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COVER SHEET

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HSI003 Rev 2

Title:

HSI Guidelines Outline for the Air Vehicle Control Station

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Abstract:

This document provides guidance to the FAA and manufacturers on how to develop UAS Pilot Vehicle Interfaces to safely and effectively integrate UASs into the NAS. Preliminary guidelines are provided for Aviate, Communicate, Navigate and Avoid Hazard functions.

Status:

Document Status DRAFT-Work in Progress

Limitations on use:

This document is a draft. The information described in this report applies to flight operations at or above FL 430. This document represents the Human Systems Integration functions and performance requirements limited to enroute operations above FL430. Operations below FL430 and terminal operations have not been addressed in this document.

DRAFT



**HSI Guidelines Outline for the Air Vehicle Control
Station**

January, 2006

Access 5

Version 2

Access 5 AVCS HSI Guidelines

1 AVIATE

The Human System Interface (HSI) shall enable the pilot to Aviate.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

All requirements and guidelines included in the Aviate section are directly applicable to the process establishing, maintaining, and monitoring aircraft flight. The distinction between Aviate and Navigate is subtle and yet very important. Aviate addresses the act of physically flying while Navigate directs where the aircraft will fly.

Reference(s):

Reference: The ROA System shall provide the pilot with the ability to command and monitor flight maneuvers in order to safely conduct flight in the NAS and comply with ATC instructions
Source(s): NATO STANAG 4568

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1 Control Unmanned Air System

The HSI shall enable the Pilot to Control the Unmanned Air System

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

The HSI shall enable the pilot/operator to obtain information about all pieces of the Unmanned Air System: Aircraft, Ground Station, Communication relay, etc. In this guideline document, the Communication and Ground Station pieces have been Addressed in sections 3 – Communicate and 5 –

Monitor and Manage systems respectively

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1 Aircraft Control

The HSI shall enable the Pilot to Control the Aircraft

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Aviation safety and Pilot Control. – Understanding and Preventing Unfavorable Pilot-Vehicle Interactions. National Research Council - Committee on the Effects of Aircraft-Pilot Coupling on Flight Safety. National Academy Press. 1997.

Performance Based Guideline:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

The pilot shall have information and control capability so that pilot-UA interactions are not adverse, unfavorable, nor compromise safety. Unfavorable interactions include anomalous aircraft-pilot coupling (APC) interactions (closed loop), pilot-involved oscillations (categories I, II or III), and non-oscillatory APC events (e.g., divergence). - Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Reference(s):

The ROA System shall provide the pilot with the ability to control vehicle position and heading, course, speed, altitude in order to safely conduct flight in the NAS - Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #4b

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background: For UA that require some element of manual control in LOS or BLOS operation, either as a primary or backup FCS mode, the UAS communication link shall not contribute to increased pilot flight control workload to the extent that pilot-vehicle coupling is produced.

Evaluation Procedure:

Evaluation Rationale:

1.1.1.1 Aircraft Control Frequencies

The HSI shall enable the Pilot to set and/or confirm Aircraft Control Frequencies.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1.2 Aircraft Speed

The HSI shall enable the Pilot to Control and/or Confirm the Settings affecting the Aircraft's Speed

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1.3 Aircraft Power System

The HSI shall enable the Pilot to Control and/or Confirm the Setting(s) of the Aircraft's Power System.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

The HSI shall enable the Pilot to adjust the Power Setting(s) onboard the Aircraft.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1.4 Aircraft Flight Path Control

The HSI shall enable the Pilot to Control and/or Confirm the Flight Path of the Aircraft.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

The ROA System shall enable the Pilot to Update/Change ROA Flight Profile

Source(s): Access 5 Program CCA – C3 Requirements

Critical Design Activities:

The C2 communications human system interface shall be capable of updating or changing the ROA flight profile. This will likely be accomplished through the ROA pilot making inputs to the flight controls and then commands being up-linked to the ROA that will alter the aircraft. The flight controls shall be accessible and responsive to inputs from the ROA pilot.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1.5 Input/Output for controlling/monitoring air vehicle altitude

The AVCS System shall provide controls and displays for controlling/monitoring the air vehicle attitude in all supported flight modes.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Example Implementation(s):

- Flight vector command consisting of heading, altitude, and speed controls
- Manual control mode consisting of pitch, roll, yaw, throttle, and collective

Reference(s):

The ROA System shall provide the pilot with information on required vehicle position and heading, course, speed, altitude as specified in flight plan or ATC clearance

Source(s): Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #4c

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1.5.1 Command and Control Specific Module Displays

The AVCS System should be able to accept and present Command and Control Interface Specific Module displays that are sent across the Command and Control Interface.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1.5.2 Accessibility to Command and Control Interface

All operators should have access to Command and Control Interface message/report generation applications.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1.5.3 Command and Control Interface Templates

The AVCS System should provide common templates that enable the operator to create messages to be sent across the Command and Control Interface.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1.5.4 ACS Display of Authorized Control Actions

The pilot shall have information available at the ACS that indicates authorized datalink actions prior to enabling control of the vehicle flight path or trajectory.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

As the pilot is the final authority for safe operation of the aircraft, the pilot must have the ability to know the state of the flight control system and any related system(s) that affect flight path or trajectory. The pilot must maintain specific situation awareness so that manual or automatic flight control is affected safely.

Reference(s):

Human Factors Requirements for Datalink. Air Transport Association Information Transfer Subcommittee. June, 1992, Para. 2.6.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.2 Monitor Aircraft Flight Performance

The HSI shall provide the pilot with the information necessary to monitor the aircraft's physical flight performance

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

The flight display should have the controls (commanded) and status reports (reported) available:
Source(s): NATO STANAG 4568

Critical Design Activities:

- Commanded flight mode and reported flight mode
- Commanded AV position and reported AV position
- Commanded altitude and reported altitude
- Commanded heading and reported heading
- Commanded roll/bank angle and reported roll/bank angle
- Commanded airspeed and reported airspeed
- Commanded engine speed and reported engine speed
- Commanded pitch angle and reported pitch angle
- Reported Angle Of Attack (AOA)
- Reported yaw
- Reported vertical velocity
- Fuel remaining/Fuel flow rate/Bingo fuel
- Icing status

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.2.1 Monitor Aircraft Flight Parameters

The HSI shall provide the pilot with the information necessary to monitor the aircraft's flight parameters

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source: Access 5 Program CCA – C3 Requirements

Performance Based Guideline:

Information about how the aircraft is operating in relation to system operational limitations shall be presented to the pilot. This information will include but is not limited to: altitude; velocity; vertical velocity; G's; etc.

Reference(s):

The ROA System shall Display Feedback from the ROA

Critical Design Activities:

The C2 communications human system interface shall be capable of displaying the ROA's current profile to include heading, altitude, attitude and airspeed and show whether or not the ROA responded to inputs from the ROA pilot. For example, a moving map indicator could be used to visually display to the ROA pilot that the inputs have been received and executed.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

1.2.2 Monitor Aircraft Flight Maneuvers

The HSI shall provide the pilot with the information necessary to monitor the aircraft's execution of flight maneuvers

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:
Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

1.3 Aircraft Control Surface Configuration

The HSI shall enable the Pilot to Configure and/or confirm Aircraft Control Surface Configuration

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:
Performance Based Guideline:
As applicable by the manufacturer, the pilot may be required to configure the aircraft flight control surfaces.
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

1.4 Aircraft System Configuration

The HSI shall enable the Pilot to Configure and/or Confirm Aircraft System Configuration Information.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:
Performance Based Guideline:
As applicable by the manufacturer, the pilot may be required to configure the aircraft systems. Variations in system configuration can be dynamic depending on phase of flight, aircraft tasking, etc.
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

1.4.1 Operation of Aircraft Guidance System

The HSI shall enable the pilot to operate the aircraft guidance system

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.4.1.1 Activation of Aircraft Guidance System

The HSI shall enable the pilot to engage and/or disengage the aircraft guidance system

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.4.1.2 Configuration of Aircraft Guidance System

The HSI shall enable the pilot to configure the aircraft guidance system

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.4.1.3 Transition between Modes of Operation

The ROA System shall be able to Transition between Modes of Operation

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The C2 communications human system interface shall be capable of providing positive hand-off

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between modes of operation. Reliable and in-place procedures need to ensure the unambiguous hand-off between line-of-sight and over-the-horizon operations

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.4.1.4 Assignment of Aircraft Control Authority

The HSI shall enable the Designated Authority to assign Permissions of Aircraft Control Authority.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

As applicable and according to manufacturer design, a designated authority (probably someone other than the pilot) will determine who has control of the aircraft as well as the level/degree of control authorized. The implementation of this control may be accomplished through an interface on the AVCS, however actual design is the decision of the manufacturer.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.4.1.4.1 Restrict the number of operators on individual applications/procedures

The AVCS System should prevent multiple operators from operating the same application/procedures at any one time. However, the AVCS System should provide the ability to allow other operators to view applications/procedures that are being used. The status of these applications and procedures should be apparent.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.4.1.4.2 Transfer Aircraft Control

The operator shall have the ability to pass AV control (handover) to another AVCS and monitor the status of the handover.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

The ROA System shall be able to Transition between Different Operating Locations

Source(s): Access 5 Program CCA - C3 Requirements

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Critical Design Activities:

The C2 communications human system interface shall be capable of providing positive hand-off between different operating locations. Procedures need to ensure the unambiguous hand-off between two different AVCSs.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.4.1.4.3 The HSI shall facilitate a manual override of any automated systems

When automatic launch and recovery systems are employed, the AVCS System shall make provision for the operator to abort launch and recovery.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.4.2 Configure Aircraft Electrical System

The HSI shall enable the pilot to configure the Aircraft Electrical System. (The manner in which the aircraft primary electrical system is switched between power busses.)

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: GAMA Publication #10

Performance Based Guideline:

The power bus arrangement and switching needs to provide logical Master Switch operation and reversion appropriate to the complexity of the power system during normal and emergency operation.

Reference(s):

Critical Design Activities:

A power system architecture should be defined that allows the pilot to protect the electrical equipment from undesirable electrical transients, to isolate failed systems logically and to maintain a maximum capability to continue safe flight with primary power outages.

Example Implementation Concepts:

Performance Rationale and Background:

Power switching is needed to control the application of power to the aircraft systems under normal, abnormal and emergency conditions.

Depending upon the expected operation of the aircraft, the availability of electrical power can have different levels of criticality. For VFR operations, only a master switch that controls all of the aircraft power may be required for small aircraft. For operation in weather, icing, etc. it is necessary to isolate primary or backup system power to ensure that adequate data is available to the pilot when system failures or primary power failures occur.

Evaluation Procedure:

Determine that power availability requirements have been addressed that are compatible with the requested operation for the aircraft.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

A master switch needs to be available to remove all the power from the aircraft systems in-flight or on the ground. The safety assessment may be reviewed to determine that the designer has addressed and defined operation for loss of electrical power. System failures when the system is being certified to be used in icing or weather operation need to be considered.

Evaluation Rationale:

The desire for the aircraft power system is that it be designed to ensure that the electrical power may be controlled appropriately for the operational conditions being requested.

Small aircraft that are not planned to be used for flying in icing conditions, whether or not they are in the Air Traffic System, need little electrical power to safely operate the aircraft. Those aircraft that are intended for other than VFR flight, must have appropriate switching, bus segregation, backup batteries, essential buses, etc. in addition to the master switching requirement. The easiest way to address these issues is through a safety assessment. This allows one to determine the effects of various failure conditions.

1.5 Regulate Aircraft Control

The HSI shall enable the pilot to monitor the Aircraft Control

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.5.1 Manage the Aircraft Guidance System

The HSI shall enable the pilot to monitor Aircraft Guidance System

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

The elements of the aircraft guidance system referred to in this section are: altitude, airspeed, pitch, roll rate, and any other parameters relative to sustaining flight.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.5.2 Monitor the Control of the Aircraft

The HSI shall enable the pilot to monitor which entity has control of the aircraft and to what extent the entity has control

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2 Navigate

The HSI shall enable the Pilot to Navigate.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

The ROA System shall provide the pilot with information needed to determine actual vehicle position and heading, course, speed, altitude in order to safely conduct flight in the NAS

Source(s): Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #4a

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.1 Ascertain Information about the Unmanned Air System

The HSI shall enable the pilot to obtain information about the Unmanned Air System

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

The HSI shall enable the pilot/operator to obtain information about all pieces of the Unmanned Air System: Aircraft, Ground Station, Communication relay, etc. In this guideline document, the Communication and Ground Station pieces have been Addressed in sections 3 – Communicate and 5 – Monitor and Manage systems respectively

Reference(s):

The ROA System shall provide the pilot with information needed to maintain an overall awareness of the situation with respect to the aircraft

Source(s): Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #5a

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.1.1 Current Aircraft Position Information

The HSI shall provide the pilot with information about the aircraft position.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Information about the aircraft's Geographical and Spatial/Temporal Information shall be presented to the pilot. This information will include but is not limited to: location of own aircraft, altitude, heading, velocity, vertical velocity, G's, flight path; and deviation from flight plan and clearances

Guidance and navigation displays that provide steering commands and indicator deviation from the desired flight path must be located so that the pilot can safely fly the aircraft during all phases of flight while seated at the primary flight controls with minimum head, eye, or hand movement.

Reference(s):

Endsley;

GAMA 10 Publication;

14 CFR PART 23.1321(a)

Critical Design Activities:

By examination or analysis, determine that navigation system inputs and navigation display parameters of commands and path deviation are located in the primary field-of-view. Other non-flight critical navigation information may be displayed in secondary-field-of-view. For example, a CDU that is not the sole or primary device being used to display dynamic position data used directly to fly the aircraft to maintain a navigation path may be in the secondary field-of-view, pedestal or side console areas and may display such data itself.

Examples of Navigation Data:

Navigation

- Deviation from path displays
- Map displays
- Radar
- GPS CDU
- INS CDU
- FMS DU
- ILS controls
- VOR controls
- DME controls
- Topographic displays

Map displays may include

- Planning
- Track Up
- Terrain
- Present Position
 - North up
 - Track up or heading up
 - Aircraft symbol location
- Hazards and means to alleviate them
 - TAWS
 - Weather Radar
 - TCAS
- Operational considerations
 - RNP, VNAV, Wind inputs, etc.

Example Implementation Concepts:

Performance Rationale and Background:

The information that the pilot needs to actively fly the navigation commands, e.g. deviation from GPS navigation path, needs to be in a location where the pilot can include the data in the primary

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instrument scan. This is real time data being used by the pilot to control the aircraft flight path. Much of the navigation information and control interface with the pilot is used as a crosscheck, as planning data or for intermittent use by the pilot. This data may be displayed in the secondary field-of-view of the pilot(s), in the pedestal or side console areas because it is required to be used by the pilot(s) to ensure the aircraft's navigation path is being flown.

Evaluation Procedure:

Determine all devices that will contribute to the required pilot(s) maintaining navigational awareness or that will provide the required pilot(s) information with respect to a flight or navigation system. Verify through analysis that these systems are located in the appropriate field-of-view (primary or secondary depending upon data criticality). These may include locations in the pedestal or side console areas.

Suggestions for procedures used to verify these locations are as follows:

- 1) Analysis or examination of engineering drawings
- 2) Reach analysis of an electronic mockup or human modeling tool
- 3) Examination/evaluation of subjects in a physical mockup or aircraft

Evaluation Rationale:

The purpose of evaluating the placement of aircraft navigation information in the required pilot(s)' primary field-of-view is to maximize the ability of the pilot(s) to concentrate attention forward of the aircraft and to minimize pilot fatigue in attaining essential aircraft control information. This is especially important during takeoff, initial climb, final approach, and landing phases of flight.

The pilot(s) should be able to monitor all systems contributing to the navigation or guidance of the aircraft, especially during critical phases of flight, with a minimum of head, eye, and hand movement. Placement of equipment in the primary field-of-view of the pilot(s) ideally facilitates this requirement.

Placing non-critical navigation information in the secondary locations such as the pedestal or console areas can ease confusion and reduce clutter in primary viewing areas.

2.1.1.1 Indication of Aircraft Location/Data Receipt

Upon receipt of data from an AV, an icon representing the AV shall appear at its current location on the map

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.1.1.1.1 Change Color of Aircraft Icon

When an AV icon is present on the map, the user shall have the ability to change the AV icon's colour

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

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Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.1.2 Availability of flight critical displays

Flight critical control/monitor displays shall be visible at all times while an AV is under control.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.2 Predict Future Unmanned Air System Information

The HSI shall facilitate the pilot in predicting the performance of the Unmanned Air System in the near future.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:
Reference(s):
Endsley
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.2.1 Intended Aircraft Position in the Near Future

The HSI shall facilitate the pilot in predicting the position of the aircraft in the near future.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.3 Flight Path Development

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

The AVCS System shall enable the operator to create, edit, and save a mission plan(s).

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Mission Plans should include route, contingency route, payload, communications, Identify Friend or Foe (IFF), and navigation aid planning.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.3.1 Enable Mission Planning and Validation

The AVCS System shall enable the operator to plan and validate the mission and review the results of mission validation.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.3.1.1 Distinguishability of different types of Waypoints

Launch, recovery, handover, action, and normal waypoints shall be specified and easily distinguishable from each other.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.3.1.2 Accessibility of data required for Mission Planning

The AVCS System shall be able to access any Data Link Interface/vehicle specific data required for mission planning through the Data Link Interface and/or the Command and Control Interface message interface.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.3.1.3 Ability to Upload Mission Plans

The AVCS System shall provide the operator with the ability to upload mission plans to the AV.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.3.1.3.1 Ability to review Pending Uploads

The operator should have the ability to review selected mission plans prior to AV upload.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.3.1.3.2 Import Mission Plans via Command and Control Interface

The operator should be able to import mission plans via the Command and Control Interface.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.3.1.3.3 Export Mission Plans via Command and Control Interface

The operator should be able to export mission plans via the Command and Control Interface.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.3.1.4 Download mission plans from Aircraft

The operator should have the ability to download mission plans from the AV.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source: NATO STANAG 4568

Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.3.1.5 Display Airspace Coordination Information

The operator should be able to display flight corridors, controlled airspace and any other relevant airspace co-ordination information.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source: NATO STANAG 4568

Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.3.1.5.1 Distinguishability of Route Segments

Constant altitude, infeasible, descending, ascending, and all other route segments should be easily distinguishable.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source: NATO STANAG 4568

Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.3.1.5.2 Distinguishability of Contingency Routes

All contingency routes shall be easily distinguishable from operational and approved scheduled

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

routes.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.3.1.5.3 Display Time-on-Station

The AVCS System should be able to display Time-on-Station information.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.3.1.5.4 Display Entrance into Ground Data Terminal

Upon entering of ground data terminal (GDT) information, a GDT icon shall appear at the current location on the map.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.3.1.6 Mission Plans Accommodating Meteorological and Environmental conditions

The AVCS System should allow mission planning to take into account meteorological and environmental conditions.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

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Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.3.1.7 Ability to De-Clutter Planning Display

The operator should be able to de-clutter the planning display to remove unnecessary items.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Displayed information shall be presented to the user in a manner that allows for rapid recognition and understanding. Display integration should enhance status interpretation, decision making and situational awareness.

Reference(s):

GAMA 10 Publication

14 CFR PART 23.1311; AC 23.1311-1A; AS-8034; ARP-1068B; NAWCADPAX-96-268-TM

Critical Design Activities:

Once the collection of data to be presented on a single display has been determined, the iterative design process should focus on ensuring that data is grouped with some or all of the following in mind:

- The amount of data presented should be easily interpretable by the user.
- Recognizing the subjectivity of the topic, consider designing different levels of display data density that can then be decluttered.
- Provide a default condition containing only the data required for a particular phase of flight.
- Provide decluttering by selectivity.
- Provide decluttering by hierarchy of information level.
- Provide ease of restoring decluttered data.
- Using an industry de facto standard grouping.
- Provide information that is related because of its common subject.
- Provide information that is required to perform a task.

Symbology color selection can have a significant role in the perception of data clutter. Considerable effort should be given to the selection of a color philosophy for a given display, a set of displays, and the full cockpit collection.

Display information design should be as uncluttered as possible. Display presentations should be perceived as uncluttered. Provide only information essential to making a decision or performing an action. Any additional information should be easily selectable/retrievable by the pilot.

Search times increase with the amount of irrelevant information on the display. The display should use the simplest, most natural and intuitive display concepts commensurate with the information transfer needs of the pilot. Consideration should be given for locating all information related to a particular task on the same display.

Example Implementation Concepts:

Performance Rationale and Background:

Displays easily become visually overwhelming, cluttered and confusing when they present too much information. Human visual performance deteriorates with high-density levels of graphic information. Performance deterioration may be evidenced by increased user response time and/or lowered accuracy of visual perception. The provisions of options for reducing the density levels of graphic information are becoming increasingly critical in user interface design. Displayed

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information shall be presented to the user in a manner that allows for rapid recognition and understanding. Display integration should enhance status interpretation, decision making and situational awareness. Simply adding information elements to a single display may cause significant loss of situational awareness if the display is cluttered.

Determination of data clutter and density is a very subjective evaluation. However, a display should provide a reasonable combination of natural data separation and data separation with the appropriate display design structures. The crew that uses the display needs to be able to find and understand the information being presented with a reasonable effort under normal and abnormal conditions. Considerable use of existing discrete and multi-functional display formats can be made to serve as examples for what has proven to be acceptable in the past.

Existing displays, that have successfully presented similar combinations of data to the new design being addressed, can serve as a starting point for a new design. However, design goals that include a reduction in cockpit displays, a combination of previously separate cockpit displays, or the development of new combinations of displays, will need to address the design of the data layouts from the beginning. They will have to address the separation of data. An iterative design process is one method that has proven most useful.

Evaluation Procedure:

Develop evaluation criteria based upon applicable guidelines and evaluate system design.
Compare design with functional requirements.

Evaluate the visual displays under typical cockpit environmental and operational conditions with representative users.

A small team of evaluators representative of the expected user population is an example of an effective evaluation scheme. This team should include test pilots and novices to take advantage of both extremes of opinions. A survey questionnaire that focuses the evaluator's attention with a structured set of questions, with some type of rating scheme, asks for recommendations and improvements of the display layout and arrangement has been shown to be effective. Performance measures could take the form of timing how long subjects take to locate/identify critical information within a display window, with the caveat that a certain amount of learning would need to be factored in or out depending on the design goals.

Evaluation Rationale:

Expect to conduct the evaluation in an iterative fashion. Iterative evaluations, conducted early in the design process, help minimize changes at the end. Iterative evaluations during development further help refine the display arrangement. Structured survey devices provide the evaluator a means to focus their response on specific aspects of the display designs. It also allows the results of the evaluation to be quantified using the rating scale as a measurement tool.

2.3.2 Availability to Replan or Update Current Mission

The AVCS System shall enable the operator to re-plan or update a current mission plan at any time before or during flight.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Rationale:

2.4 Direct Aircraft

The HSI shall enable the pilot to direct the aircraft

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.4.1 Direct the Aircraft according to Flight Path

The HSI shall enable the pilot to direct the aircraft along a flight path

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Through the HSI, the pilot will be able to direct the aircraft along a desired flight path. The flight path is a three dimensional space which crosses a geographic area while observing specified altitudes.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.4.2 Direct the Aircraft on the Ground

The HSI shall enable the pilot to direct the aircraft around an airfield.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Through the HSI, the pilot will be able to direct the aircraft around an airfield as required. Ground movement will be in accordance with ATC direction and the conventions of the airfield.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.4.3 Control Navigation System

The HSI shall enable the pilot to control the aircraft navigational system.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Source:

Performance Based Guideline:

Through the HSI, the pilot will be able to control the aircraft navigational system. The design and implementation of the navigational system will vary by manufacturer and aircraft tasking.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.4.4 Configure Navigation System

The HSI shall enable the pilot to configure the navigation system

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.5 Monitor Navigation

The HSI shall enable the pilot to monitor the aircraft's progression along its route.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.5.1 Monitor Flight Path Performance

The HSI shall enable the pilot to monitor the aircraft's flight path and identify deviations from its flight plan.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

2.5.2 Monitor ATC Clearance Observations

The HSI shall enable the pilot to monitor the aircraft's flight path and ensure the actual aircraft flight path operates within ATC clearances

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.5.3 Monitor Navigation System

The HSI shall enable the pilot to monitor the performance of the aircraft navigation system

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.5.4 Monitor Navigation System Configuration

The HSI shall enable the pilot to monitor the configuration of the aircraft navigations system.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6 Ascertain Information about the Aircraft's Environment

The HSI shall enable the pilot to obtain information about the Unmanned Air System

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Rationale:

2.6.1 Display showing Operational Environment

The HSI shall provide the Pilot with a display that illustrates the aircraft's operational environment

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The operator should be able to display, but not be limited to, the following overlays on the map:

- Flight corridors
- Restricted airspace
- Threat areas
- Sensor/Payload coverage
- Restricted payload operating areas
- Data link coverage

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.1.1 Ability to Load and Edit information from External Sources

The AVCS System shall provide a generic image display to allow the operator to edit, load, and save image files from image libraries and external Command, Control, Communications, Computers and Intelligence sources.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.1.2 Common User Interface Functions/Characteristics for Operational Environment Display

The HSI shall provide the pilot with common user interface functions/characteristics for use in manipulating the Operational Environment Display

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The map may support, but is not limited to, common user interface functions/characteristics: The ability to create user-defined overlays

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

- Incorporation of meteorological data (at the operational altitude of the UAV) as an overlay on the map
- The ability to derive geographic co-ordinates of the position of a cursor and to be able to load this data into appropriate forms/templates
- The ability to display the GDT coverage at any given altitude(s)

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.1.3 Ability to support different Map Types

The HSI shall support displaying different Map Types for the Operational Environment Display

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

The "Map" is considered a CAVCS function. It provides the primary display for situational awareness of a UAV mission, and geographic information for the mission planning.

Reference(s):

Critical Design Activities:

The map shall be able to support a variety of map types:

- Digital Terrain Elevation Data (DTED) Geographic Information Exchange Standard, STANAG 3809
- Digital Feature Analysis Data (DFAD)
- World Geodetic System - 84 (WGS-84), Mil-Std 2401
- Vector
- ARC Standard Raster Product
- Digital Geographic Information Exchange Standard (DIGEST Vers 2.1) STANAG 7074:1998

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.1.4 Scalable Map Display

The presentation scale of the map shall be selectable. Continuous scaling is preferred to discrete

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.1.4.1 Determination of Map Scale

The operator shall be able to derive the scale of the map from the display.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Descent Approach Landing Post Flight Ground Operations
Source: NATO STANAG 4568
Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.6.1.5 De-clutter Map Display

The operator shall be able to de-clutter the map display (excluding Raster maps) to remove unnecessary items.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568
Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.6.2 Display Aircraft Route Plans

The AVCS System shall provide the ability to display valid AV flight route plans

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568
Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.6.2.1 Distinguishability of Active Route Plan

When several flight routes are displayed on the map simultaneously, the active flight route should be easily distinguishable from the other routes.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568
Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.6.3 Other Aircraft

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

The HSI shall provide the pilot with information about Other Aircraft.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Information about other aircrafts' Geographical and Spatial/Temporal Information shall be presented to the pilot. This information will include but is not limited to: location of other aircraft, bearing, velocity, and vertical velocity; own capabilities in relation to other aircraft; and proximity

Reference(s):

Endsley

The ROA System shall have a Traffic Information Display

Source(s): Access 5 Program CCA - C3 Requirements

Critical Design Activities:

The traffic information display shows the ROA's information and the positions of other aircraft within a selected range and altitude. The traffic display should:

- Enhance the ROA pilot's mental image of the threat situation and aid in visual acquisition when possible
- Code displayed aircraft to differentiate between threat levels
- Be capable of presenting multiple ranges that may be manually selectable. Automatic switching to a fixed range based on traffic information may also be considered
- Limit the number of targets displayed to five when a threat situation exists. The system may have the option of displaying all the traffic within a specified volume at the crew's request
- If traffic information is presented on a display that is shared with other aircraft information, do not compromise basic flight functions provided on the display.
- Display the following intruder information: 1) relative bearing (based on actual ground track vs. magnetic heading), 2) altitude or relative altitude (i.e. FL 420 or -10 for 1000 ft below the own-ship), 3) range, 4) relative speed, and 5) vertical velocity
- Be capable of providing multiple sources of information such as Cockpit Display of Traffic Information (CDTI) to ensure all measures are available to avoid collision. This will assist the pilot in verifying information and detecting errors.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.3.1 Distinction between different types of Air Vehicles

A different icon shall be displayed for each type of air vehicle. MIL-STD 2525B is a recognized source of military symbology, though the variety of icons available to depict friendly, unfriendly, and unknown UAVs is limited.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

2.6.3.1.1 Enable/Disable Information displayed with Aircraft Icon

The user shall have the ability to individually enable/disable the display of information that appears with the AV icon

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.3.1.2 Association of Aircraft Information with Aircraft Icon

The AV information and AV trail shall be identifiable as belonging to a specific AV (e.g., this may be

as simple as being the same color).

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.3.1.3 Availability of Aircraft Information

An AV trail shall be available to be displayed on the map for every AV from which the AVCS is receiving data.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.3.1.4 Customization of Aircraft Information Trail

The HSI shall enable the pilot to customize an Aircraft's Information Trail

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

The user shall be able to control the characteristics of the AV trail:

- Length of the AV trail

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

- Enable/Disable the AV trail

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.4 Terrain

The HSI shall provide the pilot with information about Terrain.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Information about the Geographical Terrain shall be presented to the pilot. This information may include but is not limited to: Terrain Features, Airports, Cities, Waypoints, Navigation Fixes, and Landmarks.

Reference(s):

Endsley

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.5 Weather

The HSI shall provide the pilot with information about Weather.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Information about the Natural Environment shall be presented to the pilot. This information may include but is not limited to: Weather Formations, the areas affected, altitudes affected, and movement of the weather formation; temperature, icing, ceilings, clouds, fog, sun, visibility, turbulence, winds, microbursts; and IFR vs. VFR conditions..

Reference(s):

Endsley

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.5.1 Display of Hazardous Weather Data

The ACS shall display hazardous weather data for en route hazardous weather avoidance purposes

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Access 5, Human Systems Integration Pilot-Technology Interface Requirements for Weather Management

Performance Based Guideline:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

While en route, the pilot is required to operate the aircraft safely by, in part, avoiding hazardous weather. Hazardous weather is defined as: moderate to extreme turbulence, severe engine and/or airframe icing, thunderstorms, line of thunderstorms, embedded thunderstorms, windshear, moderate to heavy rain, hail, lightning, and volcanic ash. - The definition of 'hazardous' as it applies to a UA is also determined by the design of the vehicle. Some vehicles will tolerate higher or lower levels of the hazardous weather than others.

The pilot shall be able to review hazardous weather information by using one or more media available at the ACS. Media include, but are not limited to, telephone communication, on-screen display of alphanumeric data via datalink or landline, and weather maps.

Upon review of hazardous weather data, the pilot is able to make an informed decision:

1. During Flight Planning - to Avoid Hazardous Weather systems
2. Enroute - to continue on the current flight plan or request from ATC to deviate around weather. If the pilot elects to remain on course, it is incumbent on the pilot to continue monitoring hazardous weather in the UA's vicinity. If a deviation is approved, the pilot alters course and or altitude by an amount deemed appropriate for safety, and bypasses the hazardous weather. Once the pilot has seen hazardous weather data that show the aircraft is clear of hazardous weather, the pilot may request a new course and/or altitude from ATC.
3. Alternate Airports

The development of new weather products coupled with increased access to these products via the public Internet, created confusion within the aviation community regarding the relationship between regulatory requirements and new weather products. Consequently, FAA differentiates between those weather products that may be utilized to comply with regulatory requirements and those that may only be used to improve situational awareness. To clarify the proper use of aviation weather products to meet the requirements of 14 CFR, FAA defines weather products as follows:

1. Primary Weather Product. An aviation weather product that meets all the regulatory requirements and safety needs for use in making flight related, aviation weather decisions.
2. Supplementary Weather Product. An aviation weather product that may be used for enhanced situational awareness. If utilized, a supplementary weather product must only be used in conjunction with one or more primary weather product.

Reference(s):

An aviation weather product produced by the Federal Government is a primary product unless designated as a supplementary product by FAA.

All flight-related, aviation weather decisions must be based on Primary Weather Products.

2.6.5.1 Display of Hazardous Weather Data

Supplementary Weather Products augment the primary products by providing additional weather information but may not be used as stand-alone weather products to meet aviation weather regulatory requirements or without the relevant primary products. When discrepancies exist between primary and supplementary weather products describing the same weather phenomena, users must base flight-related decisions on the Primary Weather Product. Furthermore, multiple primary products may be necessary to meet all aviation weather regulatory requirements.

The FAA has determined that operators and pilots may utilize the following approved sources of aviation weather information:

1. Federal Government. The FAA and NWS collect raw weather data, analyze the observations, and produce forecasts. The FAA and NWS disseminate meteorological observations,

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analyses, and forecasts through a variety of systems. In addition, the Federal Government is the only approval authority for sources of weather observations; for example, contract towers and airport operators may be approved by the Federal Government to provide weather observations.

2. Enhanced Weather Information System (EWINS). A EWINS is an FAA approved proprietary system for tracking, evaluating, reporting, and forecasting the presence or lack of adverse weather phenomena. A EWINS is authorized to produce flight movement forecasts, adverse weather phenomena forecasts, and other meteorological advisories.
3. Commercial Weather Information Providers. In general, commercial providers produce proprietary weather products based on NWS/FAA products with formatting and layout modifications but no material changes to the weather information itself. This is also referred to as "repackaging." In addition, commercial providers may produce analyses, forecasts, and other proprietary weather products that substantially alter the information contained in government-produced products. However, those proprietary weather products that substantially alter government-produced weather products or information may only be approved for use by Part 121 and Part 135 certificate holders if the commercial provider is EWINS qualified.

Commercial weather information providers contracted by FAA to provide weather observations, analyses, and forecasts (e.g., contract towers) are included in the Federal Government category of approved sources by virtue of maintaining required technical and quality assurance standards under Federal Government oversight.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.5.1.1 Display of Hazardous Weather Effects on the UA

The ACS shall display hazardous weather data that affects UA safety of flight.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source: Access 5, Human Systems Integration Pilot-Technology Interface Requirements for Weather Management

Performance Based Guideline:

While the pilot may make every effort to plan around hazardous weather, it should be recognized that published weather data are not 100% timely, complete, or accurate. Therefore, the pilot shall be informed (via an alert) whenever an encounter with hazardous weather affects the UA. Hazardous weather in this context is defined as unexpected encounter with engine icing, airframe icing, turbulence level inappropriate for safe flight, hail, precipitation inappropriate for safe flight, lightning strike, and volcanic ash.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.5.2 Demand Hazardous Weather Data

The pilot shall have control capability to obtain access to hazardous aviation weather information from service providers.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Descent Approach Landing Post Flight Ground Operations

Source: Access 5, Human Systems Integration Pilot-Technology Interface Requirements for Weather Management

Performance Based Guideline:

This pilot shall be able to contact any provider that the pilot deems necessary to obtain hazardous weather data, on which safety of flight decisions are to be made. The pilot shall have the capability to contact one or more of these providers. These providers currently include those defined as:

1. In accordance with standard operating practices, the pilot at the ACS may be informed of hazardous weather by the Federal Aviation Administration (FAA), National Severe Storm Forecast Center, and/or National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS), and/or NOAA Aviation Digital Data Service by providing a relay or broadcast of a PIREP, AIRMET, SIGMET, WW, convective SIGMET, HIWAS, and/or CWA information.
2. In accordance with standard operating procedures for a pilot to obtain weather data en route, the pilot may gain access to National Weather Service Aviation Products, where the majority of pilot weather briefings are provided by FAA personnel at Flight Service Stations (AFSSs/FSSs).
3. In accordance with standard operating procedures for a pilot to obtain weather data en route, the pilot may gain access to FAA Weather Services, where the primary source of weather briefings is an individual briefing obtained from a briefer at the AFSS/FSS. These briefings, which are tailored to a specific flight, are available 24 hours a day through the use of the toll free number.
4. The pilot may gain access to weather data from numerous private industry sources on an individual or contract pay basis. In addition, The Direct User Access Terminal System (DUATS) can be accessed by pilots with a current medical certificate toll-free in the 48 contiguous States via personal computer.

Pilots can receive alpha-numeric weather data. The Flight Information Services Data Link (FISDL) may also be use to obtain weather data

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.6 Other Environmental Elements

The HSI shall provide the pilot with information about "other" environmental factors.

 Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
 Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Through the HSI, the pilot will be able to maintain a situational awareness about the operational environment around the aircraft both on the ground and in the air.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.6.1 Other Aerial Environmental Elements

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

The HSI shall provide the pilot with information about "other" aerial environmental elements.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

As information becomes available, the HSI shall provide the pilot with information about "other" aerial environmental elements. "Other" aerial elements may include reported flocks of birds, clear air turbulence, etc

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.6.6.2 Other Ground Environmental Elements

The HSI shall provide the pilot with information about "other" ground environmental elements.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

As information becomes available, the HSI shall provide the pilot with information about "other" ground environmental elements. "Other" ground elements may include fast moving ground support equipment, ground personnel, etc.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.7 Predict Environmental Changes in the Near Future

The HSI shall enable the Pilot to predict environmental changes in the near future.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.7.1 Predict Changes by Other Aircraft

The HSI shall enable the Pilot to predict changes by Other Aircraft in the near future.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

2.7.2 Anticipate Weather Changes

The HSI shall enable the Pilot to anticipate Weather changes in the near future.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Information about where and when Weather Formation changes are expected to be in the near future shall be interpretable by the pilot. Changes may include movement, increases or decreases in intensity, introduction of other characteristics such as gusting wind in an otherwise benign rainstorm, etc.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:
Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.8 Review and Reevaluate Acquired Information

The HSI shall enable the Pilot to review and reevaluate information presented.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

In order for the pilot to maintain Situational Awareness he/she will have to review and reevaluate the information presented. "Pilots typically employ a process of information sampling to circumvent attention limits, attending to information in rapid sequence following a pattern dictated by long-term memory concerning the relative priorities and the frequency with which this information changes." (Endsley, SA in Aviation)

Reference(s):

The ROA System shall Provide ROA Pilot Situational Awareness

Source(s): Access 5 Program CCA - C3 Requirements

Critical Design Activities:

The CCA human system interface shall be capable of providing situational awareness information to the ROA pilot to indicate relative position of other aircraft within a given, selectable range and altitude envelope

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.8.1 Review and Reevaluate Expected Aircraft Position

The HSI shall enable the Pilot to review and reevaluate Aircraft Position Information.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

In order for the pilot to maintain Situational Awareness he/she will have to review and reevaluate

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the aircraft information presented.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.8.2 Review and Reevaluate Expected Unmanned Air System

Performance

The HSI shall enable the Pilot to review and reevaluate Unmanned Air System Information.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

In order for the pilot to maintain Situational Awareness he/she will have to review and reevaluate the systemic information presented. The systemic information necessary is from all elements of the UAS: aircraft, AVCS, communication system, etc.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

2.8.3 Review and Reevaluate Expected Environmental Changes

The HSI shall enable the Pilot to review and reevaluate Environmental Change Information.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

In order for the pilot to maintain Situational Awareness he/she will have to review and reevaluate the environmental information presented.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3 Communicate

The HSI shall enable the Pilot to Communicate.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

The AVCS System shall provide the operator with the ability to generate, receive, display, edit, and send any message types that can be exchanged over the Command and Control Interface with applicable Command, Control, Communications, Computers and Intelligence systems.

Source(s): NATO STANAG 4568

Critical Design Activities:

The HSI shall contain the hardware and software required for the Pilot to Communicate with at

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minimum the same level/quality of communication as a minimally equipped, manned aircraft.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.1 Communication System Situational Awareness Display

The operator shall have an antenna/data link situational awareness display. This display does not necessarily have to be separate from the AV Control/Monitor display.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Antenna Situation awareness items may include, but are not limited to the following items:

- Graphical GDT and ADT antenna azimuth indication
- Graphical GDT and ADT antenna elevation indication
- Graphical indication of AV position relative to GDT antenna
- Graphical representation of antenna shadowing zones

Data link situational awareness/control display should include, but not be limited to the following items:

- Data link selection
- Command/active/inactive data link indication
- GDT type
- GDT tracking mode
- GDT azimuth
- GDT elevation
- Receiver mode
- Receiver status
- Transmitter power
- Transmitter status
- Up-link frequency
- Receive signal strength
- Down-link frequency
- Link quality

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.2 Control Communication System

The HSI shall enable the Pilot to Control the Communication System

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Rationale:

3.2.1 Communicate with Other Systems

The AVCS System shall provide the operator with the ability to open and control the communications links between the AVCS System and other outside agencies

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Example Implementation(s):

- C4I systems via the CCI interface
- Air traffic control via both voice and data links
- ADT/GDT

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.2.2 Accessibility of Communication Devices

Each ROA pilot inside the AVCS should have their own communication device that is capable of selecting all means of voice communication and adjusting the volume.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.2.2.1 Automatic Microphone Shut-Off

An open microphone should automatically turn off after an appropriate period of time to avoid a "stuck mic" scenario.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.3 Configure the Communication System

The HSI shall enable the pilot to configure the communication system

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.3.1 Pilot Identification of the Active Radio in ACS

The pilot shall have the capability to determine the radio in use by referring to displays and/or indicators in the ACS.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Design Guidelines for Multifunction Displays, DOT/FAA/AM-01/17, Office of Aerospace Medicine, 2001, para. 3.1.

Critical Design Activities:

Display only and all the necessary data to the pilot and ensure that radio usage data the pilot needs are available for display.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.3.2 Configure communication system between the Pilot and the Aircraft

The HSI shall enable the pilot to configure the communication system between the pilot and the aircraft.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.3.3 Configure communication system between the Pilot and Air Traffic

The HSI shall enable the pilot to configure the communication system between the pilot and Air Traffic Control.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

The HSI shall provide the pilot with ability to communicate with ATC.

Source(s): Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #2

Critical Design Activities:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

3.3.3.1 ATC Communication Radios

The HSI shall enable the Pilot to set and/or confirm ATC communication Radio Frequencies.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.3.3.1.1 Display Frequency and Mode of Operation

A communications display should indicate all frequencies and modes of operation. It should be clear to the ROA pilot, which radio is currently selected and which operating mode (such as line-of-sight and over-the-horizon) is selected.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.3.4 Configure communication system between Aircraft and ATC

The HSI shall enable the pilot/operator to configure the communication system between the aircraft and Air Traffic Control

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Depending on manufacturer design, there may be a communication system between the aircraft and Air Traffic Control. The mechanism and functioning of this potential system may have different applications. Anticipated systems may operate as:

1. A relay between the pilot and ATC
2. A transponder to inform ATC where the aircraft is located
3. An aircraft control identification system – tells ATC whether the aircraft is actively controlled by a pilot or has lost link with a control station
4. etc.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Rationale:

3.3.4.1 Tune to Assigned ATC Channel

The ROA System shall be able to Tune to Assigned ATC Channel

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA – C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The ROA – ATC communications human system interface shall be capable of tuning the ATC radio to an assigned frequency. This will likely be accomplished through a standard air-to-ground radio in which a new frequency can be input through a numeric pad or the turning of a radio dial.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.3.4.2 ATC Transponder Operation

The HSI shall enable the pilot/operator to configure the ATC transponder.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirement

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The ATC transponder should provide the following functions:

1. ability to select 4,096 discrete codes
2. have an on/off capability for altitude reporting,
3. allow the pilot the capability to use the "ident" feature.

Manual override should also be available.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.3.4.3 Pilot Control of ACS Radio Functions

The pilot shall have capability to operate the radio at the ACS. This includes capability to turn the radio on and off, select any frequency assigned by ATC for transmission and reception, adjust reception volume, and select radio modes.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration, Washington, D.C. June, 2003. Sect. 7.4.5.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Operation of the radio, including the requisite control functions, is necessary in order to

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communicate with air traffic control.

Evaluation Procedure:

Evaluation Rationale:

3.3.4.3.1 Pilot Control of ACS UA Transponder

The pilot shall have capability to control the aircraft transponder at the ACS. This includes capability to turn the transponder on and off, select any code assigned by ATC, select codes 7600 and 7700, activate the IDENT function, and select transponder modes.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration, Washington, D.C. June, 2003. Sect. 7.4.5.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Operation of the transponder, including the requisite control functions, is necessary in order to communicate with air traffic control and some airborne collision avoidance systems.

Evaluation Procedure:

Evaluation Rationale:

3.3.4.3.2 ACS Display of UA Transponder Functions

The ACS shall display feedback to the pilot regarding transponder operation at the ACS. This includes capability to present transponder on and off status, display of code selected, and transponder modes.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Design Guidelines for Multifunction Displays, DOT/FAA/AM-01/17, Office of Aerospace Medicine, 2001, para. 3.1.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Operation of the transponder, including the requisite information content, is necessary in order to communicate with air traffic control and some collision avoidance systems in other aircraft. Display only and all the necessary data to the pilot to ensure that transponder usage data the pilot needs are available for display

Evaluation Procedure:

Evaluation Rationale:

3.3.4.3.3 ACS Display of Radio Functions

The pilot shall have capability to receive feedback regarding radio operation at the ACS. This includes capability to know radio on and off status, display of frequency selected for transmission and reception, reception volume setting, and radio modes (subject to radio design).

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command,

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Design Guidelines for Multifunction Displays, DOT/FAA/AM-01/17, Office of Aerospace Medicine, 2001, para. 3.1.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Operation of the radio, including the requisite information content, is necessary in order to communicate with air traffic control. Display only and all the necessary data to the pilot to ensure that radio usage data the pilot needs are available for display.

Evaluation Procedure:

Evaluation Rationale:

3.3.5 Configure communication system between Pilot and Other Aircraft

The HSI shall enable the pilot to configure the communication system between the pilot and other aircraft.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.3.6 Configure the communication system between Aircraft and Other Aircraft

The HSI shall enable the pilot/operator to configure the communication system between the aircraft and other aircraft.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Depending on manufacturer design, there may be a communication system between the aircraft and other aircraft. The mechanism and functioning of this potential system may have different applications. Anticipated systems may operate as

1. A relay between the pilot and other aircraft
2. a transponder to inform the other aircraft where own aircraft is located
3. an aircraft control identification system – tells other aircraft whether the aircraft is actively controlled by a pilot or has lost link with a control station
4. etc.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.3.7 Configure communication system between Pilot and Other Authorities

The HSI shall enable the pilot to configure the communication system between the AVCS and

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other authorities.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Using the HSI communication system, the pilot will be able to configure the communication system between the pilot and other authorities. These authorities may include ground crews, unit dispatching, etc.

Evaluation Procedure:

Evaluation Rationale:

3.4 Initiate/Send Communications

The HSI shall enable the pilot to initiate/send communications to all elements of the Unmanned Air System

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Using the HSI Communication System, the pilot will be able to initiate and/or send communication to all elements of the Unmanned Air System. The elements the pilot is expected to communicate with are the aircraft, ATC, other aircraft, designated ground crews, etc.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.4.1 Initiate/Send communications between Pilot and Aircraft

The HSI shall enable the pilot to initiate/send communications to the aircraft

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.4.2 Initiate/Send communications between Pilot and ATC

The HSI shall enable the pilot to initiate/send communications to ATC

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

The HSI shall provide the pilot with ability to communicate with ATC.

Source(s): Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #2

The ROA System shall be able to Respond/Initiate Communication with ATC

Source(s): Access 5 Program CCA – C3 Requirements

Critical Design Activities:

The ROA – ATC communications human system interface shall be capable of providing the ROA pilot near real time responses to ATC directives and initiate communication to ATC if necessary. This will likely be accomplished through a push-to-talk (PTT) microphone in the AVCS that needs to receive and pass voice data to the communications system. If the ROA pilot sends data, a computer interface shall enable selection of “canned” responses or the means to hand type the information. If necessary, the ROA – ATC communications human system interface shall have a back-up means of communication to ensure a high level of reliability.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.4.2.1 Generate Specific Messages for ATC

If the UAV is to be flown in civil airspace, the AVCS System shall enable the operator to generate specific messages for submittal to appropriate ATC authority

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.4.2.1.1 Pilot-ATC Communications Latency

The time delay between pilot transmission from the ACS to reception by the air traffic controller and controller transmission to the pilot at the ACS shall not adversely affect ATC communications, air traffic controller functions, tasks, or workload. Neither shall it adversely affect pilot functions, tasks, and workload. The requirements for the pilot-ATC air-ground communications system shall limit voice delay to 250 ms (TBV). This 250 ms delay represents the elapsed time from when the pilot or controller begins to speak until the audio signal is received by the listener.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

The Effect of Voice Communications Latency in High Density, Communications-Intensive Airspace.

Federal Aviation Administration, Atlantic City, NJ. January, 2003.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

In the ATC environment, controllers and pilots have adopted a standard phraseology for

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conducting spoken dialogues to ensure a minimum possibility of error or misunderstanding. ATC communications safety measures, such as proper timing and read backs, assure that communication is taking place correctly. Non-standard delays in communications adversely affect operations and safety: First, delays may increase the total amount of time devoted to complete required communications tasks. Second, delays may increase the rate of deviations from the standard phraseology and procedures (e.g., partial or missing read backs) if words or pilot responses are omitted to shorten the dialogues. Third, delays may result in more simultaneous transmissions or retransmissions if the expected time window for a response is exceeded. Finally, delays may result in the untimely delivery of messages as longer transactions are crowded onto a congested communications channel. In addition, other unwanted effects may appear including user frustration, greater variability in aircraft flight paths, blocked transmissions, and reduction in ATC service.

Evaluation Procedure:

Evaluation Rationale:

3.4.3 Initiate/Send communications between Pilot and Other Aircraft

The HSI shall enable the pilot to initiate/send communications to other aircraft

	Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations						
	Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.4.4 Configure communication system between Pilot and Other

Authorities

The HSI shall enable the pilot to configure the communication system between the AVCS and other authorities.

	Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations						
	Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Using the HSI communication system, the pilot will be able to configure the communication system between the pilot and other authorities. These authorities may include ground crews, unit dispatching, etc.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.5 Receive/Respond to Communications

The HSI shall enable the pilot to initiate/send communications to all elements of the Unmanned Air System

	Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations						
	Descent	Approach	Landing	Post Flight	Ground Operations	

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Source:

Performance Based Guideline:

Using the HSI Communication System, the pilot will be able to initiate and/or send communication to all elements of the Unmanned Air System. The elements the pilot is expected to communicate with are the aircraft, ATC, other aircraft, designated ground crews, etc.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.5.1 Receive./Respond to Communications from the Aircraft

The HSI shall enable the pilot to receive and respond to communications received from the aircraft.

Preflight Operations	Ground Operations	Takeoff	Climb	Enroute	Mission
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.5.2 Receive/Respond to Communications from ATC

The HSI shall enable the pilot to receive and respond to communications from ATC.

Preflight Operations	Ground Operations	Takeoff	Climb	Enroute	Mission
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

The ROA System shall be able to Receive ATC Directives

Source(s): Access 5 Program CCA – C3 Requirements

Critical Design Activities:

The ROA – ATC communications human system interface shall be capable of receiving ATC directives and/or information. This will likely be accomplished through a headset in the AVCS that needs to provide clear and reliable audio. If data is sent from ATC, the AVCS shall provide a visual display that alerts the ROA pilot of an incoming message.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.5.2.1 ATC Datalink Annunciation

An ATC data link message should be displayed on a forward panel visible to the ROA pilot. When an incoming message is received, it should alert the pilot both visually and/or aurally.

Preflight Operations	Ground Operations	Takeoff	Climb	Enroute	Mission
Descent	Approach	Landing	Post Flight	Ground Operations	

Source: NATO STANAG 4568

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Performance Based Guideline:

Reference(s):

The ACS shall display feedback to the pilot when a datalink message arrives by a visual and/or aural alert. - Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration, Washington, D.C. June, 2003. Sect. 7.1.2.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

As the pilot will be involved in many ACS operations, it is not expected that the pilot will monitor the datalink system at all times. Humans are poor monitors over extended period of time. As a result, augmentation of pilot monitoring skill is required in the form of a visual alert and/or aural alert to inform the pilot of a change in system operational status.

Evaluation Procedure:

Evaluation Rationale:

3.5.3 Receive./Respond to Communications from Other Aircraft

The HSI shall enable the pilot to receive and respond to communications received from other aircraft.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.5.4 Receive./Respond to Communications from Other Authorities

The HSI shall enable the pilot to receive and respond to communications received from other authorities.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Using the HSI communication system, the pilot will be able to receive and respond to communications received from other authorities. These authorities may include ground crews, unit dispatching, etc.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.6 Confirm Communications

The HSI shall enable the pilot to confirm Communications

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
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The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Using the HSI, the pilot will be able to confirm the receipt and quality of communication receipt for messages sent between elements of the unmanned air system.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.6.1 ACS Display of Communication Quality

The ACS shall display feedback to the pilot regarding the status or quality of each uplink and downlink.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Design Guidelines for Multifunction Displays, DOT/FAA/AM-01/17, Office of Aerospace Medicine, 2001, para. 3.1.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Display only and all the necessary data to the pilot and ensure that datalink quality data will be available for display.

Evaluation Procedure:

Evaluation Rationale:

3.6.1.1 ACS Display of Data Describing Communication Corruption

The pilot shall not be presented with downlink data on ACS displays that have been corrupted, as determined by a datalink system function that checks the integrity of the downlink data prior to its display to the pilot.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Requirements for Datalink. Air Transport Association Information Transfer Subcommittee. June, 1992, Para. 4.2, 5.1.3.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4a.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The level of data integrity must be high enough to ensure that the message that appears on the ACS display accurately and completely represents output from the vehicle.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Procedure:

Evaluation Rationale:

3.6.1.2 ACS Display of Data Describing Communication Status/Quality Failure

The ACS shall display feedback to the pilot for any partial or full failure of a datalink.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 7.1.1.1.; Human Factors Requirements for Datalink. Air Transport Association Information Transfer Subcommittee. June, 1992, Para. 5.8.3.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

As the pilot will be involved in many ACS operations, it is not expected that the pilot will monitor the datalink status display at all times. Humans are poor monitors over extended period of time. As a result, augmentation of pilot monitoring skill is required in the form of a master visual alert and/or aural alert to warn the pilot of a datalink failure. In addition, a message should be presented to the pilot on ACS displays or indicators describing which datalink has failed and the extent of the failure, as appropriate.

Evaluation Procedure:

Evaluation Rationale:

3.6.1.3 Reliability of ACS Display of Data Describing Communication Status/Quality Failure Alert

The datalink status/quality failure alert provided to the pilot at the ACS shall not itself be subject to a silent failure.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Requirements for Datalink. Air Transport Association Information Transfer Subcommittee. June, 1992, Para. 5.8.3.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration, Washington, D.C. June, 2003. Sect. 7.1.1.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

To ensure that the pilot is informed if any part of the datalink system malfunctions, a datalink alerting function is required that itself does not fail with the datalink.

Evaluation Procedure:

Evaluation Rationale:

3.6.1.4 ACS Display of Data Describing Communication Error Checking

To the extent that the datalink system may be unable to detect certain types of errors, the ACS

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shall display feedback to the pilot regarding reasonableness of data so the pilot may determine implications for operation of the vehicle.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Requirements for Datalink. Air Transport Association Information Transfer Subcommittee. June, 1992, Para. 3.1.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

If a datalink system cannot check 100% of downlink data for security and correctness, a backup means of error checking is necessary. The pilot can serve this function at the ACS by inspection of data parameters related to the downlink as well as other systems. To the extent that the pilot is assigned this responsibility, procedures are required to ensure proper pilot performance.

Evaluation Procedure:

Evaluation Rationale:

3.6.2 Identify Source and Destination of Messages

The data link system should have the capability to unambiguously identify the source and destination of all transmitted messages. The system must ensure that messages are not being "spoofed" from an outside source.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.6.3 ACS Display of Data for System Security

The ACS shall display feedback to the pilot regarding the source of communication transmissions.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Design Guidelines for Multifunction Displays, DOT/FAA/AM-01/17, Office of Aerospace Medicine, 2001, para. 3.1.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The ACS shall display only and all necessary data to ensure that datalink security information are available to the pilot.

Evaluation Procedure:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Rationale:

3.6.4 Confirm Communications between Pilot and Aircraft

The HSI shall enable the pilot to confirm the receipt of communications between the AVCS and the Aircraft.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Using the HSI, the pilot will be able to confirm that communications were received when sent from the AVCS to the Aircraft as well as communications that were sent from the Aircraft to the AVCS.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.6.4.1 Preliminary Establishment of Communications

The pilot shall have control capability at the ACS to authorize datalink actions prior to enabling control of the vehicle flight path or trajectory.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

As the pilot is the final authority for safe operation of the aircraft, the pilot must have the ability to control the state of the flight control system and any related system(s) that affect control over flight path or trajectory.

Evaluation Procedure:

Evaluation Rationale:

3.6.5 Confirm Communications between Pilot and ATC

The HSI shall enable the pilot to confirm the receipt of communications between the AVCS and ATC.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Using the HSI, the pilot will be able to confirm that communications were received when sent from the AVCS to ATC as well as communications that were sent from ATC to the AVCS.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Procedure:

Evaluation Rationale:

3.6.6 Confirm Communications between Pilot and Other Aircraft

The HSI shall enable the pilot to confirm the receipt of communications between the AVCS and the Other Aircraft.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Using the HSI, the pilot will be able to confirm that communications were received when sent from the AVCS to other aircraft as well as communications that were sent from other aircraft to the AVCS.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.6.7 Confirm Communications between Pilot and Other Authorities

The HSI shall enable the pilot to confirm the receipt of communications between the AVCS and Other Authorities.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Using the HSI, the pilot will be able to confirm that communications were received when sent from the AVCS to the Aircraft as well as communications that were sent from the Aircraft to the AVCS. These authorities may include ground crews, unit dispatching, etc.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.7 Monitor Communications

The HSI shall enable the pilot to monitor the Communication Systems

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.7.1 Expected Communication Link Performance

The HSI shall facilitate the pilot in predicting functional status information about the UAS Communication Links in the near future.

Preflight Ground Operations Takeoff Climb Enroute Mission

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Information about the UAS Communication Link Statuses shall be presented to the pilot. This information will include but is not limited to: The strength of the bandwidth active ATC communications are being conducted on (AVCS and ATC); the strength of the "next" bandwidth for ATC Communications (AVCS and ATC); the strength of the aircraft control bandwidth signal (AVCS and Aircraft); and the strength of alternate aircraft control frequencies.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.8 Communication Link Status Information

The HSI shall provide the pilot with functional status information about the UAS Communication Links

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Information about the UAS Communication Link Statuses shall be presented to the pilot. This information will include but is not limited to: The bandwidth active ATC communications are being conducted on (AVCS and ATC); the "next" bandwidth for ATC Communications (AVCS and ATC); the bandwidth aircraft control information is being broadcast on (AVCS and Aircraft); and transponder equipment and transponder frequency (Aircraft and ATC).

Reference(s):

The status of each component of the Communications Relay (e.g., data link/bearer system, antennas, etc) should be displayed to the operator upon request. Source(s): NATO STANAG 4568

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.8.1 Communications Relay Footprint

The footprint of the Communications Relay should be displayed on the operator map display

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.8.1.1 Distinguishability of Communications Relay Footprint

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

The Communications Relay footprint shall be easily distinguishable from other footprints that may be present on the operator map display.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.8.2 Changes to Communications Relay

Changes in the status of the Communications Relay components should be positively identified to the operator.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.8.3 Monitor Communications between Pilot and Aircraft

The HSI shall enable the pilot to monitor communications between the AVCS and the Aircraft

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.8.3.1 Pilot Knowledge of LOS or BLOS Status

The ACS shall display to the pilot the LOS and BLOS status of communications.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Design Guidelines for Multifunction Displays, DOT/FAA/AM-01/17, Office of

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Aerospace Medicine, 2001, para. 3.1.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The pilot needs to know whether the system is operating LOS or BLOS. Display only and all the necessary data to the pilot to ensure that radio and datalink usage data the pilot needs are available for display.

Evaluation Procedure:

Evaluation Rationale:

3.8.4 Monitor Communications between Pilot and ATC

The HSI shall enable the pilot to monitor communications between the AVCS and ATC

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

The ROA – ATC communications human system interface shall be capable of monitoring the health of the ATC radio to the ROA pilot. In the event of a malfunction or failure of the radio, the ROA pilot shall be visually and/or audibly notified. If there is a failure of the radio, the human system interface shall provide a means to immediately change the transponder code of the ROA to 7600 (standard procedures from Aeronautical Information Manual 6-4-2).

Reference(s):

The ROA System shall be able to Monitor ATC Radio Status

Source(s): Access 5 Program CCA – C3 Requirements

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.8.5 Monitor Communications between Aircraft and ATC

The HSI shall enable the pilot to monitor communications between the Aircraft and ATC

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.8.6 Monitor Communications between Pilot and Other Aircraft

The HSI shall enable the pilot to monitor communications between the AVCS and other aircraft

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

3.8.7 Monitor Communications between the Aircraft and Other Aircraft

The HSI shall enable the pilot to monitor communications between Own Aircraft and Other Aircraft

Preflight Operations	Ground Operations	Takeoff	Climb	Enroute	Mission
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

3.8.8 Monitor Communications between the Pilot and Other Authorities

The HSI shall enable the pilot to monitor the communication system between the AVCS and other authorities.

Preflight Operations	Ground Operations	Takeoff	Climb	Enroute	Mission
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Using the HSI communication system, the pilot will be able to monitor the communication system between the pilot and other authorities. These authorities may include ground crews, unit dispatching, etc.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4 AVOID HAZARDS

The HSI shall enable the aircraft to Avoid Hazards through actions by the Pilot

Preflight Operations	Ground Operations	Takeoff	Climb	Enroute	Mission
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Aircraft Hazard avoidance shall be conducted with actions and authorizations from the Pilot. Some actions and authorizations may be pre-determined. The role the Pilot takes in Hazard Avoidance will vary depending on how the Manufacturer develops the Hazard Avoidance System. As an example (A), the Manufacturer may develop a system that only operates in restricted air

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space within which no other aircraft are allowed to travel. The role of the Pilot in Hazard Avoidance for this type of system (A) would be very limited. As another example (B), the Manufacturer may develop a system that requires the Pilot to perform all aspects of Hazard Avoidance: Detection, Evaluation, Develop a Solution, Act, and Assess. The role of the Pilot in Hazard Avoidance for this type of system (B) would be robust.

Evaluation Procedure:

Evaluation Rationale:

4.1 Detect a Hazard

The HSI shall enable the Pilot to Detect a Hazard

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

The HSI shall enable the Pilot to perceive a Potential Hazard. The method of informing a pilot that a hazard exists (aural alert, visual display, tactile, etc.) will vary depending on how the Manufacturer develops the system.

Reference(s):

The ROA System shall Detect cooperative threats

Source(s): SEIT Approved CCA Functional Requirements, Functional Requirement #1

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.1 Detect a hazardous condition between Own Aircraft and Other Aircraft

The HSI shall enable the pilot to identify a hazardous condition between own aircraft and other aircraft.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: SAE ARP4153, "HUMAN INTERFACE CRITERIA FOR COLLISION AVOIDANCE SYSTEMS IN TRANSPORT AIRCRAFT"; SAE ARP5365

Performance Based Guideline:

This detection is based on the information obtained through the Sensing and Estimation Function: proximity and closure with traffic, aircraft performance, and estimates of the aircraft's intentions. The decision that a situation is a conflict should consider the application and carefully balance safety against nuisance alerts. The system should not issue an alert when published procedures are being followed. This can be accomplished by examining a wide variety of traffic encounters, especially when the own ship, the traffic or both are maneuvering.

Reference(s):

Critical Design Activities:

The system should use the permitted traffic separation criteria to determine the protection that the system will provide. The navigation and other airplane systems may be used to provide positional information to identify the appropriate criteria

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.1.1 Avoid Cooperative Traffic

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

The ROA System shall provide the pilot with the ability to avoid cooperative traffic

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #5b

Performance Based Guideline:

Reference(s):

Critical Design Activities:

For specific guidance on the Human Interface Criteria for Collision Avoidance Systems, SAE ARP4153, "HUMAN INTERFACE CRITERIA FOR COLLISION AVOIDANCE SYSTEMS IN TRANSPORT AIRCRAFT" provides high-level instruction and information.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.1.2 Provide Conflict Resolution Information to the Pilot

The information provided by the system should enable the pilot to perform conflict resolutions, or respond to resolution guidance, in a timely manner.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance

Performance Based Guideline:

The system should generate a sense of confidence in the pilot that the pilot is seeing all of the traffic relevant to performing these resolution responses, or that the system is considering, in generating resolution guidance. Otherwise, responses may be tentative and delayed, or competing resolutions may appear better suited to the conflict. As a general statement, the information provided by the system should enable the pilot to respond in an appropriate and timely manner and should not promote incorrect or unproductive response patterns. At the same time, the pilot shall use information describing traffic according to requirements established for the design and shall not employ the design for purposes other than those for which it was intended (e.g., TCAS traffic displays shall not be used by the pilot for traffic separation) .

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 5.5.1, 5.8.3, 5.14.5, 5.14.22, 6.1.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 5.1.5, 7.1.1.8.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4i, 8.1.

Critical Design Activities:

Detailed CDTI design information requirements and recommendations can be found in SAE ARP5365. Some considerations are listed below:

Visual Display Characteristics:

Visual displays can present traffic information in two ways: graphical or textual. While users generally prefer a graphical (i.e., analog) display, cognizance and performance is not always better with graphical representations. That is, performance with either display format appears to be task dependent. In general, a graphical format is favored under the following conditions (Helander, 1987):

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- a. Rate-of-change information needs to be perceived.
- b. Estimations of the variable's magnitude are needed when it is rapidly changing.
- c. The deviation of the variable from a prescribed limit needs to be determined at a glance.

In addition, the graphical display of information is favored when the information is inherently spatial and multiple spatial relationships need to be determined at a glance. Both information mediums can be displayed within a stand alone or shared traffic display. Many of the recommendations listed below are applicable to all display types (e.g., location, size, and resolution), however, if a guideline is specific to a display type, it will be so stated.

Example Implementation Concepts:

Performance Rationale and Background:

The system should generate a sense of confidence in the pilot that the pilot is seeing all of the traffic relevant to performing these resolution responses, or that the system is considering, in generating resolution guidance. Otherwise, responses may be tentative and delayed, or competing resolutions may appear better suited to the conflict. As a general statement, the information provided by the system should enable the pilot to respond in an appropriate and timely manner and should not promote incorrect or unproductive response patterns. At the same time, the pilot shall use information describing traffic according to requirements established for the design and shall not employ the design for purposes other than those for which it was intended (e.g., TCAS traffic displays shall not be used by the pilot for traffic separation).

Evaluation Procedure:

Evaluation Rationale:

4.1.1.2.1 Display of Air Traffic Visual Alerts

Visual alerts may be provided to warn the pilot that a response to traffic is required.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance; Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance

Performance Based Guideline:

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 7.1.2, 7.1.11.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4a, 8.1, 8.3.

Critical Design Activities:

Detailed Traffic alerting design information requirements and recommendations can be found in SAE ARP5365. Some considerations are listed below:

Visual Alerts:

A visual display should be used to attract the attention of the flight crew and to give them initial information about the urgency of the situation.

Different visual alerts should be provided for each crew member for alerts with different urgencies.

The use of color may assist in distinguishing between the different levels of alerts. The use of color should be kept to a limited number of readily distinct and identifiable hues. Colors should follow standard uses as found in other alerting systems in the cockpit, such as red for the most urgent alerts.

Visual alerts should be located within fifteen degrees of the crew member's centerline of vision (both head up and head down).

- a. The onset of the visual alert should occur simultaneously with the aural alert and no more than 0.5 s after the system sensors/algorithms detect the alerting situation. The

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visual alert should remain on until it is canceled by the flight crew or until the problem has been corrected. Upon cancellation, the alert should reset and be capable of announcing a new situation or a change in the urgency of the current situation.

- b. The visual alert should be bright enough to attract the flight crew's attention. The range of brightness should provide sufficient contrast in both high and low ambient lighting conditions and should adjust automatically. The display should be capable of dimming to a level that is consistent with other displays on the flight deck.

The visual alert should subtend at least one square degree of visual angle CDTIs and their associated controls should be co-located to the maximum extent possible to facilitate parameter adjustment and monitoring function selection. During the normal operation of associated controls, or when the flight crew is engaged in normal cockpit window monitoring, all areas of the CDTI shall be visible to the crew from the design eye positions, assuming binocular vision. If a third crew member is required to monitor the CDTI, it should be visible and legible from the seated position with the (shoulder) harness condition specified for the phase of flight

Example Implementation Concepts:

Performance Rationale and Background:

Visual displays may serve to provide the pilot with alerts, which serve to direct the pilot's attention to some element of the traffic situation. The alerting displays may be integrated with a spatial presentation of the traffic.

Presentation of traffic information in the flight deck increases the capability of the flight crew to be more actively involved in traffic separation and air traffic management, requires a method for managing the information and procedures new to the flight deck, and changes the role they are willing to accept in relation to the air traffic controllers and other aircraft. Therefore, the addition of increased information content in the flight deck through improved CDTI functions should examine the need for changes in flight crew and controller coordination procedures, and should take into account changes in flight crew and controller communications that may arise in real operations as the air traffic management process becomes more observable by the pilot.

Evaluation Procedure:

Evaluation Rationale:

4.1.1.2.2 Display of Air Traffic Aural Alerts

Aural alerts may be provided to warn the pilot that a response to traffic is required.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance;

Performance Based Guideline:

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 7.1.3.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4b, 4a, 8.1.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 7.1.2., 7.1.2.10, 7.2.3, 7.2.4, 7.3.1, sect. 7.2.

Access 5 Program CCA - C3 Requirements

Critical Design Activities:

Detailed Traffic alerting design information requirements and recommendations can be found in SAE ARP5365. Some considerations are listed below:

Aural Display Characteristics:

- a. Aural alerts should be integrated and consistent with the flight deck alerting system and alerting philosophy.

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- b. Time critical and urgent alert characteristics should be standardized.
- c. Alerts should be prioritized.

Tonal Characteristics:

- a. The first presentation of tonal and voice alerts should exceed the masking threshold of the ambient noise by at least 8 dB ± 3 dB with a automatic gain control to maintain this approximate signal-to-noise ratio.
- b. For optimal attention getting quality, the frequency of the alerting sounds should be between 250 and 4000 Hz. However, because of the potential hearing loss due to the age of senior flight crew members, a more preferable range would be 500 to 3000 Hz. High urgency signals should be composed of at least two widely spaced frequencies and the frequencies should be chosen to differ from those that dominate the ambient noise.

Verbal Characteristics:

- a. If an aural sound is used with a voice message, the duration of the sound should vary depending on the urgency of the situation. For time-critical situations, the alerting sound should occur for a maximum of 0.75 s and be followed by the appropriate voice message. The off time between the sound and the voice message should be no less than 0.15 s and no more than 0.7 s. For caution level alerts, the sound should last 1.2 to 2.0 s and be repeated every 8 to 10 s until the flight crew cancels the alert or the terrain conflict no longer exists. Research indicates (Berson et al. 1981 and Anderson et al. 1989) that voice messages should not be used for caution level alerts.
- b. If possible, the sound source for the system should be perceptually separated in space by at least 90° from competing sound sources.

Alerting and Avoidance Maneuver Displays:

- a. Time critical and urgent alert characteristics should be standardized.
- b. Typically, this involves a succession of alerts from the initial situation advisory to caution information through warning and time critical alerts

Example Implementation Concepts:

Performance Rationale and Background:

Candidate Conflict Avoidance concepts may use an aural (voice or tonal) display. This display may replace or supplement graphical displays. Both basic state information about other aircraft and warnings/alerts may be provided.

Evaluation Procedure:

Evaluation Rationale:

4.1.1.2.3 Air Traffic Alert Integration

Alerts announced to the pilot shall correspond to the presentation of traffic information (on displays) to the pilot and/or command information presented (visually or aurally) to the pilot.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance;

Performance Based Guideline:

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 4.2, 8.3.1.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

To ensure that the pilot understands that the announced alert applies to a specific target, the

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target shall be represented in such a way that it indicates itself as the subject of the annunciation.

Evaluation Procedure:

Evaluation Rationale:

4.1.2 Detect a hazardous condition between Aircraft and Weather

The HSI shall enable the pilot to identify a hazardous condition between own aircraft and weather systems

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.3 Detect a hazardous condition between Aircraft and Terrain

The HSI shall enable the pilot to identify a hazardous condition between own aircraft and terrain

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.4 Detect a hazardous condition caused by resource depletion

The HSI shall enable the pilot to identify a hazardous condition caused by the depletion of resources.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Through the HSI, the pilot will be alerted to a hazardous condition caused by the depletion of resources. The resources can be either consumable or renewable.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.4 Information Transmission

The system shall have a function that allows the flight crew to obtain more detailed information

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about
the traffic situation.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: SAE ARP5365

Performance Based Guideline:

The system could enhance the flight crew's traffic awareness by allowing them to view relevant airspace/traffic geometry information. The flight crew should have a clear idea of what action to perform to resolve the conflict

Reference(s):

Critical Design Activities:

The aircraft's location (in all dimensions) relative to traffic and its velocity vectors should be displayed. When a conflict is detected and an alert is issued, additional resolution information may be needed. This may be in the form of a caution (e.g., "Traffic"), an open-loop command (e.g., "Climb"), or closed-loop command guidance (e.g., "Flight Director Bars"). The system should indicate when the potential loss of separation alerting situation no longer exists.

Example Implementation Concepts:

The appropriate display format and information content depends on the intended use and operation of the CDTI. Each format has benefits and limitations. Further research and testing is advisable before implementation. For example, the flight crew's assessment of the traffic situation and their required actions has been found to be highly dependent upon the type of display; a display showing a vertical "slice" of the traffic situation typically suggests vertical maneuvers, while a plan view or "birds eye" display typically suggests horizontal maneuvers.

Graphical Display Formats: Common to all display concepts, the presentation of aircraft position on the display aids the pilot in determining proximity to other traffic and assists in tactical operations and strategic planning. Other information elements may be presented as needed. Table 1 lists potential display viewpoint and projection characteristics. Figures 1, 2, and 3 illustrate some of characteristics of these viewpoints and projection techniques for the depiction of two buildings, where each has a different height and shape. These viewpoints and projections are discussed in more detail below, with the advantages and disadvantages of the respective display types being noted.

Perspective Projection: Perspective projection, or perspective mapping provides an integrated three dimensional representation of the traffic information. This type of projection yields images similar to those in a conventional photograph, and reflects the type of stimuli which natural vision has evolved to process. However, the exact layout within perspective images can also be hard to interpret due to difficulty in assessing object size and or object depth (distance to objects measured normal to the plane of the image). Perspective views require a frame of reference and way to relate the target aircraft to a ground plane. Perspective displays can provide "situation awareness at a glance" by building from a familiar representation. The heading and pitch scales should be consistent with the scene depiction. A perspective display may have an "inside-out" view or an "outside-in" view. The outside-in view is referenced from an outside perspective and may cover the complete field including behind the aircraft; the inside-out view depicts traffic comparable to an actual outside the window visual view. Symbology can be used to represent detailed information such as distance, direction, closure rate, flight ID, and altitude. Because of the amount of information that may be closely located on this display, a means of decluttering the display should be provided. A perspective display may be used in coordination with -- or the flight crew may select between -- a plan view display to provide longer-term information or more precise assessment of the horizontal position of the aircraft.

Isometric Projection: Isometric projection, or orthonormal mapping, totally ignores depth. As a

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result, displayed separations are strictly proportional to separations measured parallel to the image plane. This makes isometric projection very valuable for the display of two-dimensional separation, when the two dimensions are particularly significant (e.g., the horizontal dimensions of the ground). On the other hand, when the selected dimensions are unfamiliar or ambiguous, this type of projection can yield ambiguous or illusory interpretations. The most common example of an isometric projection is a map, where the elevation of the depicted terrain does not influence the displayed separation between locations. Another example of this type of projection is found in engineering drawings. Traffic information on an isometric display shows a 3-D view where the same measure is used foreground to background. An isometric display shows relative and absolute and vertical path of own ship and Other aircraft. An isometric display relies on a method to show reference to the ground plane and as a result a method to reduce display clutter should be provided. Reference lines have the potential to be confusing since they would not be depicted in perspective.

Display Point of View: Graphical displays can, of course, present many different points of view, and these may be classified in several manners. The classification into plan views, profile views, and off-axis views is especially relevant to CDTIs.

Plan View: Plan views, such as TCAS displays and NAV displays, are top down views (often called God's Eye views), and are the most familiar views to pilots. Plan views are projections of traffic information onto a horizontal slice through the airspace, and may be presented in a trackup, heading-up, or north-up format. Plan views may display traffic flying at all altitudes, or just some subset of altitudes (e.g., TCAS defaults to presenting aircraft within 2900 ft of own ship). Plan views may also be presented as relative to own ship (i.e., moving map, such as used in TCAS), or as fixed. Additionally, relative vertical information should be shown alphanumerically and/or symbolically. Depending on the use for which the format is intended, a method of viewing the range of the display should be shown, and a variety of display ranges may need to be selectable. The isometric rendering in Figure XX illustrates how a plan view format can provide good horizontal (x-y) separation information, but lacks all vertical separation information. On the other hand, the perspective rendering of a plan view does provide some vertical separation information (the vertical development of the smaller building is evident). However, the perspectival transformations shift the rendered x-y locations according to the rules of perspective, and this may make the horizontal separation information less usable.

Side-On View: The Side-On view is a projection of information on a vertical slice through the airspace and have been recommended as a means for giving altitude information to flight crews. Side-On views display traffic flying in some specific region of airspace around own ship. There are many potential Side-On views, but two (Profile and Window) are particularly interesting. The Profile view, is

Performance Rationale and Background:

The flight crew should be provided sufficient information to accurately anticipate conflict situations.

Evaluation Procedure:

Evaluation Rationale:

4.1.4.1 Detect a hazardous condition incurred from depleted consumable

The HSI shall enable the pilot to identify a hazardous condition incurred by the depletion of consumable resources.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.4.1.1 Detect a hazardous condition incurred from insufficient fuel

The HSI shall enable the pilot to identify a hazardous condition incurred by the depletion of fuel resources.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.4.2 Detect a hazardous condition incurred from depleted renewable

The HSI shall enable the pilot to identify a hazardous condition incurred by the depletion of renewable resources.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.4.2.1 Detect a hazardous condition incurred from degradation of communication links

The HSI shall enable the pilot to identify a hazardous condition incurred by the degradation of communication links.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source:

Performance Based Guideline:

Reference(s):

The operator should be alerted to the potential loss of link due to coverage limitations.

Source(s): NATO STANAG 4568

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Procedure:

Evaluation Rationale:

4.1.4.2.2 Indication that Communication link with Aircraft has been Lost

When a data link to the AV is lost, an indication on/near the AV icon shall be displayed.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.4.2.3 Contents of Lost Link Indication

Upon loss of data link, an indication shall appear. These indications shall automatically disappear when data link is regained.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation(s):

- AV Position at loss of link
- Predicted AV position
- Predicted AV heading
- Predicted AV altitude
- Predicted AV fuel level
- Loss of link timer (displays how long the link has been lost)

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.5 Detect a hazardous condition caused by System Malfunction or Failure

The HSI shall enable the pilot to identify a hazardous condition caused by a System Malfunction or Failure

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

4.1.5.1 Set Threshold System Indicators

The AVCS System shall allow the setting of threshold levels for system indicator

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

These may include, but are not limited to:

- Air Vehicle altitude and altitude rate of change
- Fuel levels
- Speed
- Maximum G loading

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.5.2 Detect a hazardous condition caused by Aircraft System Malfunction or

Failure

The HSI shall enable the pilot to identify a hazardous condition caused by a System Malfunction or Failure on board the aircraft

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.1.5.3 Detect a hazardous condition caused by AVCS System Malfunction or Failure

The HSI shall enable the pilot to identify a hazardous condition caused by a System Malfunction or Failure at the AVCS

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

The ACS shall display health and status data alerts to the pilot.

Source(s): Human Systems Integration Pilot-Technology Interface Requirements for Contingency Management

Reference: Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002. para. 7.1.1.1.

Human Factor Considerations in the Design of Multifunction Display Systems for Civil Aircraft, Aerospace Recommended Practice (ARP) 5364. Society of Automotive Engineers, March, 2003.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

para. 5.5.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

As the pilot will be involved in many ACS operations, it is not expected that the pilot will monitor the health and system status at all times. Humans are poor monitors over extended period of time. As a result, augmentation of pilot monitoring skill is required in the form of a master visual alert and/or aural alert to warn the pilot of a malfunction.

Evaluation Procedure:

Evaluation Rationale:

4.1.5.4 Exceedence of Threshold Levels

When system indicator threshold levels are exceeded, the AVCS System shall indicate a Caution, Warning, or Advisory to the operator.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

The alerting system should provide unique combinations of components to inform the pilot of the urgency level of alerts (e.g., warnings, cautions, or advisories)

Source(s): Aircraft Alerting System Standardization Study

Critical Design Activities:

When system indicator threshold levels are exceeded, the AVCS System shall indicate a Caution, Warning, or Advisory to the operator.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.2 Alert that a Hazard Exists

The HSI shall provide alerts whenever an anomaly is detected

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

The C2 communications human system interface shall be capable of notifying the ROA pilot of an emergency or on-board safety of flight issue. Audio and/or visual displays shall alert the ROA pilot of any change in the health of the ROA that can be of significant risk.

Visual and auditory alarming systems must provide signals that can be detected, easily understood and interpreted for appropriate action by the pilots under all ambient lighting and noise environments encountered during all phases of operation. The warning system must also be designed to minimize crew errors that create additional hazards.

The number of unnecessary and/or incorrect alerts have a direct impact on the usefulness of the system because they affect the pilot's perception of and confidence in the information that the system presents. False alarms and missed alerts should be eliminated.

The effect of nuisance alerts on the crew is dependent on the urgency of the alert and the expected crew response to the alert. Corrective escape maneuvers can be classified as time-

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critical alerts and, therefore, nuisance alerts (that is, conflicts resolved by normal operations such as leveling at an assigned altitude or turning to a parallel runway) should be minimized.

Research has shown that ideally there should be no more than one nuisance alert for every ten real ones. Previous work with time-critical alerting systems (for example, windshear) has indicated that the minimum acceptable ratio between nuisance and true time-critical warnings is approximately 1:1. This value promotes pilot confidence in the system.

It should be noted that information provided by nuisance alerts is at times considered useful by the pilots and a way should be identified to provide the same information without using the alert. This is also true of nuisances for caution level alerts. Even though pilots are more tolerant of these types of alerts, evidence indicates that using the same alert for normal and non-normal situations increases the probability of error (for example, the altitude alert)

Reference(s):

The ROA System shall Notify of an Emergency or Safety of Flight Issue
Source(s): Access 5 Program CCA - C3 Requirements

NASA/TM-2001-211254, "Airborne Use of Traffic Intent Information in a Distributed Air-Ground Traffic Management Concept...", SAE ARP4153

GAMA Publication #10

14 CFR PARTS 23.1309; 23.1323; 23.1311; 91; 121; 135; and AC 23.1309-1C; NAWCADPAX-96-268-TM; MIL-STD-411; British Defence Standard 00-25 Part 7; MIL-STD-1472F

Critical Design Activities:

Analysis of the visual and auditory alarm system should be performed prior to implementing detail design efforts. These analyses should address operation, prioritization and categorization of system alerts. The analyses also need to consider the ambient lighting and noise environment in which the system has to perform. The analysis should consider the user's capabilities and limitations; for example, some older pilots have substantial hearing loss and vision impairments, which should be given consideration. The design should include iterative testing via simulation or other methods with representative users to assess integration compatibility.

Example Implementation Concepts:

Alerting can be presented using various levels. For example, in CDTI displays 3 levels of alerting are applied:

Level 1: A Level 1 alert is used when information must be conveyed to the pilot, but no action is required.

Level 2: A Level 2 alert requires action by the ownship flight crew.

Level 3: A Level 3 alert requires immediate action by the own-ship flight crew

Performance Rationale and Background:

Visual:

Every attempt should be made to eliminate possible confusion of alarms with any other displayed information. High priority alarms should be placed in the pilot's primary field-of-view. If all critical alerts cannot be placed within 15 degrees, a master warning display is also appropriate. Visual alarms should be presented until the pilot has responded or until the alarm condition no longer exists. Auditory or voice alerts should accompany high priority alarms.

A system test function should be included that illuminates all alarms available and verifies that all the alarms are functional. This test should be made possible through a single action. Larger text and higher luminance may be appropriate for alerting signals. The use of flash coding should be kept to a minimum. If flashing is used, the background should be free from other flashing signals; the flash rate should be between 3-5Hz with a duty cycle of 50%. Flashing presentations that could be simultaneously active should be synchronized. Auditory alarms should direct attention, but not cause interference to required tasks. Nuisance alarms should be addressed.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Master caution, master warning, master advisory, and summation lights or indicators used to indicate the condition of an entire subsystem should be set apart from lights or indicators that show status of the subsystem components. Indicators or lights used solely for maintenance and adjustment should be extinguished, covered or non-visible during normal equipment operation. Discrete lights and other such indicators should be used sparingly and should display only that information necessary for effective system operation.

Error and status messages should be located consistently at the pilot's station and on the same dedicated area with their respective displays. These messages may be emphasized by using a contrasting display feature (e.g. reverse video, highlighting, icons, etc.)

Auditory:

Auditory signals provide rapid alerting irrespective of head or eye position. If applied wisely auditory alarms can enhance safety of operation and improve crew response to emergency situations. Judicious use of these alarms must be addressed to preclude nuisance warnings in the cockpit. The number of auditory alarms should be kept to the minimum necessary to provide the desired result. Spoken alerts have advantages over other forms of auditory warnings as they can convey an explicit piece of information without having to interpret the tone or go to the visual display to determine the failure.

Effective auditory alarm systems will typically have the following characteristics:

- False alarms should be precluded to the extent possible.
- Auditory alerts should be easily recognized and understood in order to minimize the time required for the user to detect, assess and react to the problem and to initiate appropriate corrective actions.
- Audible alarms should be detectable and understood quickly and easily under all expected operating conditions including ambient noise, radio traffic, and crew voice communications.
- Audible alarms should be standardized.
- Audible alarms should be used in conjunction with visual alerts as appropriate.
- All audible alarms must be easily recognizable from one another. Each audio signal should have only one meaning.
- If headsets are worn, the alerting system should be usable through the headset unless external alerts are demonstrated to be discernable using noise canceling headsets.
- The audible alert signal should have a duration no less than 0.5 seconds and no longer than 3.0 seconds.

Evaluation Procedure:

Develop a checklist based on applicable guidelines and evaluate system design. Compare design with functional requirements. Evaluate the visual and audio displays under varying cockpit environmental and operational conditions with representative user population.

Specifically for audio alarms:

- Test for false alarms.
- Check for background noises that may mask the alert.
- Ensure the intended meaning of the signal is clear, unambiguous and immediately understood.
- Ensure that unique audio signals are used. Measure with instrumentation as appropriate and also obtain subjective assessments during program development.
- Ensure that a single tone is not used for more than one visual display in critical warning situations.

Evaluation Rationale:

Evaluations are needed to insure that appropriate and easily understood warnings are provided to the pilot(s) under anticipated operating conditions.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

4.2.1 Attract the attention of the pilot

The HSI shall attract the attention of the pilot when an anomaly is detected.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Aircraft Alerting System Standardization Study; NATO STANAG 4568

Performance Based Guideline:

Adequate indication (cues) should be provided to the pilot(s) to ensure safe operation within the normal flight envelope.

Reference(s):

GAMA 10 Publication

14 CFR PART 23. 1309

Critical Design Activities:

The warning and caution indications shall be located in the operator's primary field of view.

Warnings and cautions shall not be obscured by other AVCS System elements.

The AVCS System should provide a separate means for alerting the operator of new warnings, depending on the severity of the warning. The AVCS System shall provide a rapid means for cancellation of such warnings.

The presentation of all required flight information must be done in a manner that the pilot can readily understand in order to maintain the airplane within its normal flight envelope. Transient /dynamic conditions that would cause the airplane to exceed its normal flight envelope should be annunciated promptly so that pilot intervention will prevent a hazardous flight condition. This applies to excessive pitch, roll and yaw attitudes as well as high and low speed awareness. In addition, engine parameter monitoring should be accomplished to ensure the safest possible engine operation. These conditions need to be sensed and specific cueing should be developed and integrated in the system design.

Example Implementation Concepts:

Performance Rationale and Background:

Under dynamic flight conditions an aircraft may transition rapidly from normal to an overspeed, stall or unstable flight condition with little pilot awareness. With adequate display cues, the pilots will know before this condition occurs and be able to intervene so as to prevent the hazardous flight condition from occurring.

Evaluation Procedure:

Determine the critical flight conditions of the aircraft. Determine that under transition flight conditions, adequate cues are presented to the pilots before warnings occur when the conditions are present. Particularly approaches to stall and overspeed conditions and unusual attitudes should be evaluated. Failure conditions should be considered. Under these conditions either symbols on the displays or other equivalent cues need to be actuated as the aircraft approaches the transition condition.

Evaluation Rationale:

The intent of cues is to have advanced indication of the impending occurrence of an undesirable condition. The cues need to be obvious to the pilot using changes in colors, flashing symbols, etc. that instill quick pilot response before a stall warning, overspeed warning or similar condition occurs.

4.2.1.1 Alerting System Components

The components of the alerting system should include Master Alerts (Visual and Aural), a visual information display, a voice information display, and a time-critical display

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Aircraft Alerting System Standardization Study

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Performance Based Guideline:

The alerting system should be highly reliable. It should be activated only when an alerting situation exists: it should not be activated

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.2.1.1.1 ROA System Aural Alert Guidelines

ROA System Aural Alert Guidelines

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance; Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Candidate CA concepts may use an aural (voice or tonal) display. This display may replace or supplement graphical displays. Both basic state information about other aircraft and warnings/alerts may be provided.

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 7.1.3.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4b, 4a, 8.1.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 7.1.2., 7.1.2.10, 7.2.3, 7.2.4, 7.3.1, sect. 7.2.

Critical Design Activities:

The master aural alert should be used as a general indication to attract the ROA pilot's attention and give preliminary information about the urgency of the situation. The master aural alert should:

- Use a unique sound for the different levels of urgency (warning vs. caution)
- Use a frequency that will attract the ROA pilot's attention (nominally 500-3000 Hz)
- Differ from ambient sound frequencies
- Not use the same indication as other aural alerts (fire, systems failure, etc.)
- Voice alerts provide specific information regarding traffic information, avoidance maneuvers, and conflict potential.

Voice guidance should:

- Use automatic voice messages for all time-critical warnings, for example, corrective escape maneuvers (i.e. "Climb, Climb, Climb.")
- Based on empirical testing, use the appropriate voice for the conditions in which it will be used (frequency range, ambient noise conditions, etc.)
- Keep the number of repetitions of voice messages to a minimum to reduce the possibility for auditory overload
- Be unambiguous, distinctive and unique to the specific alert and not contain similar phraseology, which may be misinterpreted

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.2.1.2 Detect ability of Warnings and Cautions

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Warnings and cautions shall not be obscured by other AVCS System elements.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.2.1.3 ROA System Visual Alert Guidelines

ROA System Visual Alert Guidelines

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Visual alerts may be provided to warn the pilot that a response to traffic is required.

Reference(s):

Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance; Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 7.1.2, 7.1.11.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4a, 8.1, 8.3.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Visual displays may serve to provide the pilot with alerts, which serve to direct the pilot's attention to some element of the traffic situation. The alerting displays may be integrated with a spatial presentation of the traffic.

Evaluation Procedure:

Evaluation Rationale:

4.2.2 Inform the pilot as to the urgency level of the alert

The HSI shall inform the pilot the urgency level for a detected anomaly

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Aircraft Alerting System Standardization Study

Performance Based Guideline:

The urgency of an alerting situation is usually determined by the amount of time the crew has to respond to the situation. The less time that the crew has to respond, the more the system should help in determining what response should be made. These time constraints impact how the system is used, especially at the most urgent levels. The overall time budget for the crew/aircraft system to respond to a collision avoidance alert is of critical importance. The alert should be sufficiently attention-getting to assure situational awareness by the crew in time to develop an appropriate mental set. The alert should be given in sufficient time for the crew to respond by maneuvering the aircraft to achieve the necessary miss distance. The assumption

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that should be made when designing a system around a very short pilot response time is that it is an executive system requiring immediate crew action rather than an advisory system.

Reference(s):

Based on system ability to determine the urgency of a traffic situation, alerts shall be presented to the pilot that describes the level of urgency in an unambiguous manner. Different alerts shall be provided for alerts with different urgencies. - Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance; Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 4.2, 6.2.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 7.1.1.3.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 6.2, 8.2, 8.3.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The urgency of the loss of separation or a traffic conflict situation is usually determined by the amount of time that the pilot has to respond to the situation. The less time the flight pilot has to respond, the more the system should help in determining what response should be made. These time constraints have an influence on how the system is used, especially at the most urgent levels. The system should provide enough information to ensure traffic awareness by the pilot in time for the pilot to respond by maneuvering the aircraft to achieve the necessary traffic separation. The assumption that should be made when designing a system around a very short pilot response time is that a portion of the system will have to be executive in nature (tell the pilot what response to make and expect the pilot to make it). The system should be designed to minimize the occurrence of situations requiring very short response times.

Evaluation Procedure:

Evaluation Rationale:

4.2.2.1 Traffic Alert Urgency

The HSI shall advise the pilot to the urgency of a traffic alert.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance;

Performance Based Guideline:

The system should provide enough information to ensure traffic awareness by the flight crew in time for them to respond by maneuvering the airplane to achieve the necessary traffic separation. Because of the wide range of potential traffic conflict geometries, the system should be able to accommodate situations with both long and very short response time requirements. The assumption that should be made when designing a system around a very short pilot response time is that a portion of the system will have to be executive in nature (tell the flight crew what response to make and expect them to make it). The system should be designed to minimize the occurrence of situations requiring very short response times.

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 4.2, 6.2.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 7.1.1.3.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 6.2, 8.2, 8.3.

Critical Design Activities:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Based on system ability to determine the urgency of a traffic situation, alerts shall be presented to the pilot that describes the level of urgency in an unambiguous manner. Different alerts shall be provided for alerts with different urgencies.

Example Implementation Concepts:

Performance Rationale and Background:

The urgency of the loss of separation or a traffic conflict situation is usually determined by the amount of time that the pilot has to respond to the situation. The less time the flight pilot has to respond, the more the system should help in determining what response should be made. These time constraints have an influence on how the system is used, especially at the most urgent levels. The system should provide enough information to ensure traffic awareness by the pilot in time for the pilot to respond by maneuvering the aircraft to achieve the necessary traffic separation. The assumption that should be made when designing a system around a very short pilot response time is that a portion of the system will have to be executive in nature (tell the pilot what response to make and expect the pilot to make it). The system should be designed to minimize the occurrence of situations requiring very short response times.

Evaluation Procedure:

Evaluation Rationale:

4.2.3 Contents of Individual Alert Messages

The AVCS Specific Modules shall provide all AVCS System functionality for the system while the content of individual warnings will be determined by messages from the Datalink interface.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

In this way, the AVCS System provides a common look and feel to the operator no matter what UAV is being flown without having to understand the content of all warnings from all types of vehicles.

Reference(s):

Critical Design Activities:

- Ability to provide the procedures (rules) for the alarm handling tasks that have to be accomplished
- Ability to toggle between only active cautions/warnings and a complete cautions/warnings history for the mission
- Ability to sort cautions and warnings by time
- Ability to sort cautions and warnings by severity
- Ability to sort cautions and warnings by system

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.2.4 Management of Alerts

The HSI shall facilitate the management of alerts

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.2.4.1 Data Management Control of Alerts

The HSI alerting system shall enable the pilot to monitor the status of the aircraft, and to store and recall existing alerts

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Aircraft Alerting System Standardization Study; NATO STANAG 4568; DOT/FAA/RD-81/38, 11

Performance Based Guideline:

Warnings, cautions, and advisories inform the operator about any unusual or critical condition.

Reference(s):

The AVCS System shall provide the capability to display, track, log, and otherwise manage warnings, cautions, and advisories.

Source(s): NATO STANAG 4568; DOT/FAA/RD-81/38, 11

Critical Design Activities:

Warning and caution displays may include the following characteristics:

- Ability to provide the procedures (rules) for the alarm handling tasks that have to be accomplished
- Ability to toggle between only active cautions/warnings and a complete cautions/warnings history for the mission
- Ability to sort cautions and warnings by time
- Ability to sort cautions and warnings by severity
- Ability to sort cautions and warnings by system

The HSI alerting system database should be flexible enough to be able to accommodate new alerts in a manner that does not require additional discrete enunciators

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.2.4.4 Operator Actions in response to an Alert

Each alarm should trigger, as far as possible, one task for the human operator and the corresponding advice should directly accompany the alarm.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.2.4.4.1 Operator Acknowledgement of Critical Warnings

The operator shall be required to acknowledge all critical warnings.

Preflight Ground Operations Takeoff Climb Enroute Mission

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.3 Assess the Criticality of the Hazard

The HSI shall enable the pilot to assess the criticality of the Hazard

Preflight Ground Operations Takeoff Climb Enroute Mission

Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

The HSI shall enable the Pilot to assess a Potential Hazard. The amount of information necessary to quantify and qualify the hazard will vary depending on how the Manufacturer develops the system.

Reference(s):

The ROA System shall Evaluate collision potential

Source(s): Access 5 Program. SEIT Approved CCA Functional Requirements, Functional Requirement #2

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.4 Develop a Hazard Avoidance Solution

The HSI shall facilitate the development of a Hazard Avoidance Solution through interaction with the Pilot.

Preflight Ground Operations Takeoff Climb Enroute Mission

Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

The HSI shall enable the Pilot to create, process, and review hazard avoidance solutions. The role of the Pilot in the Development of a Hazard Avoidance Solution will vary depending on how the Manufacturer develops the system. For example, the Manufacturer may develop a system where a different member of the flight crew (analogous to a Navigator in Manned Aircraft) is responsible for developing Hazard Avoidance Solutions. The "Navigator" flight crew member would then need to be able to communicate the solution to the Pilot.

Reference(s):

The ROA System shall Enable the Pilot to Determine optimum maneuver

Source(s): Access 5 Program. SEIT Approved CCA Functional Requirements, Functional Requirement #3

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The information provided by the system should enable the flight crew to perform conflict resolutions, or respond to resolution guidance in a timely manner. In support of this, the system

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should generate a sense of confidence in the flight crew that they are seeing all of the traffic relevant to performing these resolution responses, or that the system is considering in generating resolution guidance. Otherwise, responses may be tentative and delayed, or competing resolutions may appear better suited to the conflict. Similarly, when the system is used for purposes of monitoring separation, or enhanced visual acquisition, the coverage (surveillance) provided by the system should be consistent and compatible with flight crews' mental and visual models. As a general statement, the information provided by the system should enable the flight crew to respond in an appropriate manner and should not promote incorrect or unproductive response patterns.

Evaluation Procedure:

Evaluation Rationale:

4.4.1 Escape Maneuver Display

The ROA System shall present an Escape Maneuver Display

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The escape maneuver display shows the recommended corrective maneuver to avoid collision.

The escape maneuver display should:

1. Be visible to any station capable of flying the aircraft and within 15 degrees of centerline of vision for the flying pilot
2. Present maneuvers pictorially
3. Erase automatically when the alerting situation no longer exist

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.4.1.1 Contents of Recommended Procedures

The procedures provided should consist of context specific, procedural task knowledge.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The advice should be minimal, not more than necessary. Each individual procedure should however describe a complete problem-solving path to accomplish the goal.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.4.2 Recommended Hazard Avoidance Procedures

The procedures provided should consist of context specific, procedural task knowledge.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Performance Based Guideline:

The advice should be minimal, not more than necessary. Each individual procedure should however describe a complete problem-solving path to accomplish the goal.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.5 Implement the Hazard Avoidance Solution

The HSI shall facilitate the Pilot in implementing the Hazard Avoidance Solution.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

The HSI shall provide the Pilot with information necessary to execute the Hazard Avoidance Solution. Relevant information may include: time to impact, distance to impact, urgency, etc. The amount of information required vary depending on how the Manufacturer develops the system.

Reference(s):

The ROA System shall Enable the Pilot to Initiate and complete maneuver

Source(s): Access 5 Program. SEIT Approved CCA Functional Requirements, Functional Requirement #4

The ROA System shall Enable the Pilot to Respond to Threats

Source(s): NATO STANAG 4568

The ROA System shall provide the pilot with the ability to avoid hazardous weather

Source(s): Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #5c

The ACS shall display contingency management data to the pilot.

Source(s): Human Systems Integration Pilot-Technology Interface Requirements for Contingency Management; Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002. para 3.8.15.

Critical Design Activities:

The CCA human system interface shall be capable of providing sufficiently detailed information of potentially conflicting traffic by enabling an ROA pilot to assess the probability of a collision even though visual acquisition of the intruding aircraft is not achieved.

Example Implementation Concepts:

Performance Rationale and Background:

The ROA System shall provide the pilot with the ability to handle contingencies, emergencies and other abnormal conditions with the equivalent level of safety of manned aircraft. For critical software, systems, or equipment, there shall be a clear, step-by-step description of procedures to be conducted in the event of failure. The pilot should be provided with sufficient information to diagnose warning system operation or contingency management functions.

Evaluation Procedure:

Evaluation Rationale:

4.5.1 System Maneuvering based on Pilot Assessment

The ROA System shall Maneuver Based on ROA Pilot Assessment

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The CCA human system interface shall enable the ROA pilot to maneuver the ROA based upon the ROA pilot assessment. All necessary flight controls shall be available to perform an evasive maneuver of the ROA.

The operator should have the controls to implement contingency plans as necessary.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.5.3 Pilot Control of Contingency Management Information

The pilot shall have control capability to obtain access to contingency management functions.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance;

Performance Based Guideline:

Reference(s):

Human Factor Considerations in the Design of Multifunction Display Systems for Civil Aircraft, Aerospace Recommended Practice (ARP) 5364. Society of Automotive Engineers, March, 2003. para. 5.9.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002. para 3.8.15.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The pilot should be provided with sufficient controls to control warning system operation or contingency management functions.

Evaluation Procedure:

Evaluation Rationale:

4.6 Assess Effectiveness of Avoidance Maneuver

The HSI shall enable the Pilot to review the effectiveness of the Implemented Hazard Avoidance Solution.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

The ROA System shall Enable the Pilot to Assess adequacy of maneuver

Source(s): Access 5 Program. SEIT Approved CCA Functional Requirements, Functional Requirement #5

The ROA System shall Enable ROA Pilot Reassessment

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Source(s): Access 5 Program CCA - C3 Requirements

Provide information as to the adequacy of corrective actions

The HSI shall provide the Pilot with information necessary to assess the adequacy of corrective actions

Source(s): Aircraft Alerting System Standardization Study

Critical Design Activities:

The CCA human system interface shall allow the ROA pilot to reassess the probability of a collision after an initial maneuver has been made. If the potential for collision is eliminated, then no further action is necessary. However, if the potential for a collision still exists, the CCA human system interface shall allow the ROA pilot to observe the new collision potential, determine the most optimum maneuver, and execute it in a timely manner to avoid the collision.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.6.1 Expected Aircraft Position

The HSI shall enable the Pilot to evaluate whether the aircraft performed as expected during and after a Hazard Avoidance Solution with regard to aircraft position.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

4.6.2 Expected System Performance

The HSI shall enable the Pilot to evaluate whether the Hazard Avoidance Solution satisfactorily addressed the Hazard with regard to system performance.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Endsley

Critical Design Activities:

Example Implementation Concepts:

The reasons and methods for executing Hazard Avoidance Maneuvers will vary both by system design and the hazardous situation. For example "a" reason for developing and executing a Hazard Avoidance Maneuver could be for "internal" UAS Systems. To illustrate, "a" hazard that needs to be avoided could be a degrading communication signal strength. It could be that redirecting the aircraft's flight path will enable the communication link to strengthen because the altered flight path would direct the aircraft into a region where the signal strength is greater. In this example, the HSI would need to communicate the information about the communication signal strength and the performance of the UAS Systems during and after the Hazard Avoidance Solution is executed.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Performance Rationale and Background:

The reasons and methods for executing Hazard Avoidance Maneuvers will vary both by system design and the hazardous situation. For example “a” reason for developing and executing a Hazard Avoidance Maneuver could be for “internal” UAS Systems. To illustrate, “a” hazard that needs to be avoided could be degrading communication signal strength. It could be that redirecting the aircraft’s flight path will enable the communication link to strengthen because the altered flight path would direct the aircraft into a region with where the signal strength is greater. In this example, the HSI would need to communicate the information about the communication signal strength and the performance of the UAS Systems during and after the Hazard Avoidance Solution is executed.

Evaluation Procedure:

Evaluation Rationale:

4.6.3 Expected Environmental Changes

The HSI shall enable the Pilot to evaluate whether the Hazard Avoidance Solution satisfactorily addressed the Hazard with regard to Expected Environmental Changes.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

The reasons and methods for executing Hazard Avoidance Maneuvers will vary both by system design and the hazardous situation. For example “a” reason for developing and executing a Hazard Avoidance Maneuver could be to avoid physical obstacles along a flight path (like aircraft, terrain, weather, etc. In this example, the HSI would need to communicate the information about the location, bearing, intensity, speed, etc. about the environmental hazards during and after the Hazard Avoidance Solution is executed.

Performance Rationale and Background:

The reasons and methods for executing Hazard Avoidance Maneuvers will vary both by system design and the hazardous situation. For example “a” reason for developing and executing a Hazard Avoidance Maneuver could be to avoid physical obstacles along a flight path (like aircraft, terrain, weather, etc. In this example, the HSI would need to communicate the information about the location, bearing, intensity, speed, etc. about the environmental hazards during and after the Hazard Avoidance Solution is executed.

Evaluation Procedure:

Evaluation Rationale:

5 Monitor and Manage Systems

The HSI shall enable the pilot/operator to monitor and manage systems and resources

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

The HSI shall enable the pilot/operator to obtain information about all pieces of the Unmanned Air System: Aircraft, Ground Station, Communication relay, etc. In this guideline document, the Aircraft and Communication pieces have been Addressed in sections 1 - Aviate and 3 – Communicate respectively

Reference(s):

Critical Design Activities:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

5.1 Configure Unmanned Air System

The HSI shall enable the pilot to configure the Unmanned Air System

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Using the HSI, the pilot shall be able to configure the Unmanned Air System. The scope and extent of the configuration will vary by design and is determined by the manufacturer. The Unmanned Air System includes the: Aircraft, Ground Station, Communication relay, etc. In this guideline document, the Aircraft and Communication pieces have been Addressed in sections 1 - Aviate and 3 – Communicate respectively

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.1.1 AVCS System Configuration

The HSI shall enable the Pilot to Configure and/or Confirm AVCS System Configuration Information

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

As applicable by the manufacturer, the pilot may be required to configure the AVCS systems.

Evaluation Procedure:

Evaluation Rationale:

5.2 Control Unmanned Air System

The HSI shall enable the pilot to control the Unmanned Air System

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Using the HSI, the pilot shall be able to control the Unmanned Air System. The scope and extent of pilot control will vary by design and is determined by the manufacturer. The Unmanned Air System includes the: Aircraft, Ground Station, Communication relay, etc. In this guideline document, the Aircraft and Communication pieces have been Addressed in sections 1 - Aviate and 3 – Communicate respectively

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.2.1 AVCS Control

The HSI shall enable the Pilot to Control the AVCS.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.2.1.1 AVCS Power System

The HSI shall enable the Pilot to Control the AVCS Power System.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

As applicable by the manufacturer, the pilot may be required to adjust the AVCS System(s) Power Setting(s).

Evaluation Procedure:

Evaluation Rationale:

5.3 Monitor Unmanned Air System

The ROA System shall enable the Pilot to Monitor System Health

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Using the HSI, the pilot shall be able to monitor the Unmanned Air System. The scope and extent of pilot control will vary by design and is determined by the manufacturer. The Unmanned Air System includes the: Aircraft, Ground Station, Communication relay, etc. In this guideline document, portions of the Aircraft and Communication pieces have been Addressed in sections 1 - Aviate and 3 – Communicate respectively

Reference(s):

The ROA System shall provide the pilot with information needed to determine system health and status necessary to safely conduct flight in the NAS

Source(s): Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #1 Current Unmanned Air System Information

Critical Design Activities:

The CCA human system interface shall be capable of providing indications of the system's operational status and subsystem performance. This would likely be on an enunciator panel or selectable page of a multi-function display, with preliminary indication displayed on the primary flight display.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.3.1 Aircraft System Status Information

The ROA System shall Display Health and Status of the ROA

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Information about the aircraft systems' statuses shall be presented to the pilot. This information will include but is not limited to: System Operational Status, functioning and settings; altimeter equipment and settings; deviations from correct settings; flight modes and automation entries and settings; fuel; and time and distance available on fuel.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.3.1.1 ACS Display of Health and Status Data

The ACS shall display health and status data for en route Contingency Management purposes.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Contingency Management

Performance Based Guideline:

Reference(s):

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002. para 3.8.2, 3.8.3, 3.8.4, 3.8.12, 3.12.4.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Human Factor Considerations in the Design of Multifunction Display Systems for Civil Aircraft, Aerospace Recommended Practice (ARP) 5364. Society of Automotive Engineers, March, 2003. para.

3.11.1, 3.11.2, 4.4.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Health and status data shall make failures apparent and unambiguous to the pilot at the so the pilot obtains situation awareness of the vehicle state and in preparation to affect contingency management steps. In situations where automation failure would require user intervention, it is useful for the pilot to be warned that he or she will need to take manual control before the automated system fails. Information presented to the pilot should accurately reflect system and environment status in a manner so that the pilot rapidly recognizes, easily understands, and easily projects system outcomes.

Evaluation Procedure:

Evaluation Rationale:

5.3.1.2 Expected Aircraft System Performance

The HSI shall facilitate the pilot in predicting functional status information about the aircraft in the near future

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Information about how the aircraft systems are operating in relation to system operational limitations shall be presented to the pilot. This information will include but is not limited to: fuel consumption; and engine performance.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.3.2 Pilot Control of Health and Status Data

The pilot shall have control capability to obtain access to health and status data.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Contingency Management

Performance Based Guideline:

Reference(s):

Human Factor Considerations in the Design of Multifunction Display Systems for Civil Aircraft, Aerospace Recommended Practice (ARP) 5364. Society of Automotive Engineers, March, 2003. para. 5.1.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The pilot requires the capability to affect control of systems to obtain health and system status. Control capability includes access to systems and, if employed, a caution and warning and/or diagnostic system, that collects, integrates, and summarizes health and status information.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Procedure:

Evaluation Rationale:

5.3.3 Input/Output conduit to monitor vehicle systems

The operator shall have sufficient controls and displays to safely control and monitor all vehicle systems and subsystems that require user monitoring or input.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Critical Design Activities:

At a minimum these shall include:

- Airspeed
- Altitude
- Track/Heading
- Current position

Additional systems that require monitoring may include, but are not limited to the following:

- Vehicle autopilot/stability augmentation system
- Vehicle fuel system
- Vehicle lights (e.g. strobe, hazard, anti-collision, navigation)
- Vehicle identification system (e.g., IFF)
- De-icing and anti-icing systems
- Flight termination system
- Sensor calibration
- Electrical power system
- Flight Control system
- Propulsion system
- Cooling system
- Lift devices
- Airborne and AVCS data recorder
- Landing gear
- Automatic launch and recovery system

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.3.3.1 Vehicle Specific Module Displays

The AVCS System should be able to accept and present Vehicle Specific Module displays that are sent across the Data Link Interface

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Rationale:

5.4 Manage Unmanned Air System

The HSI shall enable the pilot to manage the Unmanned Air Systems

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Using the HSI, the pilot shall be able to manage the Unmanned Air Systems. The scope and extent of pilot control will vary by design and is determined by the manufacturer. The Unmanned Air System includes the: Aircraft, Ground Station, Communication relay, etc. In this guideline document, portions of the Aircraft and Communication pieces have been Addressed in sections 1 - Aviate and 3 – Communicate respectively

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.5 Monitor Unmanned Air System Resources

The HSI shall enable the pilot to monitor the Unmanned Air System Resources

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Using the HSI, the pilot shall be able to monitor the resources used by the Unmanned Air System. The resources are both consumable and renewable. The scope and extent of pilot control will vary by design and is determined by the manufacturer. The Unmanned Air System includes the: Aircraft, Ground Station, Communication relay, etc. In this guideline document, portions of the Aircraft and Communication pieces have been Addressed in sections 1 - Aviate and 3 – Communicate respectively

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.5.1 Monitor consumable resources

The HSI shall enable the pilot to monitor consumable resources.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Rationale:

5.5.1.1 Monitor fuel

The HSI shall enable the pilot to monitor fuel resources.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

There should be a fuel quantity measurement capability installed that provides accurate usable fuel quantity values through the range of the indicating system and provides an indication and an alert to a low fuel condition.

Reference(s):

GAMA Publication #10
14 CFR PARTS 23.1337; 23.963(e); 23.1553

Critical Design Activities:

The fuel measuring system, whether a manual gauge or an electric system should have an accurate indication of a full tank quantity, an unusable quantity and intermediate markings providing an indication of fuel quantity throughout the range. In addition, a low fuel warning indication is needed. The warning should provide both a visual and an aural alert to the pilot(s).

Example Implementation Concepts:

Performance Rationale and Background:

Many small aircraft accidents and fatalities are caused by fuel exhaustion and fuel starvation. This situation has been a result of the pilot not knowing how much fuel is remaining and trying to stretch the amount remaining to arrive at a destination. Reasonable accurate intermediate readings of fuel remaining and an alert when the fuel reaches an unacceptably low level need to be provided. The Small Airplane Directorate has initiated a new rule making an effort to assist in addressing this issue. There are a large number of accidents attributable to both fuel exhaustion and fuel starvation. The exhaustion incidents are caused by the pilot not knowing how much fuel he or she is actually starting with, not knowing the consumption rate, inaccurate gauges until empty, no warning of low fuel, and trying to stretch the distance flown. The fuel starvation incidents are primarily caused by mismanagement of the aircraft fuel system. Many fuel starvation accidents were caused by not switching tanks and allowing the tank being used to run dry.

Evaluation Procedure:

Determine by examination that markings are provided for full, empty and at least three intermediate markings of fuel quantity and that a low warning indication, either aural or markings on the fuel indicator, is present. Review test reports or if no such reports are provided, conduct tests to determine that in a level flight condition at least three intermediate markings are provided that indicate fuel quantity within + 5% of actual fuel in the tank, that the empty mark shows 0 units of usable fuel when the tank reaches the unusable fuel level. The low fuel alert should be designed to warn the pilot(s) when a minimum of 45 minutes of fuel remains under level flight cruise conditions.

Evaluation Rationale:

The intent is to ensure that under normal operating conditions, the pilot has a reasonably accurate indication of fuel remaining. Also, when the fuel reaches a minimum level that the pilot needs to refuel, adequate alerting of the pilot is needed to ensure that fuel exhaustion does not occur. The range of the aircraft and fuel consumption rate should be used by the manufacturer to determine what a reasonable reserve fuel level should be.

5.5.2 Monitor renewable resources

The HSI shall enable the pilot to monitor of renewable resources.

Preflight Ground Operations Takeoff Climb Enroute Mission

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.5.2.1.1 Monitor communication links

The HSI shall enable the pilot to monitor communication links.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.6 Manage Unmanned Air System Resources

The HSI shall enable the pilot to monitor the Unmanned Air System Resources

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Using the HSI, the pilot shall be able to monitor the resources used by the Unmanned Air System. The resources are both consumable and renewable. The scope and extent of pilot control will vary by design and is determined by the manufacturer. The Unmanned Air System includes the: Aircraft, Ground Station, Communication relay, etc. In this guideline document, portions of the Aircraft and Communication pieces have been Addressed in sections 1 - Aviate and 3 – Communicate respectively

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.6.1 Manage consumable resources

The HSI shall enable the pilot to manage consumable resources.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

5.6.1.1 Manage fuel

The HSI shall enable the pilot to manage fuel resources

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:
Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

5.6.2 Manage renewable resources

The HSI shall enable the pilot to manage of renewable resources.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:
Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

5.6.2.1.1 Manage communication links

The HSI shall enable the pilot to manage communication links.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:
Performance Based Guideline:
Reference(s):
Critical Design Activities:
Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

5.7 Predict Future Unmanned Air System Information

The HSI shall facilitate the pilot in predicting the performance of the Unmanned Air System in the near future.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Source:

Performance Based Guideline:

The HSI shall enable the pilot/operator to obtain information about all pieces of the Unmanned Air System: Aircraft, Ground Station, Communication relay, etc. In this guideline document, the Aircraft and Communication pieces have been Addressed in sections 1 - Aviate and 3 – Communicate respectively

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

5.7.1 Expected AVCS System Performance

The HSI shall facilitate the pilot in predicting functional status information about the AVCS in the near future.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Information about the AVCS systems’ statuses shall be presented to the pilot. This information will include but is not limited to: the status of aircraft control authority; the internal AVCS component operational statuses; and the Power Setting of the AVCS

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6 General Guidelines

General Guidelines

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.1 Identification of Information

The AVCS System shall provide adequate identification of all information displayed to the operator.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.2 Accessibility of Information

The AVCS System should enable fast and easy access to the requested information with adequate orientation cues and state explanation. It should correspond to the optimal search strategy for the specific task and situation, (e.g., support several accurate information acquisition processes for operators).

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

GAMA 10 Publication

The pilot that uses the display needs to be able to find and understand the information being presented with a reasonable effort under normal and abnormal conditions.

References:

14 CFR PARTS 23.1311; 23.1301 through 23. 1337; AC 23.1311-1A; AS-8034; ARP-1068B

Critical Design Activities:

Adopt a consistent organization for the location of various display features from one display to another:

- Commands should be entered and displayed in a standard location on the display.
- System messages should appear in standard location. Messages may be provided in window overlays.
- Information displayed to provide context for the pilot entries should be distinctive in location and format and consistently displayed from one transaction to the next.
- Menus should be displayed in consistent screen locations for all modes, transactions and sequences.

Once the collection of data to be presented on a single display has been determined, the iterative design process should focus on ensuring that data is grouped with some or all of the following in mind:

- Consider selection of either company or industry standard formatting.
- Maintain adherence to the selected formatting standards.
- Consideration for formatting that highlights the common types of information.
- Consideration for formatting that highlights information that is required to perform a task.

Symbology color selection can have a significant role in the perception of the data formats. Considerable effort should be given to the selection of a color philosophy for a given display, a set of displays, and the full cockpit collection of various displays. A consistent format for similar data display is a desired design goal. Usability under all normal and abnormal conditions is essential.

Example Implementation Concepts:

Performance Rationale and Background:

New or combined formats need to provide a means for the expected pilot population to interpret and understand the data in order to carry out the necessary tasks. Acceptable formatting involves a mixture of disciplines. Some of those disciplines will be subjective. Data with considerable prior display history already provides well-defined examples of what is acceptable.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Existing displays including annunciated switches, that have successfully presented similar combinations of data to the new design being addressed, can serve as a starting point for a new design. However, design goals that include a reduction in cockpit displays, a combination of previously separate cockpit displays, or the development of new combinations of displays, will need to address the design of the data layouts from the beginning. They will have to address the separation of data that formatting can provide. An iterative design process is one method that has proven most useful.

Evaluation Procedure:

A small team of evaluators representative of the expected user population is an example of an effective evaluation scheme. This team should include test pilots and novices to take advantage of both extremes of opinions. A survey questionnaire that focuses the evaluator's attention with a structured set of questions, with some type of rating scheme, and asks for areas for recommendations and improvements of the display layout and arrangement has been shown to be effective.

Evaluation Rationale:

Expect to conduct the evaluation in an iterative fashion. Iterative evaluations, conducted early in the design process, help minimize changes at the end. Iterative evaluations during development further help refine the display arrangement. Structured survey devices provide the evaluator a means to focus their response on specific aspects of the display designs. They also allow the results of the evaluation to be quantified using the rating scale as a measurement tool.

Documentation of results of various formats evaluated and the "paper trail" to a final configuration provides a basis for rationale when the final configuration is established for approval.

6.2.1 Availability of Information Mining Controls

Appropriate Priority Controls should be used for ROA functions that require either quick accessibility or constant availability.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Priority control devices can include, but are not limited to:

- Touch panels
- Buttons
- Switches
- Joysticks
- Keyboard shortcuts

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.2.2 Visibility of Critical functions, normal operation

The functions needed to safely control the aircraft under usual flight situations shall be located in the pilot's primary field-of-view.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: GAMA Publication #10

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Performance Based Guideline:

Critical functions will be in the pilot’s primary field-of-view with longitudinal awareness, lateral/vertical awareness and height awareness display symbols on horizontal line in front of the pilot using the information.

Reference(s):

14 CFR PART 23.1321(d)

Critical Design Activities:

By examination or analysis determine that critical display functions are in the pilot’s primary field-of-view from that pilot position.

Example Implementation Concepts:

Performance Rationale and Background:

Functions to maintain safe flight and landing need to be readily available to the pilot located in the pilot operating position.

Those functions needed to maintain safe flight tend to be ones that have fast response times with respect to aircraft position and movement. The aircraft attitude is a fast responding loop. The pilots must take immediate action to preclude getting into an unusual attitude condition. On the other hand, the outer navigation and heading control loops are slower than attitude. Pilot action can be delayed a short period of time and still be able to maintain adequate track or path control of the aircraft. This implies that the display of Airspeed, Attitude and Altitude information must be located in a prescribed manner, like the Basic-T. However, more latitude maybe taken with the navigation display locations. Other display formats may be considered.

Evaluation Procedure:

Validate that attitude, altitude, airspeed and basic level of navigation (including heading) is within the pilot’s primary field-of-view (FOV) as determined through visual field modeling in a three-dimensional electronic cockpit mockup, measurement in a development fixture or other mockup, or measurement on engineering drawings. Regardless of the specific implementation or parameter used, critical data and information should be displayed in the primary FOV.

Evaluation Rationale:

Those parameters that are needed on a real time basis to navigate the aircraft from point A to point B need to be in front of the pilot flying the aircraft.

The critical functions are typically defined as attitude, altitude, airspeed and some form of navigation, or their equivalent. Navigation includes the combined result of heading and a navigation path.

6.2.3 Visibility of Critical functions, Abnormal operation

Display of reversionary data shall be in a location so that the pilot(s) can transition to it when the source of critical display data fails.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations					
Descent	Approach	Landing	Post Flight	Ground Operations	

Source: GAMA Publication #10

Performance Based Guideline:

Under failure conditions reversionary data in the Basic-T may be in the pilot’s secondary field-of-view.

Reference(s):

14 CFR PARTs 23.1311(b); 23.1321(d)

Critical Design Activities:

By examination or analysis determine that critical reversionary display functions are in the pilot’s primary or secondary field-of-view from that pilot position.

Example Implementation Concepts:

Performance Rationale and Background:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Pilots have been found to be able to transition and safely fly the reversionary critical displayed functions in the pilot's secondary field-of-view when operating with specific failures. The data on these displays should be displayed consistently with the other cockpit displays.

Evaluation Procedure:

Determine that the display of reversionary functions is useable from the pilot's position. The displays may be located in the secondary FOV as determined through visual field modeling in a three-dimensional electronic cockpit mockup, measurement in a development fixture or other mockup, or measurement on engineering drawings.

Evaluation Rationale:

Display of reversionary data needs to be in a location so that the pilot(s) can transition to it when the source of critical display data fails.

The reversionary critical data, typically including attitude, altitude and airspeed, or their equivalent, need to be arranged and located in the cockpit to make the transition to these displays as simple as possible. The display hardware does not need to be in the primary FOV of the pilot flying, but they need to be located in a place in the cockpit that allows the pilot(s) to adequately read the data being presented. Examples have used the center instrument panel where both pilots can easily read the displays or in single pilot aircraft at the copilot's position when the distance across the cockpit is small enough to allow the reading of the displays from the pilot's operating position.

6.3 Consistency of Operation

The ROA System shall Provide Consistency of Operation for Common Functions

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The HSI shall be capable of providing consistent information if cross-referenced to the primary flight instruments. Examples of this would be showing the ROA's altitude on the collision avoidance display, which should correlate to the altimeter reading.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.3.1 Common Time Reference

All times should be displayed using the Universal Coordinated Time (UTC) to provide a common reference to all systems.

Preflight	Ground Operations	Takeoff	Climb	Enroute	Mission
Operations	Descent	Approach	Landing	Post Flight	Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.3.2 Time Synchronization

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

The HSI shall facilitate time synchronization within and between all elements of the UAS: AVCS, Flight Crew Stations, Aircraft, ATC, etc.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

The operator shall have the ability to enter and synchronize a time with the UAV System and applicable Command, Control, Communications, Computers and Intelligence systems.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.4 Data Entry

The AVCS System should maximize data re-use and minimize data re-entry

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

When a discrete list of options for a given task exists, that list should be presented to the operator to aid the appropriate response. It should be made obvious to the operator whether there is a range of options that can be selected.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.4.1 "Auto Fill" Data Fields

Common AVCS System templates should allow "auto fill" of the message fields to reduce operator workload.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.4.2 Retain/Assign Default Values and Units

The AVCS System shall enable the operator to save default values and units that have been specified for various displays and templates.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.4.3 Globally Change Units

The operator shall be able to globally change the measurement units (e.g., change from imperial units to metric, or Latitude/Longitude to Universal Transverse Mercator (UTM) or Military Grid Reference System (MGRS)).

Preflight Ground Operations Takeoff Climb Enroute Mission

Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.4.4 Mission Specific Parameter Sets

The AVCS System shall enable the operator to enter parameter sets that will adapt the AVCS for the vehicle type and the respective missions.

Preflight Ground Operations Takeoff Climb Enroute Mission

Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

It may include, but not be limited to, the following capabilities:

- Select the system functionality (e.g., operational/training/maintenance modes)
- Filter and combine information to improve situational awareness (e.g., knowledge of the state of the system and its environment)
- Import/translate the Mission Order (MO)/Air Tasking Order (ATO) and load the appropriate data sets into the Core AVCS
- Input the data/parameters for the number and types of AV and their payload configurations that are to be controlled from the AVCS
- Provision of sufficient controls and displays to initiate all system Built-in-Tests (BIT) and display the status
- The capability to save/load the AVCS set-up configuration information and revert to a default set-up configuration
- The ability to enable operator-initiated search for relevant procedures
- Provide context sensitive help to inform the operator what type or range of data is expected for a given display input
- The ability to select directional references, for example among true-, grid- and magnetic north, and relative to the AVCS platform

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

6.4.5 Print Capability

The AVCS System should provide the ability for the operator to print hard copy.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Example Implementation(s):

- Mission plans
- The map
- Messages
- Imagery
- Screen-dumps

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.5 Entry Feedback

The system should provide the operator with relevant feedback of information within an appropriate timeframe.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The provision of feedback of information should not impede system operation. Consequently, the user does not need to know when and how to search for this information and does not need to invest in these actions.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.5.1 Feedback by Data Link System

The data link system should provide feedback to the ROA pilot any time a command is input into the system. This will prevent any doubt that the input was properly accepted.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Example Implementation Concepts:
Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

6.5.1.1 ACS Display of Data Describing Error Messages in Response to Unrecognized Pilot Entry

Any unrecognized entry made by the pilot at the ACS shall cause an informative error message to be displayed and not affect the status or operation of any system.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Human Systems Integration Pilot-Technology Interface Requirements for Command, Control, and Communications (C3)

Performance Based Guideline:

Reference(s):

Human Factors Requirements for Datalink. Air Transport Association Information Transfer Subcommittee. June, 1992, Para. 5.2.3.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

When the operator attempts to make an entry that the system cannot process,

1. an error message should be displayed to the pilot so the pilot clearly understands the nature of the error and is able to take corrective action. In addition
2. no such erroneous entry should affect systems operation as the entry made by the pilot may be misinterpreted by the system and result in an inadvertent system operation and safety impact .

Evaluation Procedure:

Evaluation Rationale:

6.6 ROA System Master Visual Display Guideline

ROA System Master Visual Display Guideline

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations
Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The master visual display is used to attract the ROA pilot's attention to a potential collision and indicates the severity of the situation (caution vs. warning). The master visual display should:

- Be within 15 degrees of the pilots centerline of vision
- Occur simultaneously with the master aural alert and no more than 0.5 seconds after the sensors detect a potential conflict
- Remain on until cancelled by the pilot or the situation is remedied
- Upon reset, be immediately capable of announcing a new situation
- Be a pilot-selectable function on a rheostat (dimmer switch) or an automatic detection of changing ambient light condition
- Be bright enough to attract the crew's attention in any ambient lighting condition
- Be dimmable with the low end still being bright enough to attract attention

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Rationale:

6.6.1 Legibility of System Displays

The ROA System Displays shall be Legible

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The CCA human system interface shall be capable of providing collision avoidance display/situational awareness information in a legible format throughout a wide range of ambient lighting condition. The display should not be washed out by average interior/exterior lighting conditions.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.7 Location of Audio Display

An audio display should be present within the AVCS preferably adjacent to the communication system.

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: NATO STANAG 4568

Performance Based Guideline:

It should provide the following functions:

1. indicate the audio level,
2. display the selected transmitter/microphone, and
3. annunciate if there is a lack of an output signal due to simultaneous transmissions.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

6.8 Intelligibility of Computer Generated Voice Messages

The ROA System Computer Generated Voice Messages shall be Intelligible

Preflight Ground Operations Takeoff Climb Enroute Mission
Operations

Descent Approach Landing Post Flight Ground Operations

Source: Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

The HSI shall be capable of providing clear, concise, intelligible alerts consistent with ambient noise levels, concurrent speech message and other aural signals. Warnings shall not be overridden by other voice, data or ambient aural noise

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Performance Rationale and Background:
Evaluation Procedure:
Evaluation Rationale:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Note: The following section was a preliminary effort to provide additional detail for one of the functional areas: avoid hazards. Had the program continued beyond early 2006, additional HIS AVCS guideline material would have been supplied as well as validating the content material presented on the following pages.

AVOID HAZARDS

The HSI shall enable the aircraft to Avoid Hazards through actions by the Pilot

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Aircraft Hazard avoidance shall be conducted with actions and authorizations from the Pilot. Some actions and authorizations may be pre-determined. The role the Pilot takes in Hazard Avoidance will vary depending on how the Manufacturer develops the Hazard Avoidance System. As an example (A), the Manufacturer may develop a system that only operates in restricted air space within which no other aircraft are allowed to travel. The role of the Pilot in Hazard Avoidance for this type of system (A) would be very limited. As another example (B), the Manufacturer may develop a system that requires the Pilot to perform all aspects of Hazard Avoidance: Detection, Evaluation, Develop a Solution, Act, and Assess. The role of the Pilot in Hazard Avoidance for this type of system (B) would be robust.

Evaluation Procedure:

Evaluation Rationale:

1.1. Detect a Hazard

The HSI shall enable the Pilot to Detect a Hazard

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input type="checkbox"/> Ground Operations | | | | |

Source:

NATO STANAG 4568

Performance Based Guideline:

The HSI shall enable the Pilot to perceive a Potential Hazard. The method of informing a pilot that a hazard exists (aural alert, visual display, tactile, etc.) will vary depending on how the Manufacturer develops the system.

Reference(s):

The ROA System shall Detect cooperative threats

Source(s): SEIT Approved CCA Functional Requirements, Functional Requirement #1

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1. Detect a hazardous condition between Own Aircraft and Other Aircraft

The HSI shall enable the pilot to identify a hazardous condition between own aircraft and other aircraft.

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|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

SAE ARP4153, "HUMAN INTERFACE CRITERIA FOR COLLISION AVOIDANCE SYSTEMS IN TRANSPORT AIRCRAFT"; SAE ARP5365

Performance Based Guideline:

This detection is based on the information obtained through the Sensing and Estimation Function: proximity and closure with traffic, aircraft performance, and estimates of the aircraft's intentions. The decision that a situation is a conflict should consider the application and carefully balance safety against nuisance alerts. The system should not issue an alert when published procedures are being followed. This can be accomplished by examining a wide variety of traffic encounters, especially when the own ship, the traffic or both are maneuvering.

Reference(s):

Critical Design Activities:

The system should use the permitted traffic separation criteria to determine the protection that the system will provide. The navigation and other airplane systems may be used to provide positional information to identify the appropriate criteria

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1.1. Avoid Cooperative Traffic

The ROA System shall provide the pilot with the ability to avoid cooperative traffic

- | | | | | |
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| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #5b

Performance Based Guideline:

Reference(s):

Critical Design Activities:

For specific guidance on the Human Interface Criteria for Collision Avoidance Systems, SAE ARP4153, "HUMAN INTERFACE CRITERIA FOR COLLISION AVOIDANCE SYSTEMS IN TRANSPORT AIRCRAFT" provides high-level instruction and information.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.1.2. Provide Conflict Resolution Information to the Pilot

The information provided by the system should enable the pilot to perform conflict resolutions, or respond to resolution guidance, in a timely manner.

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|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance

Performance Based Guideline:

The system should generate a sense of confidence in the pilot that the pilot is seeing all of the traffic relevant to performing these resolution responses, or that the system is considering, in generating resolution guidance. Otherwise, responses may be tentative and delayed, or competing resolutions may appear better suited to the conflict. As a general statement, the information provided by the system should enable the pilot to respond in an appropriate and timely manner and should not promote incorrect or unproductive response patterns. At the same time, the pilot shall use information describing traffic according to requirements established for the design and shall not employ the design for purposes other than those for which it was intended (e.g., TCAS traffic displays shall not be used by the pilot for traffic separation) .

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 5.5.1, 5.8.3, 5.14.5, 5.14.22, 6.1.
Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 5.1.5, 7.1.1.8.
Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4i, 8.1.

Critical Design Activities:

Detailed CDTI design information requirements and recommendations can be found in SAE ARP5365. Some considerations are listed below:

Visual Display Characteristics:

Visual displays can present traffic information in two ways: graphical or textual. While users generally prefer a graphical (i.e., analog) display, cognizance and performance is not always better with graphical representations. That is, performance with either display format appears to be task dependent. In general, a graphical format is favored under the following conditions (Helander, 1987):

Rate-of-change information needs to be perceived.

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Estimations of the variable's magnitude are needed when it is rapidly changing. The deviation of the variable from a prescribed limit needs to be determined at a glance. In addition, the graphical display of information is favored when the information is inherently spatial and multiple spatial relationships need to be determined at a glance. Both information mediums can be displayed within a stand alone or shared traffic display. Many of the recommendations listed below are applicable to all display types (e.g., location, size, and resolution), however, if a guideline is specific to a display type, it will be so stated.

Example Implementation Concepts:

Performance Rationale and Background:

The system should generate a sense of confidence in the pilot that the pilot is seeing all of the traffic relevant to performing these resolution responses, or that the system is considering, in generating resolution guidance. Otherwise, responses may be tentative and delayed, or competing resolutions may appear better suited to the conflict. As a general statement, the information provided by the system should enable the pilot to respond in an appropriate and timely manner and should not promote incorrect or unproductive response patterns. At the same time, the pilot shall use information describing traffic according to requirements established for the design and shall not employ the design for purposes other than those for which it was intended (e.g., TCAS traffic displays shall not be used by the pilot for traffic separation).

Evaluation Procedure:

Evaluation Rationale:

Display of Air Traffic Visual Alerts

Visual alerts may be provided to warn the pilot that a response to traffic is required.

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance; Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance

Performance Based Guideline:

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 7.1.2, 7.1.11.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4a, 8.1, 8.3.

Critical Design Activities:

Detailed Traffic alerting design information requirements and recommendations can be found in SAE ARP5365. Some considerations are listed below:

Visual Alerts:

A visual display should be used to attract the attention of the flight crew and to give them initial information about the urgency of the situation.

Different visual alerts should be provided for each crew member for alerts with different urgencies.

The use of color may assist in distinguishing between the different levels of alerts. The use of color should be kept to a limited number of readily distinct and identifiable hues. Colors should follow standard uses as found in other alerting systems in the cockpit, such as red for the most urgent alerts.

Visual alerts should be located within fifteen degrees of the crew member's centerline of vision (both head up and head down).

The onset of the visual alert should occur simultaneously with the aural alert and no more than 0.5 s after the system sensors/algorithms detect the alerting situation. The visual alert should remain on until it is canceled by the flight crew or until the problem has been corrected. Upon cancellation, the alert should reset and be capable of announcing a new situation or a change in the urgency of the current situation.

The visual alert should be bright enough to attract the flight crew's attention. The range of brightness should provide sufficient contrast in both high and low ambient lighting

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conditions and should adjust automatically. The display should be capable of dimming to a level that is consistent with other displays on the flight deck.

The visual alert should subtend at least one square degree of visual angle CDTIs and their associated controls should be co-located to the maximum extent possible to facilitate parameter adjustment and monitoring function selection. During the normal operation of associated controls, or when the flight crew is engaged in normal cockpit window monitoring, all areas of the CDTI shall be visible to the crew from the design eye positions, assuming binocular vision. If a third crew member is required to monitor the CDTI, it should be visible and legible from the seated position with the (shoulder) harness condition specified for the phase of flight

Example Implementation Concepts:

Performance Rationale and Background:

Visual displays may serve to provide the pilot with alerts, which serve to direct the pilot's attention to some element of the traffic situation. The alerting displays may be integrated with a spatial presentation of the traffic.

Presentation of traffic information in the flight deck increases the capability of the flight crew to be more actively involved in traffic separation and air traffic management, requires a method for managing the information and procedures new to the flight deck, and changes the role they are willing to accept in relation to the air traffic controllers and other aircraft. Therefore, the addition of increased information content in the flight deck through improved CDTI functions should examine the need for changes in flight crew and controller coordination procedures, and should take into account changes in flight crew and controller communications that may arise in real operations as the air traffic management process becomes more observable by the pilot.

Evaluation Procedure:

Evaluation Rationale:

Display of Air Traffic Aural Alerts

Aural alerts may be provided to warn the pilot that a response to traffic is required.

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|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance;

Performance Based Guideline:

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 7.1.3.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4b, 4a, 8.1.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 7.1.2., 7.1.2.10, 7.2.3, 7.2.4, 7.3.1, sect. 7.2. Access 5 Program CCA - C3 Requirements

Critical Design Activities:

Detailed Traffic alerting design information requirements and recommendations can be found in SAE ARP5365. Some considerations are listed below:

Aural Display Characteristics:

Aural alerts should be integrated and consistent with the flight deck alerting system and alerting philosophy.

Time critical and urgent alert characteristics should be standardized.

Alerts should be prioritized.

Tonal Characteristics:

The first presentation of tonal and voice alerts should exceed the masking threshold of the ambient noise by at least 8 dB \pm 3 dB with a automatic gain control to maintain this approximate signal-to-noise ratio.

For optimal attention getting quality, the frequency of the alerting sounds should be between 250 and 4000 Hz. However, because of the potential hearing loss due to the age of senior flight crew members, a more preferable range would be 500 to 3000 Hz. High urgency signals should be composed of at least two widely spaced frequencies and the frequencies should be chosen to differ from those that dominate the ambient noise.

Verbal Characteristics:

If an aural sound is used with a voice message, the duration of the sound should vary depending on the urgency of the situation. For time-critical situations, the alerting sound should occur for a maximum of 0.75 s and be followed by the appropriate voice message. The off time between the sound and the voice message should be no less than 0.15 s and no more than 0.7 s. For caution level alerts, the sound should last 1.2 to 2.0 s and be repeated every 8 to 10 s until the flight crew cancels the alert or the terrain conflict no longer exists. Research indicates (Berson et al. 1981 and Anderson et al. 1989) that voice messages should not be used for caution level alerts.

If possible, the sound source for the system should be perceptually separated in space by at least 90° from competing sound sources.

Alerting and Avoidance Maneuver Displays:

Time critical and urgent alert characteristics should be standardized.

Typically, this involves a succession of alerts from the initial situation advisory to caution information through warning and time critical alerts

Example Implementation Concepts:

Performance Rationale and Background:

Candidate Conflict Avoidance concepts may use an aural (voice or tonal) display. This display may replace or supplement graphical displays. Both basic state information about other aircraft and warnings/alerts may be provided.

Evaluation Procedure:

Evaluation Rationale:

Air Traffic Alert Integration

Alerts annunciated to the pilot shall correspond to the presentation of traffic information (on displays) to the pilot and/or command information presented (visually or aurally) to the pilot.

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|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance;

Performance Based Guideline:

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 4.2, 8.3.1.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

To ensure that the pilot understands that the annunciated alert applies to a specific target, the target shall be represented in such a way that it indicates itself as the subject of the annunciation.

Evaluation Procedure:

Evaluation Rationale:

1.1.2. Detect a hazardous condition between Aircraft and Weather

The HSI shall enable the pilot to identify a hazardous condition between own aircraft and weather systems

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.3. Detect a hazardous condition between Aircraft and Terrain

The HSI shall enable the pilot to identify a hazardous condition between own aircraft and terrain

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.4. Detect a hazardous condition caused by resource depletion

The HSI shall enable the pilot to identify a hazardous condition caused by the depletion of resources.

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Through the HSI, the pilot will be alerted to a hazardous condition caused by the depletion of resources. The resources can be either consumable or renewable.

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.5. Information Transmission

The system shall have a function that allows the flight crew to obtain more detailed information about the traffic situation.

- | | | | | |
|---|--|--|---|--|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground
Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission
Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post
Flight |
| <input checked="" type="checkbox"/> Ground
Operations | | | | |

Source:

SAE ARP5365

Performance Based Guideline:

The system could enhance the flight crew's traffic awareness by allowing them to view relevant airspace/traffic geometry information. The flight crew should have a clear idea of what action to perform to resolve the conflict

Reference(s):

Critical Design Activities:

The aircraft's location (in all dimensions) relative to traffic and its velocity vectors should be displayed. When a conflict is detected and an alert is issued, additional resolution information may be needed. This may be in the form of a caution (e.g., "Traffic"), an open-loop command (e.g., "Climb"), or closed-loop command guidance (e.g., "Flight Director Bars"). The system should indicate when the potential loss of separation alerting situation no longer exists.

Example Implementation Concepts:

The appropriate display format and information content depends on the intended use and operation of the CDTI. Each format has benefits and limitations. Further research and testing is advisable before implementation. For example, the flight crew's assessment of the traffic situation and their required actions has been found to be highly dependent upon the type of display; a display showing a vertical "slice" of the traffic situation typically suggests vertical maneuvers, while a plan view or "birds eye" display typically suggests horizontal maneuvers.

Graphical Display Formats: Common to all display concepts, the presentation of aircraft position on the display aids the pilot in determining proximity to other traffic and assists in tactical operations and strategic planning. Other information elements may be presented as needed. Table 1 lists potential display viewpoint and projection characteristics. Figures 1, 2, and 3 illustrate some of characteristics of these viewpoints and projection techniques for the depiction of two buildings, where each has a different height and shape. These viewpoints and projections are discussed in more detail below, with the advantages and disadvantages of the respective display types being noted.

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Perspective Projection: Perspective projection, or perspective mapping provides an integrated three dimensional representation of the traffic information. This type of projection yields images similar to those in a conventional photograph, and reflects the type of stimuli which natural vision has evolved to process. However, the exact layout within perspective images can also be hard to interpret due to difficulty in assessing object size and or object depth (distance to objects measured normal to the plane of the image). Perspective views require a frame of reference and way to relate the target aircraft to a ground plane. Perspective displays can provide "situation awareness at a glance" by building from a familiar representation. The heading and pitch scales should be consistent with the scene depiction. A perspective display may have an "inside-out" view or an "outside-in" view. The outside-in view is referenced from an outside perspective and may cover the complete field including behind the aircraft; the inside-out view depicts traffic comparable to an actual outside the window visual view. Symbology can be used to represent detailed information such as distance, direction, closure rate, flight ID, and altitude. Because of the amount of information that may be closely located on this display, a means of decluttering the display should be provided. A perspective display may be used in coordination with -- or the flight crew may select between -- a plan view display to provide longer-term information or more precise assessment of the horizontal position of the aircraft.

Isometric Projection: Isometric projection, or orthonormal mapping, totally ignores depth. As a result, displayed separations are strictly proportional to separations measured parallel to the image plane. This makes isometric projection very valuable for the display of two-dimensional separation, when the two dimensions are particularly significant (e.g., the horizontal dimensions of the ground). On the other hand, when the selected dimensions are unfamiliar or ambiguous, this type of projection can yield ambiguous or illusory interpretations. The most common example of an isometric projection is a map, where the elevation of the depicted terrain does not influence the displayed separation between locations. Another example of this type of projection is found in engineering drawings. Traffic information on an isometric display shows a 3-D view where the same measure is used foreground to background. An isometric display shows relative and absolute and vertical path of own ship and Other aircraft. An isometric display relies on a method to show reference to the ground plane and as a result a method to reduce display clutter should be provided. Reference lines have the potential to be confusing since they would not be depicted in perspective.

Display Point of View: Graphical displays can, of course, present many different points of view, and these may be classified in several manners. The classification into plan views, profile views, and off-axis views is especially relevant to CDTIs.

Plan View: Plan views, such as TCAS displays and NAV displays, are top down views (often called God's Eye views), and are the most familiar views to pilots. Plan views are projections of traffic information onto a horizontal slice through the airspace, and may be presented in a trackup, heading-up, or north-up format. Plan views may display traffic flying at all altitudes, or just some subset of altitudes (e.g., TCAS defaults to presenting aircraft within 2900 ft of own ship). Plan views may also be presented as relative to own ship (i.e., moving map, such as used in TCAS), or as fixed. Additionally, relative vertical

information should be shown alphanumerically and/or symbolically. Depending on the use for which the format is intended, a method of viewing the range of the display should be shown, and a variety of display ranges may need to be selectable. The isometric rendering in Figure XX illustrates how a plan view format can provide good horizontal (x-y) separation information, but lacks all vertical separation information. On the other hand, the perspective rendering of a plan view does provide some vertical separation information (the vertical development of the smaller building is evident). However, the perspectival transformations shift the rendered x-y locations according to the rules of perspective, and this may make the horizontal separation information less usable.

Side-On View: The Side-On view is a projection of information on a vertical slice through the airspace and have been recommended as a means for giving altitude information to flight crews. Side-On views display traffic flying in some specific region of airspace around own ship. There are many potential Side-On views, but two (Profile and Window) are particularly interesting. The Profile view, is

Performance Rationale and Background:

The flight crew should be provided sufficient information to accurately anticipate conflict situations.

Evaluation Procedure:

Evaluation Rationale:

1.1.5.1. Detect a hazardous condition incurred from depleted consumable

The HSI shall enable the pilot to identify a hazardous condition incurred by the depletion of consumable resources.

- | | | | | |
|---|--|--|---|--|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground
Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission
Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post
Flight |
| <input checked="" type="checkbox"/> Ground
Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

Detect a hazardous condition incurred from insufficient fuel

The HSI shall enable the pilot to identify a hazardous condition incurred by the depletion of fuel resources.

- Preflight
- Ground Operations
- Takeoff
- Climb
- Enroute
- Mission Operations
- Descent
- Approach
- Landing
- Post Flight
- Ground Operations

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.5.2. Detect a hazardous condition incurred from depleted renewable

The HSI shall enable the pilot to identify a hazardous condition incurred by the depletion of renewable resources.

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

Detect a hazardous condition incurred from degradation of communication links

The HSI shall enable the pilot to identify a hazardous condition incurred by the degradation of communication links.

Preflight Ground Operations Takeoff Climb Enroute
Mission Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Performance Based Guideline:

Reference(s):

The operator should be alerted to the potential loss of link due to coverage limitations.

Source(s): NATO STANAG 4568

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

Indication that Communication link with Aircraft has been Lost

When a data link to the AV is lost, an indication on/near the AV icon shall be displayed.

- | | | | | |
|---|--|--|---|--|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground
Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission
Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post
Flight |
| <input checked="" type="checkbox"/> Ground
Operations | | | | |

Source:

NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

Contents of Lost Link Indication

Upon loss of data link, an indication shall appear. These indications shall automatically disappear when data link is regained.

- | | | | | |
|---|--|--|---|--|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground
Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission
Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post
Flight |
| <input checked="" type="checkbox"/> Ground
Operations | | | | |

Source:

NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation(s):

AV Position at loss of link

Predicted AV position

Predicted AV heading

Predicted AV altitude

Predicted AV fuel level

Loss of link timer (displays how long the link has been lost)

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.6. Detect a hazardous condition caused by System Malfunction or Failure

The HSI shall enable the pilot to identify a hazardous condition caused by a System Malfunction or Failure

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.6.1. Set Threshold System Indicators

The AVCS System shall allow the setting of threshold levels for system indicator

- | | | | | |
|---|--|-----------------------------------|----------------------------------|---|
| <input checked="" type="checkbox"/> Preflight | <input type="checkbox"/> Ground Operations | <input type="checkbox"/> Takeoff | <input type="checkbox"/> Climb | <input type="checkbox"/> Enroute |
| <input type="checkbox"/> Mission Operations | <input type="checkbox"/> Descent | <input type="checkbox"/> Approach | <input type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

NATO STANAG 4568

Performance Based Guideline:

These may include, but are not limited to:

Air Vehicle altitude and altitude rate of change

Fuel levels

Speed

Maximum G loading

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.6.2. Detect a hazardous condition caused by Aircraft System
Malfunction or Failure

The HSI shall enable the pilot to identify a hazardous condition caused by a System Malfunction or Failure on board the aircraft

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.1.6.3. Detect a hazardous condition caused by AVCS System Malfunction or Failure

The HSI shall enable the pilot to identify a hazardous condition caused by a System Malfunction or Failure at the AVCS

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

The ACS shall display health and status data alerts to the pilot.

Source(s): Human Systems Integration Pilot-Technology Interface Requirements for Contingency Management

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002. para. 7.1.1.1.

Human Factor Considerations in the Design of Multifunction Display Systems for Civil Aircraft, Aerospace Recommended Practice (ARP) 5364. Society of Automotive Engineers, March, 2003. para. 5.5.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

As the pilot will be involved in many ACS operations, it is not expected that the pilot will monitor the health and system status at all times. Humans are poor monitors over extended period of time. As a result, augmentation of pilot monitoring skill is required in the form of a master visual alert and/or aural alert to warn the pilot of a malfunction.

Evaluation Procedure:

Evaluation Rationale:

1.1.6.4. Exceedence of Threshold Levels

When system indicator threshold levels are exceeded, the AVCS System shall indicate a Caution, Warning, or Advisory to the operator.

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

NATO STANAG 4568

Performance Based Guideline:

Reference(s):

The alerting system should provide unique combinations of components to inform the pilot of the urgency level of alerts (e.g., warnings, cautions, or advisories)

Source(s):

Aircraft Alerting System Standardization Study

Critical Design Activities:

When system indicator threshold levels are exceeded, the AVCS System shall indicate a Caution, Warning, or Advisory to the operator.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.2. Alert that a Hazard Exists

The HSI shall provide alerts whenever an anomaly is detected

- | | | | | |
|---|--|--|---|--|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground
Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission
Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post
Flight |
| <input checked="" type="checkbox"/> Ground
Operations | | | | |

Source:

Performance Based Guideline:

The C2 communications human system interface shall be capable of notifying the ROA pilot of an emergency or on-board safety of flight issue. Audio and/or visual displays shall alert the ROA pilot of any change in the health of the ROA that can be of significant risk.

Visual and auditory alarming systems must provide signals that can be detected, easily understood and interpreted for appropriate action by the pilots under all ambient lighting and noise environments encountered during all phases of operation. The warning system must also be designed to minimize crew errors that create additional hazards.

The number of unnecessary and/or incorrect alerts have a direct impact on the usefulness of the system because they affect the pilot's perception of and confidence in the information that the system presents. False alarms and missed alerts should be eliminated.

The effect of nuisance alerts on the crew is dependent on the urgency of the alert and the expected crew response to the alert. Corrective escape maneuvers can be classified as time-critical alerts and, therefore, nuisance alerts (that is, conflicts resolved by normal operations such as leveling at an assigned altitude or turning to a parallel runway) should be minimized.

Research has shown that ideally there should be no more than one nuisance alert for every ten real ones. Previous work with time-critical alerting systems (for example, windshear) has indicated that the minimum acceptable ratio between nuisance and true time-critical warnings is approximately 1:1. This value promotes pilot confidence in the system.

It should be noted that information provided by nuisance alerts is at times considered useful by the pilots and a way should be identified to provide the same information without using the alert. This is also true of nuisances for caution level alerts. Even though pilots are more tolerant of these types of alerts, evidence indicates that using the same alert for normal and non-normal situations increases the probability of error (for example, the altitude alert)

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Reference(s):

The ROA System shall Notify of an Emergency or Safety of Flight Issue

Source(s):

Access 5 Program CCA - C3 Requirements

NASA/TM-2001-211254, "Airborne Use of Traffic Intent Information in a Distributed Air-Ground Traffic Management Concept...", SAE ARP4153

GAMA Publication #10

14 CFR PARTS 23.1309; 23.1323; 23.1311; 91; 121; 135; and AC 23.1309-1C;

NAWCADPAX-96-268-TM; MIL-STD-411; British Defence Standard 00-25 Part 7;

MIL-STD-1472F

Critical Design Activities:

Analysis of the visual and auditory alarm system should be performed prior to implementing detail design efforts. These analyses should address operation, prioritization and categorization of system alerts. The analyses also need to consider the ambient lighting and noise environment in which the system has to perform. The analysis should consider the user's capabilities and limitations; for example, some older pilots have substantial hearing loss and vision impairments, which should be given consideration. The design should include iterative testing via simulation or other methods with representative users to assess integration compatibility.

Example Implementation Concepts:

Alerting can be presented using various levels. For example, in CDTI displays 3 levels of alerting are applied:

- Level 1: A Level 1 alert is used when information must be conveyed to the pilot, but no action is required.
- Level 2: A Level 2 alert requires action by the ownship flight crew.
- Level 3: A Level 3 alert requires immediate action by the own-ship flight crew
- Performance Rationale and Background:

Visual:

Every attempt should be made to eliminate possible confusion of alarms with any other displayed information. High priority alarms should be placed in the pilot's primary field-of-view. If all critical alerts cannot be placed within 15 degrees, a master warning display is also appropriate. Visual alarms should be presented until the pilot has responded or until the alarm condition no longer exists. Auditory or voice alerts should accompany high priority alarms.

A system test function should be included that illuminates all alarms available and verifies that all the alarms are functional. This test should be made possible through a single action. Larger text and higher luminance may be appropriate for alerting signals. The use of flash coding should be kept to a minimum. If flashing is used, the background should be free from other flashing signals; the flash rate should be between 3-5Hz with a duty cycle of 50%. Flashing presentations that could be simultaneously active should be synchronized. Auditory alarms should direct attention, but not cause interference to required tasks. Nuisance alarms should be addressed.

Master caution, master warning, master advisory, and summation lights or indicators used to indicate the condition of an entire subsystem should be set apart from lights or indicators that show status of the subsystem components. Indicators or lights used solely for maintenance and adjustment should be extinguished, covered or non-visible during normal equipment operation. Discrete lights and other such indicators should be used sparingly and should display only that information necessary for effective system operation.

Error and status messages should be located consistently at the pilot's station and on the same dedicated area with their respective displays. These messages may be emphasized by using a contrasting display feature (e.g. reverse video, highlighting, icons, etc.)

Auditory:

Auditory signals provide rapid alerting irrespective of head or eye position. If applied wisely auditory alarms can enhance safety of operation and improve crew response to emergency situations. Judicious use of these alarms must be addressed to preclude nuisance warnings in the cockpit. The number of auditory alarms should be kept to the minimum necessary to provide the desired result. Spoken alerts have advantages over other forms of auditory warnings as they can convey an explicit piece of information without having to interpret the tone or go to the visual display to determine the failure.

Effective auditory alarm systems will typically have the following characteristics:

- False alarms should be precluded to the extent possible.
- Auditory alerts should be easily recognized and understood in order to minimize the time required for the user to detect, assess and react to the problem and to initiate appropriate corrective actions.
- Audible alarms should be detectable and understood quickly and easily under all expected operating conditions including ambient noise, radio traffic, and crew voice communications.
- Audible alarms should be standardized.
- Audible alarms should be used in conjunction with visual alerts as appropriate.
- All audible alarms must be easily recognizable from one another. Each audio signal should have only one meaning.
- If headsets are worn, the alerting system should be usable through the headset unless external alerts are demonstrated to be discernable using noise canceling headsets.
- The audible alert signal should have a duration no less than 0.5 seconds and no longer than 3.0 seconds.

Evaluation Procedure:

Develop a checklist based on applicable guidelines and evaluate system design. Compare design with functional requirements. Evaluate the visual and audio displays under varying cockpit environmental and operational conditions with representative user population.

Specifically for audio alarms:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

- Test for false alarms.
- Check for background noises that may mask the alert.
- Ensure the intended meaning of the signal is clear, unambiguous and immediately understood.
- Ensure that unique audio signals are used. Measure with instrumentation as appropriate and also obtain subjective assessments during program development.
- Ensure that a single tone is not used for more than one visual display in critical warning situations.

Evaluation Rationale:

Evaluations are needed to insure that appropriate and easily understood warnings are provided to the pilot(s) under anticipated operating conditions.

1.2.1. Attract the attention of the pilot

The HSI shall attract the attention of the pilot when an anomaly is detected.

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Aircraft Alerting System Standardization Study; NATO STANAG 4568

Performance Based Guideline:

Adequate indication (cues) should be provided to the pilot(s) to ensure safe operation within the normal flight envelope.

Reference(s):

GAMA 10 Publication
14 CFR PART 23. 1309

Critical Design Activities:

The warning and caution indications shall be located in the operator's primary field of view.

Warnings and cautions shall not be obscured by other AVCS System elements.

The AVCS System should provide a separate means for alerting the operator of new warnings, depending on the severity of the warning. The AVCS System shall provide a rapid means for cancellation of such warnings.

The presentation of all required flight information must be done in a manner that the pilot can readily understand in order to maintain the airplane within its normal flight envelope. Transient /dynamic conditions that would cause the airplane to exceed its normal flight envelope should be annunciated promptly so that pilot intervention will prevent a hazardous flight condition. This applies to excessive pitch, roll and yaw attitudes as well as high and low speed awareness. In addition, engine parameter monitoring should be accomplished to ensure the safest possible engine operation. These conditions need to be sensed and specific cueing should be developed and integrated in the system design.

Example Implementation Concepts:

Performance Rationale and Background:

Under dynamic flight conditions an aircraft may transition rapidly from normal to an overspeed, stall or unstable flight condition with little pilot awareness. With adequate display cues, the pilots will know before this condition occurs and be able to intervene so as to prevent the hazardous flight condition from occurring.

Evaluation Procedure:

Determine the critical flight conditions of the aircraft. Determine that under transition flight conditions, adequate cues are presented to the pilots before warnings occur when the conditions are present. Particularly approaches to stall and overspeed conditions and

unusual attitudes should be evaluated. Failure conditions should be considered. Under these conditions either symbols on the displays or other equivalent cues need to be actuated as the aircraft approaches the transition condition.

Evaluation Rationale:

The intent of cues is to have advanced indication of the impending occurrence of an undesirable condition. The cues need to be obvious to the pilot using changes in colors, flashing symbols, etc. that instill quick pilot response before a stall warning, overspeed warning or similar condition occurs.

1.2.1.1. Alerting System Components

The components of the alerting system should include Master Alerts (Visual and Aural), a visual information display, a voice information display, and a time-critical display

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Aircraft Alerting System Standardization Study

Performance Based Guideline:

The alerting system should be highly reliable. It should be activated only when an alerting situation exists: it should not be activated

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

ROA System Aural Alert Guidelines

ROA System Aural Alert Guidelines

Preflight Ground Operations Takeoff Climb Enroute
Mission Operations
Descent Approach Landing Post Flight Ground Operations

Source:

Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance; Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Candidate CA concepts may use an aural (voice or tonal) display. This display may replace or supplement graphical displays. Both basic state information about other aircraft and warnings/alerts may be provided.

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 7.1.3.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4b, 4a, 8.1.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 7.1.2., 7.1.2.10, 7.2.3, 7.2.4, 7.3.1, sect. 7.2.

Critical Design Activities:

The master aural alert should be used as a general indication to attract the ROA pilot's attention and give preliminary information about the urgency of the situation. The master aural alert should:

- Use a unique sound for the different levels of urgency (warning vs. caution)
- Use a frequency that will attract the ROA pilot's attention (nominally 500-3000 Hz)
- Differ from ambient sound frequencies
- Not use the same indication as other aural alerts (fire, systems failure, etc.)
- Voice alerts provide specific information regarding traffic information, avoidance maneuvers, and conflict potential.

Voice guidance should:

- Use automatic voice messages for all time-critical warnings, for example, corrective escape maneuvers (i.e. "Climb, Climb, Climb.")
- Based on empirical testing, use the appropriate voice for the conditions in which it will be used (frequency range, ambient noise conditions, etc.)
- Keep the number of repetitions of voice messages to a minimum to reduce the possibility for auditory overload
- Be unambiguous, distinctive and unique to the specific alert and not contain similar phraseology, which may be misinterpreted

Example Implementation Concepts:

Performance Rationale and Background:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Procedure:

Evaluation Rationale:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

1.2.1.2. Detect ability of Warnings and Cautions

Warnings and cautions shall not be obscured by other AVCS System elements.

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.2.1.3. ROA System Visual Alert Guidelines

ROA System Visual Alert Guidelines

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Visual alerts may be provided to warn the pilot that a response to traffic is required.

Reference(s):

Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance; Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 7.1.2, 7.1.11.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 4a, 8.1, 8.3.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Visual displays may serve to provide the pilot with alerts, which serve to direct the pilot's attention to some element of the traffic situation. The alerting displays may be integrated with a spatial presentation of the traffic.

Evaluation Procedure:

Evaluation Rationale:

1.2.2. Inform the pilot as to the urgency level of the alert

The HSI shall inform the pilot the urgency level for a detected anomaly

- | | | | | |
|---|--|--|---|--|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground
Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission
Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post
Flight |
| <input checked="" type="checkbox"/> Ground
Operations | | | | |

Source:

Aircraft Alerting System Standardization Study

Performance Based Guideline:

The urgency of an alerting situation is usually determined by the amount of time the crew has to respond to the situation. The less time that the crew has to respond, the more the system should help in determining what response should be made. These time constraints impact how the system is used, especially at the most urgent levels. The overall time budget for the crew/aircraft system to respond to a collision avoidance alert is of critical importance. The alert should be sufficiently attention-getting to assure situational awareness by the crew in time to develop an appropriate mental set. The alert should be given in sufficient time for the crew to respond by maneuvering the aircraft to achieve the necessary miss distance. The assumption that should be made when designing a system around a very short pilot response time is that it is an executive system requiring immediate crew action rather than an advisory system.

Reference(s):

Based on system ability to determine the urgency of a traffic situation, alerts shall be presented to the pilot that describes the level of urgency in an unambiguous manner. Different alerts shall be provided for alerts with different urgencies. - Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance; Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 4.2, 6.2.
Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 7.1.1.3.
Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 6.2, 8.2, 8.3.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The urgency of the loss of separation or a traffic conflict situation is usually determined by the amount of time that the pilot has to respond to the situation. The less time the flight pilot has to respond, the more the system should help in determining what response

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should be made. These time constraints have an influence on how the system is used, especially at the most urgent levels. The system should provide enough information to ensure traffic awareness by the pilot in time for the pilot to respond by maneuvering the aircraft to achieve the necessary traffic separation. The assumption that should be made when designing a system around a very short pilot response time is that a portion of the system will have to be executive in nature (tell the pilot what response to make and expect the pilot to make it). The system should be designed to minimize the occurrence of situations requiring very short response times.

Evaluation Procedure:

Evaluation Rationale:

1.2.2.1. Traffic Alert Urgency

The HSI shall advise the pilot to the urgency of a traffic alert.

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance;

Performance Based Guideline:

The system should provide enough information to ensure traffic awareness by the flight crew in time for them to respond by maneuvering the airplane to achieve the necessary traffic separation. Because of the wide range of potential traffic conflict geometries, the system should be able to accommodate situations with both long and very short response time requirements. The assumption that should be made when designing a system around a very short pilot response time is that a portion of the system will have to be executive in nature (tell the flight crew what response to make and expect them to make it). The system should be designed to minimize the occurrence of situations requiring very short response times.

Reference(s):

Human Interface Criteria for Cockpit Display of Traffic Information, Aerospace Recommended Practice (ARP) 5365. 1999, para. 4.2, 6.2.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002, para. 7.1.1.3.

Human Interface Criteria for Collision Avoidance Systems in Transport Aircraft, Aerospace Recommended Practice (ARP) 4153. Society of Automotive Engineers. 1988, para. 6.2, 8.2, 8.3.

Critical Design Activities:

Based on system ability to determine the urgency of a traffic situation, alerts shall be presented to the pilot that describes the level of urgency in an unambiguous manner. Different alerts shall be provided for alerts with different urgencies.

Example Implementation Concepts:

Performance Rationale and Background:

The urgency of the loss of separation or a traffic conflict situation is usually determined by the amount of time that the pilot has to respond to the situation. The less time the flight pilot has to respond, the more the system should help in determining what response should be made. These time constraints have an influence on how the system is used, especially at the most urgent levels. The system should provide enough information to ensure traffic awareness by the pilot in time for the pilot to respond by maneuvering the

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aircraft to achieve the necessary traffic separation. The assumption that should be made when designing a system around a very short pilot response time is that a portion of the system will have to be executive in nature (tell the pilot what response to make and expect the pilot to make it). The system should be designed to minimize the occurrence of situations requiring very short response times.

Evaluation Procedure:

Evaluation Rationale:

1.2.3. Contents of Individual Alert Messages

The AVCS Specific Modules shall provide all AVCS System functionality for the system while the content of individual warnings will be determined by messages from the Datalink interface.

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

NATO STANAG 4568

Performance Based Guideline:

In this way, the AVCS System provides a common look and feel to the operator no matter what UAV is being flown without having to understand the content of all warnings from all types of vehicles.

Reference(s):

Critical Design Activities:

Ability to provide the procedures (rules) for the alarm handling tasks that have to be accomplished

Ability to toggle between only active cautions/warnings and a complete cautions/warnings history for the mission

Ability to sort cautions and warnings by time

Ability to sort cautions and warnings by severity

Ability to sort cautions and warnings by system

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.2.4. Management of Alerts

The HSI shall facilitate the management of alerts

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.2.4.1. Data Management Control of Alerts

The HSI alerting system shall enable the pilot to monitor the status of the aircraft, and to store and recall existing alerts

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Aircraft Alerting System Standardization Study; NATO STANAG 4568; DOT/FAA/RD-81/38, 11

Performance Based Guideline:

Warnings, cautions, and advisories inform the operator about any unusual or critical condition.

Reference(s):

The AVCS System shall provide the capability to display, track, log, and otherwise manage warnings, cautions, and advisories.

Source(s): NATO STANAG 4568; DOT/FAA/RD-81/38, 11

Critical Design Activities:

Warning and caution displays may include the following characteristics:

- Ability to provide the procedures (rules) for the alarm handling tasks that have to be accomplished
- Ability to toggle between only active cautions/warnings and a complete cautions/warnings history for the mission
- Ability to sort cautions and warnings by time
- Ability to sort cautions and warnings by severity
- Ability to sort cautions and warnings by system

The HSI alerting system database should be flexible enough to be able to accommodate new alerts in a manner that does not require additional discrete enunciators

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.2.4.2. Operator Actions in response to an Alert

Each alarm should trigger, as far as possible, one task for the human operator and the corresponding advice should directly accompany the alarm.

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

Operator Acknowledgement of Critical Warnings

The operator shall be required to acknowledge all critical warnings.

- | | | | | |
|---|--|--|---|--|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground
Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission
Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post
Flight |
| <input checked="" type="checkbox"/> Ground
Operations | | | | |

Source:

NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.3. Assess the Criticality of the Hazard

The HSI shall enable the pilot to assess the criticality of the Hazard

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

The HSI shall enable the Pilot to assess a Potential Hazard. The amount of information necessary to quantify and qualify the hazard will vary depending on how the Manufacturer develops the system.

Reference(s):

The ROA System shall Evaluate collision potential

Source(s):

Access 5 Program. SEIT Approved CCA Functional Requirements, Functional Requirement #2

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.4. Develop a Hazard Avoidance Solution

The HSI shall facilitate the development of a Hazard Avoidance Solution through interaction with the Pilot.

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

The HSI shall enable the Pilot to create, process, and review hazard avoidance solutions. The role of the Pilot in the Development of a Hazard Avoidance Solution will vary depending on how the Manufacturer develops the system. For example, the Manufacturer may develop a system where a different member of the flight crew (analogous to a Navigator in Manned Aircraft) is responsible for developing Hazard Avoidance Solutions. The “Navigator” flight crew member would then need to be able to communicate the solution to the Pilot.

Reference(s):

The ROA System shall Enable the Pilot to Determine optimum maneuver

Source(s): Access 5 Program. SEIT Approved CCA Functional Requirements, Functional Requirement #3

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The information provided by the system should enable the flight crew to perform conflict resolutions, or respond to resolution guidance in a timely manner. In support of this, the system should generate a sense of confidence in the flight crew that they are seeing all of the traffic relevant to performing these resolution responses, or that the system is considering in generating resolution guidance. Otherwise, responses may be tentative and delayed, or competing resolutions may appear better suited to the conflict. Similarly, when the system is used for purposes of monitoring separation, or enhanced visual acquisition, the coverage (surveillance) provided by the system should be consistent and compatible with flight crews’ mental and visual models. As a general statement, the information provided by the system should enable the flight crew to respond in an appropriate manner and should not promote incorrect or unproductive response patterns.

Evaluation Procedure:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

Evaluation Rationale:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

1.4.1. Escape Maneuver Display

The ROA System shall present an Escape Maneuver Display

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Access 5 Program CCA - C3 Requirements
Performance Based Guideline:

Reference(s):

Critical Design Activities:

The escape maneuver display shows the recommended corrective maneuver to avoid collision. The escape maneuver display should:

- Be visible to any station capable of flying the aircraft and within 15 degrees of centerline of vision for the flying pilot
- Present maneuvers pictorially
- Erase automatically when the alerting situation no longer exist

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.4.1.1. Contents of Recommended Procedures

The procedures provided should consist of context specific, procedural task knowledge.

- | | | | | |
|---|--|--|---|--|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground
Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission
Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post
Flight |
| <input checked="" type="checkbox"/> Ground
Operations | | | | |

Source:

NATO STANAG 4568

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The advice should be minimal, not more than necessary. Each individual procedure should however describe a complete problem-solving path to accomplish the goal.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.5. Implement the Hazard Avoidance Solution

The HSI shall facilitate the Pilot in implementing the Hazard Avoidance Solution.

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

The HSI shall provide the Pilot with information necessary to execute the Hazard Avoidance Solution. Relevant information may include: time to impact, distance to impact, urgency, etc. The amount of information required vary depending on how the Manufacturer develops the system.

Reference(s):

The ROA System shall Enable the Pilot to Initiate and complete maneuver
Source(s): Access 5 Program. SEIT Approved CCA Functional Requirements, Functional Requirement #4

The ROA System shall Enable the Pilot to Respond to Threats
Source(s): NATO STANAG 4568

The ROA System shall provide the pilot with the ability to avoid hazardous weather
Source(s): Access 5 Program. SEIT Approved HSI Functional Requirements, Functional Requirement #5c

The ACS shall display contingency management data to the pilot.

Source(s):

Human Systems Integration Pilot-Technology Interface Requirements for Contingency Management; Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002. para 3.8.15.

Critical Design Activities:

The CCA human system interface shall be capable of providing sufficiently detailed information of potentially conflicting traffic by enabling an ROA pilot to assess the probability of a collision even though visual acquisition of the intruding aircraft is not achieved.

Example Implementation Concepts:

Performance Rationale and Background:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

The ROA System shall provide the pilot with the ability to handle contingencies, emergencies and other abnormal conditions with the equivalent level of safety of manned aircraft. For critical software, systems, or equipment, there shall be a clear, step-by-step description of procedures to be conducted in the event of failure. The pilot should be provided with sufficient information to diagnose warning system operation or contingency management functions.

Evaluation Procedure:

Evaluation Rationale:

1.5.1. System Maneuvering based on Pilot Assessment

The ROA System shall Maneuver Based on ROA Pilot Assessment

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Access 5 Program CCA - C3 Requirements

Performance Based Guideline:

Reference(s):

Critical Design Activities:

The CCA human system interface shall enable the ROA pilot to maneuver the ROA based upon the ROA pilot assessment. All necessary flight controls shall be available to perform an evasive maneuver of the ROA.

The operator should have the controls to implement contingency plans as necessary.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

1.5.2. Pilot Control of Contingency Management Information

The pilot shall have control capability to obtain access to contingency management functions.

- | | | | | |
|--|---|--|---|---|
| <input checked="" type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input checked="" type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Human Systems Integration Pilot-Technology Interface Requirements for Cooperative Conflict Avoidance;

Performance Based Guideline:

Reference(s):

Human Factor Considerations in the Design of Multifunction Display Systems for Civil Aircraft, Aerospace Recommended Practice (ARP) 5364. Society of Automotive Engineers, March, 2003. para. 5.9.

Human Factors Design Guide Update, Report Number DOT/FAA/CT-96/01. Federal Aviation Administration. 2002. para 3.8.15.

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

The pilot should be provided with sufficient controls to control warning system operation or contingency management functions.

Evaluation Procedure:

Evaluation Rationale:

1.6. Assess Effectiveness of Avoidance Maneuver

The HSI shall enable the Pilot to review the effectiveness of the Implemented Hazard Avoidance Solution.

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

The ROA System shall Enable the Pilot to Assess adequacy of maneuver

Source(s): Access 5 Program. SEIT Approved CCA Functional Requirements, Functional Requirement #5

The ROA System shall Enable ROA Pilot Reassessment

Source(s): Access 5 Program CCA - C3 Requirements

Provide information as to the adequacy of corrective actions

The HSI shall provide the Pilot with information necessary to assess the adequacy of corrective actions

Source(s):

Aircraft Alerting System Standardization Study

Critical Design Activities:

The CCA human system interface shall allow the ROA pilot to reassess the probability of a collision after an initial maneuver has been made. If the potential for collision is eliminated, then no further action is necessary. However, if the potential for a collision still exists, the CCA human system interface shall allow the ROA pilot to observe the new collision potential, determine the most optimum maneuver, and execute it in a timely manner to avoid the collision.

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale:

The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.

1.6.1. Expected Aircraft Position

The HSI shall enable the Pilot to evaluate whether the aircraft performed as expected during and after a Hazard Avoidance Solution with regard to aircraft position.

- | | | | | |
|--|---|--|---|---|
| <input type="checkbox"/> Preflight | <input checked="" type="checkbox"/> Ground Operations | <input checked="" type="checkbox"/> Takeoff | <input checked="" type="checkbox"/> Climb | <input checked="" type="checkbox"/> Enroute |
| <input checked="" type="checkbox"/> Mission Operations | <input checked="" type="checkbox"/> Descent | <input checked="" type="checkbox"/> Approach | <input checked="" type="checkbox"/> Landing | <input type="checkbox"/> Post Flight |
| <input checked="" type="checkbox"/> Ground Operations | | | | |

Source:

Performance Based Guideline:

Reference(s):

Critical Design Activities:

Example Implementation Concepts:

Performance Rationale and Background:

Evaluation Procedure:

Evaluation Rationale: