



ICAO

International Civil Aviation Organization

**Tenth Meeting of the Air Traffic Management Sub-Group
(ATM/SG/10) of APANPIRG**

Video Teleconference, 17 – 21 October 2022

Agenda Item 6: ATM Coordination (Meetings, Route Development, Contingency Planning)

SPACE ACTIVITY COORDINATION

(Presented by United States)

SUMMARY

This paper presents a proposed process for the timely coordination of space launch and re-entry activities in the Asia-Pacific region.

1. INTRODUCTION

1.1 The under-coordinated integration of space launch and re-entry of operations pose a hazard to airspace users. Decades ago, infrequent launches and lower aviation volume made these events less disruptive. The recent uptick in space operations highlights the need for streamlined coordination between States and airspace users to assure the continued safe and efficient operations of both space and aviation activities.

2. DISCUSSION

Space Launch Overview

2.1 Over the last three years, there has been a marked increase in space operations from the United States (US). As depicted in Error! Not a valid bookmark self-reference., there was a 32% increase in operations between the years 2019 and 2020, and a 53% increase between 2020 and 2021. Cumulative space operations in 2022 will result in another year over year increase. It is important to note, this increased activity is not limited to North America but reflective of the entire space industry in South America, Europe and Asia.

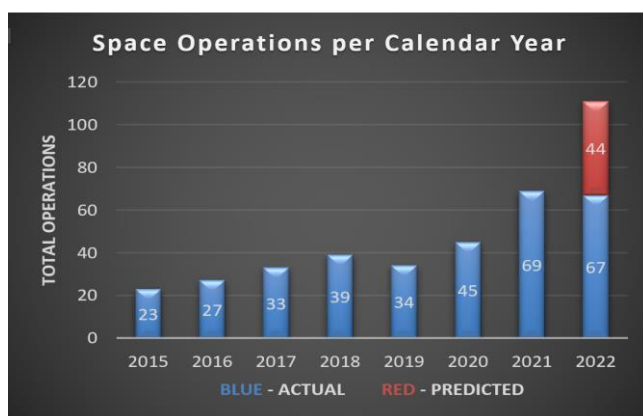


Figure 1: Space Operations per Calendar Year - USA

2.2 Safe and efficient integration of space operations into airspace systems requires evaluation, identification and clearance of areas bounded by predetermined risk tolerances based on system standards. The space launch authority determines the tolerance of risk associated with space operations, while the Air Navigation Service Provider (ANSP) determines the acceptable level of safety in an airspace system. Aircraft Hazard Areas (AHAs) are used to characterize geographic areas subject to higher risk during space operations, which are defined by a series of points, associated dates, times, and duration. Once developed, ANSPs receive AHAs for assessment related to operational impact and the development of mitigation measures. Dissemination of AHAs to airspace users occurs via NOTAMs as Danger Areas.

2.3 During launch and re-entry operations, AHAs segregate launch or re-entry vehicles from non-participating operations. Launch and re-entry AHA locations and durations meet the US regulatory and internationally accepted requirement of 1×10^{-6} probability of individual casualty (fatality or serious injury) per aircraft per launch. Application of this standard permits airspace users and ANSPs a consistent metric to determine level of risk and impact to non-participating airspace.

2.4 In the standard US process, ANSPs have ten days to assess and coordinate AHA requests within their FIRs and stakeholder organizations, depending on mission complexity and requirements. ANSPs develop route structures around AHAs through collaboration with affected air traffic facilities. Parallel discussions take place among airspace user forums and military entities to circulate information related to the launch window, AHA coordinates, and backup dates.

2.5 For US-based launches affecting non-US managed airspace, the Federal Aviation Administrations (FAA) leads and/or assists in coordinating required international NOTAMs. Upon receipt of mission specific AHAs, FAA develops NOTAM requests for each affected Flight Information Region (FIR). Once refined in-house, FAA uses Aeronautical Message Handling System (AMHS) to deliver requests and follows up with email notification for added situational awareness.

2.6 Through the decades of space activity, several long-standing relationships and coordination processes with military and State or regional space agencies remain efficient and effective in assuring timely notification of affected airspace users and ANSPs. Many of the best practices are reflected in the proposals contained within this paper.

Past Regional Challenges

2.7 Prior coordination efforts that did not allow ANSPs or stakeholders to assess mission impacts or provide timely feedback have occurred. These instances posed unacceptable risk to airspace users. With proper coordination, these situations are avoidable. In some instances where ANSPs were notified late, or not at all, AHAs were not coordinated in a way that allowed timely promulgation of Danger Area NOTAMs. Similarly, undeveloped coordination channels have led to gaps in the process responsible for notifying ANSPs of changes following successful launch resulting in unnecessary closures of airspace for extended periods of time.

2.8 For many States, the launch authority is not the Civil Aviation Authorities (CAA), but the military or an independent space agency. Typically, the space launch authority coordinates well with the CAA for launch activities affecting the States own airspace. In cases where the hazard area extends beyond the State's sovereign or delegated airspace, additional coordination is required but occasionally not completed. There are some examples where the State-to-State notification occurred through diplomatic channels and failed to include the associated CAAs for further coordination with ANSPs.

Intragovernmental Challenges

2.9 Traditionally, the military or the National Aeronautics and Space Administration (NASA) managed US government sponsored space operations. Stakeholders for these operations included launch proponents, and the Federal Range, who coordinated with other government agencies for airspace and mariner notifications on behalf of the launch proponent. Due to changes in US policy, interests of the government are no longer exclusively carried out on State-owned vehicles. Payloads brought to orbit on commercially licensed vehicles require the involvement of the US commercial space regulator, the FAA's Office of Commercial Space (AST).

2.10 The US developed an internal process to assure a unified approach to, and mutual awareness of, US space activity affecting airspace outside the US FIR. This transition meant to address several occasions where multiple parties attempted independent coordination with a common external stakeholder.

Frequently Affected Geographic Areas

2.11 While uncontrolled re-entries occur on occasion, most re-entries are planned, controlled and pre-coordinated. Re-entry locations are determined based on downstream impacts of the ground track after completing mission requirements. For final rocket stages that enter orbit with their payloads, best practice is to identify a safe location in the ocean, and perform a controlled reentry over such uninhabited areas. Re-entry trajectories impose the lowest acceptable risk to air and surface traffic while avoiding land and populated areas. These parameters result in the majority of re-entry events occurring in the southern portions of the Pacific, Indian and Atlantic Oceans (see **Figure 2**). Similarly, orbit inclination requirements, including satellite placement needs and planetary alignment, dictate azimuth on ascent while also considering any reduction in risk to non-participants. Assessments for all missions occur prior to mission approval; therefore, precluding operations over land due to exceeded risk tolerances. Therefore, the coordination process must address the concerns and needs of relatively few States.

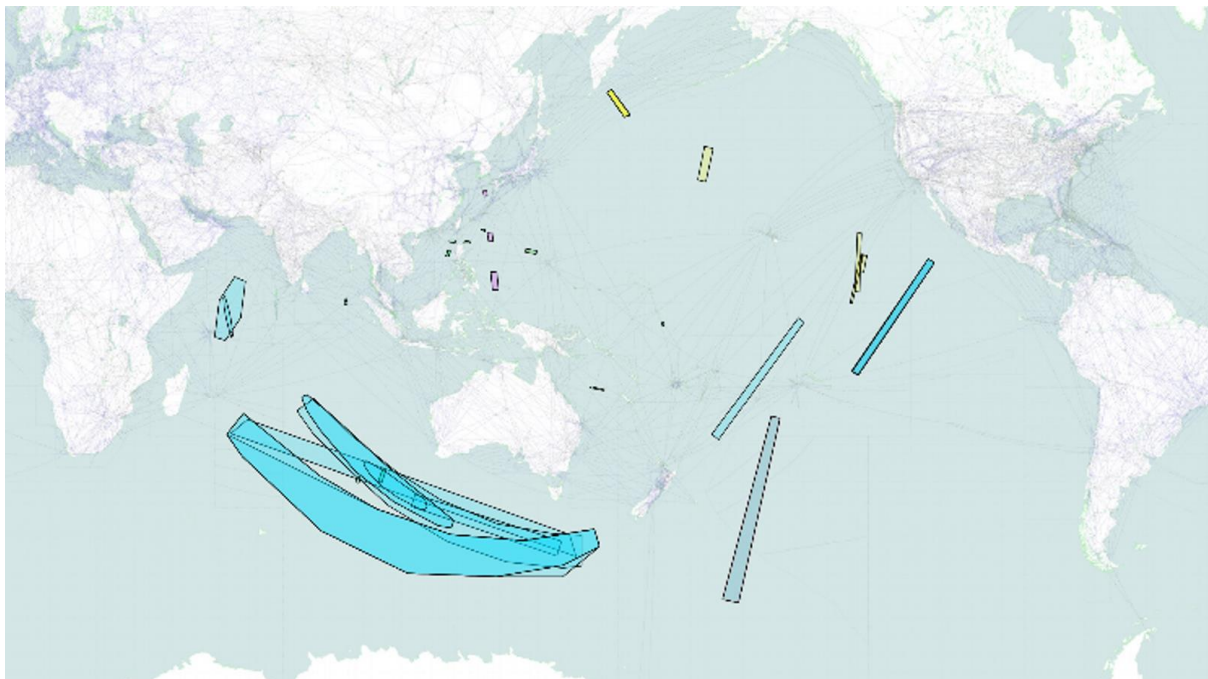


Figure 2: Frequently Affected Geographic Areas – Majority of Re-Entry Events

2.12 **Figure 3** shows AHAs for missions coordinated by the US during the year 2022. The map depicts heavily impacted areas in the Indian and Pacific Oceans. FAA conducted extensive outreach during the development of space NOTAM coordination procedures, particularly with regions affected most frequently. States including Argentina, Australia, Fiji, Mauritius and Tahiti, now use AMHS as the primary means for operational coordination of NOTAMs, with supplemental awareness materials sent through email. Due to the frequency of coordination with these States, the streamlined process has increased efficiency and reduced overall workload, while utilizing existing infrastructure at no additional cost.

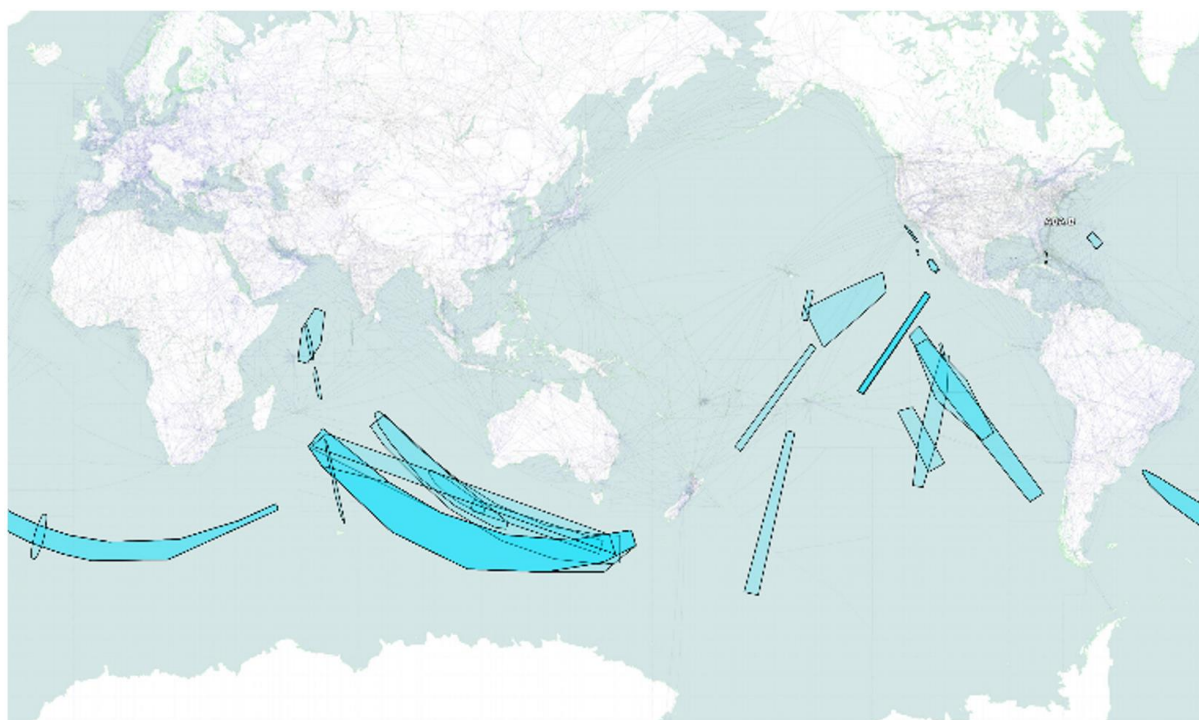


Figure 3: AHAs for Missions Coordinated by the US - 2022

Regional Guidance

2.13 Recognizing the need for improved coordination, Asia Pacific (APAC) States developed high-level procedures and described in broad terms, the process necessary to conduct effective coordination. These were approved at APANPIRG/29 and codified in Volume III of the Air Navigation Plan and identical text in the APAC Seamless Air Navigation Services (ANS) Plan v3.0.

2.14 Specifically, all States with organizations that conduct ballistic launch or space re-entry activities should ensure:

- The development of written coordination agreements between the State civil aviation authority and the launch/re-entry agency concerned;
- that strategic coordination is conducted between the State civil aviation authority and any States affected by the launch/re-entry activity at least 14 days prior to the proposed activity, providing notice of at least:
 - three days for the defined launch window; and
 - 24 hours for the actual planned launch timing;
- that consideration of affected airspace users and ANSPs is made after consultation, so that the size of the airspace affected is minimized and the launch window is optimized for the least possible disruption to other users ; and

- that communication is established with affected ANSPs to provide accurate and
- timely information on the launch/re-entry activity to manage tactical responses (for example, emergencies and activity completion) (Priority 1).

Note 1: increasingly, ballistic launch and space re-entry activity is being conducted by commercial organizations, so this element applies equally to State or private operations.

Note 2: guidance for States on ballistic launch and space re-entry activity is available on the ICAO Asia/Pacific eDocuments webpage.

2.15 Additionally, ICAO published the Asia/Pacific Planning Checklist for Ballistic Launch and Space Re-Entry as Appendix A to the APANPIRG/29 Report. This checklist provides a template to consider when coordinating space activity with other States.

Process Refinement

2.16 Recognizing the need for improved, simplified, and repeatable coordination processes, the US established procedures for events affecting US airspace and for US-sponsored events affecting airspace outside of US control. The US strives to support space activities by issuing NOTAMs once coordination between launch proponents and affected ANSPs is complete.

2.17 In years prior, proponent States would contact individuals via email or phone to carry out coordination. This resulted in a haphazard and labor-intensive approach as distribution lists quickly became outdated, or key offices were missed. To resolve this internally and ease external NOTAM coordination efforts, US established a single email address (DCCNOTAMS@faa.gov) to receive requests with the words “SPACE COORDINATION” in the subject line. Information received by this address routes to the appropriate offices and organizations for analysis and action. By maintaining a single point-of-contact, external NOTAM requestors no longer need to maintain multiple contacts within the US to execute operational coordination. Additionally, for requests from the US, affected CAAs or ANSPs may respond with questions to a single address whereby the US will assure a prompt response.

2.18 **Figure 4** is a recent example of a NOTAM request sent by China affecting US managed airspace. In June of 2022, China coordinated a NOTAM request with US, detailing the dates, times, and coordinates of a respective AHA. Among the distribution list was (DCCNOTAMS@faa.gov). By including this group box, DCC NOTAMs forwarded the request to office responsible for evaluating space operational impacts in the US FIR. They were able to analyze impacted areas, and further communicate with necessary internal stakeholders prior to the publication of a NOTAM.

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01GGNC01CO
NCS335 RC=01
GG KDZZNAXX
140729 ZBBBYNYX
DEAR COLLEAGUES,
MSG DTG 071103 AIRSPACE FLIGHT ACTIVITY CHANGED AS FLW:
NOF CHINA.

ATTENTION ON DUTY.
AIR TRAFFIC MANAGEMENT BUREAU OF CAAC TO REMIND THE RELEVANT
UNITS
OF ATTENTION.
DUE TO AN AEROSPACE FLIGHT ACTIVITY, THE FLIGHT SAFETY OF THE
AIRCRAFT IN THE FOLLOWING AREAS MAY BE AFFECTED ON JUN 20, 2022.
0212-0238.
WE RECOMMEND THAT THE CIVIL AVIATION AUTHORITIES AND OPERATORS
CONCERNED TAKE THE NECESSARY MEASURES TO ENSURE THE SAFETY OF
FLIGHT. DETAILS ARE AS FOLLOWS:
THE UNBURNED DEBRIS IS EXPECTED TO FALL IN THE S0754E09034, THE
POSSIBLE FALLING AREA WILL NOT EXCEED THE RANGE WITHIN:
S0818E09017-S0823E09038-S0730E09050-S0725E09029, FOUR POINT
CONNECTION RANGE(VPCC-NW,MELBOURNE FIR-YMMM). VERTICAL ALTITUDE:
SFC-UNL.

ANY CHANGES TO THE SCHEDULE WILL BE FORWARDED TO YOU IMMEDIATELY.
THANK YOU FOR COOPERATION.
OPERATION SUPERVISORY DIVISION OF OPERATION SUPERVISORY CENTER OF
CAAC IS RESPONSIBLE FOR CONSULTING THE SPACEFLIGHT ACTIVITY
NOTIFICATION ISSUED BY CAAC.
AFS: ZBBBZGZX
TEL: 86-10-64012907
FAX: 86-10-65135983
E-MAIL:ZONGDIAO@CAAC.GOV.CN

CNS001I MESSAGE CONTAINS NO TRANSACTION IDENTIFIER
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Figure 4: Example Notification - China

US Coordination with Others

2.19 In the US, challenges related to coordination may become strenuous due to multiple stakeholders involved in planning and execution of space operations. Primary considerations are who the space operator is, e.g. government or commercial space provider, and where the operation is occurring, e.g. a federal facility, or a privately run facility. Historically, when operations occurred from US-government-sponsored facilities, the facility would execute coordination on behalf of the operator whether they were commercial or government, and if operations were taking place elsewhere the onus would fall to the launch service provider.

2.20 Beginning in 2022, the US government sponsored launch facilities restructured coordination processes, developing distinct pathways for missions carried out exclusively for the State, and missions licensed as commercial space operations. In cases of commercial operations, the commercial space operator maintains primary responsibility for NOTAM coordination per their license. This change identified a need for updated and streamlined coordination procedures between space operators, the FAA, and other impacted ANSPs.

2.21 Within the APAC region, the US maintains a database of requirements for ANSPs related to space operational coordination, as well as contact lists for each FIR typically affected by space operations. When coordinating NOTAM requests in the APAC region, FAA sends a detailed request via AMHS including the proposed dates, times and coordinates of areas impacted, and follows up by email and telephone communication as needed. These dual pathways assure regulators, Aeronautical Information Services (AIS) and ANSP have the timely details of the planned activity.

2.22 The US worked within the Informal South Pacific Air Traffic Services Coordinating Group (ISPACG) and Informal Pacific ATC Coordinating Group (IPACG) to refine the process outlined in the Asia/Pacific Planning Checklist for Ballistic Launch and Space Re-Entry. This collaboration led to development of the following guidelines:

- establishment of a single email coordination address assures appropriate distribution within a State
- AMHS usage serves to satisfy systemic record requirements for operational coordination;
- lead times of 10 days for planning and three days for publication are sufficient in most cases;
- AHAs should be defined by blocks of four, but up to six points within an FIR;
- AHAs crossing FIR boundaries must define separate areas wholly contained within each FIR with two shared points for each at the boundary;
- events times must be the minimum required to meet mission needs and limit traffic disruption and include the primary and up to six back up times;
- AHAs should avoid dense traffic areas and times;
- Updates (mission success or postponed) via email and AMHS should occur within 1 hour of event completion;
- Launch proponents and affected FIR stakeholders are to provide timely feedback during, and after the event to improve future activities.

SUBJ: NOTAM REENTRY APREQ for FALCON 9 STARLINK 4-2 stage 2 REENTRY

****THIS REQUEST IS FOR UPPER STAGE REENTRY **** Hazardous Area EAST of AUCKLAND

Request NOTAM for AUCKLAND OCEANIC FIR (NZZO):

1. SpaceX will be conducting hazardous operations surface to unlimited for atmospheric re-entry and splashdown of launch vehicle upper stage within the following areas.

AREA: 3053S 17030W
2943S 17218W
1028S 15700W
1352S 15700W to beginning

2. Hazard periods for STARLINK 4-2 Second Stage REENTRY:

Primary REENTRY day:	11 Sep 22 / 0224Z	thru	11 Sep 22 / 0500Z
Backup REENTRY day (1):	12 Sep 22 / 0202Z	thru	12 Sep 22 / 0439Z
Backup REENTRY day (2):	13 Sep 22 / 0141Z	thru	13 Sep 22 / 0417Z
Backup REENTRY day (3):	14 Sep 22 / 0119Z	thru	14 Sep 22 / 0355Z
Backup REENTRY day (4):	15 Sep 22 / 0058Z	thru	15 Sep 22 / 0334Z
Backup REENTRY day (5):	16 Sep 22 / 0036Z	thru	16 Sep 22 / 0312Z
Backup REENTRY day (6):	17 Sep 22 / 0014Z	thru	17 Sep 22 / 0251Z

3. Please advise of scheduling conflicts ASAP to POC.

4. Please confirm receipt to both sender and POC.

5. POC is ATO Space Operations International email at 9-AJO-AJR-SpaceOps-Intl@faa.gov

Figure 5: Example USA NOTAM Request (Pacific)

2.23 **Figure 5** is a recent example of a NOTAM request in the Pacific. Mechanical or atmospheric anomalies may result in a mission scrub.

2.24 To address the potential to reschedule, launch proponents plan primary launch windows and several back-up days, outlining dates and times in their initial requests. Postponing generally affects the day launch occurs, while the remaining pre-coordinated information, including AHAs, remain unchanged.

2.25 In April 2022, the US conducted a live test with Fiji (NFOF) to validate AMHS as a means to coordinate NOTAMs for international launch and re-entry operations, for both the US NOTAM Office and Fiji. During this test, both states were able to identify shortfalls and develop streamlined solutions associated with AMHS and procedures. USNOF and NFOF collaborated on the development of a standard request format for space launch and re-entry NOTAMs, as well as general guidelines that alleviate confusion or duplication of efforts.

2.26 The adoption of these processing procedures has resulted in increased efficiency and reduced workload at no additional cost. This process works and provides wider dissemination of information to interested parties and reduces coordination errors.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) note the information contained in this paper;
- b) discuss any relevant matters as appropriate;
- c) offer feedback to further refine and improve the process;
- d) for States routinely affected by space activity recommend the establishment of a single email distribution list to assure all concerned parties are aware of impending space activities affecting the airspace;
- e) For States conducting or supporting space launches consider coordination using direct email and AMHS in addition to diplomatic notifications; and
- f) Recommend ICAO include Space Coordination contact information into the current regional experts list.

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