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## COVER SHEET

### Access 5 Project Deliverable

**Deliverable Number:** *HSI011*

**Title:** *Step 1: Human System Integration Pilot-Technology Interface Requirements for Weather Management*

**Filename:**

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**Abstract:**

*This document involves definition of technology interface requirements for Hazardous Weather Avoidance. Technology concepts in use by the Access 5 Weather Management Work Package were considered. Beginning with the Human System Integration (HSI) high-level functional requirement for Hazardous Weather Avoidance, and Hazardous Weather Avoidance technology elements, HSI requirements for the interface to the pilot were identified. Results of the analysis describe (1) the information required by the pilot to have knowledge of hazardous weather, and (2) the control capability needed by the pilot to obtain hazardous weather information. Fundamentally, these requirements provide the candidate Hazardous Weather Avoidance technology concepts with the necessary human-related elements to make them compatible with human capabilities and limitations. The results of the analysis describe how Hazardous Weather Avoidance operations and functions should interface with the pilot to provide the necessary Weather Management functionality to the UA-pilot system. Requirements and guidelines for Hazardous Weather Avoidance are partitioned into four categories: (1) Planning En Route (2) Encountering Hazardous Weather En Route, (3) Planning to Destination, and (4) Diversion Planning Alternate Airport. Each requirement is stated and is supported with a rationale and associated reference(s).*

**Status:**

<b>Document Status</b> <b>Work in Progress</b>

**Limitations on use:**

*This document is an interim deliverable. It 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.*

# **Step 1: Human System Integration Pilot-Technology Interface Requirements for Weather Management**



Access 5

August 31, 2005

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## Executive Summary

Access 5 is a NASA-led project tasked to recommend the policies, procedures, and functional requirements that will ensure High Altitude Long-Endurance (HALE) Unmanned Aircraft Systems (UAS) operate as safely as other routine users of the National Airspace System (NAS). Four phases or “STEPS” are planned to systematically develop the necessary technology, policies and regulations to enable manufacturers to apply for Federal Aviation Administration (FAA) certification and approval needed to operate their civil UAS in the NAS. Current (FY05) effort limits focus to UASs that operate above 43,000 feet (STEP 1).

In order for UAS to be integrated into the NAS, it is necessary to identify the human systems integration requirements that ensure safe operations in the NAS. As a result, the Human System Integration (HSI) Work Package was established within the overall Access 5 program to address this objective. In FY05, several HSI products were developed to contribute to overall program objectives.

This product involves definition of technology interface requirements for Hazardous Weather Avoidance. This was performed through a review of weather-related, HSI requirements documents, standards, and recommended practices. Technology concepts in use by the Weather Management WP were assessed also.

Beginning with the HSI high-level functional requirement for Hazardous Weather Avoidance, and Hazardous Weather Avoidance technology elements, HSI requirements for the interface to the pilot were identified. Results of the analysis describe (1) the information required by the pilot to have knowledge of hazardous weather, and (2) the control capability needed by the pilot to obtain hazardous weather information. Fundamentally, these requirements provide the candidate Hazardous Weather Avoidance technology concepts with the necessary human-related elements to make them compatible with human capabilities and limitations. The results of the analysis describe how Hazardous Weather Avoidance operations and functions should interface with the pilot to provide the necessary Weather Management functionality to the UA-pilot system.

Requirements and guidelines for Hazardous Weather Avoidance are partitioned into four categories: (1) Planning En Route (2) Encountering Hazardous Weather En Route, (3) Planning to Destination, and (4) Diversion Planning Alternate Airport.

Each requirement is stated and is supported with a rationale and associated reference(s).

## Acronym List

ATC	Air Traffic Control
ACS	Aircraft Control Station
AIRMET	Airman Meteorological Information
ASOS	Automated Surface Observation System
BLOS	Beyond-Line-of-Sight
CIP	Current Icing Potential CWA Center Weather Advisory
DUATS	Direct User Access Terminal System
EWINS	Enhanced Weather Information System
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FISDL	Flight Information Services Data Link
FRD	Functional Requirements Document
FSS	Flight Service Station
GTG	Graphical Turbulence Guidance
HIWAS	Hazardous In Flight Weather Advisory Service
HSI	Human System Integration
LOS	Line-of-Sight
NCWF	National Convective Weather Forecast
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather service
PIREP	Pilot Report
SIGMET	Significant Meteorological Information
SWPCS	Situational Weather Product Classification & Selection
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
WP	Work Package
WW	Weather Warnings

# 1. Introduction

## 1.1. Background

Access 5 is a NASA-led project tasked to recommend the policies, procedures, and functional requirements that will ensure High Altitude Long-Endurance (HALE) Unmanned Aircraft Systems (UAS) operate as safely as other routine users of the National Airspace System (NAS). Four phases or “STEPS” are planned to systematically develop the necessary technology, policies and regulations to enable manufacturers to apply for Federal Aviation Administration (FAA) certification and approval needed to operate their civil UAS in the NAS. Current (FY05) effort limits focus to UASs that operate above 43,000 feet (STEP 1).

In order for UAS to be integrated into the NAS, it is necessary to identify the human systems integration requirements that ensure safe operations in the NAS. As a result, the Human System Integration (HSI) Work Package was established within the overall Access 5 program to address this objective. In FY05, several HSI products were developed to contribute to overall program objectives. The FY05 HSI effort followed a standard, HSI process methodology that produced the following deliverables (Figure 1):

Deliverable 1: Human System Integration Step 1 Functional Requirement Document (FRD)

Deliverable 2: Human System Integration (HSI) Step 1 Design Guidelines for the Unmanned Aircraft System (UAS) Ground Control Station

Deliverable 3: High Altitude Long Endurance (HALE) Unmanned Aircraft System (UAS) Pilot Rating Criteria (Draft)

Deliverable 4: HSI Requirements and Guidelines for Experimental Certification of the Unmanned Aircraft System

Deliverable 5: Human Systems Integration Step 1 Pilot-Technology Interface Requirements

Deliverable 5a: Human Systems Integration Step 1 Pilot-Technology Interface Requirements for Command, Control, and Communications (C3) in Unmanned Aircraft Systems

Deliverable 5b: Human Systems Integration Step 1 Pilot-Technology Interface Requirements for Collision Avoidance in Unmanned Aircraft Systems

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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.*

Deliverable 5c: Human Systems Integration Step 1 Pilot-Technology Interface Requirements for Contingency Management System in Unmanned Aircraft Systems

Deliverable 5d: Human Systems Integration Step 1 Pilot-Technology Interface Requirements for the Weather System in Unmanned Aircraft Systems

Deliverable 6: Human Systems Integration Support to Simulation and Flight Test for Step 1

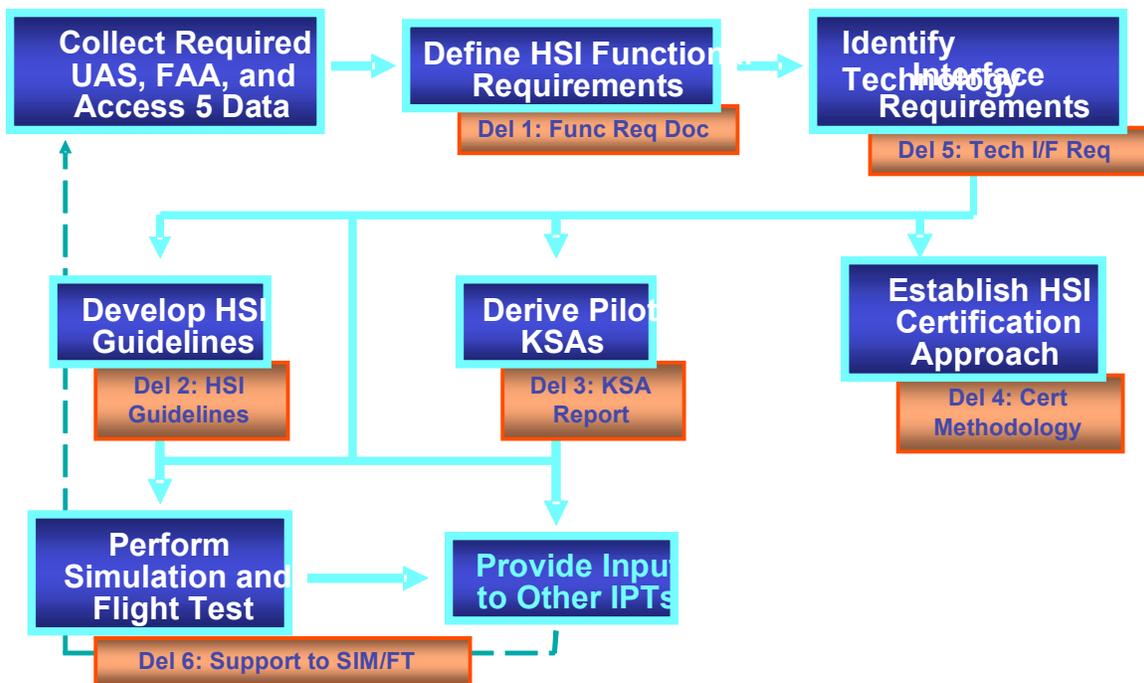


Figure 1. FY05 HSI Process and Deliverable Overview

## 2. Document Purpose

The purpose of this document is to define HSI technology interface requirements for Weather Management.

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Research of human capabilities and limitations known for Hazardous Weather Avoidance was performed through a review of HSI requirements documents, standards, and recommended practices.

Technology concepts in use by the Weather Management WP were assessed.

Beginning with the HSI high-level functional requirement for Hazardous Weather Avoidance, and Hazardous Weather Avoidance technology elements, HSI requirements for the interface to the pilot were identified. Results of the analysis describe (1) the information required by the pilot to have knowledge of hazardous weather, and (2) the control capability needed by the pilot to obtain hazardous weather information. Fundamentally, these requirements provide the candidate Hazardous Weather Avoidance technology concepts with the necessary human-related elements to make them compatible with human capabilities and limitations. The results of the analysis describe how Hazardous Weather Avoidance operations and functions should interface with the pilot to provide the necessary Weather Management functionality to the UA-pilot system.

Requirements and guidelines for Hazardous Weather Avoidance are partitioned into four categories: (1) Planning En Route (2) Encountering Hazardous Weather En Route, (3) Planning to Destination, and (4) Diversion Planning Alternate Airport.

Each requirement is stated and is supported with a rationale and associated reference(s).

### 3. Scope

#### 3.1. Ground Rules

3.1.1. Requirements are based on Access 5 Program Weather Management Work Package (WP) requirements and concepts as well as HSI standards and recommended practices.

3.1.2. Requirements defined are for the Access 5 program, Step 1, which limits scope to Weather Management only for flight above FL430.

3.1.3. HSI Requirement Verification for dynamic operations (e.g., pilot assessment and diversion in response to severe weather) requires verification in a dynamic environment (i.e., simulation or flight test). HSI Requirement Verification for static operations (e.g., description of a weather access control function) does not

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require verification in a dynamic environment, e.g., to be verified by analysis.

- 3.1.4. Requirements defined are independent of any design solution except those specified by the Weather Management WP.
- 3.1.5. No distinction is made between Weather Management requirements for line-of-sight (LOS) and beyond-line-of-sight (BLOS) HSI requirements
- 3.1.6. Requirements do not distinguish between a UAS ACS equipped or not equipped with datalink capability for receiving weather information directly.
- 3.1.7. Hazardous weather includes: 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<sup>1</sup>.
- 3.1.8. 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<sup>2</sup>, AIRMET<sup>3</sup>, SIGMET<sup>4</sup>, WW<sup>5</sup>, convective SIGMET<sup>6</sup>, HIWAS<sup>7</sup>, and/or CWA<sup>8</sup> information.

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<sup>1</sup> 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.

<sup>2</sup> **PILOT WEATHER REPORT (PIREP)** - A report of meteorological phenomena encountered by aircraft in flight.

<sup>3</sup> **AIRMEN METEOROLOGICAL INFORMATION (AIRMET)** - In-flight weather advisories issued only to amend the area forecast concerning weather phenomena which are of operational interest to all aircraft and potentially hazardous to aircraft having limited capability because of lack of equipment, instrumentation, or pilot qualifications. AIRMETs concern weather of less severity than that covered by SIGMETs or Convective SIGMETs. AIRMETs cover moderate icing, moderate turbulence, sustained winds of 30 knots or more at the surface, widespread areas of ceilings less than 1,000 feet and/or visibility less than 3 miles, and extensive mountain obscurement.

<sup>4</sup> **SIGNIFICANT METEOROLOGICAL INFORMATION (SIGMET)** - A weather advisory issued concerning weather significant to the safety of all aircraft. SIGMET advisories cover severe and extreme turbulence, severe icing, and widespread dust or sandstorms that reduce visibility to less than 3 miles.

<sup>5</sup> **SEVERE WEATHER FORECAST ALERTS/ SEVERE WEATHER WATCH BULLETIN (WW)**- Preliminary messages issued in order to alert users that a Severe Weather Watch Bulletin (WW) is being issued. These messages define areas of possible severe thunderstorms or tornado

- 3.1.9. 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).
- 3.1.10. 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.
- 3.1.11. 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.
- 3.1.12. 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

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activity. The messages are unscheduled and issued as required by the National Severe Storm Forecast Center at Kansas City, Missouri.

<sup>6</sup> **CONVECTIVE SIGMET** - A weather advisory concerning convective weather significant to the safety of all aircraft. Convective SIGMETs are issued for tornadoes, lines of thunderstorms, embedded thunderstorms of any intensity level, areas of thunderstorms greater than or equal to VIP level 4 with an area coverage of  $\frac{4}{10}$  (40%) or more, and hail  $\frac{3}{4}$  inch or greater.

<sup>7</sup> **HAZARDOUS INFLIGHT WEATHER ADVISORY SERVICE (HIWAS)** - This is a continuous broadcast of in-flight weather advisories including summarized AWW, SIGMETs, Convective SIGMETs, CWAs, AIRMETs, and urgent PIREPs. HIWAS has been adopted as a national program and will be implemented throughout the conterminous U.S. as resources permit. In those areas where HIWAS is commissioned, ARTCC, Terminal ATC, and AFSS/FSS facilities have discontinued the broadcast of in-flight advisories as described in the preceding paragraph. HIWAS is an additional source of hazardous weather information which makes these data available on a continuous basis. It is not, however, a replacement for preflight or in-flight briefings or real-time weather updates from Flight Watch (EFAS).

<sup>8</sup> **CENTER WEATHER ADVISORY (CWA)** - An unscheduled weather advisory issued by Center Weather Service Unit meteorologists for ATC use to alert pilots of existing or anticipated adverse weather conditions within the next 2 hours. A CWA may modify or redefine a SIGMET.

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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<sup>9</sup>:

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.

*NOTE-*

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

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

3.1.14. The FAA has determined that operators and pilots may utilize the following approved sources of aviation weather information<sup>10</sup>:

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

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<sup>9</sup> Aeronautical Information Manual, para. 7-1-3.

<sup>10</sup> Aeronautical Information Manual, para. 7-1-3.

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). An EWINS is an FAA approved, proprietary system for tracking, evaluating, reporting, and forecasting the presence or lack of adverse weather phenomena. An 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.

NOTE-

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.

3.2. Assumptions

3.2.1. Weather dissemination system operation is normal, all modes are fully-operational, no inhibits are active, and there are no partial failures.

3.2.2. The pilot has all necessary control and display capabilities in the ACS to satisfy HSI requirements for obtaining weather data.

#### 4. Method

Research and documentation of human capabilities and limitations known for Weather Management was performed through a review of HSI requirements documents, standards, and recommended practices. Sources examined include Aeronautical Information Manual; FAA regulatory and advisory material; FAA Human Factors Design Guide; other key research papers.

The technology concepts in use by the Weather Management WP were assessed. These are described above. Program documents were also used as reference material.<sup>11</sup>

For these Weather Management technology elements, HSI requirements for the interface to the pilot (in the form of pilot information and control requirements) were identified. Fundamentally, these requirements provide the candidate technology concepts with the necessary human-related elements to make them compatible with human capabilities and limitations.

#### 5. Technology Interface Requirements

The HSI FRD describes the highest level functional requirement for hazardous weather avoidance as follows: "The Human System Interface shall convey information to the pilot to avoid hazardous weather."<sup>12</sup> Technology interface requirements in this document fall under this requirement.

Technology interface requirements are a necessary element of the HSI functional decomposition analysis of Weather Management Functional and Performance requirements. The results of the analysis describe how Weather Management operations and functions should interface with the pilot to provide the necessary Hazardous Weather Avoidance functionality to the UA-pilot system.

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<sup>11</sup> Weather Requirements & Procedures for Step 1. March 2005.

Step 1: Functional Requirements Document, Preliminary Draft. May 2005

<sup>12</sup> Step 1: Human System Integration (HSI) Functional Requirements Document (FRD), Version 1.1, July 2005.

They represent high-level, requirements for (1) pilot control of a Weather Management system and (2) information required by the pilot to understand current and forecast hazardous weather.

Requirements and guidelines for Hazardous Weather Avoidance are partitioned into four categories: (1) Planning En Route (2) Encountering Hazardous Weather En Route, (3) Planning to Destination, and (4) Diversion Planning Alternate Airport.

Each requirement is stated and is supported with a rationale and associated reference(s).

## 5.1. Planning En Route

5.1.1. ACS Display of Hazardous Weather Data (Display Requirement). The ACS shall display hazardous weather data for en route hazardous weather avoidance purposes in accordance with the guidelines described in 3.1.12, 3.1.13, and 3.1.14.

5.1.1.1. Rationale. While en route, the pilot is required to operate the aircraft safely by, in part, avoiding hazardous weather. Hazardous weather is defined in 3.1.7.

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 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.<sup>13</sup>

5.1.2. Pilot Control of Hazardous Weather Data (Control Requirement). The pilot shall have control capability to obtain access to en route hazardous aviation weather information from service providers.

5.1.2.1. Rationale. 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. These providers currently include those defined in 3.1.8, 3.1.9, 3.1.10, and

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<sup>13</sup> Aeronautical Information Manual, Chapter 7. February 17, 2005.  
FAR 91.167 Fuel requirements for flight in IFR conditions.

3.1.11. The pilot shall have the capability to contact one or more of these providers.<sup>14</sup>

## 5.2. Encountering Hazardous Weather En Route

5.2.1. ACS Display of Hazardous Weather Effects on the UA (Display Requirement). The ACS shall display hazardous weather data that affects UA safety of flight.

5.2.1.1. Rationale. 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.<sup>15</sup>

5.2.2. Pilot Control of Data Describing Hazardous Weather Effects on the UA (Control Requirement). The pilot shall have control capability to obtain information describing the effect of hazardous weather of the UA.

5.2.2.1. Rationale. This pilot shall be able to affect systems control to obtain any and all data regarding the UA to determine the impact on it of hazardous weather.<sup>16</sup>

5.2.3. Pilot Control of Hazardous Weather Countermeasures (Control Requirement). If a UA encounters hazardous weather, and it is equipped with countermeasures, the pilot shall have control capability to activate the countermeasure(s).

5.2.3.1. Rationale. Once encountering hazardous weather, the pilot will activate systems to support continued safe flight. For example, airframe and engine anti-ice systems provide protection against unexpected icing conditions and defogging systems provide protection

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<sup>14</sup> Aeronautical Information Manual, Chapter 7. February 17, 2005.  
FAR 91.167 Fuel requirements for flight in IFR conditions.

against icing or fogging of sensors. Countermeasures are UA design specific.<sup>17</sup>

5.2.4. ACS Display of Hazardous Weather Countermeasures Status (Display Requirement). If a UA encounters hazardous weather, and it is equipped with countermeasures, the ACS shall display the status and operation of the countermeasure(s).

5.2.4.1. Rationale. Once encountering hazardous weather, the pilot will activate systems to support continued safe flight. Feedback regarding operation of these systems is required for the pilot to know that the systems are or are not operating properly.<sup>18 19</sup>

### 5.3. Planning to Destination

5.3.1. ACS Display of Hazardous Weather Data (Display Requirement). The ACS shall display hazardous weather data for the destination airport for hazardous weather avoidance purposes in accordance with the guidelines described in 3.1.12, 3.1.13, and 3.1.14.

5.3.1.1. Rationale. While en route, the pilot routinely reviews updated and timely destination weather data. If no hazardous weather is forecast for the destination at the UA's estimated time of arrival (ETA), the pilot will maintain the current flight plan and proceed to the destination.<sup>20</sup>

5.3.2. Pilot Control of Hazardous Weather Data (Control Requirement). The pilot shall have control capability to obtain access to destination airport forecast hazardous weather available from weather information service providers.<sup>21</sup>

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<sup>15</sup> Instrument Flying Handbook. FAA-H-8083-15. Chapter 10 and 11. 2001

<sup>16</sup> Instrument Flying Handbook. FAA-H-8083-15. Chapter 10 and 11. 2001

<sup>17</sup> Instrument Flying Handbook. FAA-H-8083-15. Chapter 11. 2001

<sup>18</sup> Instrument Flying Handbook. FAA-H-8083-15. Chapter 11. 2001

<sup>19</sup> 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,

<sup>20</sup> Aeronautical Information Manual, Chapter 4 and 7. February 17, 2005.

FAR 91.167 Fuel requirements for flight in IFR conditions.

<sup>21</sup> Aeronautical Information Manual, Chapter 4 and 7. February 17, 2005.

FAR 91.169. IFR flight plan: Information Required.

5.3.2.1. Rationale. This pilot shall be able to contact any provider that the pilot deems necessary to obtain hazardous weather data for the destination, on which safety of flight decisions are to be made. These providers currently include those defined in 3.1.8, 3.1.9, 3.1.10, and 3.1.11. The pilot shall have the capability to contact one or more of these providers.

#### 5.4. Diversion Planning to Alternate Airport

5.4.1. ACS Display of Hazardous Weather Data (Display Requirement). The ACS shall display hazardous weather data for alternate airport(s) for hazardous weather avoidance purposes in accordance with the guidelines described in 3.1.12, 3.1.13, and 3.1.14.

5.4.1.1. Rationale. While en route, the pilot routinely reviews updated and timely destination weather data. If hazardous weather is forecast for the destination at the UA's ETA, or another factor prohibits the aircraft from landing at the destination, the pilot will divert to an alternate airport. Hazard weather forecast information shall be made available for the alternate(s).<sup>22</sup>

5.4.2. Pilot Control of Hazardous Weather Data (Control Requirement). The pilot shall have control capability to obtain access to alternate airport(s) forecast hazardous weather available from weather information service providers.

5.4.2.1. Rationale. This pilot shall be able to contact any provider that the pilot deems necessary to obtain hazardous weather data for one or more alternate airports, on which safety of flight decisions are to be made. Forecast data shall be made available for the UA's ETA at each alternate airport. Providers currently include those defined in 3.1.8, 3.1.9, 3.1.10, and 3.1.11. The pilot shall have the capability to contact one or more of these providers.<sup>23</sup>

## 6. Future Work

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<sup>22</sup> Aeronautical Information Manual, Chapter 4 and 7. February 17, 2005.

FAR 91.169. IFR flight plan: Information Required.

<sup>23</sup> Aeronautical Information Manual, Chapter 4 and 7. February 17, 2005.

#### 6.1. Step 1 Lower Level Information and Control Requirements.

The requirements described in this document represent a high level definition for pilot information and control capability. Future work is required to continue this analysis to the level appropriate to the needs of the program and its customers, (e.g., the FAA). Lower level information and control requirements will provide the FAA and manufacturers with an appropriate level of guidance without restricting the flexibility of design. The level of detail required is exemplified in FAR 23.777, "Means must be provided to indicate to the flight crew the tank or function selected." For Access 5 purposes, an analogous information requirement would read, "(For the top-level, Aviate functional requirement) A means must be provided at the ACS to indicate to the pilot the tank or function selected." Once this level of detail is developed for each top-level functional requirement, the information and control requirements definition effort for Step 1 will be complete.

#### 6.2. Step 2, 3, and 4 Information and Control Requirements.

After work for Step 1 has been completed, information and control requirements analyses are necessary for the succeeding Steps. The analysis will follow the functional requirements developed for these Steps and will focus on phases from takeoff to cruise and from cruise to landing. The analysis for altitudes between approximately FL180 and FL430 will require only minor additions to Step 1 results. Significantly new information will be produced from this analysis for the critical takeoff, climb, approach, and landing phases.

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