10.2 WEATHER INTEGRATION CONCEPT OF OPERATIONS FOR TRANSFORMING THE NATIONAL AIRSPACE SYSTEM

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1.0 INTRODUCTION

1.1 Background

The Joint Planning and Development Office (JPDO) is developing the Next Generation Air Transportation System (NGATS) concept for 2025. The NGATS concept envisions safe, efficient and reliable movement of large numbers of people and goods throughout the air transportation system in a way that is consistent with national security objectives.

The NGATS is being designed to respond to changing user needs and provide cost-effective services that scale up and down as needs change. It will remove many of the constraints in the current system, support a wider range of operations, and deliver an overall system capacity up to three times (3x) that of current operating levels. The NGATS vision will require a system-wide transformation that involves changes and innovations in organization, culture, and policy.

The NGATS 2025 Concept is founded on an underlying set of eight operating principles that permeate every aspect of the vision and are focused on the "user." These eight key capabilities represent characteristics of the NGATS that are missing from today's National Airspace System (NAS). In the NGATS, the more foundational, underpinning capabilities are listed first; while the more narrowly focused, domain-oriented capabilities are listed last. Also, there are multiple interdependencies among these NGATS capabilities.

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Assimilating weather into air traffic management decision making is listed as one of the NGATS foundational, underpinning capabilities and is the third of the eight NGATS operating principles. Today, weather impacts are responsible for nearly 70% of all NAS delays over 15 minutes (ACE Plan 2003). To meet the 3x demand in 2025, revolutionary efforts to mitigate weather impacts must be enacted. But in what direction must this revolution evolve?

To help define this revolution in aviation weather support, the JPDO Weather Integrated Product Team (IPT) integration team is developing an NGATS Weather Concept of Operations (CONOPS). The Weather CONOPS uses the NGATS 2025 Concept and the eight key NGATS capabilities to identify the weather support implications and resulting guiding principles for NGATS weather support.

This paper presents the core elements and direction of the NGATS Weather CONOPS. A key purpose of the CONOPS is to facilitate the integration of NGATS-relevant weather information with Air Traffic Management (ATM) decision support tools. Ultimately, the NGATS Weather CONOPS will guide the long-term research and development of NGATS weather information and its integration with ATM decision support tools.

Past practices have typically led to the development of ATM decision support tools and weather information in parallel with little to no regard for how the two should be integrated. This lack of integration has led to less than optimal operational performance of the current NAS. The goal of ATM-Weather Integration is to identify critical NGATS-relevant weather information and develop a combined system of ATM-relevant weather services, and weather-savvy automation and procedures for NGATS decision makers. This paper outlines the NGATS ATM-Weather concepts and potential user needs to achieve the goals of the Next Generation Air Transportation System.

1.2 NGATS Weather Concept of Operations

The first step in the development of the NGATS Weather CONOPS was to determine the use of the document, and the resulting scope and approach. The NGATS Weather CONOPS represents the future vision for aviation weather support concepts in the year 2025. It provides an outline of the principle concepts for providing weather support to NGATS. It also serves as the basis for planning by the JPDO Weather IPT. (Figure 1 below shows the format of the document.)

Figure 1: NGATS Weather Concept of Operations Table of Contents

Section	Title
1.0	Background/Purpose
2.0	NGATS 2025 Concept – Weather Implications/Impacts
3.0	Weather Concept of Operations Principles and Assumptions
4.0	ATS Functions – Weather Support Concepts (2025 Concept)
Appendices	A. Definitions/Acronyms
	B. References
	C. Functional Table Summary
	D. Scenarios a. Full NGATS Performance Capabilities b. Some NGATS Performance Capabilities c. Minimum/No NGATS Performance Capabilities

The remainder of this paper outlines the key capabilities of the NGATS 2025 Concept, with brief descriptions for each of the Weather CONOPS Sections 2 through 4 as outlined in Figure 1 above. The topics discussed provide a general focus for future research and development needs in the area of aviation weather and ATM automation.

It is important to note that the NGATS Weather CONOPS is a living document. The document will continue to evolve as the NGATS 2025 Concept is defined in more detail and as the JPDO IPTs work toward a better understanding of what capabilities will be possible in the next 20 years. It also needs to be emphasized that the NGATS Weather CONOPS does not address the evolution or transition roadmap from the current NAS to the future NGATS weather support systems and procedures; they will be addressed in a separate document.

2.0 NGATS 2025 CONCEPT AND ASSOCIATED WEATHER IMPLICATIONS

The JPDO Agile Air Transportation System (ATS) IPT is responsible for developing the NGATS 2025 Concept. Version 4.8a of that concept was used as the basis of this paper. Background information and earlier versions of the NGATS curb-to-curb vision are available on the JPDO website: http://www.jpdo.aero/.

2.1 NGATS 2025 Key Capabilities

Within the NGATS 2025 Concept (4.8a), there are eight key capabilities. Those capabilities include:

1. Net-Enabled Information Access – The NGATS system will make information available in a secure and useable form and in real-time to support decision making appropriately during normal operations, abnormal events and system-wide crises. Everything operating in the NGATS system becomes part of the system. Even the aircraft become mobile "nodes" in the network.

2. Performance-Based Services – Rather than first come, first served; NGATS will include tiers of air traffic service based on given performance levels (communications, navigation, and surveillance). This will allow the government to move from equipment-based regulations to performance-based regulations. Multiple service levels will permit a wider range of tailored services to better meet individual needs.

3. Weather Assimilated into Decision Making – Through the NGATS Network Enabled Information Access (see item 1 above), a

"common weather picture" will be provided to support NGATS decision making. There will be less emphasis on text and graphical products and greater emphasis on total integration of weather information and products into NGATS decision algorithms and processes; bypassing the need for human interpretation. Computer-based decision making will take advantage of improved probabilistic weather information to make more airspace available to the NGATS system. Differences between forecasts and actual conditions will be measured and analyzed, along with how well this weather information was used in NGATS decision making. The resulting analyses will be used by "learning automation" technology to improve NGATS performance in future situations.

4. Layered, Adaptive Security – The layered adaptive security concept will integrate security functions into NGATS in a way that increases security, while facilitating the movement of more people and requiring proportionally fewer resources to do it.

5. Broad Area Precision Navigation – NGATS will replace the localized-service model with a broad area service. "Instrument landings" will be possible at any "air portal" or location within the coverage area. This will allow better use of small or regional airports that do not have precision navigation aids today.

6. Aircraft Trajectory-Based Operations – The NGATS system will be capable of managing daily operations based on aircraft trajectories rather than today's system which is tied to a fixed NAS airspace structure. NGATS will dynamically adjust the airspace structure to best meet user needs and security requirements. The NGATS trajectory management is "block-to-block" and includes strategic planning (days/weeks/months) as well as separation management (20 minutes or less). An integral component in implementing NGATS trajectory management is the "evaluator" function that continuously evaluates all inputs and demands for mutual compatibility. The evaluator will provide predictions for "over demand" situations and provide proposed resolutions. Weather information and forecast uncertainties will be used to plan aircraft trajectories and respond more effectively to unpredicted weather events.

7. Equivalent-Visual Operations – This capability will provide aircraft with critical information needed to maintain safe distances from other aircraft during non-visual conditions including a capability to operate at "visual performance" levels on the airport surface during low-visibility conditions. With this capability, pilots will assume more responsibility for maintaining safe distances from other aircraft during visual operations, allowing distances between aircraft to be closer than possible during ground-based control. This will lead to greater predictability of operations at busy airports, including ground operations.

8. Super Density Operations – NGATS will match the land and airside throughput of an airport to include reducing separation standards and employing less restrictive runway operations to enable high-capacity traffic operations on the airport surfaces. Separation standards will be reduced in conjunction with the NGATS Performance-Based Services (see item 2 above), as well as better tools to detect and avoid wake vortices. These reductions will result in the ability to perform closely-spaced and converging approaches at distances closer than currently allowed.

2.2 Weather Implications for the NGATS 2025 Concept Key Capabilities

The second step in developing the NGATS Weather CONOPS was to review and evaluate the weather implications of each of the eight NGATS key capabilities listed in paragraph 2.1 above. A small team of the JPDO Weather IPT integration team members performed this evaluation. Based on their expertise, 20 weather implication statements were developed. To facilitate thinking outside-the-box, a second group of team members was asked to independently develop futuristic aviation weather support concepts. The initial set of weather implication statements for each of the key NGATS capabilities are described below.

1. Net-Enabled Information Access. Seven weather support implications are suggested:

All weather information (observations, forecasts, climatology, etc.) is integrated into an

NGATS 4-Dimensional (4-D) weather database, which is the single, authoritative source of data.

Vendors can provide tailored support to meet user needs or missions based on the NGATS 4-D weather database.

Users can integrate air-to-air (aircraft) weather data with 4-D weather database products.

Aircraft have two-way communications to provide weather data, as well as receive data for decision support.

Parity of information (intended information content is the same) is maintained regardless of what node you are on.

Weather support involves both broadcast and addressed enabled communications.

Space weather support needs to be provided for satellite data.

2. Performance-based Service. Three weather support implications are suggested:

Minimum requirements for aircraft equipage with weather sensors are defined.

Aircraft are capable of receiving and transmitting weather information.

Weather impacts are mitigated through aircraft and airframe technology.

3. Weather-Assimilated Decision Making. Three weather support implications are suggested.

Multiple weather observations are fused into the 4-D database.

Weather is assimilated into NGATS "decision loops" in real-time.

"Learning-automation" accounts for uncertainties in weather and managing aircraft trajectories.

4. Layered, Adaptive Security. The following weather support implication is suggested:

Weather data for chemical, biological and nuclear (radiation) security incidents is provided in real-time.

5. Broad Area Precision Navigation. Two weather support implications are suggested:

Observations and forecasts for non-towered airports are provided at the required spatial and temporal resolutions.

Impacts of space weather on the Broad Area Precision Navigation system are identified and appropriate observation and forecast techniques are developed.

6. Trajectory Based Aircraft Operations. Two weather support implications are suggested:

The NGATS 4-D weather database draws upon climatology for long range planning and unusual situations.

The NGATS 4-D weather database provides the NGATS "evaluator" with trajectory-specific weather from months prior to the flight to touch down at destination.

7. "Equivalent Visual" Operations. The following weather support implication is suggested:

The NGATS 4-D weather database provides timely, high fidelity hazardous weather information.

8. "Super Density" Operations. The following weather support implication is suggest:

Wake vortex impacts across all required dimensions are provided for impacted areas.

3.0 GUIDING PRINCIPLES AND ASSUMPTIONS

The third step in developing the NGATS Weather CONOPS was to identify the major attributes and components of weather support necessary to meet the 20 weather support implications outlined in Section 2.2 above. These attributes and components were grouped into Guiding Principles and Assumptions/Constraints for the development of the NGATS Weather CONOPS.

3.1 Guiding Principles

Guiding Principles for NGATS weather support are firm statements of weather support capabilities that are envisioned for 2025. They provide the baseline for the ATS Functions – Weather Support Concepts that will be contained in Section 4 of the NGATS Weather CONOPS. Eight Guiding Principles were identified and are described below:

NGATS weather support will be a joint agency responsibility.

NGATS operations will evolve toward more collaborative flight management and flight control based on Net Centric Information sharing.

Decision-assistance tools, including graphics, will be the primary method for NGATS weather support.

NGATS weather impact decisions will be based on four criteria: 1) FAR requirements (IFR vs. VFR, Part 121, Part 135, Part 91, etc); 2) Weather avoidance (adverse and/or hazardous); 3) Flight efficiency (favorable winds); and 4) Flight quality (aircrew/passenger stress and/or comfort).

NGATS weather support products will be consistent across all flight domains with continuity from preflight to flight to post-flight operations, including oceanic and international.

Dynamic in-flight rerouting capabilities will be based on the NGATS "evaluator" capability using timely updates of NGATS weather products provided to all users including pilots/aircrews.

NGATS weather system support procedures and concepts will be designed for efficient user integration and application, requiring minimal ATC personnel action for dissemination or interpretation.

Aircraft "Equipped for Service" will include data link capability for: 1) accessing and processing in-flight updates to NGATS weather products; 2) transmitting and receiving aircraft weather data generated through on-board automation such as the Meteorological Data Collection and Reporting System (MDCRS) or a Tropospheric Airborne Meteorological Data Reporting (TAMDAR) type system.

3.2 Assumptions/Constraints

Assumptions and/or Constraints represent those NGATS weather support capabilities that are projected but less certain and imply an element of risk in the envisioned NGATS Weather CONOPS. Four Assumptions and/or constraints were identified and are described below:

NGATS weather support will provide increased resolution in weather product support, both observations and forecasts, to support Super Density operations with reduced aircraft spacing and separation (terminal and en route); also new weather support capabilities for wake vortex/turbulence avoidance.

NGATS weather support will provide increased coverage in airport observations and forecasts (TAFS) for non-towered airports to support increased IFR operations using Broad-Area Precision Navigation (WAAS approaches).

Legacy text weather products will be targeted for elimination in the far-term.

Pilots/aircrews will rely primarily on self-briefing for both preflight planning and in-flight updates with less need for Flight Service Station support.

4.0 AIR TRANSPORTATION SYSTEM FUNCTIONS – WEATHER CONCEPTS FOR 2025

The final section in the NGATS Weather CONOPS will describe the overall concepts for weather support to the NGATS based on the weather support principles and assumptions outlined above in Section 3. Unique needs per user class (e.g., pilot, dispatch, ATS, DoD, DHS) will be highlighted as appropriate. Also, alternative approaches to the weather support concepts will be included, especially futuristic approaches.

The descriptions of the NGATS weather support concepts will be functionally organized using air transportation functions (e.g., flight planning, airspace management, air traffic control). For each function, the NGATS Weather CONOPS will describe the air transportation function, the decisions made in that function and the weather impact to those decisions. The final published version of the NGATS Weather CONOPS will also include scenarios that illustrate how weather support will be provided to typical NGATS flight operations under varying flight conditions.

Although the focus of NGATS and the transformation of the NAS are revolutionary, many of the decisions made today will continue to be made in the future, but the decision maker will frequently change. Additionally, some new decision makers and users will be included in NGATS (e.g., pilots of micro jets and UASs) and some decisions may no longer be needed. As a result, in Section 4, the weather implications will be further developed in association with the function(s) they support. This is where the weather impacting users' decisions will be fully described.

5.0 SUMMARY

The NGATS Weather CONOPS is being developed to describe weather support required to meet the vision for 2025. It will also provide insight into the mitigation capabilities to be implemented in NGATS to reduce the loss of airspace due to weather uncertainty. When completed, the CONOPS will define the JPDO Weather IPT's consensus on how weather will support the continuum of users, from the most NGATS performance capable aircraft to the least, and especially how weather information will be integrated in the myriad NGATS decision support tools.

Much work remains to be done, especially research and development in defining capabilities and attributes of the NGATS 4-D weather database, the application of probabilities in aviation weather support, and the integration of NGATS ATM-Weather concepts.

6.0 ACRONYMS

ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Transportation System
CONOPS	Concept of Operations
DHS	Department of Homeland Security
DoD	Department of Defense
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
IFR	Instrument Flight Rules
IPT	Integrated Product Team
JPDO	Joint Planning and Development Office
MDCRS	Meteorological Data Collection and Reporting System
NAS	National Airspace System
NGATS	Next Generation Air Transportation System
NWS	National Weather Service
TAF	Terminal Aerodrome Forecast
TAMDAR	Tropospheric Airborne Meteorological Data Reporting
UAS	Unmanned Aerial Systems
VFR	Visual Flight Rules
WAAS	Wide Area Augmentation System
4-D	Four Dimensional

7.0 REFERENCES

FAA 2003 Aviation Capacity Enhancement (ACE) Plan, Washington, D.C.

JPDO website (http:/www.jpdo.aero/)

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