Beneficiary and were equivalent to at least 90 % of the 'annual workable hours'.	
A.3	<p>HOURLY PERSONNEL RATES</p> <p><u>I) For unit costs calculated in accordance to the Beneficiary's usual cost accounting practice (unit costs):</u></p> <p>If the Beneficiary has a "Certificate on Methodology to calculate unit costs " (CoMUC) approved by the Commission, the Beneficiary provides the Auditor with a description of the approved methodology and the Commission's letter of acceptance. The Auditor verified that the Beneficiary has indeed used the methodology approved. If so, no further verification is necessary.</p> <p>If the Beneficiary does not have a "Certificate on Methodology" (CoMUC) approved by the Commission, or if the methodology approved was not applied, then the Auditor:</p> <ul style="list-style-type: none"> ○ reviewed the documentation provided by the Beneficiary, including manuals and internal guidelines that explain how to calculate hourly rates; ○ recalculated the unit costs (hourly rates) of staff included in the sample following the results of the procedures carried out in A.1 and A.2. <p><u>II) For individual hourly rates:</u></p> <p>The Auditor:</p> <ul style="list-style-type: none"> ○ reviewed the documentation provided by the Beneficiary, including manuals and internal guidelines that explain how to calculate hourly rates; 	<p>28) The Beneficiary applied [<i>choose one option and delete the other</i>]:</p> <p>[Option I: "Unit costs (hourly rates) were calculated in accordance with the Beneficiary's usual cost accounting practices"]</p> <p>[Option II: Individual hourly rates were applied]</p> <p><i>For option I concerning unit costs and if the Beneficiary applies the methodology approved by the Commission (CoMUC):</i></p> <p>29) The Beneficiary used the Commission-approved methodology to calculate hourly rates. It corresponded to the organisation's usual cost accounting practices and was applied consistently for all</p>	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	<ul style="list-style-type: none"> recalculated the hourly rates of staff included in the sample (recalculation of all hourly rates if the Beneficiary uses annual rates, recalculation of three months selected randomly for every year and person if the Beneficiary uses monthly rates) following the results of the procedures carried out in A.1 and A.2; (only in case of monthly rates) confirmed that the time spent on parental leave is not deducted, and that, if parts of the basic remuneration are generated over a period longer than a month, the Beneficiary has included only the share which is generated in the month. 	activities irrespective of the source of funding.	
	<p><u>“UNIT COSTS CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICES”:</u></p> <p><i>IT IS CALCULATED BY DIVIDING THE TOTAL AMOUNT OF PERSONNEL COSTS OF THE CATEGORY TO WHICH THE EMPLOYEE BELONGS VERIFIED IN LINE WITH PROCEDURE A.1 BY THE NUMBER OF FTE AND THE ANNUAL TOTAL PRODUCTIVE HOURS OF THE SAME CATEGORY CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH PROCEDURE A.2.</i></p> <p><u>HOURLY RATE FOR INDIVIDUAL ACTUAL PERSONAL COSTS:</u></p> <p><i>IT IS CALCULATED FOLLOWING ONE OF THE TWO OPTIONS BELOW:</i></p> <p><i>A) [OPTION BY DEFAULT] BY DIVIDING THE ACTUAL ANNUAL AMOUNT OF PERSONNEL COSTS OF AN EMPLOYEE VERIFIED IN LINE WITH PROCEDURE A.1 BY THE NUMBER OF ANNUAL PRODUCTIVE HOURS VERIFIED IN LINE WITH PROCEDURE A.2 (FULL FINANCIAL YEAR HOURLY RATE);</i></p> <p><i>B) BY DIVIDING THE ACTUAL MONTHLY AMOUNT OF PERSONNEL COSTS OF AN EMPLOYEE VERIFIED IN LINE WITH PROCEDURE A.1 BY 1/12 OF THE NUMBER OF ANNUAL PRODUCTIVE HOURS VERIFIED IN LINE WITH PROCEDURE A.2.(MONTHLY HOURLY RATE).</i></p>	<p><i>For option I concerning unit costs and if the Beneficiary applies a methodology not approved by the Commission:</i></p> <p>30) The unit costs re-calculated by the Auditor were the same as the rates applied by the Beneficiary.</p>	
		<p><i>For option II concerning individual hourly rates:</i></p> <p>31) The individual rates re-calculated by the Auditor were the same as the rates applied by the Beneficiary.</p> <p>31.1) The Beneficiary used only one option (per full financial year or per month) throughout each financial year examined.</p> <p>31.2) The hourly rates do not include additional remuneration.</p>	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
A.4	TIME RECORDING SYSTEM To verify that the time recording system ensures the fulfilment of all minimum requirements and that the hours declared for the action were correct, accurate and properly authorised and supported by documentation, the Auditor made the following checks for the persons included in the sample that declare time as worked for the action on the basis of time records: <ul style="list-style-type: none"> ○ description of the time recording system provided by the Beneficiary (registration, authorisation, processing in the HR-system); ○ its actual implementation; ○ time records were signed at least monthly by the employees (on paper or electronically) and authorised by the project manager or another manager; ○ the hours declared were worked within the project period; ○ there were no hours declared as worked for the action if HR-records showed absence due to holidays or sickness (further cross-checks with travels are carried out in B.1 below) ; ○ the hours charged to the action matched those in the time recording system. 	32) All persons recorded their time dedicated to the action on a daily/ weekly/ monthly basis using a paper/computer-based system. <i>(delete the answers that are not applicable)</i>	
		33) Their time-records were authorised at least monthly by the project manager or other superior.	
		34) Hours declared were worked within the project period and were consistent with the presences/absences recorded in HR-records.	
		35) There were no discrepancies between the number of hours charged to the action and the number of hours recorded.	
	<p><i>ONLY THE HOURS WORKED ON THE ACTION CAN BE CHARGED. ALL WORKING TIME TO BE CHARGED SHOULD BE RECORDED THROUGHOUT THE DURATION OF THE PROJECT, ADEQUATELY SUPPORTED BY EVIDENCE OF THEIR REALITY AND RELIABILITY (SEE SPECIFIC PROVISIONS BELOW FOR PERSONS WORKING EXCLUSIVELY FOR THE ACTION WITHOUT TIME RECORDS).</i></p> <p><u>If the persons are working exclusively for the action and without time records</u></p> <p>For the persons selected that worked exclusively for the action without time records, the Auditor verified evidence available demonstrating that they were in reality exclusively dedicated to the action and that the Beneficiary signed a declaration confirming that they have worked exclusively for the action.</p>	36) The exclusive dedication is supported by a declaration signed by the Beneficiary and by any other evidence gathered.	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
B	COSTS OF SUBCONTRACTING		
B.1	<p>The Auditor obtained the detail/breakdown of subcontracting costs and sampled cost items selected randomly (full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest).</p> <p>To confirm standard factual findings 37-41 listed in the next column, the Auditor reviewed the following for the items included in the sample:</p> <ul style="list-style-type: none"> ○ the use of subcontractors was foreseen in Annex 1; ○ subcontracting costs were declared in the subcontracting category of the Financial Statement; ○ supporting documents on the selection and award procedure were followed; ○ the Beneficiary ensured best value for money (key elements to appreciate the respect of this principle are the award of the subcontract to the bid offering best price-quality ratio, under conditions of transparency and equal treatment. In case an existing framework contract was used the Beneficiary ensured it was established on the basis of the principle of best value for money under conditions of transparency and equal treatment). <p>In particular,</p> <ol style="list-style-type: none"> i. if the Beneficiary acted as a contracting authority within the meaning of Directive 2004/18/EC (or 2014/24/EU) or of Directive 2004/17/EC (or 2014/25/EU), the Auditor verified that the applicable national law on public procurement was followed and that the subcontracting complied with the Terms and Conditions of the Agreement. ii. if the Beneficiary did not fall under the above-mentioned category the Auditor verified that the Beneficiary followed their usual procurement rules and respected the Terms and Conditions of the Agreement.. 	<p>37) The use of claimed subcontracting costs was foreseen in Annex 1 and costs were declared in the Financial Statements under the subcontracting category.</p> <p>38) There were documents of requests to different providers, different offers and assessment of the offers before selection of the provider in line with internal procedures and procurement rules. Subcontracts were awarded in accordance with the principle of best value for money.</p> <p><i>(When different offers were not collected the Auditor explains the reasons provided by the Beneficiary under the caption “Exceptions” of the Report. The Commission will analyse this information to evaluate whether these costs might be accepted as eligible)</i></p> <p>39) The subcontracts were not awarded to other Beneficiaries</p>	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	For the items included in the sample the Auditor also verified that: <ul style="list-style-type: none"> ○ the subcontracts were not awarded to other Beneficiaries in the consortium; ○ there were signed agreements between the Beneficiary and the subcontractor; ○ there was evidence that the services were provided by subcontractor; 	of the consortium.	
		40) All subcontracts were supported by signed agreements between the Beneficiary and the subcontractor.	
		41) There was evidence that the services were provided by the subcontractors.	
C	COSTS OF PROVIDING FINANCIAL SUPPORT TO THIRD PARTIES		
C.1	<p>The Auditor obtained the detail/breakdown of the costs of providing financial support to third parties and sampled [] cost items selected randomly <i>(full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest).</i></p> <p>The Auditor verified that the following minimum conditions were met:</p> <ul style="list-style-type: none"> a) the maximum amount of financial support for each third party did not exceed EUR 60 000, unless explicitly mentioned in Annex 1; b) the financial support to third parties was agreed in Annex 1 of the Agreement and the other provisions on financial support to third parties included in Annex 1 were respected. 	42) All minimum conditions were met	

D	OTHER ACTUAL DIRECT COSTS		
D.1	COSTS OF TRAVEL AND RELATED SUBSISTENCE ALLOWANCES The Auditor sampled [] cost items selected randomly (<i>full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is the highest</i>). The Auditor inspected the sample and verified that: <ul style="list-style-type: none"> ○ travel and subsistence costs were consistent with the Beneficiary's usual policy for travel. In this context, the Beneficiary provided evidence of its normal policy for travel costs (e.g. use of first class tickets, reimbursement by the Beneficiary on the basis of actual costs, a lump sum or per diem) to enable the Auditor to compare the travel costs charged with this policy; ○ travel costs are correctly identified and allocated to the action (e.g. trips are directly linked to the action) by reviewing relevant supporting documents such as minutes of meetings, workshops or conferences, their registration in the correct project account, their consistency with time records or with the dates/duration of the workshop/conference; ○ no ineligible costs or excessive or reckless expenditure was declared (see Article 6.5 MGA). 	43) Costs were incurred, approved and reimbursed in line with the Beneficiary's usual policy for travels.	
		44) There was a link between the trip and the action.	
		45) The supporting documents were consistent with each other regarding subject of the trip, dates, duration and reconciled with time records and accounting.	
		46) No ineligible costs or excessive or reckless expenditure was declared.	
D.2	DEPRECIATION COSTS FOR EQUIPMENT, INFRASTRUCTURE OR OTHER ASSETS The Auditor sampled [] cost items selected randomly (<i>full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is the highest</i>). For “equipment, infrastructure or other assets” [from now on called “asset(s)”] selected in the sample the Auditor verified that: <ul style="list-style-type: none"> ○ the assets were acquired in conformity with the Beneficiary's internal guidelines and procedures; 	47) Procurement rules, principles and guides were followed.	
		48) There was a link between the grant agreement and the asset charged to the action.	
		49) The asset charged to the action was traceable to the accounting records and the underlying documents.	

	<ul style="list-style-type: none"> ○ they were correctly allocated to the action (with supporting documents such as delivery note invoice or any other proof demonstrating the link to the action) ○ they were entered in the accounting system; ○ the extent to which the assets were used for the action (as a percentage) was supported by reliable documentation (e.g. usage overview table); <p>The Auditor recalculated the depreciation costs and verified that they were in line with the applicable rules in the Beneficiary's country and with the Beneficiary's usual accounting policy (e.g. depreciation calculated on the acquisition value).</p> <p>The Auditor verified that no ineligible costs such as deductible VAT, exchange rate losses, excessive or reckless expenditure were declared (see Article 6.5 GA).</p>	50) The depreciation method used to charge the asset to the action was in line with the applicable rules of the Beneficiary's country and the Beneficiary's usual accounting policy.	
		51) The amount charged corresponded to the actual usage for the action.	
		52) No ineligible costs or excessive or reckless expenditure were declared.	
D.3	<p>COSTS OF OTHER GOODS AND SERVICES</p> <p>The Auditor sampled [] cost items selected randomly (<i>full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest</i>).</p> <p>For the purchase of goods, works or services included in the sample the Auditor verified that:</p> <ul style="list-style-type: none"> ○ the contracts did not cover tasks described in Annex 1; ○ they were correctly identified, allocated to the proper action, entered in the accounting system (traceable to underlying documents such as purchase orders, invoices and accounting); ○ the goods were not placed in the inventory of durable equipment; ○ the costs charged to the action were accounted in line with the Beneficiary's usual accounting practices; ○ no ineligible costs or excessive or reckless expenditure were declared (see Article 6 GA). <p>In addition, the Auditor verified that these goods and services were acquired in conformity with</p>	53) Contracts for works or services did not cover tasks described in Annex 1.	
		54) Costs were allocated to the correct action and the goods were not placed in the inventory of durable equipment.	
		55) The costs were charged in line with the Beneficiary's accounting policy and were adequately supported.	
		56) No ineligible costs or excessive or reckless expenditure were declared. For internal invoices/charges only the cost element was charged, without any mark-ups.	

	<p>the Beneficiary's internal guidelines and procedures, in particular:</p> <ul style="list-style-type: none"> ○ if Beneficiary acted as a contracting authority within the meaning of Directive 2004/18/EC (or 2014/24/EU) or of Directive 2004/17/EC (or 2014/25/EU), the Auditor verified that the applicable national law on public procurement was followed and that the procurement contract complied with the Terms and Conditions of the Agreement. ○ if the Beneficiary did not fall into the category above, the Auditor verified that the Beneficiary followed their usual procurement rules and respected the Terms and Conditions of the Agreement. <p>For the items included in the sample the Auditor also verified that:</p> <ul style="list-style-type: none"> ○ the Beneficiary ensured best value for money (key elements to appreciate the respect of this principle are the award of the contract to the bid offering best price-quality ratio, under conditions of transparency and equal treatment. In case an existing framework contract was used the Auditor also verified that the Beneficiary ensured it was established on the basis of the principle of best value for money under conditions of transparency and equal treatment); <p><i>SUCH GOODS AND SERVICES INCLUDE, FOR INSTANCE, CONSUMABLES AND SUPPLIES, DISSEMINATION (INCLUDING OPEN ACCESS), PROTECTION OF RESULTS, SPECIFIC EVALUATION OF THE ACTION IF IT IS REQUIRED BY THE AGREEMENT, CERTIFICATES ON THE FINANCIAL STATEMENTS IF THEY ARE REQUIRED BY THE AGREEMENT AND CERTIFICATES ON THE METHODOLOGY, TRANSLATIONS, REPRODUCTION.</i></p>	<p>57) Procurement rules, principles and guides were followed. There were documents of requests to different providers, different offers and assessment of the offers before selection of the provider in line with internal procedures and procurement rules. The purchases were made in accordance with the principle of best value for money.</p> <p><i>(When different offers were not collected the Auditor explains the reasons provided by the Beneficiary under the caption “Exceptions” of the Report. The Commission will analyse this information to evaluate whether these costs might be accepted as eligible)</i></p>	
D.4	<p>AGGREGATED CAPITALISED AND OPERATING COSTS OF RESEARCH INFRASTRUCTURE</p> <p>The Auditor ensured the existence of a positive ex-ante assessment (issued by the EC Services) of the cost accounting methodology of the Beneficiary allowing it to apply the guidelines on direct costing for large research infrastructures in Horizon 2020.</p>	<p>58) The costs declared as direct costs for Large Research Infrastructures (in the appropriate line of the Financial Statement) comply with the methodology described in the positive ex-ante assessment report.</p>	

	<p><i>In the cases that a positive ex-ante assessment has been issued (see the standard factual findings 58-59 on the next column),</i> The Auditor ensured that the beneficiary has applied consistently the methodology that is explained and approved in the positive ex ante assessment;</p> <p><i>In the cases that a positive ex-ante assessment has NOT been issued (see the standard factual findings 60 on the next column),</i> The Auditor verified that no costs of Large Research Infrastructure have been charged as direct costs in any costs category;</p> <p><i>In the cases that a draft ex-ante assessment report has been issued with recommendation for further changes (see the standard factual findings 60 on the next column),</i></p> <ul style="list-style-type: none"> The Auditor followed the same procedure as above (when a positive ex-ante assessment has NOT yet been issued) and paid particular attention (testing reinforced) to the cost items for which the draft ex-ante assessment either rejected the inclusion as direct costs for Large Research Infrastructures or issued recommendations. 	59) Any difference between the methodology applied and the one positively assessed was extensively described and adjusted accordingly.	
		60) The direct costs declared were free from any indirect costs items related to the Large Research Infrastructure.	
D.5	<p>Costs of internally invoiced goods and services</p> <p>The Auditor sampled cost items selected randomly (full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest).</p> <p>To confirm standard factual findings 61-65 listed in the next column, the Auditor:</p> <ul style="list-style-type: none"> obtained a description of the Beneficiary's usual cost accounting practice to calculate costs of internally invoiced goods and services (unit costs); reviewed whether the Beneficiary's usual cost accounting practice was applied for the Financial Statements subject of the present CFS; ensured that the methodology to calculate unit costs is being used in a consistent manner, based on objective criteria, regardless of the source of funding; verified that any ineligible items or any costs claimed under other budget categories, in particular indirect costs, have not been taken into account when calculating the costs of 	61) The costs of internally invoiced goods and services included in the Financial Statement were calculated in accordance with the Beneficiary's usual cost accounting practice.	
		62) The cost accounting practices used to calculate the costs of internally invoiced goods and services were applied by the Beneficiary in a consistent manner based on objective criteria regardless of the source of funding.	
		63) The unit cost is calculated using the actual costs for the good or service recorded in the Beneficiary's accounts, excluding any ineligible cost or costs included in other	

	<p>internally invoiced goods and services (see Article 6 GA);</p> <ul style="list-style-type: none"> o verified whether actual costs of internally invoiced goods and services were adjusted on the basis of budgeted or estimated elements and, if so, verified whether those elements used are actually relevant for the calculation, and correspond to objective and verifiable information. o verified that any costs of items which are not directly linked to the production of the invoiced goods or service (e.g. supporting services like cleaning, general accountancy, administrative support, etc. not directly used for production of the good or service) have not been taken into account when calculating the costs of internally invoiced goods and services. o verified that any costs of items used for calculating the costs internally invoiced goods and services are supported by audit evidence and registered in the accounts. 	<p>budget categories.</p>	
		64) The unit cost excludes any costs of items which are not directly linked to the production of the invoiced goods or service.	
		65) The costs items used for calculating the actual costs of internally invoiced goods and services were relevant, reasonable and correspond to objective and verifiable information.	
E	USE OF EXCHANGE RATES		
E.1	<p><u>a) For Beneficiaries with accounts established in a currency other than euros</u></p> <p>The Auditor sampled [] cost items selected randomly and verified that the exchange rates used for converting other currencies into euros were in accordance with the following rules established in the Agreement (full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest):</p> <p><i>COSTS RECORDED IN THE ACCOUNTS IN A CURRENCY OTHER THAN EURO SHALL BE CONVERTED INTO EURO AT THE AVERAGE OF THE DAILY EXCHANGE RATES PUBLISHED IN THE C SERIES OF OFFICIAL JOURNAL OF THE EUROPEAN UNION (https://www.ecb.int/stats/exchange/eurofxref/html/index.en.html), DETERMINED OVER THE CORRESPONDING REPORTING PERIOD.</i></p> <p><i>IF NO DAILY EURO EXCHANGE RATE IS PUBLISHED IN THE OFFICIAL JOURNAL OF THE EUROPEAN UNION FOR THE CURRENCY IN QUESTION, CONVERSION SHALL BE MADE AT THE AVERAGE OF THE MONTHLY ACCOUNTING RATES ESTABLISHED BY THE COMMISSION AND PUBLISHED ON ITS WEBSITE (http://ec.europa.eu/budget/contracts_grants/info_contracts/inforeuro/inforeuro_en.cfm),</i></p>	<p>66) The exchange rates used to convert other currencies into Euros were in accordance with the rules established of the Grant Agreement and there was no difference in the final figures.</p>	

	DETERMINED OVER THE CORRESPONDING REPORTING PERIOD.		
	<p>b) For Beneficiaries with accounts established in euros</p> <p>The Auditor sampled [] cost items selected randomly and verified that the exchange rates used for converting other currencies into euros were in accordance with the following rules established in the Agreement (full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest):</p> <p><i>COSTS INCURRED IN ANOTHER CURRENCY SHALL BE CONVERTED INTO EURO BY APPLYING THE BENEFICIARY'S USUAL ACCOUNTING PRACTICES.</i></p>	67) The Beneficiary applied its usual accounting practices.	

[legal name of the audit firm]

[name and function of an authorised representative]

[dd Month yyyy]

<Signature of the Auditor>



ANNEX 6

MODEL FOR THE CERTIFICATE ON THE METHODOLOGY

- For options [*in italics in square brackets*]: choose the applicable option. Options not chosen should be deleted.
- For fields in [grey in square brackets]: enter the appropriate data.

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TERMS OF REFERENCE FOR AN AUDIT ENGAGEMENT FOR A METHODOLOGY CERTIFICATE IN CONNECTION WITH ONE OR MORE GRANT AGREEMENTS FINANCED UNDER THE HORIZON 2020 RESEARCH AND INNOVATION FRAMEWORK PROGRAMME

INDEPENDENT REPORT OF FACTUAL FINDINGS ON THE METHODOLOGY CONCERNING GRANT AGREEMENTS FINANCED UNDER THE HORIZON 2020 RESEARCH AND INNOVATION FRAMEWORK PROGRAMME

**Terms of reference for an audit engagement for a methodology certificate
in connection with one or more grant agreements financed
under the Horizon 2020 Research and Innovation Framework Programme**

This document sets out the ‘**Terms of Reference (ToR)**’ under which

[OPTION 1: *[insert name of the beneficiary]* (*‘the Beneficiary’*)] [OPTION 2: *[insert name of the linked third party]* (*‘the Linked Third Party’*), third party linked to the Beneficiary *[insert name of the beneficiary]* (*‘the Beneficiary’*)]

agrees to engage

[insert legal name of the auditor] (*‘the Auditor’*)

to produce an independent report of factual findings (*‘the Report’*) concerning the *[Beneficiary’s]* *[Linked Third Party’s]* usual accounting practices for calculating and claiming direct personnel costs declared as unit costs (*‘the Methodology’*) in connection with grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme.

The procedures to be carried out for the assessment of the methodology will be based on the grant agreement(s) detailed below:

[title and number of the grant agreement(s)] (*‘the Agreement(s)’*)

The Agreement(s) has(have) been concluded between the Beneficiary and [OPTION 1: *the European Union, represented by the European Commission* (*‘the Commission’*)] [OPTION 2: *the European Atomic Energy Community (Euratom), represented by the European Commission* (*‘the Commission’*)] [OPTION 3: *the [Research Executive Agency (REA)] [European Research Council Executive Agency (ERCEA)] [Innovation and Networks Executive Agency (INEA)] [Executive Agency for Small and Medium-sized Enterprises (EASME)]* (*‘the Agency’*), under the powers delegated by the European Commission (*‘the Commission’*)].

The *[Commission]* *[Agency]* is mentioned as a signatory of the Agreement with the Beneficiary only. The *[European Union]* *[Euratom]* *[Agency]* is not a party to this engagement.

1.1 Subject of the engagement

According to Article 18.1.2 of the Agreement, beneficiaries *[and linked third parties]* that declare direct personnel costs as unit costs calculated in accordance with their usual cost accounting practices may submit to the *[Commission]* *[Agency]*, for approval, a certificate on the methodology (*‘CoMUC’*) stating that there are adequate records and documentation to prove that their cost accounting practices used comply with the conditions set out in Point A of Article 6.2.

The subject of this engagement is the CoMUC which is composed of two separate documents:

- the Terms of Reference (*‘the ToR’*) to be signed by the *[Beneficiary]* *[Linked Third Party]* and the Auditor;
- the Auditor’s Independent Report of Factual Findings (*‘the Report’*) issued on the Auditor’s letterhead, dated, stamped and signed by the Auditor which includes; the standard statements (*‘the Statements’*) evaluated and signed by the *[Beneficiary]* *[Linked Third Party]*, the agreed-upon procedures (*‘the Procedures’*) performed by the Auditor and the standard factual findings

(‘the Findings’) assessed by the Auditor. The Statements, Procedures and Findings are summarised in the table that forms part of the Report.

The information provided through the Statements, the Procedures and the Findings will enable the Commission to draw conclusions regarding the existence of the *[Beneficiary’s] [Linked Third Party’s]* usual cost accounting practice and its suitability to ensure that direct personnel costs claimed on that basis comply with the provisions of the Agreement. The Commission draws its own conclusions from the Report and any additional information it may require.

1.2 Responsibilities

The parties to this agreement are the *[Beneficiary] [Linked Third Party]* and the Auditor.

The *[Beneficiary] [Linked Third Party]*:

- is responsible for preparing financial statements for the Agreement(s) (‘the Financial Statements’) in compliance with those Agreements;
- is responsible for providing the Financial Statement(s) to the Auditor and enabling the Auditor to reconcile them with the *[Beneficiary’s] [Linked Third Party’s]* accounting and bookkeeping system and the underlying accounts and records. The Financial Statement(s) will be used as a basis for the procedures which the Auditor will carry out under this ToR;
- is responsible for its Methodology and liable for the accuracy of the Financial Statement(s);
- is responsible for endorsing or refuting the Statements indicated under the heading ‘Statements to be made by the Beneficiary/ Linked Third Party’ in the first column of the table that forms part of the Report;
- must provide the Auditor with a signed and dated representation letter;
- accepts that the ability of the Auditor to carry out the Procedures effectively depends upon the *[Beneficiary] [Linked Third Party]* providing full and free access to the *[Beneficiary’s] [Linked Third Party’s]* staff and to its accounting and other relevant records.

The Auditor:

- *[Option 1 by default: is qualified to carry out statutory audits of accounting documents in accordance with Directive 2006/43/EC of the European Parliament and of the Council of 17 May 2006 on statutory audits of annual accounts and consolidated accounts, amending Council Directives 78/660/EEC and 83/349/EEC and repealing Council Directive 84/253/EEC or similar national regulations].*
- *[Option 2 if the Beneficiary or Linked Third Party has an independent Public Officer: is a competent and independent Public Officer for which the relevant national authorities have established the legal capacity to audit the Beneficiary].*
- *[Option 3 if the Beneficiary or Linked Third Party is an international organisation: is an [internal] [external] auditor in accordance with the internal financial regulations and procedures of the international organisation].*

The Auditor:

- must be independent from the Beneficiary *[and the Linked Third Party]*, in particular, it must not have been involved in preparing the Beneficiary’s *[and Linked Third Party’s]* Financial Statement(s);
- must plan work so that the Procedures may be carried out and the Findings may be assessed;
- must adhere to the Procedures laid down and the compulsory report format;
- must carry out the engagement in accordance with these ToR;
- must document matters which are important to support the Report;
- must base its Report on the evidence gathered;
- must submit the Report to the *[Beneficiary] [Linked Third Party]*.

The Commission sets out the Procedures to be carried out and the Findings to be endorsed by the Auditor. The Auditor is not responsible for their suitability or pertinence. As this engagement is not an assurance engagement the Auditor does not provide an audit opinion or a statement of assurance.

1.3 Applicable Standards

The Auditor must comply with these Terms of Reference and with¹:

- the International Standard on Related Services ('ISRS') 4400 *Engagements to perform Agreed-upon Procedures regarding Financial Information* as issued by the International Auditing and Assurance Standards Board (IAASB);
- the *Code of Ethics for Professional Accountants* issued by the International Ethics Standards Board for Accountants (IESBA). Although ISRS 4400 states that independence is not a requirement for engagements to carry out agreed-upon procedures, the Commission requires that the Auditor also complies with the Code's independence requirements.

The Auditor's Report must state that there was no conflict of interests in establishing this Report between the Auditor and the Beneficiary *[and the Linked Third Party]* that could have a bearing on the Report, and must specify – if the service is invoiced - the total fee paid to the Auditor for providing the Report.

1.4 Reporting

The Report must be written in the language of the Agreement (see Article 20.7 of the Agreement).

Under Article 22 of the Agreement, the Commission, *[the Agency]*, the European Anti-Fraud Office and the Court of Auditors have the right to audit any work that is carried out under the action and for which costs are declared from *[the European Union]* *[Euratom]* budget. This includes work related to this engagement. The Auditor must provide access to all working papers related to this assignment if the Commission¹, *the Agency*, the European Anti-Fraud Office or the European Court of Auditors requests them.

1.5 Timing

The Report must be provided by [dd Month yyyy].

1.6 Other Terms

[The [Beneficiary] [Linked Third Party] and the Auditor can use this section to agree other specific terms, such as the Auditor's fees, liability, applicable law, etc. Those specific terms must not contradict the terms specified above.]

[legal name of the Auditor]
[name & title of authorised representative]
[dd Month yyyy]
Signature of the Auditor

[legal name of the [Beneficiary] [Linked Third Party]]
[name & title of authorised representative]
[dd Month yyyy]
Signature of the *[Beneficiary] [Linked Third Party]*

¹ Supreme Audit Institutions applying INTOSAI-standards may carry out the Procedures according to the corresponding International Standards of Supreme Audit Institutions and code of ethics issued by INTOSAI instead of the International Standard on Related Services ('ISRS') 4400 and the Code of Ethics for Professional Accountants issued by the IAASB and the IESBA.

Independent report of factual findings on the methodology concerning grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme

(To be printed on letterhead paper of the auditor)

To

[name of contact person(s)], [Position]
[[Beneficiary's] [Linked Third Party's] name]
[Address]
[dd Month yyyy]

Dear [Name of contact person(s)],

As agreed under the terms of reference dated [dd Month yyyy]

with [OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')],

we

[name of the auditor] ('the Auditor'),

established at

[full address/city/state/province/country],

represented by

[name and function of an authorised representative],

have carried out the agreed-upon procedures ('the Procedures') and provide hereby our Independent Report of Factual Findings ('the Report'), concerning the [Beneficiary's] [Linked Third Party's] usual accounting practices for calculating and declaring direct personnel costs declared as unit costs ('the Methodology').

You requested certain procedures to be carried out in connection with the grant(s)

[title and number of the grant agreement(s)] ('the Agreement(s)').

The Report

Our engagement was carried out in accordance with the terms of reference ('the ToR') appended to this Report. The Report includes: the standard statements ('the Statements') made by the [Beneficiary] [Linked Third Party], the agreed-upon procedures ('the Procedures') carried out and the standard factual findings ('the Findings') confirmed by us.

The engagement involved carrying out the Procedures and assessing the Findings and the documentation requested appended to this Report, the results of which the Commission uses to draw conclusions regarding the acceptability of the Methodology applied by the [Beneficiary] [Linked Third Party].

The Report covers the methodology used from [dd Month yyyy]. In the event that the [Beneficiary] [Linked Third Party] changes this methodology, the Report will not be applicable to any Financial Statement¹ submitted thereafter.

The scope of the Procedures and the definition of the standard statements and findings were determined solely by the Commission. Therefore, the Auditor is not responsible for their suitability or pertinence.

Since the Procedures carried out constitute neither an audit nor a review made in accordance with International Standards on Auditing or International Standards on Review Engagements, we do not give a statement of assurance on the costs declared on the basis of the [Beneficiary's] [Linked Third Party's] Methodology. Had we carried out additional procedures or had we performed an audit or review in accordance with these standards, other matters might have come to its attention and would have been included in the Report.

Exceptions

Apart from the exceptions listed below, the [Beneficiary] [Linked Third Party] agreed with the standard Statements and provided the Auditor all the documentation and accounting information needed by the Auditor to carry out the requested Procedures and corroborate the standard Findings.

List here any exception and add any information on the cause and possible consequences of each exception, if known. If the exception is quantifiable, also indicate the corresponding amount.

.....

Explanation of possible exceptions in the form of examples (to be removed from the Report):

- i. the [Beneficiary] [Linked Third Party] did not agree with the standard Statement number ... because...;
- ii. the Auditor could not carry out the procedure ... established because (e.g. due to the inability to reconcile key information or the unavailability or inconsistency of data);
- iii. the Auditor could not confirm or corroborate the standard Finding number ... because

Remarks

We would like to add the following remarks relevant for the proper understanding of the Methodology applied by the [Beneficiary] [Linked Third Party] or the results reported:

Example (to be removed from the Report):

Regarding the methodology applied to calculate hourly rates ...
 Regarding standard Finding 15 it has to be noted that ...
 The [Beneficiary] [Linked Third Party] explained the deviation from the benchmark statement XXIV concerning time recording for personnel with no exclusive dedication to the action in the following manner:
 ...

Annexes

Please provide the following documents to the auditor and annex them to the report when submitting this CoMUC to the Commission:

¹ Financial Statement in this context refers solely to Annex 4 of the Agreement by which the Beneficiary declares costs under the Agreement.

1. Brief description of the methodology for calculating personnel costs, productive hours and hourly rates;
2. Brief description of the time recording system in place;
3. An example of the time records used by the [Beneficiary] [Linked Third Party];
4. Description of any budgeted or estimated elements applied, together with an explanation as to why they are relevant for calculating the personnel costs and how they are based on objective and verifiable information;
5. A summary sheet with the hourly rate for direct personnel declared by the [Beneficiary] [Linked Third Party] and recalculated by the Auditor for each staff member included in the sample (the names do not need to be reported);
6. A comparative table summarising for each person selected in the sample a) the time claimed by the [Beneficiary] [Linked Third Party] in the Financial Statement(s) and b) the time according to the time record verified by the Auditor;
7. A copy of the letter of representation provided to the Auditor.

Use of this Report

This Report has been drawn up solely for the purpose given under Point 1.1 Reasons for the engagement.

The Report:

- is confidential and is intended to be submitted to the Commission by the [Beneficiary] [Linked Third Party] in connection with Article 18.1.2 of the Agreement;
- may not be used by the [Beneficiary] [Linked Third Party] or by the Commission for any other purpose, nor distributed to any other parties;
- may be disclosed by the Commission only to authorised parties, in particular the European Anti-Fraud Office (OLAF) and the European Court of Auditors.
- relates only to the usual cost accounting practices specified above and does not constitute a report on the Financial Statements of the [Beneficiary] [Linked Third Party].

No conflict of interest² exists between the Auditor and the Beneficiary [and the Linked Third Party] that could have a bearing on the Report. The total fee paid to the Auditor for producing the Report was EUR [] (including EUR [] of deductible VAT).

We look forward to discussing our Report with you and would be pleased to provide any further information or assistance which may be required.

Yours sincerely

[legal name of the Auditor]

[name and title of the authorised representative]

[dd Month yyyy]

Signature of the Auditor

² A conflict of interest arises when the Auditor's objectivity to establish the certificate is compromised in fact or in appearance when the Auditor for instance:

- was involved in the preparation of the Financial Statements;
- stands to benefit directly should the certificate be accepted;
- has a close relationship with any person representing the beneficiary;
- is a director, trustee or partner of the beneficiary; or
- is in any other situation that compromises his or her independence or ability to establish the certificate impartially.

Statements to be made by the Beneficiary/Linked Third Party ('the Statements') and Procedures to be carried out by the Auditor ('the Procedures') and standard factual findings ('the Findings') to be confirmed by the Auditor

The Commission reserves the right to provide the auditor with guidance regarding the Statements to be made, the Procedures to be carried out or the Findings to be ascertained and the way in which to present them. The Commission reserves the right to vary the Statements, Procedures or Findings by written notification to the Beneficiary/Linked Third Party to adapt the procedures to changes in the grant agreement(s) or to any other circumstances.

If this methodology certificate relates to the Linked Third Party's usual accounting practices for calculating and claiming direct personnel costs declared as unit costs any reference here below to 'the Beneficiary' is to be considered as a reference to 'the Linked Third Party'.

<i>Please explain any discrepancies in the body of the Report.</i>	
Statements to be made by Beneficiary	Procedures to be carried out and Findings to be confirmed by the Auditor
<p>A. Use of the Methodology</p> <p>I. The cost accounting practice described below has been in use since /dd Month yyyy/.</p> <p>II. The next planned alteration to the methodology used by the Beneficiary will be from [dd Month yyyy/.</p>	<p>Procedure:</p> <p>✓ The Auditor checked these dates against the documentation the Beneficiary has provided.</p> <p>Factual finding:</p> <p>1. The dates provided by the Beneficiary were consistent with the documentation.</p>
<p>B. Description of the Methodology</p> <p>III. The methodology to calculate unit costs is being used in a consistent manner and is reflected in the relevant procedures.</p> <p><i>[Please describe the methodology your entity uses to calculate <u>personnel costs</u>, productive hours and hourly rates, present your description to the Auditor and annex it to this certificate]</i></p> <p><i>[If the statement of section "B. Description of the methodology" cannot be endorsed by the Beneficiary or there is no written methodology to calculate unit costs it should be listed here below and reported as exception by the Auditor in the main Report of Factual Findings:</i></p> <p>- ...]</p>	<p>Procedure:</p> <p>✓ The Auditor reviewed the description, the relevant manuals and/or internal guidance documents describing the methodology.</p> <p>Factual finding:</p> <p>2. The brief description was consistent with the relevant manuals, internal guidance and/or other documentary evidence the Auditor has reviewed.</p> <p>3. The methodology was generally applied by the Beneficiary as part of its usual costs accounting practices.</p>

<i>Please explain any discrepancies in the body of the Report.</i>	
Statements to be made by Beneficiary	Procedures to be carried out and Findings to be confirmed by the Auditor
<p>C. Personnel costs</p> <p><u>General</u></p> <p>IV. The unit costs (hourly rates) are limited to salaries including during parental leave, social security contributions, taxes and other costs included in the remuneration required under national law and the employment contract or equivalent appointing act;</p> <p>V. Employees are hired directly by the Beneficiary in accordance with national law, and work under its sole supervision and responsibility;</p> <p>VI. The Beneficiary remunerates its employees in accordance with its usual practices. This means that personnel costs are charged in line with the Beneficiary's usual payroll policy (e.g. salary policy, overtime policy, variable pay) and no special conditions exist for employees assigned to tasks relating to the European Union or Euratom, unless explicitly provided for in the grant agreement(s);</p> <p>VII. The Beneficiary allocates its employees to the relevant group/category/cost centre for the purpose of the unit cost calculation in line with the usual cost accounting practice;</p> <p>VIII. Personnel costs are based on the payroll system and accounting system.</p> <p>IX. Any exceptional adjustments of actual personnel costs resulted from relevant budgeted or estimated elements and were based on objective and verifiable information. <i>[Please describe the 'budgeted or estimated elements' and their relevance to personnel costs, and explain how they were reasonable and based on objective and verifiable information, present your explanation to the Auditor and annex it to this certificate].</i></p> <p>X. Personnel costs claimed do not contain any of the following ineligible costs: costs related to return on capital; debt and debt service charges; provisions for future losses or debts; interest owed; doubtful debts; currency exchange losses; bank costs charged by the Beneficiary's bank for transfers from the Commission/Agency; excessive or reckless expenditure; deductible VAT or costs incurred during suspension of the implementation of the action.</p> <p>XI. Personnel costs were not declared under another EU or Euratom grant</p>	<p>Procedure:</p> <p><i>The Auditor draws a sample of employees to carry out the procedures indicated in this section C and the following sections D to F.</i> <i>[The Auditor has drawn a random sample of 10 employees assigned to Horizon 2020 action(s). If fewer than 10 employees are assigned to the Horizon 2020 action(s), the Auditor has selected all employees assigned to the Horizon 2020 action(s) complemented by other employees irrespective of their assignments until he has reached 10 employees.].</i> For this sample:</p> <ul style="list-style-type: none"> ✓ the Auditor reviewed all documents relating to personnel costs such as employment contracts, payslips, payroll policy (e.g. salary policy, overtime policy, variable pay policy), accounting and payroll records, applicable national tax, labour and social security law and any other documents corroborating the personnel costs claimed; ✓ in particular, the Auditor reviewed the employment contracts of the employees in the sample to verify that: <ul style="list-style-type: none"> i. they were employed directly by the Beneficiary in accordance with applicable national legislation; ii. they were working under the sole technical supervision and responsibility of the latter; iii. they were remunerated in accordance with the Beneficiary's usual practices; iv. they were allocated to the correct group/category/cost centre for the purposes of calculating the unit cost in line with the Beneficiary's usual cost accounting practices; ✓ the Auditor verified that any ineligible items or any costs claimed under other costs categories or costs covered by other types of grant or by other grants financed from the European Union budget have not been taken into account when calculating the personnel costs; ✓ the Auditor numerically reconciled the total amount of personnel costs used to calculate the unit cost with the total amount of personnel costs recorded in the statutory accounts and the payroll system.

<i>Please explain any discrepancies in the body of the Report.</i>	
Statements to be made by Beneficiary	Procedures to be carried out and Findings to be confirmed by the Auditor
<p>(including grants awarded by a Member State and financed by the EU budget and grants awarded by bodies other than the Commission/Agency for the purpose of implementing the EU or Euratom budget in the same period, unless the Beneficiary can demonstrate that the operating grant does not cover any costs of the action).</p> <p><u>If additional remuneration as referred to in the grant agreement(s) is paid</u></p> <p>XII. The Beneficiary is a non-profit legal entity;</p> <p>XIII. The additional remuneration is part of the beneficiary's usual remuneration practices and paid consistently whenever the relevant work or expertise is required;</p> <p>XIV. The criteria used to calculate the additional remuneration are objective and generally applied regardless of the source of funding;</p> <p>XV. The additional remuneration included in the personnel costs used to calculate the hourly rates for the grant agreement(s) is capped at EUR 8 000 per full-time equivalent (reduced proportionately if the employee is not assigned exclusively to the action).</p> <p><i>[If certain statement(s) of section "C. Personnel costs" cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor in the main Report of Factual Findings:</i></p> <p>- ...]</p>	<p>✓ to the extent that actual personnel costs were adjusted on the basis of budgeted or estimated elements, the Auditor carefully examined those elements and checked the information source to confirm that they correspond to objective and verifiable information;</p> <p>✓ if additional remuneration has been claimed, the Auditor verified that the Beneficiary was a non-profit legal entity, that the amount was capped at EUR 8 000 per full-time equivalent and that it was reduced proportionately for employees not assigned exclusively to the action(s).</p> <p>✓ the Auditor recalculated the personnel costs for the employees in the sample.</p> <p>Factual finding:</p> <p>4. All the components of the remuneration that have been claimed as personnel costs are supported by underlying documentation.</p> <p>5. The employees in the sample were employed directly by the Beneficiary in accordance with applicable national law and were working under its sole supervision and responsibility.</p> <p>6. Their employment contracts were in line with the Beneficiary's usual policy;</p> <p>7. Personnel costs were duly documented and consisted solely of salaries, social security contributions (pension contributions, health insurance, unemployment fund contributions, etc.), taxes and other statutory costs included in the remuneration (holiday pay, thirteenth month's pay, etc.);</p> <p>8. The totals used to calculate the personnel unit costs are consistent with those registered in the payroll and accounting records;</p> <p>9. To the extent that actual personnel costs were adjusted on the basis of budgeted or estimated elements, those elements were relevant for calculating the personnel costs and correspond to objective and verifiable information. The budgeted or estimated elements used are: — (indicate the elements and their values).</p> <p>10. Personnel costs contained no ineligible elements;</p> <p>11. Specific conditions for eligibility were fulfilled when additional</p>

<i>Please explain any discrepancies in the body of the Report.</i>	
Statements to be made by Beneficiary	Procedures to be carried out and Findings to be confirmed by the Auditor
	remuneration was paid: a) the Beneficiary is registered in the grant agreements as a non-profit legal entity; b) it was paid according to objective criteria generally applied regardless of the source of funding used and c) remuneration was capped at EUR 8000 per full-time equivalent (or up to up to the equivalent pro-rata amount if the person did not work on the action full-time during the year or did not work exclusively on the action).
<p>D. Productive hours</p> <p>XVI. The number of productive hours per full-time employee applied is <i>[delete as appropriate]</i>:</p> <p>A. 1720 productive hours per year for a person working full-time (corresponding pro-rata for persons not working full time).</p> <p>B. the total number of hours worked in the year by a person for the Beneficiary</p> <p>C. the standard number of annual hours generally applied by the beneficiary for its personnel in accordance with its usual cost accounting practices. This number must be at least 90% of the standard annual workable hours.</p> <p><u>If method B is applied</u></p> <p>XVII. The calculation of the total number of hours worked was done as follows: annual workable hours of the person according to the employment contract, applicable labour agreement or national law plus overtime worked minus absences (such as sick leave and special leave).</p> <p>XVIII. ‘Annual workable hours’ are hours during which the personnel must be working, at the employer’s disposal and carrying out his/her activity or duties under the employment contract, applicable collective labour agreement or national working time legislation.</p> <p>XIX. The contract (applicable collective labour agreement or national working time legislation) do specify the working time enabling to calculate the annual workable hours.</p>	<p>Procedure (same sample basis as for Section C: Personnel costs):</p> <ul style="list-style-type: none"> ✓ The Auditor verified that the number of productive hours applied is in accordance with method A, B or C. ✓ The Auditor checked that the number of productive hours per full-time employee is correct. ✓ If method B is applied the Auditor verified i) the manner in which the total number of hours worked was done and ii) that the contract specified the annual workable hours by inspecting all the relevant documents, national legislation, labour agreements and contracts. ✓ If method C is applied the Auditor reviewed the manner in which the standard number of working hours per year has been calculated by inspecting all the relevant documents, national legislation, labour agreements and contracts and verified that the number of productive hours per year used for these calculations was at least 90% of the standard number of working hours per year. <p>Factual finding:</p> <p><u>General</u></p> <p>12. The Beneficiary applied a number of productive hours consistent with method A, B or C detailed in the left-hand column.</p> <p>13. The number of productive hours per year per full-time employee was accurate.</p> <p><u>If method B is applied</u></p> <p>14. The number of ‘annual workable hours’, overtime and absences was</p>

<i>Please explain any discrepancies in the body of the Report.</i>	
Statements to be made by Beneficiary	Procedures to be carried out and Findings to be confirmed by the Auditor
<p><u>If method C is applied</u></p> <p>XX. The standard number of productive hours per year is that of a full-time equivalent.</p> <p>XXI. The number of productive hours per year on which the hourly rate is based i) corresponds to the Beneficiary's usual accounting practices; ii) is at least 90 % of the standard number of workable (working) hours per year.</p> <p>XXII. Standard workable (working) hours are hours during which personnel are at the Beneficiary's disposal performing the duties described in the relevant employment contract, collective labour agreement or national labour legislation. The number of standard annual workable (working) hours that the Beneficiary claims is supported by labour contracts, national legislation and other documentary evidence.</p> <p><i>[If certain statement(s) of section "D. Productive hours" cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor:</i> - ...]</p>	<p>verifiable based on the documents provided by the Beneficiary and the calculation of the total number of hours worked was accurate.</p> <p>15. The contract specified the working time enabling to calculate the annual workable hours.</p> <p><u>If method C is applied</u></p> <p>16. The calculation of the number of productive hours per year corresponded to the usual costs accounting practice of the Beneficiary.</p> <p>17. The calculation of the standard number of workable (working) hours per year was corroborated by the documents presented by the Beneficiary.</p> <p>18. The number of productive hours per year used for the calculation of the hourly rate was at least 90 % of the number of workable (working) hours per year.</p>
<p>E. Hourly rates</p> <p>The hourly rates are correct because:</p> <p>XXIII. Hourly rates are correctly calculated since they result from dividing annual personnel costs by the productive hours of a given year and group (e.g. staff category or department or cost centre depending on the methodology applied) and they are in line with the statements made in section C. and D. above.</p> <p><i>[If the statement of section 'E. Hourly rates' cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor:</i> - ...]</p>	<p>Procedure</p> <ul style="list-style-type: none"> ✓ The Auditor has obtained a list of all personnel rates calculated by the Beneficiary in accordance with the methodology used. ✓ The Auditor has obtained a list of all the relevant employees, based on which the personnel rate(s) are calculated. <p>For 10 employees selected at random (same sample basis as Section C: Personnel costs):</p> <ul style="list-style-type: none"> ✓ The Auditor recalculated the hourly rates. ✓ The Auditor verified that the methodology applied corresponds to the usual accounting practices of the organisation and is applied consistently for all activities of the organisation on the basis of objective criteria irrespective of the source of funding. <p>Factual finding:</p>

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	19. No differences arose from the recalculation of the hourly rate for the employees included in the sample.
<p>F. Time recording</p> <p>XXIV. Time recording is in place for all persons with no exclusive dedication to one Horizon 2020 action. At least all hours worked in connection with the grant agreement(s) are registered on a daily/weekly/monthly basis <i>[delete as appropriate]</i> using a paper/computer-based system <i>[delete as appropriate]</i>;</p> <p>XXV. For persons exclusively assigned to one Horizon 2020 activity the Beneficiary has either signed a declaration to that effect or has put arrangements in place to record their working time;</p> <p>XXVI. Records of time worked have been signed by the person concerned (on paper or electronically) and approved by the action manager or line manager at least monthly;</p> <p>XXVII. Measures are in place to prevent staff from:</p> <ul style="list-style-type: none"> i. recording the same hours twice, ii. recording working hours during absence periods (e.g. holidays, sick leave), iii. recording more than the number of productive hours per year used to calculate the hourly rates, and iv. recording hours worked outside the action period. <p>XXVIII. No working time was recorded outside the action period;</p> <p>XXIX. No more hours were claimed than the productive hours used to calculate the hourly personnel rates.</p> <p><i>[Please provide a brief description of the <u>time recording system</u> in place together with the measures applied to ensure its reliability to the Auditor and annex it to the</i></p>	<p>Procedure</p> <ul style="list-style-type: none"> ✓ The Auditor reviewed the brief description, all relevant manuals and/or internal guidance describing the methodology used to record time. <p>The Auditor reviewed the time records of the random sample of 10 employees referred to under Section C: Personnel costs, and verified in particular:</p> <ul style="list-style-type: none"> ✓ that time records were available for all persons with not exclusive assignment to the action; ✓ that time records were available for persons working exclusively for a Horizon 2020 action, or, alternatively, that a declaration signed by the Beneficiary was available for them certifying that they were working exclusively for a Horizon 2020 action; ✓ that time records were signed and approved in due time and that all minimum requirements were fulfilled; ✓ that the persons worked for the action in the periods claimed; ✓ that no more hours were claimed than the productive hours used to calculate the hourly personnel rates; ✓ that internal controls were in place to prevent that time is recorded twice, during absences for holidays or sick leave; that more hours are claimed per person per year for Horizon 2020 actions than the number of productive hours per year used to calculate the hourly rates; that working time is recorded outside the action period; ✓ the Auditor cross-checked the information with human-resources records to verify consistency and to ensure that the internal controls have been effective. In addition, the Auditor has verified that no more hours were charged to Horizon 2020 actions per person per year than the number of productive hours per year used to calculate the hourly rates, and verified that

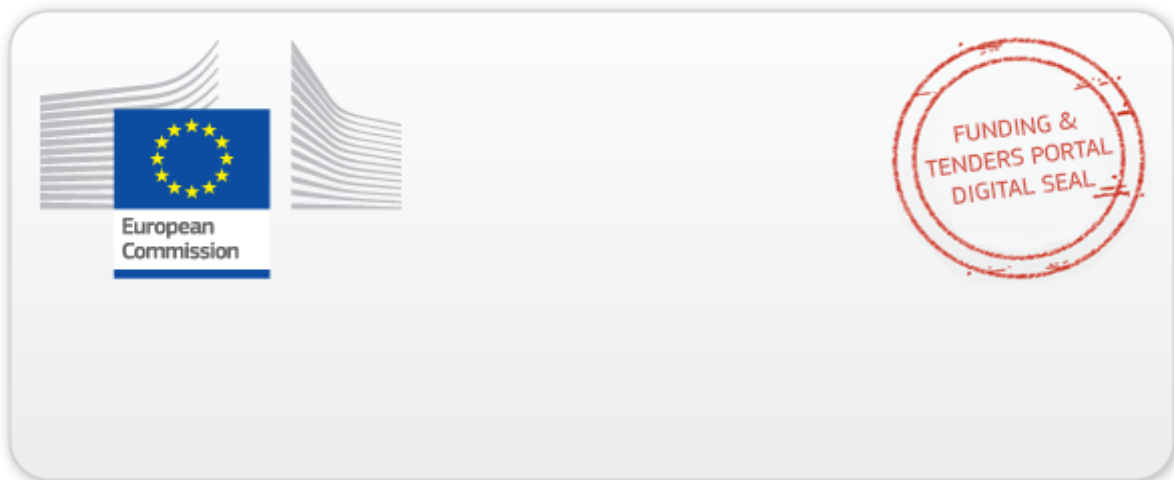
<i>Please explain any discrepancies in the body of the Report.</i>	
Statements to be made by Beneficiary	Procedures to be carried out and Findings to be confirmed by the Auditor
<p><i>present certificate¹].</i></p> <p><i>[If certain statement(s) of section “F. Time recording” cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor: - ...]</i></p>	<p>no time worked outside the action period was charged to the action.</p> <p>Factual finding:</p> <ol style="list-style-type: none"> 20. The brief description, manuals and/or internal guidance on time recording provided by the Beneficiary were consistent with management reports/records and other documents reviewed and were generally applied by the Beneficiary to produce the financial statements. 21. For the random sample time was recorded or, in the case of employees working exclusively for the action, either a signed declaration or time records were available; 22. For the random sample the time records were signed by the employee and the action manager/line manager, at least monthly. 23. Working time claimed for the action occurred in the periods claimed; 24. No more hours were claimed than the number productive hours used to calculate the hourly personnel rates; 25. There is proof that the Beneficiary has checked that working time has not been claimed twice, that it is consistent with absence records and the number of productive hours per year, and that no working time has been claimed outside the action period. 26. Working time claimed is consistent with that on record at the human-resources department.

¹ The description of the time recording system must state among others information on the content of the time records, its coverage (full or action time-recording, for all personnel or only for personnel involved in H2020 actions), its degree of detail (whether there is a reference to the particular tasks accomplished), its form, periodicity of the time registration and authorisation (paper or a computer-based system; on a daily, weekly or monthly basis; signed and countersigned by whom), controls applied to prevent double-charging of time or ensure consistency with HR-records such as absences and travels as well as its information flow up to its use for the preparation of the Financial Statements.

Grant Agreement number: [insert number] [insert acronym] [insert call identifier]

H2020 Model Grant Agreements: H2020 General MGA — Multi: v5.0 – dd.mm.2017

<i>Please explain any discrepancies in the body of the Report.</i>	
Statements to be made by Beneficiary	Procedures to be carried out and Findings to be confirmed by the Auditor
<i>[official name of the [Beneficiary] [Linked Third Party]]</i>	<i>[official name of the Auditor]</i>
<i>[name and title of authorised representative]</i>	<i>[name and title of authorised representative]</i>
<i>[dd Month yyyy]</i>	<i>[dd Month yyyy]</i>
<i><Signature of the [Beneficiary] [Linked Third Party]></i>	<i><Signature of the Auditor></i>



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