Part 3C

Design, Development and Verification Plan for the

Definition / Technology / Product / Product Demonstration Phase

Proposal Reference: (reference number)

**Notes for the Use of this Template**

Material presented in this plain style is suggested content for a Full Proposal. This is intended to be an example of a response to the related Agency requirements, which the Tenderer needs to properly complement by activity-specific information. The suggested material may be adopted as is, or modified at the Tenderer’s discretion. It remains the responsibility of the Tenderer to ensure that all of the Agency’s requirements of the present Call for Proposals are properly addressed.

This style is used to identify information that must be modified and/or completed by the Tenderer for the proposed activity. This supplementary information should be presented in plain typeface (i.e. not red) in the final version of the Full Proposal.

This style is used for explanatory notes and guidance to help you to develop the Full Proposal content (e.g. to indicate a selection between mutually-exclusive options). This information should be removed from the final version of the Full Proposal.

Use of this Full Proposal Template is optional. However, the Agency recommends not to change the structure of this Part of the Full Proposal (i.e. the table of contents should remain as indicated in this Full Proposal Template).

Table of Contents

[1 Introduction 3](#_Toc514223043)

[2 Scope and Objectives of the Proposed Development Phase 4](#_Toc514223044)

[2.1 Objectives 4](#_Toc514223045)

[2.2 Starting and Target Readiness Levels 9](#_Toc514223046)

[3 Models/Prototypes to be Developed 10](#_Toc514223047)

[4 Risk Mitigation Activities 11](#_Toc514223048)

[5 Qualification, Certification and Type Approval Activities 12](#_Toc514223049)

[6 Verification Activities 15](#_Toc514223050)

[7 Work Logic 16](#_Toc514223051)

[7.1 Development Logic 16](#_Toc514223052)

[7.2 Items to be Developed 17](#_Toc514223053)

[7.3 Key Technology 17](#_Toc514223054)

[7.4 Manufacturing Approach 17](#_Toc514223055)

[7.5 Initial System and Service Architecture 18](#_Toc514223056)

[7.6 Industrialisation 18](#_Toc514223057)

[7.7 Commercialisation 18](#_Toc514223058)

[8 Flight Opportunity 19](#_Toc514223059)

[8.1 Flight Items 19](#_Toc514223060)

[8.2 Accommodation of the Flight Items 21](#_Toc514223061)

[8.3 Mission Details 21](#_Toc514223062)

[8.4 Launch Activities and In-Orbit Test 22](#_Toc514223063)

[9 Pilot Configuration 23](#_Toc514223064)

[10 Pilot Utilisation Plan (PilUP) 25](#_Toc514223065)

# Introduction

This document presents the Design, Development and Verification Plan (DDVP) for the Definition/Technology/Product/Demonstration Phase. It is the plan to develop the product from its current state of development (Readiness Level, RL) to a state where all the development objectives defined for this phase have been met.

include the following (as appropriate)

The following documents are attached to the proposal. Collectively these constitute the Design, Development and Verification Plan for this Development Phase in its entirety.

or

The following documents are attached to the proposal. These form part of the Design, Development and Verification Plan for this Development Phase and are supplemented by additional information provided in this document. References to the supporting documents are made at the relevant points in the text.

**Supporting documentation**

|  |  |  |
| --- | --- | --- |
| **Document Title** | **Scope** | **Reference** |
| *e.g. Qualification Plan* … | … | … |
| *e.g. Design Verification Plan* … | … | … |
| … | … | … |
| … | … | … |

The Product Development Plan has been produced in compliance with the following standard(s): standard reference(s).

# Scope and Objectives of the Proposed Development Phase

## Objectives

The objectives of this development phase and the corresponding key outputs and achievements are summarised in the table below.

include and complete the table below, as appropriate, if this Part of the Proposal is for the Definition Phase

**Objectives of the Definition Phase**

| **Objective** | **Key outputs/achievement** |
| --- | --- |
| Objective 1 | … |
| Objective 2 | … |
| Etc. | … |
| Update the business plan to reflect the increased maturity of the product. | Updated Business Plan *(Req. 2.3)* |
| Update the plans to organise, direct and conduct the remaining development work in the subsequent Development Phase. | Updated development plan, including schedule, cost, reviews and deliverables. |
| Generate a complete set of Product Requirements. | … |
| Complete an initial design concept to allow development work to continue. | … |
| Generate the appropriate supporting analyses demonstrating technical and economic feasibility of the product. | … |

include and complete the table below, as appropriate, if this Part of the Proposal is for the Technology Phase (Req. 10.2, 10.3)

**Objectives of the Technology Phase**

| **Objective** | **Key outputs/achievement** |
| --- | --- |
| Objective 1 | … |
| Objective 2 | … |
| Etc. | … |
| Update the business plan to reflect the increased maturity of the product. | Updated Business Plan *(Req. 2.3)* |
| Update the plans to organise, direct and conduct the remaining development work in the subsequent Development Phase. | Updated development plan, including schedule, cost, reviews and deliverables. |
| Produce a development model that is sufficiently representative of the final product to mitigate the technical risks targeted in this development phase. | breadboard/prototype/EM |
| Demonstrate the functionality and/or performance of the product by suitable testing of the development model. | … |

include the text below if this Part of the Proposal is for the Technology Phase: (Req. 10.1)

We confirm that the work to be undertaken in the Technology Phase does not include any of the following:

* Materials qualification activities;
* Component qualification activities;
* Process qualification activities;
* Qualification activities on the equipment;
* Industrialisation of the product.

include and complete the table below, as appropriate, if this Part of the Proposal is for the Product  Phase

**Objectives of the Product Phase**

| **Objective** | **Key outputs/achievement** |
| --- | --- |
| Objective 1 | … |
| Objective 2 | … |
| Etc. | … |
| Update the business plan to reflect the increased maturity of the product. | Updated Business Plan *(Req. 2.3)* |
| Update the plans to organise, direct and conduct the remaining development work in the subsequent Development Phase. | Updated development plan, including schedule, cost, reviews and deliverables. |
| *include the objectives below if this Part of the Proposal includes a Space Segment element:  (Req. 11.1, 11.2)* | |
| Complete all qualification testing of the product for flight on the specified spacecraft and launch vehicles, i.e. TRL 7 shall have been reached. | … |
| Complete all non-recurring development activities to prepare for the commercial production of the product. | … |
| Complete all materials qualifications required for the product. | … |
| Complete all parts qualifications required for the product. | … |
| Complete all process qualifications required for the product. | … |
| Complete the industrialisation of the product. | … |
| Complete the development of the product test system. | … |
| *include the objectives below if this Part of the Proposal includes a Ground Segment or System element:  (Req. 12.1, 12.2)* | |
| Verify the product in a non-operational environment. | … |
| Complete the product design and industrialisation, ready for commercial exploitation. | … |
| Complete the verification of the product performance, via a suitable test program, confirming that the performance of the product is suitable for the target market. | … |
| Industrialisation of the product/product test system. | … |
| *include the objectives below if this Part of the Proposal includes an Application element:  (Req. 13.1)* | |
| Complete the verification of the product performance via a suitable test program. This verification will confirm that the application/service is ready for entering in a validation stage with operational users. | … |

include and complete the table below, as appropriate, if this Part of the Proposal is for the Demonstration  Phase

**Objectives of the Demonstration Phase**

| **Objective** | **Key outputs/achievement** |
| --- | --- |
| Objective 1 | … |
| Objective 2 | … |
| Etc. | … |
| Update the business plan to reflect the increased maturity of the product. | Updated Business Plan *(Req. 2.3)* |
| *include the objectives below if this Part of the Proposal includes a Space Segment element:*  *(Req. 14.1, 14.2)* | |
| *select from the following three options:*  Demonstrate the product in its operational environment (TRL 9) /  Support the launch of in-orbit flight hardware to be used in a system, service or application product /  Support the launch of in-orbit flight hardware to be used in demonstrators to verify the functioning of the technology in a system context. | … |
| Measure the performance of the product by ground testing, including unit acceptance testing and spacecraft acceptance testing. | On-ground test results. |
| Measure the performance of the product during in-orbit testing (IOT). | Results compared to on-ground test results. |
| Measure the in-orbit performance during the first year after the completion of in-orbit testing. | Results compared to on-ground and IOT test results. |
| *include the objective below if this Part of the Proposal includes a Ground Segment or System element:*  *(Req. 15.1, 15.2)* | |
| Validate the performance of the product by measurement in an operational environment. | Data demonstrating that the product is fully validated in all its technical and operational elements, and ready to be offered to a well-identified customer(s). |
| *include the objectives below if this Part of the Proposal includes an Application element:*  *(Req. 16.1, 16.2)* | |
| Application/service validated with relevant users and customers and ready for a commercial roll-out. | Data demonstrating that the application/service is fully defined and validated in all its technical and operational elements, and ready to be offered by a well identified service provider, under clear contractual and commercial conditions. |

## Starting and Target Readiness Levels

The table below identifies the starting readiness level and the targeted (ending) readiness level for the product and for each of its major subsystems and key enabling technologies.

**Functional modules**

|  |  |  |  |
| --- | --- | --- | --- |
| **Product/Subsystem** | **Functions/Features** | **Starting RL** | **Targeted RL** |
| Product | … | … | … |
| Subsystem 1 | … | … | … |
| Technology 1 | … | … | … |
| Etc. | … | … | … |

include further details below, as appropriate, to explain the above assessments of the readiness levels

…

# Models/Prototypes to be Developed

this section is not required if this Part of the Proposal is only for the Application Domain

As part of the activities covered in this phase, the following models will be manufactured and verified:

| **Model** | **Model Type** | **Product Characteristics/ Functionalities to be Verified** | **Key Requirements** | **Comments** |
| --- | --- | --- | --- | --- |
| Model1 | BreadBoard | … | … | … |
| … | … | … |
| … | … | … |
| … | … | … |
| Model2 | EQM | … | … | … |
| … | … | … |
| … | … | … |
| … | … | … |
| … | … | … | … | … |
| … | … | … |

Provide supplementary information to fully describe the model philosophy, the proposed development models and the key characteristics/functionalities they aim to verify. Include interface descriptions and functional block diagrams as appropriate.

…

# Risk Mitigation Activities

The current development phase allows de-risking the following risks, identified in section 9 of Part 3B of this tender.

**Technical risks and risk mitigation**

| **Description of Risk** | **Severity** | **Probability of Occurrence** | **Mitigated in Model** | **Mitigation Plan** | **Environment** (\*) |
| --- | --- | --- | --- | --- | --- |
| … |  |  | … | … | … |
| … |  |  | … | … | … |
| … |  |  | … | … | … |
| … |  |  | … | … | … |

(\*): Environmental conditions for the Space Segment, Ground Segment and System Domains.  
User environment for the Application Domain.

Provide further information as required to properly explain the risk mitigation strategy and plans. It is expected that the table contains the risks identified for this phase in Part 3B of this tender. Please note that the severity/probability of occurrence shall be as well consistent with Part 3B.

For the Technology Phase, please be sure to highlight the technology risks that are considered high enough to justify mitigation in a Technology Phase prior to commencing a Product Development.

The mitigation activities of risk1 will consist of …

The mitigation activities of risk2 will consist of …

…

# Qualification, Certification and Type Approval Activities

Qualification refers to demonstrating that the product is capable of operating in the specified environment. For the Ground Segment, the term validation is often used in place of qualification.

Certification refers to meeting the safety or regulatory requirements (e.g. CE marking).

Type approval refers to a demonstration, by test to the extent practicable, that a product meets the technical requirements for its use within a given satellite system, with a certification that all units of the same product type will meet the requirements in a similar manner.

include one of the following statements

No qualification, certification or type approval activities will be carried out in this Development Phase.

or

Qualification/certification/type approval activities will be carried out in this Development Phase as detailed below.

**Qualification/certification/type approval activities**

| **Activity** | **Model** | **Applicable Standard(s)** | **Comments** |
| --- | --- | --- | --- |
| Activity 1 | … | ECSS XXX | … |
| Activity 2 | … | MIL STD XXX | … |
| etc. | … | … | … |
| … | … | … | … |
| … | … | … | … |
| … | … | … | … |
| … | … | … | … |

provide supplementary information as necessary to fully describe each of the activities identified above.

…

include one of the following statements and the table, if appropriate, if this Part of the proposal includes a   
Space Segment Product Phase

No component qualification activities will be carried out in this Development Phase.

or

Component qualification activities will be carried out in this Development Phase as detailed below.

**Component qualification activities**

| **Component** | **Model** | **Applicable Standard(s)** | **Comments** |
| --- | --- | --- | --- |
| Component 1 | … | ECSS XXX | … |
| Component 2 | … | MIL STD XXX | … |
| etc. | … | … | … |

provide supplementary information as necessary to fully describe each of the component qualifications identified above.

…

include one of the following statements and the table, if appropriate, if this Part of the proposal includes a   
Space Segment Product Phase

No material qualification activities will be carried out in this Development Phase.

or

Material qualification activities will be carried out in this Development Phase as detailed below.

**Material qualification activities**

| **Material** | **Model** | **Applicable Standard(s)** | **Comments** |
| --- | --- | --- | --- |
| Material 1 | … | ECSS XXX | … |
| Material 2 | … | MIL STD XXX | … |
| etc. | … | … | … |

provide supplementary information as necessary to fully describe each of the material qualifications identified above.

…

include one of the following statements and the table, if appropriate, if this Part of the proposal includes a   
Space Segment Product Phase

No process qualification activities will be carried out in this Development Phase.

or

Process qualification activities will be carried out in this Development Phase as detailed below.

**Process qualification activities**

| **Process** | **Model** | **Applicable Standard(s)** | **Comments** |
| --- | --- | --- | --- |
| Process 1 | … | ECSS XXX | … |
| Process 2 | … | MIL STD XXX | … |
| etc. | … | … | … |

provide supplementary information as necessary to fully describe each of the process qualifications identified above.

…

# Verification Activities

The following table identifies the verification activities to be performed in this Development Phase.

extend and complete the table below, as appropriate, making reference to the product requirements

**Verification activities**

| **Activity** | **Functionalities/ Requirements Verified** | **Verification Method(s)** | **Verification Model** | **Verification Environment** | **Success Criteria** | **Outputs** |
| --- | --- | --- | --- | --- | --- | --- |
| … | … | test | breadboard | … | … | … |
| … | … | analysis | … | … | … | … |
| … | … | simulation | … | … | … | … |
| … | … | inspection | … | … | … | … |
| … | … | … | … | … | … | … |

Column 1: A brief description of the verification activity.

Column 2: The aspect(s) of the product to be confirmed by the verification activity (e.g. product functions, technical performance, market potential, etc.).

Column 3: The verification method (test, analysis, simulation, inspection, etc.).

Column 4: The analytical, simulation, hardware or software model that will be used as a vehicle to perform the verification.

Column 5: The verification environment. For Space Segment, Ground Segment and System developments this is typically the environmental (e.g. thermal) conditions. For Application Segment Developments this is typically the user environment.

Column 6: The criteria to be applied that will provide the necessary confidence to proceed with the development (e.g. compliant performance achieved with margin).

Column 7: The outputs of the verification activity (e.g. documentation).

include supplementary information as necessary to fully describe the verification approach and the individual verification activities, emphasising those related to critical aspects of the development

The verification approach …

The verification activities related to the critical aspects of the development are …

The analysis carried out in this phase will …

include details of analysis and simulation tools to be used for verification purposes (if relevant.

The following software tools will be required to carry out verification activities identified above:

* …
* …
* …

# Work Logic

## Development Logic

The development activities breakdown is presented in a WBS in Part5B of this tender. The following figure shows the development logic and provides a visual description of the work packages interrelations as well as the logical flow of activities.

insert a diagram of the work logic and associated work packages.

.

The following subsections provide a detailed zoom into the actual work planned for each of the work packages.

provide a description of the work to be performed to arrive at each key milestone, including clear references to the completed work packages and their interdependences.

The work to be reviewed at milestone 1 includes …

The work to be reviewed at milestone 2 includes …

## Items to be Developed

The items to be assessed or developed within this development phase are indicated in the table below.

**Items to be developed**

| **ID** | **Item** | **Item Type** | **Associated Work Package(s)** | **Comments** |
| --- | --- | --- | --- | --- |
| 1 | … | … | … | … |
| 2 | … | … | … | … |
| 3 | … | … | … | … |
| 4 | … | … | … | … |
| 5 | … | … | … | … |

*Item types could be, for example, technologies, techniques, systems, performances, environments etc.*

provide supplementary text to fully describe each item to be assessed or developed within this development phase and its importance in the context of the product development

Item … is …

## Key Technology

With reference to the table above, the key technologies to be developed in this development phase are:

* Item …
* Item …
* Item …

provide supplementary text as necessary to explain the reasons why these items are considered to be key technologies for the proposed development

The … technology is …

## Manufacturing Approach

The current development phase will make use of the following manufacturing strategies/approaches: …

In order to manufacture the planned Models, the following key resources are required:

* Resource 1
* Resource 2
* Etc.

## Initial System and Service Architecture

include this section if this Part of the Proposal includes an Application (all phases)   
(Req. 9.2, 10.4, 13.2, 16.2)

Reference document(s) … detail the proposed initial version of the System and Service Architecture.

or the following statement

The System and Service Architecture, depicted in figure(s) below, is composed of the following elements:

* System/Service element 1
* System/Service element 2
* …

A detailed description of each element and their relationship is described hereafter: …

## Industrialisation

include this section if this Part of the Proposal includes a Space or Ground Segment Product Phase   
(Req. 11.7, 12.4)

The following product industrialisation activities will be undertaken in this development phase:

* …
* …
* …

provide supplementary text as necessary to fully describe these activities

These activities …

## Commercialisation

Include this section if this Part of the Proposal is for a Product Phase (Req. 11.6, 12.3, 13.1). For the Application Domain this section is only required if the proposal includes software (Req. 13.1).

The following development activities are required in order to prepare the product for commercial production:

- …

- …

- …

provide supplementary text as necessary to fully describe these activities

These activities …

# Flight Opportunity

Include this section if this Part of the Proposal includes a Space Segment Demonstration Phase (ATLAS)  
(Req. 14.3 – 14.18 inclusive)

## Flight Items

The following products are proposed to be developed and flown as part of the Demonstration Phase (ATLAS). Support is requested for an embedded/passenger case.

**Items to be developed and flown**

| **Product** | **Total Number of Units in Spacecraft** | **Number of Units Supported by ATLAS** | **Function/Usage Within the Main Mission** *\** | **Fully Representative of Recurrent Flight Product** |
| --- | --- | --- | --- | --- |
| Product 1 | … | … | … | Yes/No |
| Product 2 | … | … | … | Yes/No |
| Product 3 | … | … | … | Yes/No |
| … | … | … | … | Yes/No |

\* Explain how the ATLAS-supported units will be embedded in the main mission and how they will be used in the context of the payload architecture (e.g. redundant unit within a redundancy ring, with the rest of the hardware being standard hardware).

Provide supplementary information as necessary to fully describe the intended operational use of each product in the proposed flight opportunity, i.e. whether these products will be part of the nominal operation or used in a redundant mode only, and whether there is an equivalent conventional item(s) installed as a redundant unit.

The operational use of Product 1 will be …(E.g. Primary element, redundant element, …).

The operational use of Product 2 will be …(E.g. Primary element, redundant element, …).

The table below contains further information on the innovative nature of the proposed flight items and, in cases where more than one unit of the same product is proposed to be flown with ATLAS support, why it is necessary to fly more than one unit.

**Flight item details**

| **Product** | **Innovative Nature of the Flight Item***1* | **Rationale for More than One ATLAS-Supported Flight Item of the Same Type***2* |
| --- | --- | --- |
| Product … | … | … / not applicable |
| Product … | … | … |
| Product .. | … | … |
| … | … | … |

1 Nature of the innovation that justifies the need for Atlas support for this particular product (first flight heritage of a new product or product variant).

2 What function(s) would not be adequately demonstrated by flying only one unit and how would these function(s) be adequately demonstrated by flying the proposed number of units?

Include the following statement and table if any of the above flight items are not fully representative of the recurrent flight product

Some of the flight items identified above are not fully representative of the recurrent flight product. The following table explains the differences in each case and provides a justification for why a fully recurrent product is not proposed to be flown.

**Rationale for flying items not fully representative of the recurrent flight product**

| **Product** | **Differences with Respect to the Recurrent Flight Product** | **Rationale for not Flying a Representative Example of the Recurrent Flight Product** |
| --- | --- | --- |
| Product … | … | … |
| Product … | … | … |
| Product .. | … | … |
| … | … | … |

## Accommodation of the Flight Items

No activities associated with the accommodation of ATLAS-supported flight items on board the spacecraft are included in this development phase.

or

The following table indicates the activities associated with the accommodation of the ATLAS-supported flight items on board the spacecraft.

**Activities associated with accommodating the flight items on board the spacecraft**

| **Activity** | **Description** | **Performed By** | **Included in the Proposal** |
| --- | --- | --- | --- |
| Accommodation Studies | … | contractor/spacecraft manufacturer | Yes/No |
| Accommodation in the Spacecraft | … | … | … |
| ... | … | … | … |
| … | … | … | … |

The nature of any work foreseen to be carried out by the spacecraft manufacturer shall be identified. For example, accommodation studies, design modifications performed to accommodate the innovative item, hardware specifically required for accommodation purposes and satellite level assembly, integration and test (AIT), specific activities related to the innovative product during the AIT and launch campaigns.

## Mission Details

Include this section if this Part of the Proposal includes a Space Segment Demonstration Phase (ATLAS) Passenger Case (Req. 14.14 , 14.15, 14.16)

Details of the main mission in which the Passenger case products are embarked are provided in the table below.

**Details of the main mission**

| **Item** | **Value** | **Comments** |
| --- | --- | --- |
| Operator | … | … |
| Mission Name | … | … |
| Mission Objective | … | … |
| Launch Vehicle (if known) | … | … |

## Launch Activities and In-Orbit Test

Include this section if this Part of the Proposal includes a Space Segment Demonstration Phase (ATLAS) Passenger Case (Req. 14.17, 14.18)

No activities associated with the launch campaign and in orbit testing of the ATLAS‑supported flight items are included in this development phase.

or

The following table indicates the activities associated with the launch campaign, in orbit test and verification of the performance and function of the ATLAS-supported flight items.

**Activities associated with the launch campaign and in orbit testing**

| **Activity Type** | **Activity** | **Performed By** | **Included in the Proposal** |
| --- | --- | --- | --- |
| Launch campaign | … | … | Yes/No |
| … | … | … | … |
| In-Orbit Test | … | … | … |
| … | … | … | … |

Launch campaign activities could include the part of the testing and early operation phase specific to the item, for verification of function and performance or monitoring.

# Pilot Configuration

include this section if this Part of the Proposal includes a Ground Segment or System Demonstration Phase   
(Req. 15.3 – 15.6 inclusive)

The following products are proposed to be developed and tested as part of the Ground Segment/System Demonstration Phase. We confirm that the pilot configuration is of a scale sufficient to demonstrate the commercial attractiveness of the product.

**Items to be developed and tested in the Demonstration Phase**

| **Product** | **Total Number of Units** | **Number of Units Supported by ARTES C&G** | **Function/Usage Within the Ground Segment /System Architecture** *\** | **Fully Representative of Recurrent Product** |
| --- | --- | --- | --- | --- |
| Product 1 | … | … | … | Yes/No |
| Product 2 | … | … | … | Yes/No |
| Product 3 | … | … | … | Yes/No |
| … | … | … | … | Yes/No |

\* Explain how the units supported by ARTES C&G will be embedded within the Ground Segment/System architecture.

Provide supplementary information as necessary to fully describe how each product is embedded in the Ground Segment/System architecture and its intended operational use in the context of both the proposed pilot phase and the end-to-end system.

The operational use of Product 1 will be …

The operational use of Product 2 will be …

Include the following statement and table if any of the above items are not fully representative of the recurrent product

Some of the items identified above are not fully representative of the recurrent product. The following table explains the differences in each case and provides a justification for why a fully recurrent product is not proposed for the Demonstration Phase.

**Rationale for items not being fully representative of the recurrent product**

| **Product** | **Differences with Respect to the Recurrent Product** | **Rationale for Not Employing a Representative Example of the Recurrent Product in the Demonstration Phase** |
| --- | --- | --- |
| Product … | … | … |
| Product … | … | … |
| Product .. | … | … |
| … | … | … |

# Pilot Utilisation Plan (PilUP)

include this section if this Part of the Proposal includes a Ground Segment, Application or System Demonstration Phase (Req. 15.7, 16.4)

An initial version of the Pilot Utilisation Plan (PilUP) is provided in the following reference document(s), which is/are attached to this part of the proposal.

or

The initial version of the Pilot Utilisation Plan is described hereafter.

The activities carried out in the pilot utilisation plan will …

The Pilot utilisation baseline will included …

The preparation of the pilot will include the following elements …

The Pilot risks are mitigated through …

…