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John C. Stennis Space Center
Range Safety Program

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PREFACE

P.1 PURPOSE

a. The purpose of this National Aeronautics and Space Administration (NASA) John C. Stennis Space Center (SSC) Procedural Requirements (SPR) document is to define the Center's Range Safety Program through the establishment of policy, requirements, and processes applicable to all range operations – NASA, NASA-sponsored, and U.S. military – conducted aboard, in the airspace above, and the waterways located within the SSC Fee Area and/or Buffer Zone. The Range Program at SSC is an integrated program between Range Safety and Range Operations and encompasses all range activities.

b. This SPR implements Stennis Policy Directive (SPD) 8715.4, Stennis Safety and Health Policy, regarding the protection of the public, workforce, and property during SSC-sponsored range operations.

P.2 APPLICABILITY

This document is applicable to all range operations conducted and all personnel conducting or participating in range operations on NASA-owned property or in special use airspace where NASA is the using agency. Deconfliction between NASA sectors and Navy sectors of restricted airspace will be accomplished through scheduling of all sectors through NASA/SSC Range Operations (per Federal Aviation Administration (FAA) Joint Use Restricted Area Letter of Procedure, Procedures for Use of Restricted Areas R4403 A/B/C/E/F). Physical deconfliction between missions and/or aircraft to maintain safe operation will be coordinated with the Range Safety Manager (RSM).

P.3 AUTHORITY

a. 14 Code of Federal Regulations (CFR) 73.15, Federal Aviation Regulation (FAR) Part 73 Using Agency

b. NASA Policy Directive (NPD) 8700.1, NASA Policy for Safety and Mission Success

c. SPR 8715.4, Stennis Safety and Health Policy

P.4 APPLICABLE DOCUMENTS

a. FAA AC 70/7460/1K, Obstruction Marking and Lighting

b. FAA JO 7400.2, Procedures for Handling Airspace Matters

c. FAA JO 7400.10, Special Use Airspace

d. FAA JO 8130.34, Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft

e. FAA, New Orleans Sectional

f. MIL-HDBK-828, Department of Defense (DoD) Handbook: Range Laser Safety

g. NASA Procedural Requirement (NPR) 1800.1, NASA Occupational Health Program Procedure

h. NPR 7900.3, Aircraft Operations Management Manual

i. NPD 7900.4, NASA Aircraft Operations Management

j. NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating and Recordkeeping

k. NPD 8710.1, NASA Emergency Preparedness Program

l. NPR 8715.2, NASA Emergency Preparedness Plan Procedural Requirements

m. NPR 8715.3, NASA General Safety Program Requirements

n. NPR 8715.5, Range Flight Safety Program

o. NASA-STD-8719.25, Range Flight Safety Requirements

p. OCHMO-STD-1880.1, NASA Aviation Medical Certification Standards

q. OPNAVINST 3770.2L, Department of the Navy Airspace Procedures and Planning

r. Range Commanders Council (RCC) 319, RCC FTS Commonality Standard

s. RCC 321, Common Risk Criteria Standards for National Test Ranges

t. RCC 323, RCC Range Safety Criteria for Unmanned Air Vehicles

u. RCC 555, User Guide for Unmanned Aerial Systems Operations on National Ranges

v. Stennis Common Work Instruction (SCWI)-3410-0003, Training/Certification Plan and Schedule Report

w. SCWI-3410-0015, On the Job Training (OJT)

x. SCWI-7900-0002, Range Control Procedures

y. SCWI-8700-0002, Health Physics (Radiation) Program Procedures

z. SOI-8080-0055, Protection of Sensitive Customer Information

aa. SPD 7120.5, Institutional Risk Management

bb. SPD 8715.1, John C. Stennis Space Center Operational Readiness Program

cc. Stennis Plan (SPLN)-1040-0006, John C. Stennis Space Center Emergency Management Plan

dd. SPLN-1200-0003, John C. Stennis Space Center Safety and Mission Assurance Technical Authority Implementation Plan

ee. SPLN 8621-0003, Mishap Preparedness & Contingency

ff. SPR 8715.1, Stennis Space Center Safety and Health Procedural Requirement

gg. SPR 8715.2, John C. Stennis Space Center Operational Readiness Program Procedural Requirements

hh. SPR 8739.1, Software Assurance Procedural Requirements

ii. SPR 7120.5, SSC Risk Management Procedural Requirements

jj. SPR 7900.3, SSC Range and Aviation Operations Management

P.5 MEASUREMENT/VERIFICATION

Compliance with the requirements contained in this SPR will be verified through processes contained in NPR 8705.6, Safety and Mission Assurance Audits, Reviews, and Assessments, NPR 8715.5, Range Flight Safety Program, and the applicable items in NPR 7900.3, Aircraft Operations Management Manual.

P.6 CANCELLATION

SPR 8715.7 rev B, dated January 2017.

RICHARD GILBRECH Digitally signed by RICHARD GILBRECH Date: 2021.04.14 08:24:40 -05'00'

Richard J. Gilbrech, Ph.D.
Director

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CHAPTER 1. POLICY, ROLES, AND RESPONSIBILITIES

1.1 SSC Range Safety Policy

a. The SSC Range is defined as a permanent or temporary area or volume of land, water/waterway, or airspace within or over the SSC Buffer Zone and/or Fee Area used to contain range activities (including, but not limited to rocket propulsion testing/activation and unmanned aerial or underwater vehicles). This also includes the entry of any vehicle into said area or volume. See Appendix A, Background, for more detailed information on the establishment of SSC Restricted Airspace. Appendix B depicts the New Orleans Sectional Map showing Restricted Airspace Sectors R4403A/B/C/E/F. Appendix C shows the SSC Fee Area with the Restricted Airspace sectors.

b. SSC applies the following precedence of hazard prevention and control:

(1) Elimination – As applied to range operations, this means to contain the hazards of range operations to completely prevent public and non-participating personnel exposure.

(2) Engineering controls – Where containment of range operations is impracticable, employ Flight Termination Systems (FTS) or contingency management systems.

(3) Safe Work Practices – Personnel subjected or potentially subjected to hazards must be trained and equipped with Personal Protective Equipment (PPE) to protect them from such hazards and monitored periodically to determine effectiveness of PPE to mitigate such hazards that could produce long-term health issues (such as a hearing conservation program).

(4) Administrative controls – Use work/rest cycles, additional manpower, or personnel rotations to reduce worker exposure to hazards and mitigate fatigue-induced human error.

c. SSC shall rely on Kennedy Space Center (KSC) Chief of Flight Operations and Aviation Safety support where NPR 7900.3 requirements apply and as appropriate for all other NASA sponsored range operations (Memorandum of Understanding, Small Unmanned Aircraft Systems (sUAS) Flight Operations and Aviation Safety Support dated May 31, 2017).

d. The RSM will use best efforts to ensure that sensitive range customer information is not inadvertently provided to or made available to unauthorized personnel.

1.2 Roles and Responsibilities

1.2.1 Center Director

The Center Director (or NASA designee) shall:

a. Establish and maintain an SSC Range Safety program within the Safety and Mission Assurance Directorate (SMA).

b. Appoint via letter a Center RSM for SSC.

c. Enter into agreements with NASA Centers to provide airworthiness, flight safety review, and flight readiness review capabilities in order to comply with applicable requirements set forth in NPR 8715.5 and NASA STD 8719.25.

1.2.2 Director, SMA Directorate

The Director, SMA, shall:

a. Designate Range Safety Officers (RSOs), in writing, and specify the types of range operations for which they are qualified to oversee.

b. Oversee identification of range requirements and the performance, evaluation, and approval of range hazard analyses.

c. Evaluate and approve acquisition, maintenance, modernization, and disposal of all SSC range safety systems – including determination of operational readiness, establishment of performance standards, and acceptance criteria for range safety systems.

d. Evaluate and coordinate with applicable approval authorities range safety tailoring and requests for waivers.

e. Support efforts to establish and maintain agreements with NASA aeronautics Centers to provide airworthiness, flight safety review, and flight readiness review capabilities not organic to SSC in order to comply with applicable standards set forth in NPR 7900.3.

1.2.2.1 SSC RSM

The SSC RSM is responsible for overseeing, monitoring, and evaluating Center and project implementation of NPR 8715.5, NASA-STD-8719.25, and applicable Federal laws and regulations.

The SSC RSM shall:

a. Coordinate with all range users to use best efforts to eliminate or mitigate hazards that may arise in range operations, in accordance with the requirements and procedures specified by this SPR.

b. Interface with range customers to establish rules and parameters for range operations.

c. Review agreements to ensure inclusion of range safety requirements.

d. Review NASA/SSC Unmanned Aircraft System (UAS) or aviation services acquisitions to ensure compliance with Center and Agency Range Safety requirements.

e. Determine the level of oversight for range operations, required hazard mitigation and the need for flight termination capabilities based on the level of risk established by the hazard analysis.

f. Establish an RSO training program, qualification procedures and currency standards to provide qualified, certified, and competent RSOs capable of supporting NASA and NASA-sponsored range operations aboard or within the airspace above, waterways, and land in the SSC Buffer Zone and/or Fee Area (see Appendix D, RSO Personnel Qualification Standards).

g. Review training material and verify completion of training requirements with RSO candidates.

h. Review and disposition range scheduling submissions (through the Range Scheduling System and test area activities scheduling) from a range safety perspective and determine appropriate range and airspace usage required to contain the hazards associated with the operation.

i. Serve as alternate in coordinating scheduling of special use airspace with the FAA in accordance with the Joint Use Letter of Procedure for R-4403A/B/C/E/F.

j. Serve as alternate for communicating activation and de-activation of special use airspace with the FAA in accordance with the Joint Use Letter of Procedure for R-4403A/B.

k. Provide range safety orientation briefings to all range users proposing operations at SSC.

l. Coordinate requests for range safety waivers and requirements tailoring.

m. Brief the Center Director and/or other cognizant directors/managers on pertinent range safety requirements.

n. Support the development of emergency response plans and ensure coordination with appropriate emergency response agencies to prevent or mitigate the exposure of the public or workforce to any hazard associated with range operations. Ensure compliance with mishap investigation requirements per the chart in SPLN-8621-0003, Appendix J, Aircraft Investigating Authorities.

o. For all military range operations at SSC, monitor operations and coordinate with the cognizant DoD range safety organization to ensure applicable SSC requirements are satisfied.

p. Ensure assignment of RSOs for all NASA and NASA-sponsored range operations aboard or within the airspace above, waterways, and ground located within the SSC Buffer Zone and/or Fee Area.

q. Ensure proper, timely coordination with maritime, aviation, and other authorities in order to comprehensively fulfill public safety requirements for all applicable range operations having the potential to affect the public.

r. Develop (or oversee the development of) range hazard analyses.

s. Develop, coordinate, and deliver (or oversee the delivery of) mission range safety briefs to the NASA/SSC Safety and Mission Assurance Technical Authority (TA) Board. KSC Airworthiness and Flight Safety Review Board (AFSRB) chair is included in the TA Board distribution list for package review (Memorandum of Understanding, sUAS Flight Operations and Aviation Safety Support, dated May 31, 2017).

t. Ensure all FAA obstructions located at SSC comply with applicable safety and lighting requirements.

u. Provide Range Safety input and coordinate Stennis Control Board and Range and Aviation Review Board (RARB) and Flight Readiness Review Board (FRRB) briefing packages with Range Operations for range projects as appropriate.

v. Advise the Center Director and SMA Director on the range safety aspects of restricted airspace sector utilization.

w. Provide concurrence on equivalent level of safety determinations.

x. Report on results of mission products and activities through Range Safety After Action Reports/Lessons Learned and daily RSO reports. Provides After Action Reports/Lessons Learned to the appropriate stakeholders. After Action Reports/Lessons Learned are stored on the SMA Share Drive.

y. Inform the Center Director and SMA Director of non-compliances with Agency Range Safety requirements and of other unsafe activities and practices. Records of non-compliances will be maintained within SMA records.

1.2.2.2 RSO

The RSO is responsible for real-time safety decisions during a range operation, including response to adverse weather conditions and adherence to mitigation requirements. The RSO has the authority to hold or abort the range operation or take a risk mitigation action, which can include terminating the operation. Required RSO personnel qualifications are listed in detail in

Appendix D. RSO training has been separated into two levels. Level I training allows an RSO to participate in low risk range operations, as determined by the RSM. An RSO is considered fully trained when Level II training is complete and the RSM has signed the training certification document. Training requirements in Appendix D do not apply to the SMA personnel performing RSO duties during rocket propulsion test or activation events. The RSM will provide specific instructions for activation and deactivation of airspace for these events.

The RSO for each range operation at SSC shall:

a. Be a qualified NASA civil servant with functional independence from the program/project conducting the range operation. NASA/SSC UAS shall complete Appendix D RSO Personnel Qualifications Standards.

b. RSO duties for rocket propulsion test and activation activities shall be performed by the SMA personnel supporting the test or activation event. SMA personnel supporting rocket propulsion testing and activation events as RSO shall use the RSO instructions and log sheet provided by the RSM. The RSM will review the instructions with the RSO.

c. Coordinate with the program and the SSC RSM to develop and implement operational range safety requirements, plans, procedures – including contingency plans and procedures – and checklists, including mission rules (i.e. participate in all safety aspects of Range Safety Process detailed in Chapter 2 and as shown in Appendix E, Range Safety Process Map). See Appendix F for mission brief information requirements.

d. If applicable and with guidance from the RSM, develop the range hazard analysis for the specific mission.

e. Conduct or participate in mission safety briefings prior to every range operation (see Appendix G for mission readiness and safety checklists).

f. Activate/deactivate restricted airspace, coordinate with SSC Range Control (RC) and with non-participating aircraft (if possible) as needed to facilitate separation of aircraft and protect the public.

g. Verify issuance of Notices to Airmen (NOTAMs) 24 hours prior to commencement of range operations where applicable (i.e., all activations of R-4403A/B/C/E/F).

h. Verify that operational parameters are adhered to during range operations.

i. Halt or terminate any range operation upon identification or notification of an unsafe condition or procedure.

j. Maintain documented medical readiness as required by NPR 8715.5, NPR 8715.3, and NASA-STD-8719.25.

k. Coordinate input with RSM and promulgate Range Safety After Action Reports for each range event to the distribution list for that specific mission.

l. Use the RSO Rocket Propulsion Test Log Sheet to log all rocket propulsion testing restricted airspace activation activities and provide the log to the RSM at the end of each day's activities.

m. Use the RSO Log Sheet to log all Unmanned Aerial Vehicles (UAV) activities and provide log to the RSM at the end of each day's activities.

For any vehicle that operates from NASA/SSC land or within NASA/SSC SUA, the RSO shall:

(1) Coordinate with the program and the SSC RSM to develop flight termination activation criteria.

(2) Perform real-time monitoring of the vehicle flight path/trajectory, vehicle systems, range safety systems, and the performance of the FTS.

(3) Make a flight termination decision when any aspect of the flight (including, but not limited to, vehicle or support system performance) violates preplanned termination criteria.

1.2.3 Director, Engineering and Test Directorate (ETD)

The Director, ETD, shall:

a. Ensure that the test program Project Manager or designee coordinate testing schedules and test profiles and parameters with the RSM in order to determine appropriate use of restricted airspace

b. Provide projections for range project demand for workforce forecasts to the RSM.

1.2.4 Director, Center Operations Directorate (COD)

The Director, COD, shall:

a. Provide access to communications systems during missions (i.e. radios to communicate with RC).

b. Provide trained and qualified RC support during missions.

c. Provide range activity scheduling information at least four weeks prior to a new range activity and two weeks prior to a repeat range activity so that the appropriate level of hazard analysis and

review may be performed. Range operations that are performed in the pre-approved training areas must be submitted 5 days in advance for review by the RSM. Range operations performed in the pre-approved training areas must meet the conditions of those specific areas.

d. Coordinate with RSM on all range activities.

e. Provide at least two weeks to review agreements so that applicable range safety requirements may be included.

f. Provide a detailed log for each day of range activities utilizing the shout line.

g. Ensure the construction plans for new and existing SSC facilities and structures, identified as aviation obstructions, include requirements and funding for the installation and maintenance of night-vision compatible lighting systems. Existing structures only require update to night-vision compatible fixtures when existing light fixtures must be replaced or relocated due to maintenance or configuration change.

1.2.5 SSC Human Resources Services Branch

The SSC Human Resources Services Branch will maintain records for each employee qualifications including any OJT (SSC-794) and copies of any supporting documentation utilized to support the employees' qualification status as RSO.

1.2.6 Range Users

Range users consist of any entity, both public and private, that wishes to conduct range operations using SSC property or special use airspace. Range users shall:

a. Submit range requests and obtain flight permits using the Range Scheduling System for new flight projects four weeks prior to planned event; two weeks prior for repeat events.

b. Prepare and provide formal documentation pertaining to the proposed range project for review by both the RSM and Range and Aviation Operations Manager. For UAS flight, surface and underwater testing, range users will complete Appendix H Questionnaire for Unmanned Aircraft, Surface and Underwater Systems (UAS/USS/UUS) Operations.

c. Identify risks, project requirements (design, operational, and support requirements as well as any known restrictions) associated with the range activity prior to performing operations at SSC and communicate and coordinate information with the RSM.

d. Determine any operational controls needed to isolate each hazard and prevent/mitigate the risk due to the hazard, especially for test stand activities. Communicate and coordinate all information on operation controls necessary to isolate each hazard to the RSM.

e. Participate in discussions to familiarize all participating personnel with all aspects of the flight project and proposed range operations.

f. Participate in failure/anomaly investigations and provide all data as required (reference SPLN-8621-0003, Mishap Preparedness & Contingency Plan).

g. Ensure development and implementation of operational range safety requirements, plans, procedures (including contingency plans and procedures), and checklists, including mission rules.

h. Working with the RSO, ensure that all range safety criteria are satisfied prior to initiating each phase of a given operation.

i. For a military range operation, the DoD program/project manager shall ensure that the military range operation is conducted under the authority and direct cognizance of a DoD range safety organization or equivalent working in coordination with the SSC RSM.

1.2.7 AFSRB

Since SSC does not possess a Flight Operations Office or a Chief of Flight Operations, it therefore cannot locally fulfill NPR 7900.3 requirements for airworthiness certification. As such, SSC shall rely on KSC (per Memorandum of Understanding, sUAS Flight Operations and Aviation Safety Support, dated May 31, 2017) to provide such services when required and as appropriate.

CHAPTER 2. RANGE SAFETY POLICIES AND REQUIREMENTS

2.1 Range Safety Process

Range users conducting range operations at SSC shall adhere to the following process depicted in the flowchart in Appendix E and coordinate the range operations with the SSC RSM and the RSO designated for each range operation:

2.1.1 Project/Mission Initiation:

a. Range users will submit requests for new missions (i.e. never before performed at SSC or performed infrequently) four weeks prior to requested event date. Repeat missions require two weeks notice. This timeline is required to evaluate the request and perform appropriate and applicable risk assessments.

b. Range requests may also be submitted as communication between NASA and Navy Special Warfare (NSW) when conducting flights under their existing FAA Certificate of Authorization.

The RSM will review and provide comments on these range requests either via the Range Request System or email.

c. At a minimum, range users shall provide documentation of vehicle type and classification, team/crew identification, a mission profile that defines the goals and objectives of the missions, specific mission tasks, and associated timeline. Mission brief minimum essential requirements are located in Appendix F. This information is required to determine if the mission is feasible/supportable.

d. The RSM, along with the Range and Aviation Operations Manager, will determine if the proposed mission is feasible and supportable.

e. Rocket propulsion testing requires scheduling of restricted airspace within the timeframes agreed upon in the Letter of Procedure (FAA, Joint Use Restricted Area Letter of Procedure, Procedures for Use of Restricted Areas 4403 A/B/C/E/F, Effective May 26, 2016). Not all rocket propulsion testing or activation activities require restricted airspace. The RSM will determine if restricted airspace is required in support of rocket propulsion testing and for activation activities.

2.1.2 Project/Mission Concept of Operation and Range Safety Hazard Analysis

a. The RSM will determine if the proposed mission is a repeat/routine or a new mission based on the following criteria:

(1) Vehicle, location, and general mission parameters remain the same

(2) Payload changes that do not interfere with vehicle operations

(3) Frequency of missions

b. If the project/mission is a repeat mission, the RSM will ensure that there is a valid existing range safety hazard analysis for the proposed activities in which items, including but not limited to, the characteristics of the vehicle, its payloads, mission profile and area of operations are unchanged and analyzed in a pre-existing range safety hazard analysis.

c. The RSM will determine if restricted airspace, other FAA instrument, or other means of containment is required for any proposed use of SSC airspace, test area activation activity/rocket propulsion testing, or ground and waterway range activities.

d. If restricted airspace is required, the RSM will ensure that an RSO is available to support the activation or testing activity to provide real-time range decision capability and interface with SSC RC.

e. Using the information provided in the questionnaire (see Appendix H, Questionnaire for Unmanned Aircraft and Underwater Systems Operations), the range user, the RSO, and SSC RSM shall generate the necessary analyses to determine any risk to the general public, workforce, high value facilities, and equipment. A risk scorecard is provided in Appendix I.

(1) When controlling risk through mitigation, a range safety hazard analysis shall establish the operational constraints that negate the risk or reduce it to a level that is acceptable with appropriate management approval.

(2) Any residual risk not fully mitigated shall be reviewed by the TA Board.

f. The RSO or RSM shall prepare the project/mission TA Board package. The RSM will provide the package and any additional information required for review by the KSC AFSRB Chair.

g. The range safety hazard analysis must be approved by the TA Board prior to being provided to the RARB or FRRB. See Appendix I for range safety hazard analysis information requirements. The official range safety hazard analysis and other range safety records are kept in the SMA Share Drive.

2.1.3 Deconflictions

a. All NASA, NASA sponsored and tenant/customer range activities, including NSW, restricted airspace activities conducted at SSC require safety risk-based deconfliction to mitigate potential hazards associated with multiple events taking place at similar times and locations.

b. Physical deconfliction between NASA and NASA sponsored missions, tenant/customer missions, will be evaluated and dispositioned by the RSM and included in the mission specific range safety hazard analysis. The RSM shall review and evaluate all deconfliction measures being taken to mitigate identified hazards.

c. Airspace deconfliction between NASA sectors and Navy sectors of restricted airspace will be accomplished through scheduling of all sectors through NASA/SSC (per FAA Joint Use Restricted Area Letter of Procedure, Procedures for Use of Restricted Areas R4403 A/B/C/E/F). The Range and Aviation Operations Manager will notify the RSM of all scheduled missions.

2.1.4 SMA TA Board Review

a. All range safety presentations and hazard analyses for range operations will be reviewed by the SMA TA board per SPLN-1200-003.

b. Following concurrence from all voting TA board members and approval from the TA board chair (either via email or signed approval from the TA board meeting), the Range Safety

requirements for the specified range activities will be provided to the RARB or FRRB. The flight permit will include the TA board approval date.

c. Any follow-up action items resulting from the TA board will be resolved and documented in the final version of the TA package and disseminated to all TA and RARB or FRRB voting members prior to mission commencement.

2.1.5 Mission Execution

a. The RSO will conduct a mission brief prior to each mission and document conditions on the checklists in Appendix G. Operations shall not commence until the mission brief has been completed with all mission essential personnel (see Appendix G and its Annexes).

b. Only cooperative mission essential personnel as defined in NASA STD 8719.25 will be allowed within the area of operations by the RSO or RSM.

c. The RSO will use the RSO log sheet provided by the RSM to document calls made to RC for activation and de-activation of airspace. Calls to RC are only required when using restricted airspace.

d. When using restricted airspace, the RSO will alert RC when real-time activation and de-activation is required for the operation.

2.1.6 Debriefing/Post Mission Reporting

a. For test area activation or rocket engine testing, the RSO will send an email to the test program Project Manager, ETD Director, SMA Director, RSM, Range and Aviation Operations Manager to document real-time activation, de-activation of airspace and any pertinent information.

b. For all other missions, upon mission completion the range users shall support the RSO and the SSC RSM in generating a Range Safety after action report with lessons learned.

CHAPTER 3. RANGE SAFETY

3.1 Introduction

NASA Range Operations that may be suitable for SSC (e.g., sUAS and low altitude rocket vehicle testing) are subject to the requirements and risk criteria of this requirements document. The RSM shall work with the Range and Aviation Operations Manager to ensure that range safety requirements are addressed in the establishment of any Certificate of Authorization (COA) for NASA UAS operations.

> ***Note:*** *RCC 323, Range Safety Criteria for Unmanned Air Vehicles and RCC 555, User Guide for Unmanned Aerial System Operations on the National Ranges provide additional guidance for organizations hosting or sponsoring a UAS operation.*

Range safety considerations include the following elements of range safety hazard analysis, range safety systems, radiation systems, laser hazard controls, safety critical software, and operational requirements. This chapter provides a basic description of these elements and related concepts and provides the associated requirements.

3.2 Range Safety Hazard Analysis

A range safety hazard analysis will be performed for any range operation conducted from NASA-owned property, within NASA-owned waterways or within special use airspace where NASA is the using agency and will include (but not be limited to) the following:

a. The range safety hazard analysis shall determine any operational controls needed to isolate each hazard and prevent/mitigate the risk due to the hazard.

b. The RSO and the SSC RSM, in conjunction with the program/mission point of contact, shall establish the containment criteria needed to address normal and potentially malfunctioning range operations.

c. The range safety hazard analysis shall provide the basis for establishing the geographical areas from which people and any property identified are to be excluded during operations.

d. Any residual risk due to any hazard not fully contained shall employ the risk management scorecard of Appendix I and be brought to the board chair for review.

3.3 Range Safety Systems

a. All NASA range safety systems are subject to the requirements of NPR 8715.5 and NASA STD 8719.25. This includes, FTSs, Autonomous FTSs, Recovery Systems, Contingency Management Systems, Vehicle Tracking, Telemetry, and FTS Command Systems.

b. DoD range safety systems designed, tested, and operated in accordance with RCC Range Safety Standards are acceptable for use at SSC.

Note: *NASA is a full member of the RCC and participates in the development of RCC standards. For example, NASA FTS requirements in NPR 8715.5 refer to RCC 319, RCC Flight Termination System Commonality Standard.*

3.4 Radiation Systems

All programs/projects shall coordinate with the SSC RSM, SSC Range and Aviation Operations Manager, SSC Spectrum Manager, and the SSC Health Physics Program Manager to ensure NASA requirements related to radiation sources are satisfied.

3.5 Laser Hazard Controls

Range operations at SSC involving the use of lasers are subject to the requirements of NPR 1800.1, NPR 8715.3, SCWI 8700-0002, Military Handbook 828, and local range requirements. All programs/projects shall coordinate with the SSC RSM and Range and Aviation Operations Manager to ensure NASA requirements related to lasers are satisfied.

Note: *This requires assessment and approval by NASA laser safety officials, including the SSC Industrial Hygienist, coordination with the FAA for lasers entering the National Airspace, and coordination with the DoD Laser Safety Clearinghouse.*

3.6 Safety-Critical Software

Range users and the SSC RSM shall identify safety-critical software in range safety systems owned by NASA or used to support range operations at SSC and ensure it satisfies NPR 7150.2, NASA Software Engineering Requirements, and NASA STD 8719.13, *Software Safety* and SPR 8739.1, Software Assurance Procedural Requirements.

3.7 Operational Safety Requirements

The range user is responsible for providing the following verification. As determined by the RSM, the RSO will also verify the following elements prior to mission commencement:

a. Assurance that the collision avoidance requirements are satisfied for any flight.

b. Surveillance of any established hazard areas.

c. Verification that all range safety systems are available and operational.

d. Verification that the meteorological conditions, such as wind and visibility, are within the limits defined by the range safety hazard analysis.

e. Verification that natural and triggered lightning constraints are within limits.

f. Verification that the range safety risk criteria are satisfied, including any specific range safety risk constraints.

CHAPTER 4. AVIATION OBSTRUCTIONS

4.1 Introduction

SSC possesses a number of aviation obstructions greater than 200 feet above ground level. These obstructions shall be registered with the FAA, and lit, marked and painted in accordance with FAA requirements.

4.2 Obstruction Evaluations

COD shall submit construction proposals for the new construction or modification to elevation or FAA lighting/marking of existing infrastructure greater than 200 feet above ground level to the SSC RSM for review. The SSC RSM will retain records of safety reviews and copies of associated FAA obstruction evaluation aeronautical studies for the duration that the obstructions exist.

4.3 Obstruction Lighting

The RSM will ensure that for all new construction, or modification to elevation or FAA lighting/marking of existing infrastructure (including replacement or relocation of light fixtures) greater than 200 feet above ground level, that the Center complies with FAA AC 70/7460/1K, Obstruction Marking and Lighting, and also procures aviation lights visible to pilots operating on night vision goggles (NVGs). This directive is not intended to trigger site-wide retrofit of all FAA lighting, but rather a phased approach that leverages economy of scale for otherwise required infrastructure improvements. NVGs cannot detect certain wavelength ranges of aviation red Light Emitting Diode lights, making the lights completely invisible to pilots using NVGs. The United States Navy, Air Force, and Army regularly conduct low altitude, night-time flight operations in close proximity to SSC test stands, so it is imperative that SSC critical infrastructure be marked and lit in a manner to prevent avoidable loss of military aircraft or crew as well as mitigate the potential for critical infrastructure damage that could interrupt the SSC (and greater NASA) mission.

4.4 Reporting Lighting Failures or Malfunctions

Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, must be reported immediately to the SSC RSM and Range and Aviation Operations Manager.

APPENDIX A: BACKGROUND

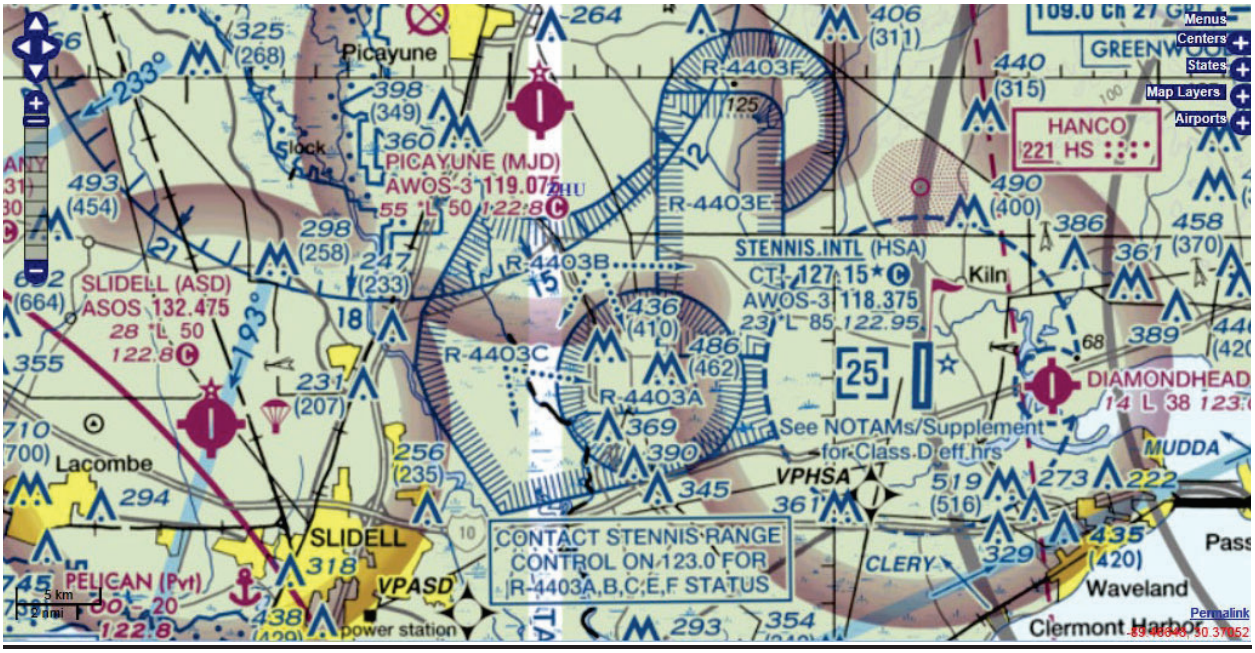
NASA conducts engine testing for government space launch programs and other propulsion programs at SSC. As a result of the engine testing, the acoustic Buffer Zone was created to protect people and property. This zone reduces the harmful impact of the acoustic and vibratory effects produced in the rocket testing area. The harmful effects, such as sonic vibrations associated with the sound waves, are contained within the Buffer Zone. SSC contains 125,000 acres of "Buffer Zone" and 13,800 acres of "Fee Area." NASA owns the land in the Fee Area, and a combination of private and governmental agencies own the land in the Buffer Zone. The runway sections and other elements of both Stennis International Airport and Picayune Municipal Airport reside inside of the Buffer Zone. The Department of the Navy (DoN) owns approximately 5,000 acres of land to the west of the Fee Area, which is called the Western Maneuver Area. All occupants of the Buffer Zone must comply with the restrictive easement provisions established for the Buffer Zone.

Scattered tracts of land within the Buffer Zone are owned by NASA. These properties shall be subject to the rules and regulations of the Fee Area unless otherwise noted.

Restricted Airspace R-4403A/B/C/E/F

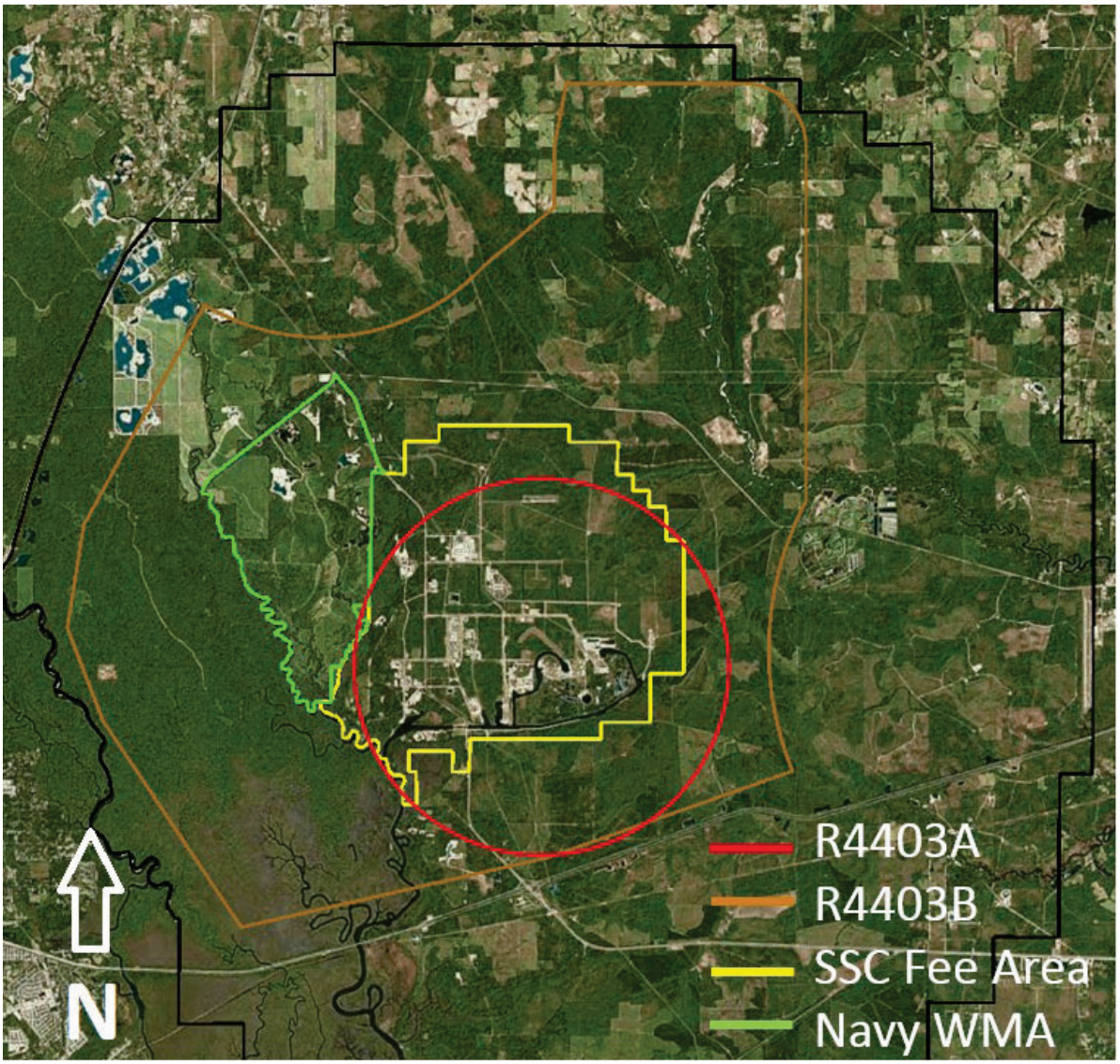
The FAA established R-4403 Gainesville Mississippi (R-4403) May 1965 for the purpose of protecting general aviation from the hazards posed by rocket propulsion testing. After years of negotiation between the FAA, Naval Special Warfare Command (a tenant of SSC) and NASA SSC, R-4403 was expanded and redesignated on May 26, 2016 when R-4403 was replaced with restricted areas R-4403A/B/C/E/F. These new sectors support NASA rocket propulsion testing, NASA unmanned systems flight testing and Special Operations Forces live-fire training. A sectional chart and map overlays of R-4403A/B/C/E/F may be found in Appendices F and G while the legal description may be found at https://www.federalregister.gov/articles/2016/03/29/2016-07055/redesignation-and-expansion-of-restricted-area-r-4403-gainesville-ms. The environmental assessment and accompanying Find of No Significant Impact – conducted by the U.S. Navy, signed by Naval Special Warfare Command and NASA SSC, and adopted by the FAA – supporting the 2016 expansion and redesignation of R-4403 may be found at http://www.ssc.nasa.gov/environmental/docforms/eas/eas.html.

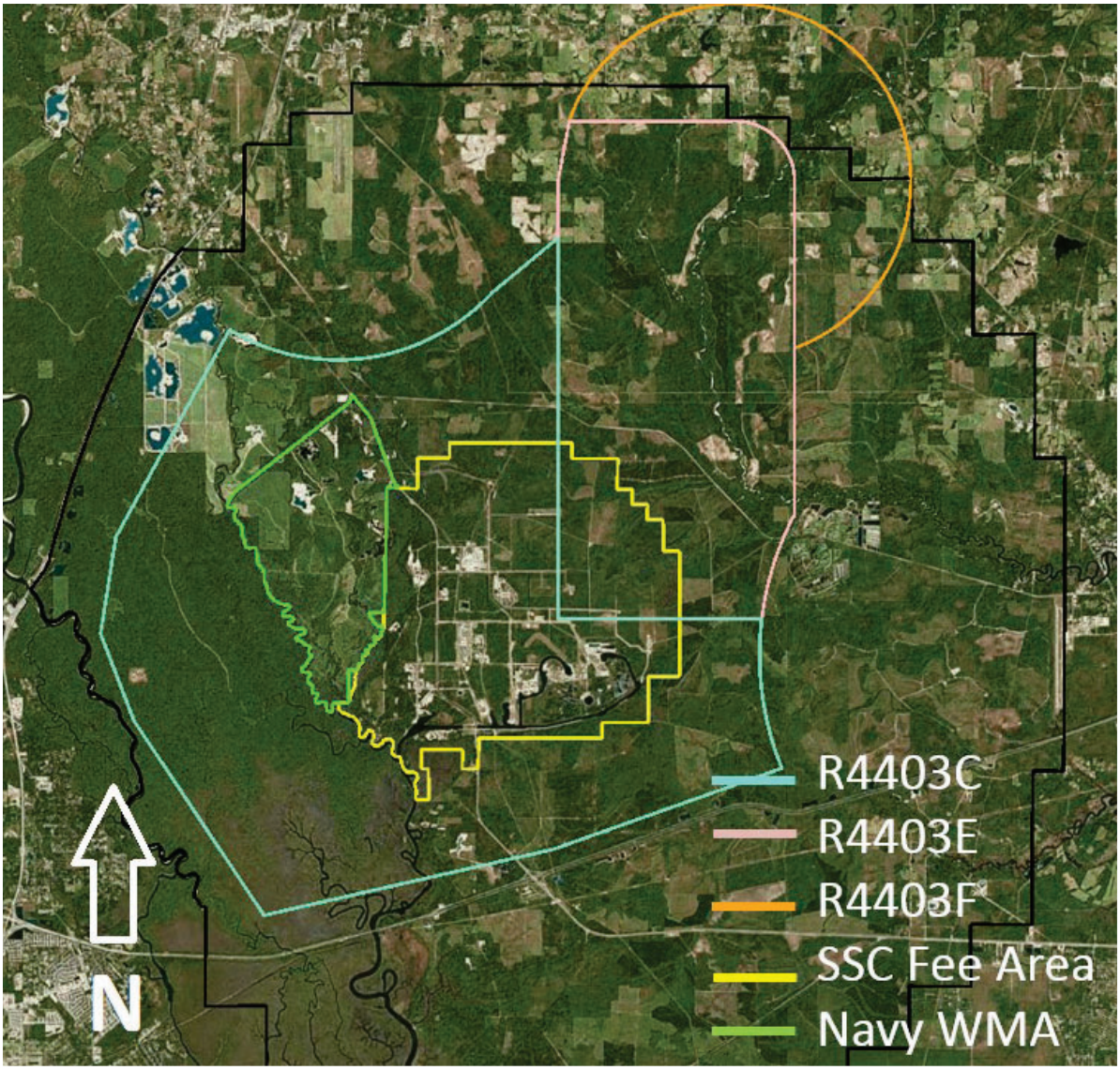
APPENDIX B: NEW ORLEANS SECTIONAL RESTRICTED AIRSPACE SECTORS R-4403A/B/C/E/F



Note: This sectional chart is for information purposes. Check FAA website for the latest version of the New Orleans sectional chart.

APPENDIX C: MAP OF SSC FEE AREA WITH RESTRICTED AIRSPACE SECTORS




R4403C
R4403E
R4403F
SSC Fee Area
Navy WMA
N

APPENDIX D: RSO PERSONNEL QUALIFICATION STANDARDS

This standard describes the minimum required elements for initial and annual re-qualification training for RSOs to oversee both Propulsion Test/System Activation and UAS operations at SSC. The goal of this standard is to maintain qualified, proficient RSOs for mission assurance and range flight safety.

This training is administered and monitored by the SSC RSM or designee. Signatures for personnel qualification on each topic shall be provided only after demonstrating proficiency in the subject presented. Requirements for Level I and Level II RSO are denoted. Level II RSOs are required to demonstrate proficiency in both the Level I and Level II requirements.

Candidate or Requalifying RSO Information

Name _____ Phone _____

Title _____ Email Address _____

Organization _____

Section 1: System for Administration, Training, and Education Resources (SATERN) Courses

1.1 *Range Safety Orientation* (SMA-AS-WBT-410), available on SATERN, attach certificate (I)

1.2 *Basics of Aviation Safety* (SMA-SA-WBT-100), available on SATERN, attach certificate (I)

1.3 *Flight Safety System (FSS)* (SMA-AS-WBT-335), available on SATERN, attach certificate (II)

1.4 *Range Safety Operations* (instructor led) (SMA-SAFE-NSTC-0097) (II)

1.5 *Risk Management Overview* (SMA-OV-WBT-111), available on SATERN, attach certificate (II)

Section 2: Review of NASA Agency-level Requirements

2.1 Review NASA Procedural Requirements 8715.5, *Range Flight Safety Program* (I)

Certifier signature: _____ Date: _____

2.2 Review NASA Procedural Requirements 8700.1, *Policy for Safety and Mission Success* (II)

Certifier signature: _____ Date: _____

2.3 Review NASA Procedural Requirements 8715.3, *General Safety Program* (II)

Certifier signature: _____ Date: _____

2.4 Review NASA Procedural Requirements 7900.3, *Aircraft Operations Management Manual* (II)

Certifier signature: _____ Date: _____

2.5 Review NASA Technical Standard 8719.25, *Range Flight Safety Requirements* (I)

Certifier signature: _____ Date: _____

Section 3: Review of National Range Safety Standards and Supplements

3.1 Review RCC 319 *Flight Termination Systems Commonality Standard* (II)

Certifier signature: _____ Date: _____

3.2 Review RCC 321 *Common Risk Criteria Standards for National Test Ranges* (II)

Certifier signature: _____ Date: _____

3.3 Review RCC 323 *Range Safety Criteria for Unmanned Air Vehicles* (II)

Certifier signature: _____ Date: _____

3.4 Review RCC 555 *User Guide for UAS Operations on the National Ranges* (II)

Certifier signature: _____ Date: _____

Section 4: Review of FAA Policies

4.1 Review FAA JO 7400.10 *Special Use Airspace* (I)

Certifier signature: _____ Date: _____

4.2 Review FAA JO 8130.34 *Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft* (I)

Certifier signature: _____ Date: _____

4.3 Review FAR Part 107 for small UAS operations in the National Airspace System (I)

Certifier signature: _____ Date: _____

4.4 Review FAA Joint Use Restricted Area Letter of Procedure *Subj: Procedures for Use of Restricted Areas 4403 A/B/C/E/F (R-4403A/B/C/E/F)* dated 26 May 2016 (I)

Certifier signature: _____ Date: _____

4.5 Review FAA Ruling May 1, 2018, Amendment for Restricted Area R–4403A (I)

Certifier signature: _____ Date: _____

4.6 Review most recent FAR AIM, specifically for Right-of-Way Rules (91.113), Visual Flight Rules (91.155) (I)

Certifier signature: _____ Date: _____

4.7 Review 14 CFR 73 *Special Use Airspace,* specifically for roles and responsibilities of using agencies and controlling agencies (I)

Certifier signature: _____ Date: _____

Section 5: FAA Online Courses

5.1 Review FAA online course *ALC-42: Airspace, Special Use Airspace and TFRs* available here: https://www.faasafety.gov/gslac/ALC/course_content.aspx?cID=42&sID=237&preview=true (report dead link to SSC RSM if applicable), attach certificate (I)

5.2 Review FAA online course *Radio Communications Phraseology and Techniques - P-8740-47* available here: https://www.faasafety.gov/gslac/ALC/libview_normal.aspx?id=17272 (report dead link to SSC RSM if applicable), attach certificate (I)

Section 6: Local Policies/Procedures, Charts, Agreements and Certificates

6.1 Review SPR 8715.7 (I)

Certifier signature: _____ Date: _____

6.3 Review most recent New Orleans sectional chart (new charts released every May and November) (I)

Certifier signature: _____ Date: _____

6.4 Review Certificates of Authorization for all UAS operated at SSC (e.g. 2016-ESA-80-R for Raven and Puma issued to US Special Operations Command) (I)

Certifier signature: _____ Date: _____

6.5 Review all Space Act Agreements for flight operations at SSC (II)

Certifier signature: _____ Date: _____

6.6 Review all support agreements with other Centers for flight operations support, airworthiness and flight safety review and flight readiness review (II)

Certifier signature: _____ Date: _____

6.7 Review SPR 7900.3 (I)

Certifier signature: _____ Date: _____

Section 7: Field Check

7.1 RSM or designee to observe and document annual RSO field check (I)

Certifier signature: _____ Date: _____

Section 8: Medical Clearance

8.1 FAA or Equivalent Medical, attach certificate (I)

Class: _____ Expiration Date: _____

8.2 CPR training (II)

Training completion date: _____

8.3 Basic First Aid training (II)

Training completion date: _____

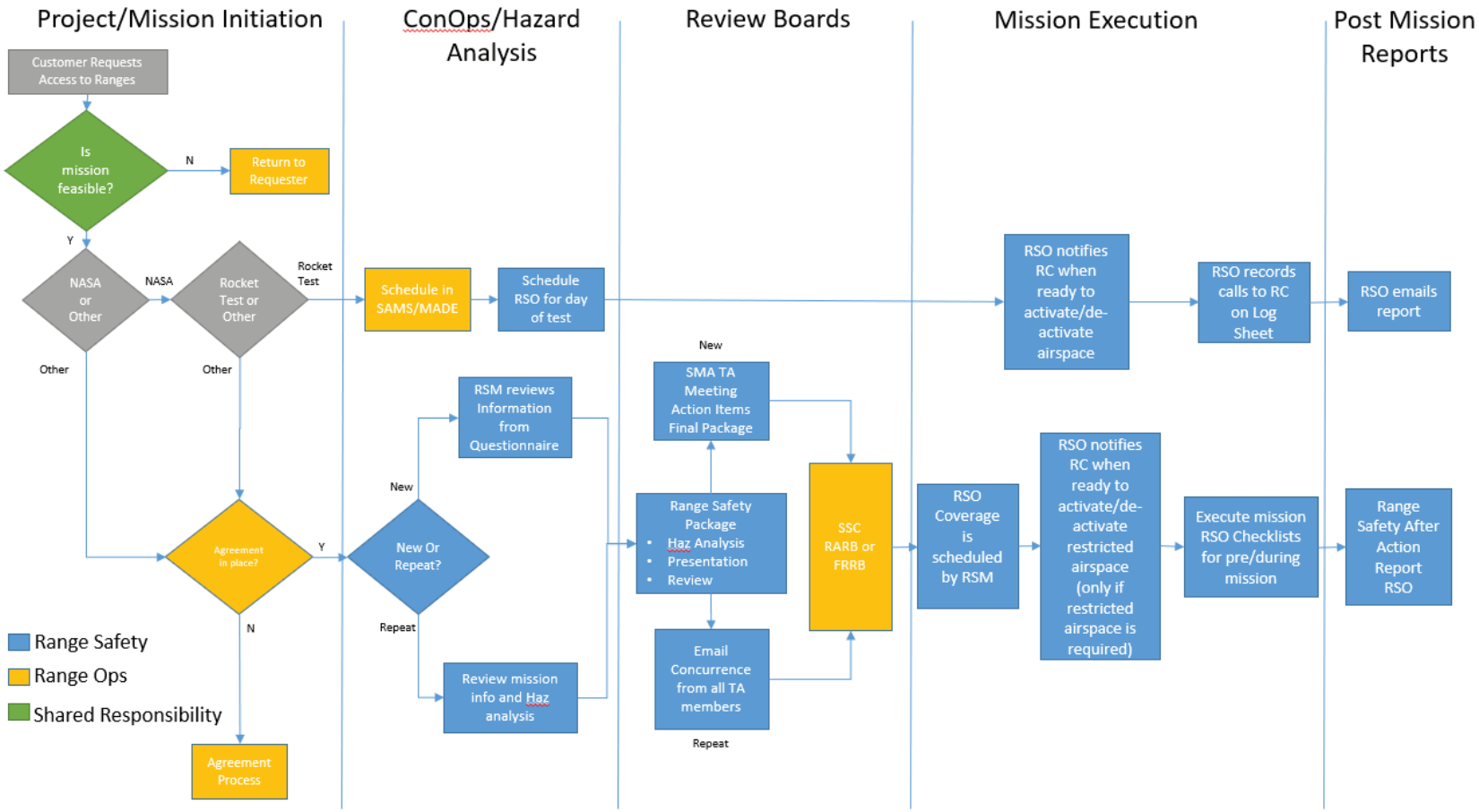
Section 9: Certification of Completion

All items completed as appropriate with signature and date.

Certifying Official Name and Title: _____

Signature: _____ Date: _____

APPENDIX E: RANGE SAFETY PROCESS MAP



APPENDIX F: MISSION BRIEF INFORMATION REQUIREMENTS

F.1 Program Overview

1. Program Description and Objectives
2. Program Management
3. Vehicle/Aircraft information
4. Proposed Vehicle/Aircraft Modifications
5. Instrumentation Hardware/Software and Flight Test Data Measurement Requirements
6. Proposed Schedule

F.2 Mission Concept of Operations

1. Location
2. Planned Start of Operations
3. Planned Number of Operations
4. Frequency of Operations
5. Test Procedures
6. Planned Area of Operations

F.3 Support Requirements

1. Supporting Organizations
2. Safe Access to Area of Operations
3. Infrastructure Improvements or Modifications
4. Photo and/or Television Coverage
5. Spectrum Management
6. Tracking
7. Telemetry
8. Communications
9. Meteorological Conditions
10. Data
11. Other Special Reporting Requirements

F.4 Safety

1. System Safety Program
   a. Hazard Analyses
   b. Risk Assessments
2. General Operational Restrictions and Conditions
   a. Weather
   b. Personal Protective Equipment
   c. Minimum On-board Equipment (Go/No Go checklist)

d. Weight and Balance
e. Operation Test Envelope (only if operating outside of normal operational envelope of proposed vehicle/aircraft)

3. Abort Procedures
4. Emergency Plans, Procedures, and Contacts
   a. Mishap Plan
   b. Medical Evacuation Plan
   c. Fire Response Plan
5. Configuration Control Responsibilities

APPENDIX G: NASA SSC RANGE SAFETY OPERATIONAL READINESS REVIEW CHECKLIST

G.1 Introduction

In accordance with NPR 8715.5, *N*ASA Range Safety, and SPR 8715.7, SSC Range Safety Program, this document shall be used to establish commit criteria (go/no-go) for all SSC UAS flight range operations. These criteria are verified by the assigned RSO in coordination with the respective project management and the mission flight crew. A hard copy of this checklist shall be provided to the SSC RSM and retained for a minimum of three (3) years.

G.2 Scope

The items listed in this document cover all phases of the flight mission including pre-deployment, day of flight, and the flight operation. These commit criteria are satisfied by the appropriate notation and signature of the RSO for that mission's Day of Flight Test Site/Safety Briefing Checklist. Items that do not apply shall be marked "N/A". Additional line items may be added at the discretion of the RSO. Items that cannot be verified shall cause the mission to be put on hold until completed/resolved.

G.3 Mission/Facility Pre-deployment General Criteria

SSC Range Scheduling System Permit Valid for -

- ☐ Launch and Recovery Site Location
- ☐ Start Date/Time
- ☐ End Date/Time
- ☐ Mission Duration (Days)

  Permit Number: _____

☐ AFSRB Approval Valid for Aircraft as Configured

☐ TA Approval

Date: _____

☐ FSR Current

☐ Valid Range Safety Hazard Analysis

☐ Radio Frequency Approvals Current

☐ Radio Frequency Approval

Date: _____

☐ Valid Joint Use Letter of Procedure (if using R-4403B)

- ☐ Verify Issuance of NOTAM 24 hours prior to event for proper date/time and sector
- ☐ NOTAM number and location _____

- ☐ Valid Certificate of Authorization or Waiver (if not using R-4403B)
  COA: _____

G.4 Flight Crew

- ☐ Flight Crew Staffing and Training Requirements Satisfied
- ☐ Spotter(s)/Visual Observer(s)
- ☐ Pilot(s)
- ☐ Ground Station Operator(s)

G.5 Aircraft

- ☐ Aircraft Airworthiness Requirement Satisfied
  - ☐ Issued by/date: _____

G.6 Day of Flight Criteria

- ☐ Test Site Checklist (see Annex 1)
- ☐ Safety Briefing Checklist (see Annex 2)

G.7 Flight Operation Criteria

- ☐ Pre-flight Checklist available
- ☐ Operation Checklist available
- ☐ Post-flight Checklist available

Annex 1 to Appendix G: R4403A Activation/Deactivation for Rocket Propulsion Hazardous Activity Instructions and Checklist

Rocket Propulsion Testing RSO Airspace Activation and Deactivation Instructions

1. Verify NOTAM is in place 24 hours in advance of test date/time. NOTAM #:

2. Contact NASA RC (**228-688-RANGE (7264)**) to contact Gulfport and Stennis International approximately 4 hours prior to airspace activation. Inform them of planned activation window. (i.e. For a 1400 test time, the 4-hours prior call would be done at 0900 because airspace activation is at 1300.) Use whole hours (Example statement: **"This is name, R-4403A activation window for today is currently planned for 1300-1500 local time.")**

Note: activation window is typically 60 minutes prior to test until approximately 10 minutes after the test or last flaring event, whichever is greater. Activation times are test program dependent. Verify all activation times with the RSM.

Document time of call to NASA RC.
Time of call: _____

3. Please be in the TCC 2 hours prior to test start/hot-fire and let the test conductor know you're on-station.

4. 90 minutes prior to test start/hot fire (verify time with RSM):

   a. Call NASA RC. Identify yourself and what sector you're calling about **("This is [name], we are 30 minutes out from commencing hazardous activities."**
   b. Document time of call to NASA RC
   Time of call: _____

5. 60 minutes prior to test start/hot-fire (30 min past the 90-minute call) (verify time with RSM):

   a. Call NASA RC. Identify yourself and what sector you're calling about **("This is [name], R4403A is going hot".**
   b. Verbally inform test conductor that you activated the airspace.
   c. Document time of call to NASA RC
   Time of call: _____

6. Verify with test conductor that all post-test transfer operations are complete.

7. After verifying that all post-test transfer operations are complete (approximately 10 minutes after test ends):

a. Call NASA RC. Identify yourself and tell them restricted airspace "**R-4403A go cold.**"
b. Verbally inform test conductor that you de-activated the airspace.
c. Document time of call to NASA RC
Time of call: _____

NOTES:

Annex 2 to Appendix G: R4403B Mission Checklist and Instructions

Location: _____ **Date:_____** **Time:_____**

Range Safety Officer: _____ **Project Manager:_____**

RSS Flight Permit: _____

Notations: (check) = Approved; N/A = Not Applicable

Pre-Mission Inspections and Verifications:

	NOTAM(s) issued NOTAM #: (attach NOTAM)
	Flight operations and hazard areas reviewed (attach Range Safety hazard analysis)
	Verify approval for mission
	Verify time and location of operation
	CO2/Water Fire Extinguisher(s) in working order and properly located
	First Aid kit located at the site
	Sunglasses, ear plugs/protection, sunscreen, insect repellent and water available
	Verify handheld radios (including Unicom) are charged and ready for use

Pre-Flight Inspections and Verifications:

	Arrive at site 1 hour prior to mission commencement
	Handheld radios set to Channel:
	Unicom radio set to Channel:
	Radio check with RC
	Call RC for 30-minute notification of hazardous activity
	Record radio check and all calls to RC on RSO log sheet
	Verify removal of Foreign Object Debris (FOD) from engine start area, taxi area, take-off/landing area
	Site Inspected for Trip Hazards, tools, equipment, generator & extension cords
	Verify weather minimums per Range Safety hazard analysis and record on RSO Log Sheet
	Perform preflight Range Safety briefing, including Pilot emergency procedures and weather briefing

	Hazard Area Clear; Team Members & Observers in Designated Areas
	Pre-flight checklist completed and flight hardware ready for the day's operation

Launch Operations

	Verify no non-participant aircraft are in the area
	Verify that mission and non-mission personnel/vehicles are clear of the launch area
	Communicate launch time to RC
	Record launch time on RSO log sheet

Recovery Operations

	Verify no non-participant aircraft are in the area
	Verify that mission and non-mission personnel/vehicles are clear of the launch area
	Communicate recovery time to RC
	Record recovery time on RSO log sheet

Operations Complete for the Day

	Verify with range user that operations are complete for the day
	Notify RC that operations are complete for the day and to go "COLD" (deactivate restricted airspace)
	Record go "COLD" time on RSO log sheet
	Send daily report to management

Annex 3 to Appendix G: sUAS Mission Instructions and Checklist

Location: _____ **Date:**_____ **Time:**_____

Range Safety Officer: _____ **Project Manager:**_____

RSS Flight Permit: _____ **Pilot:** _____

Visual Observer: _____

Pre-Mission Inspections and Verifications:

	Flight operations and hazard areas reviewed (attach Range Safety hazard analysis)
	Verify approval for mission
	Verify time and location of operation
	CO2/Water Fire Extinguisher(s) in working order and properly located
	First Aid kit located at the site
	Sunglasses, ear plugs/protection, sunscreen, insect repellent and water available
	Verify handheld radios (including Unicom) are charged and ready for use

Pre-Flight Inspections and Verifications:

	Arrive at site at least 15-30 minutes prior to mission commencement
	Unicom radio set to Channel:
	Review Communications procedures: clear and adequate for conditions
	Verify removal of Foreign Object Debris (FOD) from engine start area, taxi area, take-off/landing area
	Site Inspected for Trip Hazards, tools, equipment, generator & extension cords
	Review area of operations boundaries with pilot and visual observer
	Weather brief: Winds, temperature, chance of rain/thunderstorms or deviations (attach Aviation Weather for KHSA and KASD)
	Verify weather minimums per Range Safety hazard analysis and record on RSO Log Sheet
	Visibility ≥ 3 miles: _____
	Cloud base ceiling > 1,000 Ft above intended operating altitude:_____

	Mission temperature:_____
	Surface wind condition limits; steady ≤ 15 mph, gusts ≤ 20 mph
	Surface Winds _____ Gusts _____ Time _____
	Review Pilot's safety and emergency procedures (fire on ground and/or air, controllability, ditch areas)
	Perform preflight Range Safety briefing, including Pilot emergency procedures and weather briefing
	Reminders regarding: Heat, water, sunscreen, Ticks bug bites, ear protection, sunglasses / safety glasses
	Cell phones (on vibrate) – No mission essential personnel may accept calls during flight ops
	Hazard Area Clear; Team Members & Observers in Designated Areas
	Flight plan; maximum altitude for flight operations today
	Define flight transition/activation areas; no fly areas; ditch areas
	Verify Return to Home (RTH) location setting with pilot prior to take off
	Pilot's pre-flight checklist completed and flight hardware ready for the day's operation
	Pilot & spectator barriers, road blocks and/or fencing properly installed
	Call awareness to any unblocked roadways or potential traffic entering the area
	Verify minimum number of satellites acquired with pilot (minimum for safe flight is 12)
	Review safe battery practice with pilot (Return to Home at 30%, land with no less than 20%)
	General Safety, do not ignore problem indicators
	Does anyone have anything to add regarding safety or today's flight (ask each person)
	RSO gives ok to start mission

During operation, continue to monitor the weather, non-participants (aircraft, vehicles, pedestrians), and location of sUAV relative to area of operations, no fly and no hover areas, and potential obstacles. Verify the Visual Observer is monitoring sUAV location.

Objectives/priorities for the day:

_____

_____

New equipment and/or procedure review

_____

Deviations from normal operating procedures:

_____

_____

Notes:

APPENDIX H: QUESTIONNAIRE FOR UNMANNED AIRCRAFT AND SURFACE/UNDERWATER SYSTEMS (UAS/USS/UUS) OPERATIONS

H.1 UAS Description, Performance, History and Operator Information

Information about the UAS/UUS -- its performance and mishap history, as well as pilot training and experience -- is required to understand the system well enough to make a defensible risk assessment. This information is used as a starting point for identifying potential system hazards and reviewing existing system safeguards. To assist the Boards (Airworthiness and Flight Safety Review, Flight Readiness Review or Range Safety Review Boards) in understanding the system, suggested subject areas are listed below with example questions for further clarification and explanation.

H.1.1 Vehicle Description and Mission Concept of Operations

1. User's handbook
2. Modifications from Manufacturer's original configuration (if applicable)
3. Physical dimensions
4. Weight (empty and max)
5. Mission description/Concept of Operations
6. Crewing requirements
7. Description of command and control system
8. List of hazardous material associated with this vehicle and ground support equipment (GSE)
9. Fuel type, quantity/rate of consumption

H.1.2 Vehicle Airworthiness/Seaworthiness

1. How is vehicle airworthiness determined and/or maintained? If necessary, what is the availability of a Certificate of Airworthiness from the Federal Aviation Administration (FAA)?
2. How is the vehicle seaworthiness determined and/or maintained?

H.1.3 Vehicle Performance

1. Performance charts
2. Max altitude
3. Max endurance
4. Max range
5. Range vs. altitude (estimated glide)
6. Cruise speed
7. Max speed
8. Rate of climb, rate of descent
9. Buoyancy

H.1.4 Vehicle Safety History and Reliability

1. Mishap history: What is the flight history of this model UAS? How many crashes and failures have occurred? What has been the corrective action to ensure the failures do not occur again?
2. Any hazard analyses from contractor or system safety?
3. Is there an estimate for system mean time between failures (MTBF)? How has this MTBF been determined (analysis or actual data)?
4. What performance or environmental limitations were used to estimate system MTBF? Will the proposed test exceed any of these limitations?
5. Is there a software safety program for this UAS?
6. What flight critical components are software controlled?
7. Have software safety analyses been performed?

H.1.5 Operator Qualifications

1. List of personnel involved in the mission and their respective function/role
2. What information do they have to make safety-related decisions?
3. List of operator qualifications
4. How much experience do they have?
5. Operator proficiency and recent training on the specific vehicle being used during the proposed mission

H.2 Cause of Loss of Control

Vehicle loss of control can easily result in a mishap. If we can identify any potential causes of loss of control that may have been overlooked, safeguards can be applied, or test conditions can be restricted to reduce risk to an acceptable level. The following questions focus on system vulnerabilities previously experienced, some of which have resulted in mishaps.

H.2.1 Loss of Command Links

1. What happens when command link is lost?
2. How does the vehicle respond if link is never re-established?
3. How does the vehicle recognize that loss of command link has occurred?
4. How does the UAS operator in the ground control station recognize loss of command link has occurred?

H.2.2 Backup Communications Links

1. Is there a backup command transmitter and receiver?
2. Does the backup transmitter have the same or more “effective radiated power”?

H.2.3 Link Analysis

1. Has radio frequency (RF) link analysis been performed to verify both primary and backup transmitters can communicate with the vehicle at the furthest point in its planned operation?

2. Does link analysis address all RF links?
   a. Uplinks from primary and backup ground stations
   b. Secondary uplinks from each ground station
   c. Downlinks to primary and backup ground stations
   d. Flight Termination System (FTS) Link
3. Does link analysis consider RF horizon?
4. Is maximum range for each link explicitly stated?
5. Is there at least 12 dB of signal excess in FTS link?
6. How do you determine if the primary and backup transmitters are radiating specified output power?
7. How do you determine if the vehicle primary and backup command and control receivers and FTS receivers are operating at specified sensitivity?
8. Are there any nulls in the command transmitter antenna pattern? Do the operators know where they are?
9. Are there areas of RF masking due to location of antennas on the UAS relative to their position and to ground station antennas? Are there RF null spots based on orientation of the UAS?
10. What is the link susceptibility to multipath? What is the system response if multipath is experienced?

H.2.4 Radio Frequency Interference (RFI)

1. What is the effect of RFI on the command and control system?
2. Is there a frequency allocation for all RF links?
3. What frequency does the UAS system operate on and does this cause any interference with any other local systems? Is the backup command link sufficiently protected from spurious command signals?

H.2.5 Loss of Vehicle Position Information

1. What are the sources of vehicle navigation position information to the UAS operator?
2. Are there redundant sources so the UAS operator can tell if there is a discrepancy?
3. If the UAS operator loses primary position information, is control also lost?
4. Does the UAS operator have access to any external sources of position information that could serve as a backup (RADAR, flight following, binoculars)?
5. How does the vehicle autopilot respond to loss of primary internal navigation source?
6. Is there a backup?
7. What are the indications in the ground station to the UAS operator?

H.2.6 Loss of Flight Reference Data

1. What are the on-board sources of position, attitude, heading, altitude, and airspeed information to the UAS operator and/or autopilot?
2. How does the vehicle autopilot respond to loss of primary attitude source? Is there a backup? What are the indications to the UAS operator?

3. How does the vehicle autopilot respond to loss of primary heading source? Is there a backup? What are the indications to the UAS operator?
4. How does the vehicle autopilot respond to loss of primary altitude source? Is there a backup? What are the indications to the UAS operator?
5. How does the vehicle autopilot respond to loss of primary airspeed source? Is there a backup? What are the indications to the UAS operator?

H.2.7 Unresponsive Flight Controls

1. What will happen if a servo or flight control sticks or becomes unresponsive? How does the autopilot respond? Is there a backup? How quickly will the UAS operator recognize this?
2. What happens if the throttle is stuck? How will the UAS operator recognize this condition? Is there a recovery procedure?

H.2.8 Loss of Propulsion

1. What happens to the vehicle when propulsion stops?
2. Will sufficient velocity and electrical power remain for “controlled ditch” or “dead stick landing”?
3. Can the engine be restarted in flight?
4. Is the propulsion system affected by environmental conditions (including temperature, icing, dust, humidity)? What are the limits? Are the limits and failure modes confirmed by test data? Are limits considered in test plan?
5. How is fuel volume or fuel utilization monitored?

H.2.9 Loss of Electrical Power

1. What happens when primary electrical power is lost?
2. Is there a separate battery bus? What does battery bus power? Does automatic system load shedding occur if power is reduced? Are there "essential busses" for reduced power operations?
3. Are all flight essential systems on an essential bus?
4. Is there a battery power available time limit associated with loss of electrical power? How long? What if the UAS is too far from base to get back before power runs out?
5. Does FTS activate if battery backup fails (i.e., fails “safe”)?
6. Does FTS operate on an independent battery circuit?
7. How is backup battery checked prior to takeoff?
8. Safety backup system battery lifetime is a critical issue. How do you know how much emergency battery power is left? Is battery usage data available on telemetry? Is a battery use log kept?

H.2.10 Ground Control Station (GCS)

1. What is the source of electrical power for the GCS? Is there an uninterruptable backup power source?
2. What happens if electrical power is lost?

3. Do backup command transmitter and emergency systems have adequate protection from loss of electrical power?
4. If power to the GSC is lost, does it affect how flight information is calculated? Do all flight parameters get reset to zero?

H.3 Review of Common Safeguards

Many UAS designs take similar approaches (including "return home" modes, FTS, parachutes) to safeguards in order to reduce the risk associated with loss of control. Some of these approaches have not always been adequate. This section asks questions related to the adequacy of those approaches to loss of control safeguards, based on previous experience with several UAS designs.

H.3.1 Degraded Modes of Flight

1. What subsystems will fail and cause the UAS (not) to be able to continue flying?
2. Loss of which subsystems will cause the flight to be aborted (i.e., precautionary return to base)?

H.3.2 Return Home Modes

1. Does this vehicle have an automatic "return home" feature (also called "reversion mode" or "Preprogrammed Emergency Mission" in some vehicles) in the event of loss of link?
2. What conditions cause the vehicle to go into "return home" mode?
3. What does the vehicle do once it arrives at the "return home" point? Will it climb to a specific altitude? Orbit? Can it land itself? What is the timing and sequence of events?

H.3.3 Selection of “Return Home” Point

1. Is the selected "return home" point a safe place to bring an uncontrolled vehicle?
2. Can the "return home" point be any location, or just the takeoff point?
3. Does flight path to “return home point” from all points in the test flight plan pass over populated areas? Will the vehicle cross any airspace boundaries? Any mountains or towers higher than its altitude?
4. During "return home" mode, are altitude limits defined (airspace deconfliction question)? Are these altitude limits compatible with the airspace? What happens if the altitude limits are exceeded?
5. Will the vehicle be high enough and/or close enough to be in line of sight of primary and backup ground stations?
6. Are there multiple “return home” points?

H.3.4 Operator Entry of "Return Home" Mode Position

1. How is the “return home” position entered?
2. What safeguards prevent erroneous position input?

3. If the UAS is required to go to an intermediate waypoint before the "return home" point, how is the waypoint entered and how is it verified?
4. Is there a pre-launch check of the "return home" mode? Can the "return home" mode "fly to" position be corrected or updated in flight?

H.3.5 Global Positioning System (GPS) Vs Dead Reckoning (DR) Navigation Source and "Return Home" Mode

1. How does "return home" mode navigate (dead reckoning, inertial navigation, radio beacon homing, GPS)?
2. Is the reversionary mode tied to GPS? What happens if GPS is not being received or GPS jamming tests are being conducted?
3. Is there a DR "return home" mode if GPS or inertial driven navigation is unavailable or degraded?

H.3.6 Failure to Regain Control

1. What happens if the UAS operator fails to regain control of the vehicle once it arrives at the "return home" point and climbs to altitude? Is there a time limit? Does a “Fail Safe” event occur? Does it try to land?

H.3.7 Ditching/Dead Stick Landings

1. What situations would cause the UAS operator to perform a forced landing?

H.3.8 Pre-planned Ditching Locations

1. Do pre-planned ditching or forced landing locations exist? Can these locations be reached from any point in the planned route of flight?
2. What is the criteria for the selection of those locations?
3. How do you know if these locations will be clear of people? Will the locations be in a controlled area or under surveillance?

H.4 Flight Termination Systems (FTS)

H.4.1 FTS Function

1. Is an FTS installed?
2. What hazards does it address?
3. What happens if the UAS is below the RF horizon for both FTS transmitter and vehicle command and control links?
4. What happens when the FTS activates? Shut off propulsion? Tumble or glide? Does it deploy a parachute?
5. Who has FTS activation command authority? Vehicle operator? Mission commander? Range safety?
6. How are vehicle termination parameters monitored?

H.4.2 FTS Transmitter

1. Where is the FTS transmitter located?
2. Does FTS coverage equal or exceed the command transmitter coverage? Does the coverage meet or exceed the maximum range the UAS will fly?

H.4.3 Flight Termination Criteria

1. What is the criteria for command activation of the FTS? Do the criteria include:
   a. Loss of all tracking data
   b. After all other remedial actions have been taken, a vehicle that cannot be contained within the operating area or range
   c. If during loss of link mode, a vehicle that does not fly to a predetermined “return home" point
2. Is the FTS activation criteria adequate to ensure a "good" vehicle is not interpreted as "bad," causing inappropriate use of the FTS?

H.4.4 FTS Testing and Certification

1. Who certifies the FTS as "flight ready," and what processes are involved in issuing the certification?
2. Is the FTS independent of other vehicle systems? Does it have its own antenna, receiver, signal processing capability, and power supply?

H.4.5 Fail Safe Mode

1. Is there a “fail safe” mode that comes into play if FTS command is not received? What conditions cause it to activate? What happens (engine shut off, flight controls to “turn” or “tumble”)?
2. What causes self-activation of the FTS? Electrical power loss? Loss of flight critical function? Loss of FTS signal?
3. Is there a specified time delay between what triggers fail safe mode and actions taken to cause the vehicle to stop flying?

H.4.6 Parachute

1. If the UAS has a parachute system, at what altitude will the chute deploy and what is the impact and drift rate?
2. What is the rate of descent at max weight?
3. Are there altitude, airspeed, or attitude limits on deploying the parachute?
4. Does the UAS have a weight-on-gear inhibit for the parachute system? How is it tested and is the status sent back to the ground with telemetry?
5. Does the engine have to shut off prior to the deployment of the parachute, and what happens if the engine fails to shut down? Can an operating engine fail the parachute shroud line?

H.5 Mid-air Collision Hazards

H.5.1 Airspace

1. Will test procedures require exclusive (i.e. restricted) airspace? If not, how will risk to other aircraft be minimized?
2. If shared, is UAS airspace use compatible or incompatible with any type aircraft or type mission?
3. How will air traffic control occur with a UAS in the same airspace as manned aircraft?
4. If required by the FAA, what is the availability of a Letter of Authorization or Certificate of Authorization (COA)?

H.5.2 UAS Routes

1. Do planned test routes consider locations of published standard approaches and departures?
2. Does the test plan specify standoff distances from densely populated areas (schools/hospitals/nursing homes)? Are those sites identified?
3. Are standoffs required for hazardous sites (including fuel depots, weapons storage, tall towers, terrain features)?
4. Does the test plan address standoff distances from small civilian airfields?
5. Do "return home" mode locations account for standoffs?

H.5.3 Collision Avoidance

1. How does the UAS operator “see and avoid” other aircraft that may be nearby (RADAR, IFF, visual)?
2. What does the vehicle use to ensure pilots of other aircraft will see it (Traffic Collision Avoidance System, strobes, bright paint scheme)?

H.5.4 Interaction with Air Traffic Control (ATC)

1. Is there an existing UAS/ATC memorandum of agreement or current FAA Certificate of Authorization?
2. Will ATC be briefed for this test or series of tests? What is included in the brief?
3. Is there an explicit communication link between the UAS ground control and ATC? Is there a backup link in case of emergency?
4. What are ATC procedures if an unauthorized aircraft enters exclusive airspace being used by a UAS?
5. What are ATC procedures if UAS leaves exclusive airspace? Does ATC monitor for this?
6. How do civilian airports and civilian aircraft corridors affect airspace use by UAS?
7. What are the weather minimums for this type vehicle? Can the UAS fly in clouds or IFR conditions?
8. There may already be as much as a 30-second delay for control actions between ATC and manned aircraft. How much will this delay be increased with the operation of this UAS?

APPENDIX I: SSC RANGE SAFETY RISK MANAGEMENT SCORECARD

SSC Range Safety Risk Management Scorecard

Likelihood Risk Attribute Definitions

Level	Probability	Qualitative Criteria	Quantitative Criteria	
			Safety	Other Impacts
5	Very High	Highly likely. Existing controls have little or no effect and cannot prevent this risk scenario; no alternative controls available.	$P>10^{-2}$	P > 50%
4	High	Likely. Existing controls have significant limitations and/or uncertainties and will likely not prevent this risk scenario; additional actions will be required.	$10^{-3} < P \leq 10^{-2}$	33% < P ≤ 50%
3	Moderate	Could happen. Existing controls have some limitations and/or uncertainties and may prevent this risk scenario; additional actions may be required.	$10^{-4} < P \leq 10^{-3}$	10% < P ≤ 33%
2	Low	Unlikely. Existing controls have minor limitations and/or uncertainties and usually are sufficient to prevent this risk scenario; some additional actions may be required.	$10^{-6} < P \leq 10^{-4}$	5% < P ≤ 10%
1	Very Low	Highly unlikely. Existing controls are strong and are expected to prevent this risk scenario.	$P \leq 10^{-6}$	P ≤ 5%

Consequence Risk Attribute Definitions

Level	1	2	3	4	5
Categories	Very Low	Low	Moderate	High	Very High
Safety	Magnitude of harm or discomfort to employees, contractors, or public is not greater than ordinarily encountered in daily life – Or – Negligible damage to asset consistent with normal wear and tear (Close call but which possesses a potential to cause a mishap)	Minor first-aid treatment (does not adversely affect personal safety or health) – Or – Minor loss/damage to agency capabilities, resources or assets – Or – Administrative regulatory non-compliance (scoped to safety, health and environment) (Type D mishap criteria)	Medical treatment for an injury or incapacitation – Or – Moderate loss/damage to agency capabilities, resources or assets – Or – moderate regulatory non-compliance (scoped to safety, health and environment) (Type C mishap criteria)	Severe injury or incapacitation – Or – Major loss/damage to agency capabilities, resources or assets – Or – Major regulatory non-compliance (scoped to safety, health and environment) (Type B mishap criteria)	Death or permanent disability – Or – complete loss of critical agency capabilities, resources or assets (Type A mishap criteria)
Performance	Nuisance. No impact on Center/Program Mission objective – Or – No loss of Agency capability – Or – Non-compliance with internal policy or procedures – No corrective action or modification is needed to current or future Missions	Minor impact on Center/Program Mission – Or – Minor loss of Agency capability – Or – Administrative regulatory non-compliance – Mild corrective actions or slight modifications are needed to achieve Program Mission goal, to maintain Agency capability, or remedy non-compliance to current or future Missions	Moderate impact on Center/Program Mission goals – Or – Moderate loss of Agency capability – Or – Moderate regulatory non-compliance – Corrective actions or modifications are available to achieve Program Mission goal, to maintain Agency capability, or remedy non-compliance to current or future Missions	Major impacts to Center/Program Mission goals – Or – Major loss of Agency capability – Or – Major regulatory non-compliance – Corrective actions or modifications may be technically feasible. Program Mission goal, Agency capability, or non-compliance remedy cannot be achieved through available resources or time constraints to current or future missions	Center/Program Mission goals are not achievable – Or – Complete loss of critical Agency capability for current or future Missions
Schedule	Negligible impact with slight schedule adjustments. Impact can be compensated by available schedule with no change of end date (e.g. 1 month delay to major project milestones)	Negligible impact with slight schedule change. Impact cannot be compensated by available schedule and impacts end date (e.g. 1 to 3 month delay to major project milestones)	Moderate overall schedule impact (e.g. >3 month delay to major project milestone – Or – 1 month delay to major program milestone)	Major overall schedule impact (e.g. 1 to 3 month delay to major program milestone)	Unable to achieve key/major milestone (e.g. >3 month delay to major program milestone)
Cost	Impact of <0.1% to Mission functional/project budget – Or – $40K impact	Impact of >0.1% and <1% to Mission functional/project budget – Or -- >$40K and <$400K	Impact of >1% and <10% to Mission functional/project budget – Or -- >$400K and <$4M	Impact of >10% and <25% to Mission functional/project budget – Or -- >$4M and <$10M	Impact of >25% to Mission functional/project budget – Or -- >$10M
Profile	No concern from outside SSC (Ex. Internal activities)	Little political effects or generates minor local interest	Registers politically/locally (Ex. Small projects with congressional funding, university projects) or requires unplanned engagement with NASA Headquarters/Mission Directorates	Political consequences, local media coverage, loss of jobs	Negative political/regional impact, large media coverage, probable loss of jobs, environmentally sensitive, high cost projects with congressional funding (Ex. SLS related)

APPENDIX J: ACRONYMS

AFSRB	Airworthiness and Flight Safety Review Board
ATC	Air Traffic Control
CFR	Code of Federal Regulations
COA	Certificate of Authorization or Waiver
COD	Center Operations Directorate
DoD	Department of Defense
DR	Dead Reckoning
ETD	Engineering and Test Directorate
FAA	Federal Aviation Administration
FRRB	Flight Readiness Review Board
FTS	Flight Termination System
GCS	Ground Control Station
GSE	Ground Support Equipment
IFF	Identification Friend or Foe
KSC	Kennedy Space Center
MTBF	mean time between failures
NASA	National Aeronautics and Space Administration
NASA STD	NASA Technical Standard
NOTAM	Notice to Airmen
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NVG	Night Vision Goggle
OHC	Office of Human Capital
OJT	On the Job Training
PPE	Personal Protective Equipment
RARB	Range and Aviation Review Board
RC	Range Control
RCC	Range Commanders Council
RF	radio frequency
RFI	Radio Frequency Interference
RSM	Range Safety Manager
RSO	Range Safety Officer
RSRB	Range Safety Review Board
SCWI	Stennis Common Work Instruction
SMA	Safety and Mission Assurance Directorate
SPD	Stennis Policy Directive
SPLN	Stennis Plan
SPR	Stennis Procedural Requirements
SSC	John C. Stennis Space Center
sUAS	Small Unmanned Aircraft Systems

TA	Technical Authority
TCC	Test Control Center
UAS	Unmanned Aircraft Systems
UAV	Unmanned Aerial Vehicle