2010

NASA Range Safety Annual Report

**This 2010 Range Safety Annual Report
is produced by virtue of funding and
support from the following:**

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I. INTRODUCTION

Welcome to the 2010 edition of the NASA Range Safety Annual Report. Funded by NASA Headquarters, this report provides a NASA Range Safety overview for current and potential range users. This report contains articles which cover a variety of subject areas, summaries of various NASA Range Safety Program activities conducted during the past year, links to past reports, and information on several projects that may have a profound impact on the way business will be done in the future.

Specific topics discussed in the 2010 NASA Range Safety Annual Report include a program overview and 2010 highlights; Range Safety Training; Range Safety Policy revision; Independent Assessments; Support to Program Operations at all ranges conducting NASA launch/flight operations; a continuing overview of emerging range safety-related technologies; and status reports from all of the NASA Centers that have Range Safety responsibilities.

Every effort has been made to include the most current information available. We recommend this report be used only for guidance and that the validity and accuracy of all articles be verified for updates. Once again, the web-based format was used to present the annual report. We continually receive positive feedback on the web-based edition and hope you enjoy this year's product as well.

As is the case each year, contributors to this report are too numerous to mention, but we thank individuals from the NASA Centers, the Department of Defense, and civilian organizations for their contributions. In acknowledging Range Safety personnel who contributed to our success, I would also like to recognize my predecessor, Mr. Rich Lamoreaux, who did an exemplary job while at NASA. Rich left our family this year to return closer to family roots in New Jersey via Picatinny Arsenal. We wish him well.

In conclusion, it has been a very busy and productive year. I'd like to extend a personal Thank You to everyone who contributed to make this year a successful one, and I look forward to working with all of you in the upcoming year.

Alan G. Dumont
NASA Range Flight Safety Program Manager

II. RANGE SAFETY PROGRAM OVERVIEW AND 2010 HIGHLIGHTS

2010 continued the busy pace of previous years in Range Safety. Before highlighting the areas covered in this year's edition, it's important to restate the goal of the NASA Range Safety Program as defined in NPR 8715.5 Rev A, "Range Flight Safety Program," dated 19 September 2010, and signed by the Office of Safety and Mission Assurance. The goal of the program is to protect the public, the workforce, and property during range operations such as launching, flying, landing, and testing launch/flight vehicles. This goal applies to all Centers and test facilities and all NASA vehicle programs, including expendable launch vehicles, reusable launch vehicles, unmanned aircraft systems, the Space Shuttle, and the Constellation Program. Also included in this group are NASA-funded commercial ventures that involve range operations. We meet the goal of NPR 8715.5 Rev A by evaluating, mitigating, and controlling the hazards associated with range operations such as debris, distant focusing overpressure, and toxics.

This is our fifth year providing the annual report via a web-based format. While many articles are continuations of Range Safety topics discussed in previous years, we have provided articles on several new topics as well. New article topics include the aeronautical activities being considered by John F. Kennedy Space Center (KSC), the specific activities at our field centers, as well as an article from the new Range Safety Representative at Stennis Space Center (SSC), a position instituted in response to the need to assess hazards from new activities being considered at Stennis. As always, this report takes a comprehensive look at Range Safety to demonstrate how we meet or implement the Range Safety Program.

During 2010, we were very busy with the development, implementation, and support of Range Safety policy and with the update of local agreements between KSC and the 45th Space Wing. After coordinating across the Agency, folding in lessons learned, and adapting to new national risk criteria, a new revision to NASA's Range Safety Program policy (NPR 8715.5, Revision A) was posted in September 2010. Despite the announcement of the cancellation of the Constellation Program, we continued to support tailoring activities for the Ares I vehicle while awaiting final authority to close out the Program. Additionally, we supported a number of Space Shuttle and Expendable Launch Vehicle launches this year and worked to update agreements with our partners at the Eastern and Western Ranges.

NASA Range Safety personnel continue to support the Range Commanders Council meetings and have been involved in updating policy related to flight safety systems and flight safety risk criteria. A summary of these efforts is highlighted in this report. Additionally, we continue to support HQ-sponsored assessments and audits of NASA Centers conducting Range Safety Operations, and we provide a synopsis of Intercenter Aircraft Operations Panel (IAOP) Reviews of Ames Research Center (ARC) and Dryden Flight Research Center (DFRC).

Finally, emerging range safety technology continues to interest many in the Range Safety community. This year we continued to support national discussions focused on the development of autonomous flight safety systems concepts.

III. AGENCY PROGRAM

A. Range Safety Training 2010 Updates

The NASA Range Safety Training Program was initiated in 2004. To date, NASA Range Safety has conducted over 40 training courses for NASA, Department of Defense (DoD), Federal Aviation Administration (FAA), and contractor personnel. The course breakout and number of students is shown in Figure 1.

Courses	# Classes	# Students
Range Safety Orientation	22	588
Range Flight Safety Analysis	7	127
Range Flight Safety Systems	9	130
Range Safety Operations	4	24

FIGURE 1: TOTAL NUMBER OF CLASSES AND STUDENTS TAUGHT

NASA Safety Training Center (NSTC) funding has been severely reduced for 2011. Only three courses are currently scheduled, as shown below. The Range Safety Office will take this opportunity to revamp the analysis course and to transfer instruction of the operations course to Wallops Flight Facility personnel.

Course	Date	Location
Range Safety Orientation	25-26 Apr 2011	KSC
Range Safety Orientation	13-14 Jul 2011	SSC
Range Flight Safety Systems	2-4 Aug 2011	KSC
Range Flight Safety Analysis	None Scheduled	
Range Flight Safety Operations	None Scheduled	

FIGURE 2: 2011 COURSE SCHEDULE

1. Range Safety Orientation (SMA-SAFE-NSTC-0074)

The Range Safety Orientation Course is designed to provide an understanding of the Range Safety mission, associated policies and requirements, and NASA roles and responsibilities. It introduces the students to the major ranges and their capabilities, defines and discusses the major elements of Range Safety (flight analysis, flight safety systems, and range operations), and briefly addresses associated range safety topics such as ground safety, frequency management, and unmanned aircraft systems (UASs). The course emphasizes the principles of safety risk management to ensure the public and NASA/range workforces are not subjected to risk of injury greater than that of normal day-to-day activities.

The Range Safety Orientation Course is designed to inform the audience of the services offered by the Range Safety organization, present timeframes that allow adequate interface with Range Safety during Program/Project startup and design in an effort to minimize potential delays and costs, and recommend ways of making the working relationship with Range Safety the most beneficial for the Range User. This course includes a visit to Range Safety facilities at Cape

Canaveral Air Force Station (CCAFS)/KSC when normally presented at the Eastern Range. If you wish to discuss presenting the class at your location, please contact the NSTC staff.

Target Audience:

- Senior, program, and project managers
- Safety, Reliability, Quality, and Maintainability professionals with an interest in range safety activities

FIGURE 3: RANGE SAFETY ORIENTATION COURSE OUTLINE

In addition to the two NSTC-sponsored Range Safety Orientation courses in 2010, a specially tailored one-day orientation course was presented to the new Constellation Space Transportation Planning Office (CSTPO) at KSC in June 2010. The course was tailored and presented by the NASA Range Safety Office and not sponsored by NSTC.

2. Range Flight Safety Analysis (SMA-SAFE-NSTC-0086)

The Range Flight Safety Analysis course was not taught in 2010, and the NASA Range Safety Office is using this down time to develop a new NASA-centric course. The new course is being designed to give the student a detailed understanding of range safety analysis but will focus more on NASA processes rather than Air Force processes and on risk management rather than containment. The current course, which will remain a standalone course for DoD and FAA customers, includes NASA, FAA, and DoD requirements for flight safety analysis; a discussion of range operation hazards, risk criteria, and risk management processes; and an in-depth coverage of the containment and risk management analyses performed for expendable launch vehicles (ELVs) at the Eastern Range.

The new course (outline still TBD) will include other vehicles [Reusable Launch Vehicles (RLVs), UASs, balloons, etc.] and other NASA ranges. The course will still concentrate on debris hazards and analyses and will include an overview of toxic, blast, and radiation risks and analyses. Class exercises will cover many aspects of the flight analysis process.

Prerequisite: Completion of NSTC Course 074, "Range Safety Orientation," or equivalent experience.

Target Audience:

- NASA, FAA, and DoD Range Safety Analysts
- Range safety personnel in other disciplines
- Program/project managers and engineers who design potentially hazardous systems to operate on a range

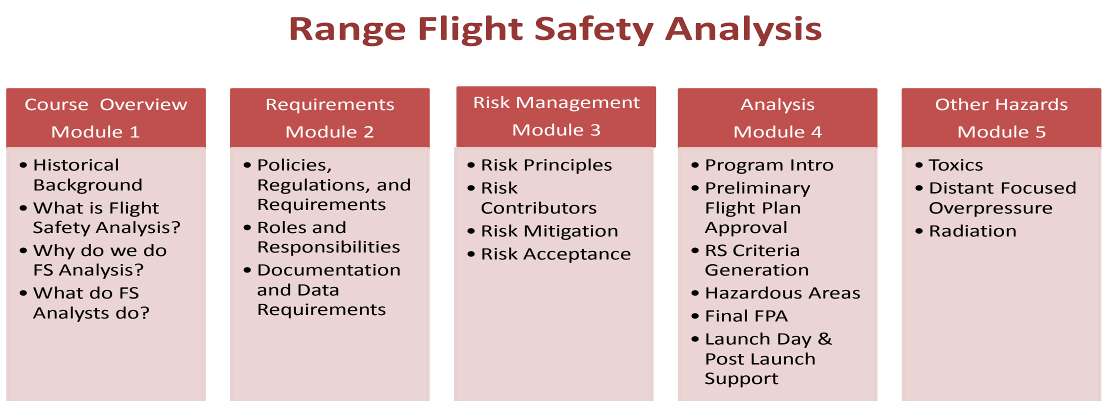


FIGURE 4: CURRENT RANGE FLIGHT SAFETY ANALYSIS COURSE OUTLINE

3. Range Flight Safety Systems (SMA-SAFE-NSTC-0096)

The Flight Safety Systems (FSS) Course describes FSS responsibilities and Flight Termination System (FTS) design, test, performance, implementation, analysis, and documentation requirements. The course also includes a review of Unmanned Aerial Vehicle (UAV) flight termination systems, balloon universal termination packages, and the Enhanced Flight Termination System (EFTS). The FSS class concludes with a description of the Autonomous Flight Safety System (AFSS) and a tour of the Naval Ordnance Test Unit (NOTU) facilities when the class is held at Kennedy Space Center.

Prerequisites:

1. Completion of NSTC 074, "Range Safety Orientation," or equivalent level of experience or training, is required
2. Completion of NSTC 002, "System Safety Fundamentals," or NSTC 008, "System Safety Workshop," is recommended

Target Audience:

- NASA, FAA, and DoD Range Safety Personnel working Flight Safety Systems issues

- Range safety personnel in other disciplines
- Program/project managers and engineers who design potentially hazardous systems to operate on a range
- Personnel who conduct hazardous operations on a range

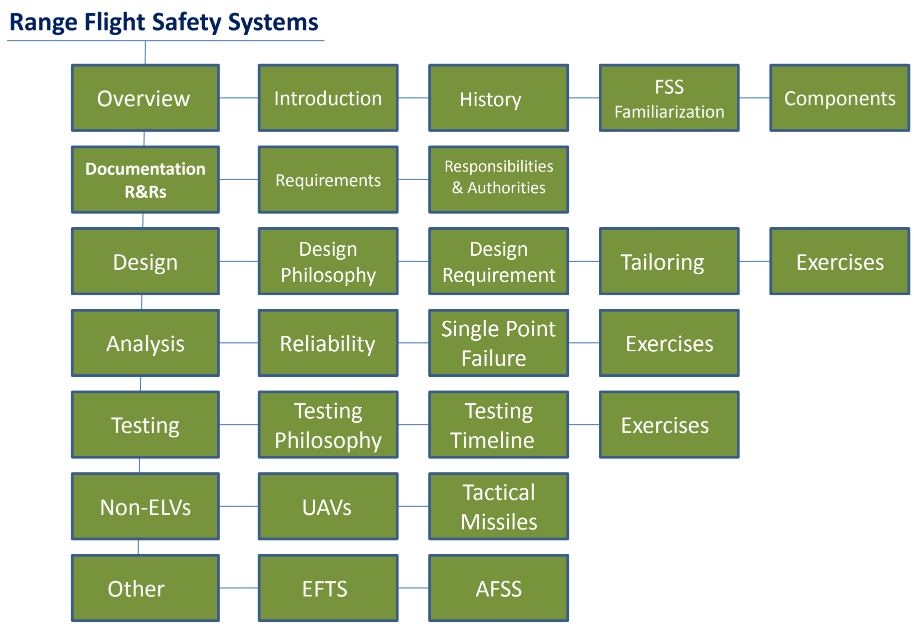


FIGURE 5: RANGE FLIGHT SAFETY SYSTEMS COURSE OUTLINE

4. Range Safety Operations Course (SMA-SAFE-NSTC-0097)

To ensure mission success and safe operations for the Range, a formal process has evolved within the Range community to provide range safety operations. This course addresses the roles and responsibilities of the Range Safety Officer (RSO) for range safety operations as well as real-time support, including pre-launch, launch, flight, re-entry, landing, and any associated mitigation. Mission rules, countdown activities, and display techniques are presented. Additionally, tracking, telemetry, and vehicle characteristics are covered in detail. Finally, post operations, lessons learned, and the use and importance of contingency plans are presented. Students receive hands-on training and exercises to reinforce the instruction.

This course is only presented at WFF (Wallops Flight Facility) and is limited to six participants. To reduce cost and increase course availability, WFF personnel will instruct this course beginning in 2011. NASA Range Safety will still review and control the course content to ensure its applicability across all Centers.

Prerequisites:

1. Completion of NSTC course 074, “Range Safety Orientation,” or equivalent experience and/or training, and a background in range safety.
2. Completion of NSTC course 0086, “Range Flight Safety Analysis,” or equivalent experience and/or training.

3. Completion of NSTC course 0096, “Flight Safety Systems,” or equivalent experience and/or training

Target audience: Persons identified as needing initial training for future/current job as RSO with NASA or RSO management.

FIGURE 6: RANGE SAFETY OPERATIONS COURSE OUTLINE

If you wish to attend any of the courses offered, please contact your Center training manager, or refer to the NSTC web site course catalogue located at: https://satern.nasa.gov/elms/learner/catalog/

B. Range Safety Policy

1. NASA Procedural Requirements (NPR) 8715.5A

The latest revision of NPR 8715.5, “Range Flight Safety Program,” was posted during this year. The document had not been updated since July 2005 and was due to be reviewed with an eye toward incorporating lessons learned, further clarifying the waiver process, and adopting emerging trends seen in the national range safety community.

In addition to numerous administrative changes and the incorporation of a better-defined tailoring and waiver process in the new revision, there are a few areas which deserve to be highlighted.

- Revision A adopts the new Range Commanders Council (RCC) risk aggregation criteria found in RCC 321-10, “Common Risk Criteria for National Test Ranges.” In the previous NPR, each hazard had its own risk criteria. This meant that for debris, toxics, and blast overpressure hazards, a mission had to meet collective public risk criteria equal to or less than thirty-in-a-million for each hazard being analyzed. The new criteria combines the hazards and has been set to less than or equal to one hundred-in-a-million.
- The satellite collision avoidance methodology section was expanded to allow for classical spherical miss distance, ellipsoidal criteria, as well as utilizing hit probability.
- The need was identified for the NASA Range Safety Manager to support not only Infrastructure, Facilities, and Operations Audits conducted by HQ, but also Inter-Center Aircraft Operations Panel reviews for aeronautical activities which have range safety ramifications.
- High-level Autonomous Flight Safety System (AFSS) policy for NASA was provided. The policy details the need to design and qualify to standards approved by the cognizant Center range safety organization or the NASA Range Flight Safety Manager. When used on vehicles which will contain human inhabitants, the AFSS must also meet human rating fault tolerance requirements for catastrophic events.

2. Launch Support Policy

2010 was a very busy year for updating launch support policy and agreements. In addition to the NPR 8715.5 update mentioned above, KCA-1305, “KSC/45 SW/SSP Memorandum of Agreement (MOA) for Range Safety,” and KCA-1308, “KSC/45 SW Joint Operating Procedure (JOP) for Safety,” were scheduled for triennial review. These documents define range safety processes associated with launch vehicle/payload processing and launch and/or recovery of launch vehicles, missiles, and unmanned aircraft missions that involve joint operations between Kennedy Space Center and Cape Canaveral Air Force Station and/or Patrick Air Force Base.

For the MOA, NASA Range Safety (NRS) coordinated the review between NASA, the 45th Space Wing, and the Space Shuttle Program Office. During the review process, all parties jointly determined the applicability of each piece of the agreement and made updates and/or deletions as needed.

The review team added a requirement for NASA ELV missions to notify NASA Range Safety of any flight safety waiver request that involves airborne or ground flight termination or tracking systems, significant increase in KSC risk, or exceedance of acceptable risk criteria as outlined in the applicable range safety requirements documents.

For non-NASA launches it was agreed that the 45th Space Wing (45 SW) will retain responsibility for the protection of the public. However, KSC is the final decision authority regarding the coordinated approaches used to mitigate risk on KSC.

The revised MOA, KCA-1305, Rev D, was approved and signed on 14 September 2010 and has been released in TechDocs.

To view the MOA KCA 1305, Rev D. click here

For the JOP, KCA 1308, NASA Range Safety again worked with the 45 SW to perform a line by line review of content. Most of the changes were administrative in nature. The usual round of capturing organizational changes and updates to referenced documents were done. As there was an effort to coordinate and sign an MOA between the Launch Services Program (LSP) and the 45 SW during the same timeframe, a note was added to the JOP to ensure that agreements between LSP and 45 SW were not in conflict. The JOP is in coordination as of this writing.

3. Range Commanders Council Range Safety Group (RSG)

The Range Commanders Council (RCC) was founded in 1951 to provide a way for DoD test ranges to communicate and discuss common problems.

The RCC Range Safety Group (RSG) continues to provide a forum in which ranges can standardize, develop, and improve on a variety of subjects and processes related to range safety. NASA participates in this forum on a regular basis and became an official voting member in 2008. Range Safety representatives from NASA HQ, KSC, Dryden Flight Research Center (DFRC), and Wallops Flight Facility (WFF) actively support the RSG and its subcommittees on a regular basis. DFRC is currently the Flight Termination Systems Committee Chair while WFF is scheduled to become the RSG Chair in 2011 and lead the entire RSG. Two RSG meetings were held during 2010, as summarized below.

a. 106th Range Safety Group Conference

The 106th Range Safety Group Conference was hosted by Aberdeen Test Center (ATC) on 4-6 May 2010. The RSG main committee, Risk Committee, and Flight Termination Systems Committee (FTSC) participated in the conference.

In the main committee, the host range (ATC) presented an orientation briefing regarding operations occurring at ATC, and Failure Analysis, Inc. gave a presentation on prognostic analysis used to measure equipment reliability and its potential benefit to range safety.

In the Risk Committee, representatives of the NASA Range Safety Program reviewed and agreed with changes to risk standards contained in RCC 321-10, "Common Risk Criteria for National Test Ranges," the basic document that defines consensus standards for the range risk management process and risk criteria. NASA's participation included representatives from WFF, DFRC, KSC, and NASA Headquarters', Office of Safety and Mission Assurance (OSMA). The companion document, RCC 321-10 Supplement, provides additional detailed information to assist in the implementation of standards in the basic document.

The changes to risk standards contained in RCC 321-10 expanded the document to address the range safety criteria, policies, and processes to manage conditional risks, critical asset protection, and treatment of risk model uncertainty. The update also clarified that the acceptable risk criteria is to be applied separately to launch and re-entry missions. The update also modified and clarified risk definitions.

In the FTSC, DFRC gave a presentation regarding Enhanced Flight Termination System (EFTS) implementation and testing efforts occurring at DFRC/Edwards AFB (EAFB). The presentation included information regarding the development of the new Advanced Command Destruct System (ACDS), a joint EAFB/DFRC project to centralize the operations and maintenance of all command transmitters at EAFB. There was also discussion regarding the recertification testing for EFTS receivers, and ATK gave a briefing on their new developments in ordnance initiator systems. Additionally, several RCC documents were also discussed in the meeting including the Test Standard for EFTS Receivers, RCC 319 FTS Commonality Standard, and GPS Dynamic Simulation Testing appendix for RCC 324.

RCC 321-10 Standard and Supplement updates were submitted to the RCC Secretariat for publication in July 2010.

b. 107th Range Safety Group Conference

The 107th Range Safety Group Conference was hosted by Nellis AFB on 19-21 October 2010. The RSG main committee, Risk Committee, and FTSC participated in the conference.

In the main committee, Nellis AFB, as the host range, gave a presentation familiarizing the group with range operations occurring at Nellis AFB. ATK personnel then gave an update on their Autonomous Flight Safety System (AFSS) development, which is currently ongoing. This development uses the NASA-developed AFSS software and flight rules as a baseline in their design. Next, NASA Wallops gave a presentation on the current status and latest flight test results of their AFSS. There was also a brief presentation on RCC 323 (“Range Safety Criteria for Unmanned Air Vehicles”) and a discussion on comments and possible changes to the document for a future update.

Several topics were discussed in the Risk Committee. Debris catalog and empirical database development were discussed along with updates on proposed RSG Risk Committee tasks: uncertainty, vulnerability, and RSO response time. Discussion for the remainder of the meeting revolved around a variety of issues including recent aircraft hazard area analysis, recent aircraft vulnerability test results, catastrophic risk discussion, conditional risk discussion, population and sheltering input data, launch and reentry benchmark guidelines, upper-stage debris risk analysis guidelines, reentry risk analysis guidelines, and probability of failure guidelines. At the end of the discussions, the risk committee developed a prioritized task list for future work in the committee:

1. Aircraft Protection Criteria and Vulnerability Modeling
2. Reusable Launch Vehicles (RLV) and Reentry Related Issues
3. Launch and Reentry Benchmark Guidelines
4. Debris Catalog Database
5. Population and Sheltering Input Data Guidelines
6. Probability of Failure Analysis Guidelines
7. RSO Delay Time

In the FTSC, Enhanced Flight Termination System (EFTS) implementation at various ranges was discussed as was the overall path forward for several ranges planning to utilize EFTS in the near future. A very informative FTS battery discussion involving various ranges and range users took place regarding current test requirements and battery chemistries. There was also a discussion on pyrotechnic shock testing of components and how the testing and corresponding results can be improved. The items and lessons learned that will be included in the rewrite of RCC 319 (FTS Commonality Standard) were discussed. Discussions also occurred regarding the new RCC document covering testing and recertification of EFTS receivers, which is currently undergoing final review.

For more background and information on the Range Commanders Council and the Range Safety Group, *click here*.

4. Common Standards Working Group (CSWG)

The Common Standards Working Group (CSWG) is an interagency organization that was formally chartered in 2004 to "establish common public safety requirements for space transportation at Federal and non-Federal sites." This includes the launch and reentry of expendable and reusable vehicles. NASA is a founding member of the CSWG, which was initially co-chaired by the FAA and USAF until 2010.

This year, the CSWG revised its charter to incorporate NASA as a tri-chair and designated Bryan O'Connor as the NASA member of the Senior Steering Group (SSG) that provides senior executive leadership and guidance to the CSWG. Each agency has a designated tri-chair representative identified and confirmed by the SSG membership; the tri-chairs are responsible for executing the direction of the SSG via the various CSWG subgroups. Mike Dook is the designated NASA tri-chair for the CSWG.

In 2010, achieving interagency consensus on the probability of a failure relevant to public safety during the maiden flights of the Falcon 9, including allocation to various flight times and vehicle response modes, was a major accomplishment. Estimating the failure rate profile for a new vehicle is a major technical challenge, and achieving interagency consensus on such a complex subject required substantial effort. The CSWG leveraged the resources of the three agencies involved to perform an in-depth analysis of the demonstrated reliability of new orbital expendable vehicles launched previously. Additional work is planned that will expand the scope of this initial assessment for the Falcon 9 to include other new vehicles developed by more experienced operators.

Another significant CSWG accomplishment in 2010 was to achieve interagency consensus on appropriate definitions for the scope of quantitative public risk assessments performed for launch and reentry. The results of this effort were also integrated into the draft updates to the Range Commanders Council, "Common Risk Criteria Standards for National Test Ranges" (RCC 321-10).

In addition to the development and maintenance of common safety standards, the CSWG is also charged with coordinating the review and disposition of requests for relief from launch or reentry safety requirements. The CSWG's coordinated relief process enables launch operators to seek equivalent level of safety or waiver determinations for the requirements that are common to multiple agencies. Another major 2010 accomplishment was establishment of a Web-based, interagency non-compliance database to serve as a single central storage and coordination location for the CSWG.

Some additional historic accomplishments of the CSWG include establishment of a procedure for no-test ordnance shelf life extension requests, optimization of data latency considerations for conjunction on launch assessments, and the establishment of an interagency process for joint tailoring of requirements for launch and reentry. These examples demonstrate the effectiveness of this interagency organization in helping to establish and maintain common standards for safety across all ranges.

The CSWG is currently planning several key activities for 2011 including an interagency review of the standards for safety critical batteries, development of common requirements for commercial crew and spaceflight participants, and publication of guidelines on how to develop and allocate failure probability estimates for new launch vehicles.

C. Independent Assessments

NASA Range Safety supports NASA HQ audits and reviews on a regular basis, including Institutional/Facility/Operational (IFO) audits and Inter-Center Aircraft Operations Panel (IAOP) reviews. NASA Range Safety augmented NASA HQ IAOP team visits to Ames Research Center (ARC) in March 2010 and Dryden Flight Research Center (DFRC) in May 2010.

The IAOP provides peer review and objective management evaluation of the procedures and practices being used at the operating Centers to ensure safe and efficient accomplishment of assigned missions and goals. The review teams also identify deficiencies in, or deviations from, NASA wide policies, procedures, and guidelines. The primary focus of the Range Safety team during IAOP reviews is on the application of range safety requirements and techniques to NASA operations involving Unmanned Aircraft Systems (UAS). The intersecting aviation safety and range safety requirements that apply to NASA UAS operations dictate the need for close coordination between the NASA aviation and range safety offices. To facilitate a coordinated review process, NASA Range Safety personnel participate in IAOP reviews at NASA Centers that conduct and/or host UAS operations. At this time those Centers include: ARC, DFRC, LaRC, and GSFC/WFF. Range safety findings during IAOP reviews and associated Center corrective actions are documented and tracked using IAOP systems and processes established by the NASA aviation office. The Range Safety team participated in the IAOPs at ARC and DFRC to understand each Center's Range Safety Office UAS support activities and to assess compliance with NPR 8715.5 requirements.

The NASA Range Safety team developed review checklists and a NPR 8715.5 compliance matrix prior to arrival at Ames and DFRC. The team conducted interviews and reviewed documentation based on the pre-established checklists and matrix. Center Range Safety personnel also provided tours of a variety of different aircraft and UAS projects being supported by the Range Safety Office.

In addition to general compliance with NPR 8715.5, the team concentrated on the following specific areas of interest:

- Range Safety Office Input to Determining Need for FTS on Vehicles
- Range Safety Personnel Training Documentation Process
- Range Safety Waiver Process
- Range Safety Risk Assessment for Small UAS Operations
- Range Safety Officer – UAS Pilot Flight Termination Process Exercise
- Documentation of Range Safety Risk Assessment Tool Acceptance Process
- Range Safety Officer Training Simulator
- Review and Approval Process for Allowing a Range Safety Officer to Perform Multiple Functions for a UAS Mission

IV. CENTER REPORTS

A. NASA Headquarters

The Safety and Assurance Requirements Division (SARD) at NASA Headquarters (HQ) Office of Safety and Mission Assurance (OSMA) provides corporate leadership in the definition and implementation of NASA's Agency-wide Safety and Mission Assurance policies, procedures, standards, tools, techniques, and training. The HQ Range Safety Representative is located within SARD and provides leadership and oversight of the NASA Range Safety and ELV Payload Safety Programs.

The HQ Range Safety Representative and other members of OSMA participated in many NASA Range Safety activities in 2010, including support to Intercenter Aircraft Operations Panel (IAOP) Reviews at Ames Research Center (ARC) and DFRC, participation in two Range Commanders Council Range Safety Group (RSG) meetings, and completion of Revision A to NPR 8715.5, “NASA Range Flight Safety Program.” The release of NPR 8715.5A completed a two-year effort led by the HQ Range Safety Representative. Many significant changes to NASA Range Safety requirements were captured in this revision (as detailed in this report in the NPR 8715.5 revision article).

The HQ Range Safety Representative was designated as the NASA Co-Chair to the USAF/FAA/NASA Common Standards Working Group (CSWG). The CSWG functions to implement provisions of US Space Transportation Policy directing coordination between the USAF, FAA, and NASA to establish common public safety requirements for space transportation. The CSWG’s activities and products are focused on protecting the public from hazards associated with space launch and entry events.

The HQ Range Safety Representative is a member of the ELV Payload Safety Agency Team. This past year, the Agency Team assisted a number of ELV payload projects as they work to successfully accomplish the NASA ELV payload safety process defined by NPR 8715.7. The Agency Team also worked closely with the USAF to tailor a set of payload safety requirements. The tailored requirements will be accepted by the USAF for use at the Eastern and Western Ranges and will apply to all NASA ELV payload projects. The tailored requirements are scheduled to be published in a new NASA Standard in 2011.

Other activities included support to the Space Shuttle and Constellation Range Safety Panels, and support to research and development projects like the Joint Advanced Range Safety System, Autonomous Flight Safety System, Enhanced Flight Termination System, and design and testing of the Max Launch Abort System (MLAS).

B. Kennedy Space Center

In addition to hosting the NASA Range Safety Staff, KSC has its own Center Range Safety team led by the KSC Range Safety Representative. The KSC Range Safety Representative is tasked with implementing NASA policy and keeping the NASA Range Safety Manager informed of all KSC activities related to range safety. Over the course of the past year, KSC Range Safety supported a multitude of range safety activities including Design, Development, Test, and Evaluation (DDT&E) support to new programs, support to Shuttle and ELV launch operations on both coasts, and support to emerging operations for the future. The following articles provide a brief summary of these activities.

1. DDT&E Support

a. Constellation Program (CxP) Support

KSC Range Safety continued to provide technical support to the Constellation Program throughout 2010. Most of the effort involved tailoring AFSPCMAN 91-710, "Range Safety Requirements," for Ares 1. Early in the year, tailoring for Volumes 1, 2, and 8 was completed and submitted to the Program. The team also began tailoring Volume 6 and supported an initial tailoring meeting for Volume 4. In addition to this generic tailoring for Ares 1, the team also supported specific tailoring efforts for Ares Flight Test #2. These tailoring efforts helped ensure proper interpretation and implementation of range safety requirements while providing the Eastern Range and CxP with the authority and flexibility needed to accomplish the mission.

Per NPR 8715.5, the Constellation Program submitted a draft Ares 1 Range Safety Risk Management Plan (RSRMP) in January 2010 describing the CxP risk management program and how they plan to satisfy the risk criteria in NPR 8715.5. NASA and KSC Range Safety reviewed this document in detail and provided comments to the Program. They also participated in Launch Constellation Range Safety Panel (LCRSP) meetings to work topics including GPS metric tracking requirements, range safety system destruct timing, Ares 1-X flight closeout, FTS Launch Abort System (LAS) status, Ares 1 debris catalogue, range product milestones, and the LCRSP forward plan. Later in the year, KSC Range Safety started supporting the Constellation System Integration Panel (CxSIP) to work Flight Test 2, 3, and 4 ascent trajectory dispersion cases and FTS considerations for the LAS. Based on risk analysis, the Program anticipated requesting a waiver for Orion 1 to fly with no FTS on an active LAS. NASA and KSC Range Safety were still assessing this at year's end.

b. 21st Century Space Launch Complex (21 CSLC)

The advent of the 21st Century Space Launch Complex (21 CSLC), and in particular the Range Interface and Control Services Product Line, provides a unique opportunity for NASA and the USAF to work together to increase the flexibility, responsiveness, affordability, and capacity to support launches with the frequency and turnaround times necessary to meet customers' needs.

KSC Range Safety provided technical support and leadership to the 21 CSLC Range Interface and Control Services (RICS) Product Line in 2010. KSC Range Safety and 45th Space Wing (45 SW) safety personnel submitted several potential 21 CSLC projects and became the technical co-leads for the Range Architecture Study Tools & Processes sub-team which contains most of the range safety-related projects. KSC Range Safety worked closely with 45

SW safety personnel and Space and Missile System Center (SMC) personnel in 2010 to fully research, justify, and plan the technical approach and acquisition strategy for these projects, in addition to developing an overall range architecture for the future (2011 goal). Selected projects will be submitted to the 21 CSLC Program Control Board in 2011 for final approval and funding. Some of the range safety projects submitted for consideration are highlighted below.

(1) Population Data Server

This project consists of the purchase and activation of a population database server for KSC/CCAFS. Similar to the current KSC system, it will automate the manual collection system used at CCAFS, provide improved risk analysis run times and submittals, and provide more efficient and accurate collection of base populations to be used in the 45 SW risk analysis.

(2) Chevron and Destruct Line Automation

This project replaces the chevron and destruct line manual AutoCAD processing with automated processing using the 45 SW's Safety Hazard Analysis and Risk Processing (SHARP) toolset. Other range processes have already been developed, certified, and replaced at the 45 SW using SHARP. Chevron lines enable rapid interpretation and response of an anomalous vehicle and provide higher fidelity in the immediate launch area where it is needed. This project could reduce the flight analysis mission support timeline by as much as three to five days.

(3) Risk-Based Safe Siting Tools

This project develops a suite of software tools for risk-based explosive safe siting and hazard assessment (RES). Traditional Quantity-Distance safe siting is by simple equation, based only on weight and type of energetic material. RES approach allows for more realistic analysis of fragmentation, thermal effects, acoustics, toxics, etc., and integrates with a detailed evaluation of hazards. The RES toolset can be used across NASA for hazardous operations analysis to reduce conservatism and increase flexibility. With physics-based tools, the safety staff can focus on protecting people and critical equipment while identifying unnecessary/costly mitigations. A product of one of the tools being developed by ACTA, Inc is shown in Figure 7.

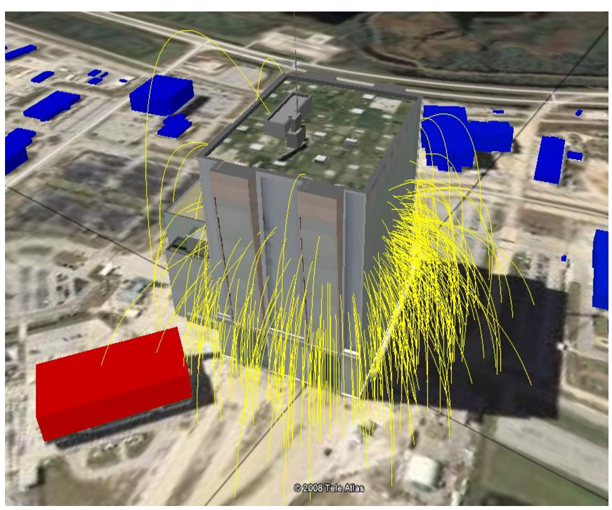


FIGURE 7: VAB RES DEMO

ACTA Inc

(4) Joint Advanced Range Safety System (JARSS) Upgrades

This project provides upgrades to the Joint Advanced Range Safety System (JARSS) risk tool, a state-of-the-art mission planning, risk analysis, and risk management tool for range safety. These upgrades will provide capability to support the required analysis for all horizontal take off/landing customers at KSC. They will also provide all necessary data to support program and KSC go/no-go decisions for Unmanned Aerial Vehicles (UAV) and Reusable Launch Vehicles (RLV) operations. The improved JARSS tool will greatly increase KSC marketability to horizontal takeoff and landing customers, and will provide full risk analysis capability and quick turnarounds for real time operational scenarios. For additional information, see the JARSS article in Section V, Emerging Technologies.

(5) Central Command Remoting System (CCRS) Upgrade

This project replaces the current 1970s technology Central Command Remoting System (CCRS) located in the Morrell Operations Center (MOC) at CCAFS. The current system has vanishing spares and equipment failures that have caused Range Red conditions for several missions. The Air Force is currently funding FY10 development and testing of a prototype system that includes Enhanced Flight Termination System (EFTS) flight code capability. The current CCRS does not have EFTS capability, which must be in place by 2015 to meet USAF requirements. This project will help fund the installation, testing, and operational acceptance of the new CCRS system at Jonathan Dickinson Missile Tracking Annex.

FIGURE 8: JONATHAN DICKINSON MISSILE TRACKING ANNEX

(6) Additional Projects

Many other Range Safety project submissions are being evaluated and assessed as part of the overall RICS range architecture study. Some projects, such as the Autonomous Flight Safety System, metric tracking, Range Safety System Modernization, are large, long-term projects that require close coordination and collaboration with ongoing DoD and Air Force architecture studies. The RICS architecture study is a joint USAF/NASA team, and key 45 SW and SMC participants are providing the required coordination.

c. Commercial Crew Development Planning Office (CCDPO)

KSC Range Safety provided technical support to the Commercial Crew Development Planning Office (CCDPO) in 2010 by developing the Range Safety inputs for the Commercial Crew suite of requirements and standards documents.

The requirements document will contain the technical, safety, and crew health and medical requirements that are mandatory for commercial provider's attempting to obtain a Crew Transportation System Certification to transport NASA crew and limited cargo to and from the International Space Station. The NASA Range Flight Safety Program (NPR 8715.5 Rev A) requirements are currently listed as part of these mandatory requirements. If the commercial crew missions are licensed by the FAA, then FAA Safety regulations will apply and NPR 8715.5 will not. Thanks to the efforts of the Common Standards Working Group, any differences between the FAA regulations and NASA range safety requirements are minimal. NASA range safety would remain engaged as needed to support the CCDPO and coordinate with safety authorities regarding any FAA licensed activities.

The standards document will contain descriptions of processes, standards, and specifications, as well as the criteria that will be used to evaluate the acceptability of the commercial provider's proposed processes, standards, and specifications. Portions of NPR 8715.5 Rev A and/or its referenced documents may be included in this standard.

The NASA Range Safety Office will continue to support refinement of these documents and the associated range safety requirements for commercial crew as the program evolves in 2011.

2. Current Operations (Eastern and Western Range)

NASA/KSC Range Safety supported 12 launches this year. All launches were from the Eastern Range (1 NASA-sponsored expendable launch vehicle, 7 non-NASA launches in the 45th Space Wing Risk Assessment Center, and 4 Shuttle launches).

In order to ensure the requirements of NPR 8715.5 are met during pre-launch, launch, and post launch operations, NRS personnel worked side-by-side with our Department of Defense counterparts in the Eastern or Western Range Operations Control Centers. NRS personnel ensured any range safety-related activities that could have an impact on NASA launch criteria were communicated to the NASA Safety and Program decision makers to ensure safe flight and compliance with requirements identified in NASA Range Safety directives.

We look forward to 2011 and supporting the numerous ELV launches at both the Eastern and Western Ranges. Additionally, we anticipate supporting three Shuttle missions.

Eastern and Western Range				
Mission	**Vehicle**	**Launch Site**	**Launch Date**	**Responsible Org**
ISS 20A	STS-130	KSC	02/08/10	NASA
SDO	Atlas V	CCAFS	02/11/10	NASA
GOES P	Delta IV	CCAFS	03/04/10	DoD
ISS 19A	STS-131	KSC	04/05/10	NASA
OTV-1	Atlas V	CCAFS	04/22/10	DoD
ULF-4	STS-132	KSC	05/14/10	NASA
GPS 2F-1	Delta IV	CCAFS	5/27-28/10	DoD
Dragon	Falcon 9	CCAFS	06/04/10	Commercial
AEHF-1	Atlas V	CCAFS	08/24/10	DoD
NROL-32	Delta IV	CCAFS	11/18/10	DoD
Dragon C1	Falcon 9	CCAFS	12/8/10	Commercial

FIGURE 9: EASTERN AND WESTERN RANGE MISSIONS 2010

3. Emerging Operations

a. Unmanned Aircraft System (UAS) Policy Development

Several Unmanned Aircraft System (UAS) operators have requested the use of KSC assets for their operations. Given NASA's plans to expand KSC business beyond launching and processing rockets, KSC Range Safety reexamined NASA's UAS policy and how UAS policy is implemented at KSC. This review began as a small internal effort within the KSC range safety community, focusing mainly on range safety-related requirements and processes. It has since expanded to include other key players at KSC as part of a joint effort to develop an overall Center process to evaluate and approve UAS projects wishing to conduct operations at KSC. This effort is still underway and has culminated in the chartering of a KSC Aviation Working Group (KAWG). The KAWG will, among other duties, develop a process for evaluating and approving all newly proposed aviation activities at KSC.

b. Department of Homeland Security (DHS) Predator

The Department of Homeland Security (DHS), Customs and Border Protection, currently operates a Predator B unmanned aircraft system (UAS) out of the Cape Canaveral Air Force Station (CCAFS) Skid Strip. KSC was approached by DHS with a proposal to use the Shuttle Landing Facility (SLF) as a possible backup landing location, and due to the lack of a safe hangar at the Skid Strip, a request to use the Reusable Launch Vehicle (RLV) Hangar as a possible storage location for the Predator in the event of a hurricane evacuation. The RLV Hangar would provide adequate protection for the UAS and its associated Ground Control Station during hurricane conditions and make available the use of the Predator for FEMA, if needed, during hurricane recovery operations.

To evaluate the DHS proposal, KSC Range Safety reviewed the data for the UAS and the pre-coordinated route that the vehicle would fly during its landing and takeoff from the KSC SLF. KSC Range Safety ensured that the vehicle would not overfly areas with high population density or high priority facilities. Based on the findings of KSC Range Safety and the Center-wide team assigned to review the request, the use of the SLF and RLV hangar by the DHS Predator was approved by the KSC Center Director for use in the event of a hurricane.

FIGURE 10. PREDATOR B GUARDIAN

c. E-Green

E-Green Technologies has developed an engine-propelled, manned airship designed to break high altitude and endurance world records. The airship will mark the introduction and first use of E-Green's Algae-Diesel fuel. E-Green Technologies is currently discussing with KSC the potential for using KSC facilities to conduct airship operations. Initial negotiations led to the decision to allow E-Green's demonstration flights for FAA certification to be conducted at Ames Research Center, pending their completion of the Ames Airworthiness and Flight Safety Review Board (AFSRB) process. After obtaining FAA certification, the airship will be transported to KSC to conduct their proposed flight operations. KSC Range Safety has remained involved throughout the planning process. The level of future Range Safety involvement will vary depending on E-Green Technologies' ability to obtain FAA certification, their operations plan, and the specific flights proposed at KSC.

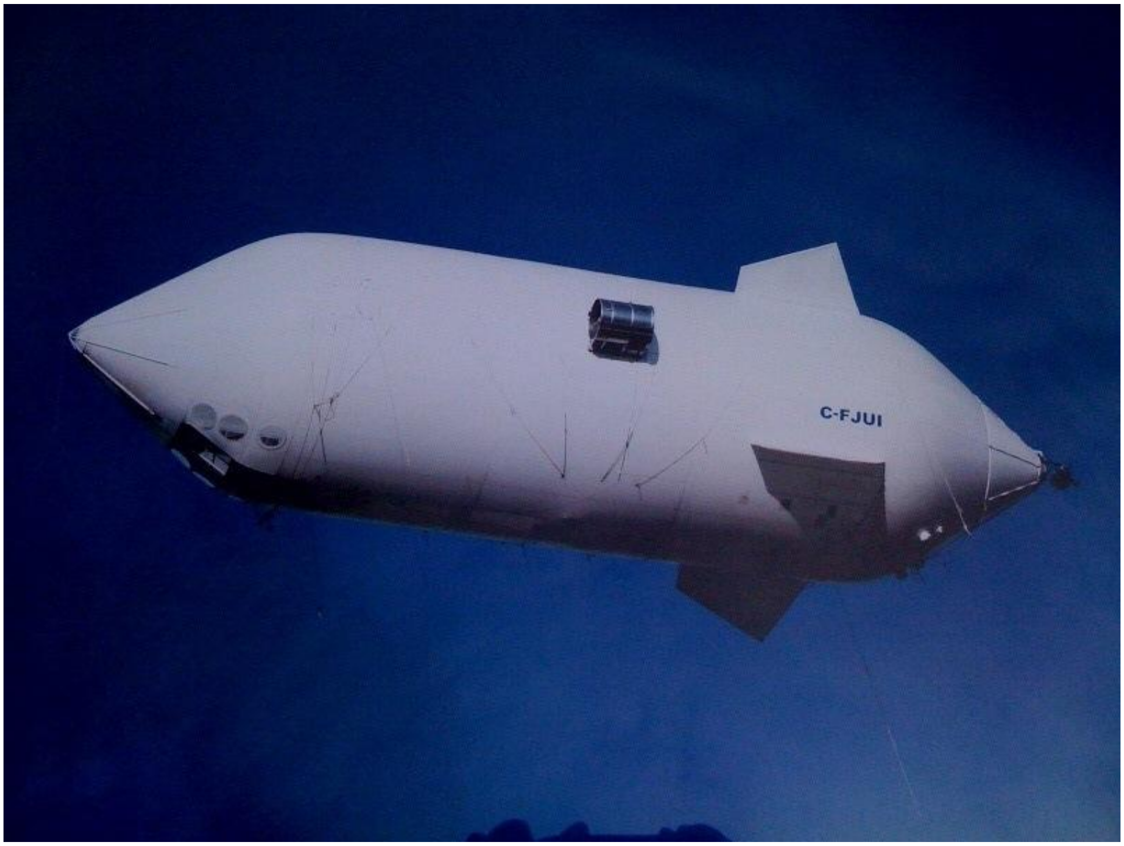


FIGURE 11: E-GREEN AIRSHIP

d. Global Hawk

NASA Dryden Flight Research Center (DFRC) Global Hawks supported two successful earth science campaigns this year, Global Hawk Pacific, GloPac 2010, and Genesis and Rapid Intensification Processes, GRIP 2010 (see DFRC article for more details). For the GRIP missions flown over the Atlantic Ocean, DFRC requested the use of the KSC Shuttle Landing Facility (SLF) as an Emergency Divert Airfield in the event that a situation arose during one of the missions making it unwise and/or unsafe to fly the UAS back to Dryden at Edwards AFB, CA.

To evaluate this request, KSC Range Safety worked with NASA Dryden Range Safety to conduct a risk analysis for flights of the Global Hawk into the KSC SLF. KSC provided flight path assumptions, population densities and facility information; and reviewed the analysis performed by DFRC. The results of the analysis showed that all risks were well below the allowed requirements from NPR 8715.5 and were acceptable. These results were also coordinated with the 45th Space Wing Range Safety office which controls the restricted airspace around KSC and CCAFS.

The use of the KSC SLF was approved as an emergency divert location by the KSC Center Director setting the stage for future involvement in UAS activities by KSC.

e. Max Launch Abort System (MLAS) Flight Test Vehicle 2 (FTV-2)

KSC was approached last fall by the Max Launch Abort System (MLAS) project team about conducting a flight test from the LC 39 complex area in the March 2013 timeframe. Initial conversations between the MLAS project, KSC Range Safety, and 45 SW Range Safety ensued with particular emphasis on determining if a Flight Termination System (FTS) would be needed for this second test. Since the MLAS project had successfully flown without an FTS at Wallops Flight Facility (WFF), the WFF FTV-1 flight test was examined in detail to identify similarities applicable to the proposed KSC flight test.

The MLAS project began in 2007 when the NASA Associate Administrator for Exploration asked the NASA Engineering and Safety Center (NESC) to develop and demonstrate an alternate Launch Abort System (LAS) as risk mitigation for the baseline Orion LAS. The MLAS project was subsequently undertaken with three goals:

1. Identify the simplest LAS concept that will satisfy Orion launch abort requirements while maximizing nominal ascent performance.
2. Design and deliver a Flight Test Article (FTA) in the shortest possible time.
3. Conduct a flight test to gather data suitable for assessing FTA performance and validating design models and tools.

FTV-1 was developed in response to these goals. Since the FTV-1 was an unguided vehicle, the WFF Flight Safety team determined that an FTS would not be needed so long as the flight hazards could be contained. By canting the launch vehicle platform from vertical, analysis showed that all hazards could be contained and that no FTS was needed. Figure 12, below, shows a depiction of a vertical and canted platform.

FIGURE 12: FTV-1 ON A VERTICAL AND A CANTED LAUNCH PLATFORM

FIGURE 13: FTV-1 FLIGHT TEST

MLAS met its goals and objectives with a successful flight test on 8 July 2009. The video can be viewed at http://www.youtube.com/watch?v=5xEshwVHnMY&feature=related.

One of the first questions to be asked and answered with any proposed flight project is whether an FTS will be needed. In this case, the previous analysis performed by WFF does not translate well to the proposed test as there are major differences in the test goals and objectives. The primary differences causing concern are that the flight test vehicle proposed for test flight at KSC will be guided, and the project proposes to conduct a high fidelity pad-abort test which requires a vertical launch from one of the LC 39 launch pads.

KSC Range Safety will work closely with the MLAS Project and the 45 SW to determine the FTS requirements.

C. Wallops Flight Facility

Wallops Flight Facility's (WFF) mission is to be a national resource for enabling low-cost aerospace-based science and technology research. WFF is NASA's primary facility for implementation of suborbital science research programs, including sounding rockets, balloons, and airborne science. Wallops also builds small spacecraft systems, develops advanced technologies, conducts Earth Science research, and provides mission operations via the Wallops Launch and Mobile Ranges, Research Airport, and Orbital Tracking Station. Wallops activities annually support each of NASA's Mission Directorates and a wide array of U.S. Department of Defense (DoD) research and development (R&D) and training missions, including target and missile launches and aircraft development.

A growing percentage of WFF business comes from the private sector. Wallops provides launch support for the emerging commercial launch industry, either directly or through the Mid-Atlantic Regional Spaceport. Wallops also supports numerous aircraft companies that utilize the Research Airport for activities such as water ingestion testing.

The Wallops Safety Office (Code 803) supports all missions at Wallops and at various other locations around the world as needed. This support includes ground safety and flight safety analysis, documentation of operational rules, and active support of ground processing and flight operations. Below are highlights of Wallops missions that the Safety Office supported in 2010.

1. Balloon Program Office

The Balloon Program Office at Wallops Flight Facility conducted 11 missions during 2010. Flight operations were conducted from Fort Sumner, New Mexico, McMurdo, Antarctica, and Alice Springs, Australia in support of Space science payloads as well as a test flight for a new balloon design. During the launch attempt of the Nuclear Compton Telescope (NCT) on 28 April 2010 from Alice Springs, the mission suffered a high-visibility mishap, damaged the payload, and posed a grave threat to public safety. In response to the mishap, the program is undertaking corrective actions to make the balloon program a safer, more effective program in the future.

During 2010, flight durations ranged from 4 hours to 37 days, with the longest flight occurring over Antarctica for the Cosmic Ray Energetics and Mass (CREAM) mission. The Balloon Program Office continued development of the Super Pressure Balloon. The balloon is being developed to provide ultralong duration flights, upwards of 60-100 days, at constant float altitudes. Plans for 2011 call for a test flight of the 14 million cubic foot Super Pressure Balloon from Antarctica.

The Balloon Program plans to conduct remote campaigns in 2011 from McMurdo, Antarctica; Alice Springs, Australia; Kiruna, Sweden; and Fort Sumner, New Mexico.

FIGURE 14: CREAM

2. WFF Aircraft Office

The WFF Aircraft Office conducted multiple Unmanned Aircraft Systems (UAS) flights during 2010. Vehicles flown included Aerosonde, Viking 300/Tigershark, and Magpie. These missions were a combination of NASA, DoD, and commercial flights. One such flight was in response to a Blanket Purchase Agreement between the company L-3/BAI Unmanned Systems and NASA for a UAV Technology Project.

FIGURE 15: VIKING 300

3. Sounding Rocket Program

The WFF Sounding Rockets Program (SRP) conducted 18 missions in 2010, including the first flight of the newly designed Nihka upper stage rocket motor and the first flight of the new Terrier Improved Malamute launch vehicle. The launch manifest consisted of four technology development/demonstration missions, one undergraduate student outreach mission, nine science missions (including space physics investigations and satellite under-flight calibrations, among others), and four reimbursable missions for the Department of Defense. Launch sites included Wallops Island (five launches), Poker Flat Research Range (two launches), White Sands Missile Range (seven launches), and San Nicholas Island (four launches). The Sounding Rockets program achieved an overall mission success rate of 94% for the missions launched in 2010 with only one mission not achieving its stated mission success criteria.

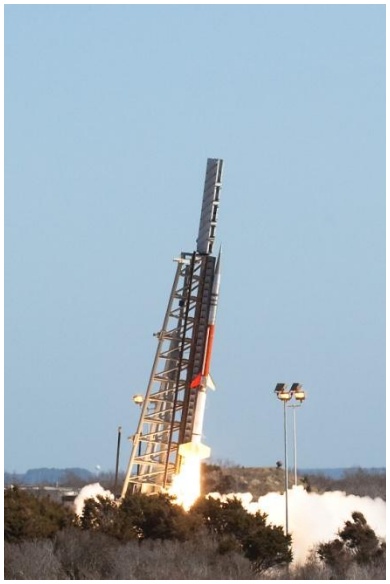


FIGURE 16: TERRIER IMPROVED MALAMUTE

One of the Sounding Rocket missions launched from Wallops was SubTECIII. SubTECIII's primary payload was a technology flight demonstration of NASA's Autonomous Flight Safety System (AFSS). This is an onboard system that, when operational, can enhance the function of the human ground command flight termination system. In the event of a deviance off the assigned flight path, the AFSS would send a destruct signal to the rocket, causing it to break apart in flight, keeping it from endangering public areas. This mission was the third in the series of AFSS flight demonstrations. SubTECIII carried two additional payloads: a NASA package of seven sensors to observe the rocket's performance and a Federal Aviation Administration payload designed to inform aircraft and air traffic control systems of the in-flight location and velocity of launch vehicles that could post a collision hazard to aircraft.

FIGURE 17: SUBTECIII

4. Earth Science Research Support

During 2010, Wallops began implementation of a new initiative to develop and demonstrate technologies that improve the use of UAS and small satellites in support of Earth Science research. During 2010, Wallops personnel have developed both an engineering prototype of a "6U CubeSat" small satellite system with standardized and modular avionics spacecraft systems supporting scientific instruments. Wallops also developed similar flight hardware for a UAS instrument support suite that shared a compatible architecture with the CubeSat project in order to enable the potential for a common instrument to fly on either carrier with minimal changes to the instrument interfaces. The UAS system was built, tested, and flown with the CloudSat instrument suite on a Viking 300 UAS in four series of flight tests which were completed in September 2010. WFF Safety played an integral role in the approval of the flight system and supported the UAS flight operations.

FIGURE 18: SMALLSAT/UAS ADVANCED TECHNOLOGY PROJECT

5. Launch Support

Wallops Range Safety personnel are supporting two Minotaur 4 launches in 2011 from Kodiak Alaska. In addition to flight safety risk analysis and certification of the Flight Termination System, Wallops will provide on-console launch support, including taking flight termination action, if necessary. Wallops personnel attended training in Cocoa Beach, Florida on the Range Safety and Telemetry System (RSTS) which provides redundant telemetry data sources, redundant command uplink for flight termination, and redundant computer systems with displays for real-time position and health status for launches at the Kodiak Launch Complex (KLC). This mission is a first for Wallops in that no radar tracking sources will be used by the Safety team. Wallops is utilizing two independent GPS based data sources from the vehicle (certified jointly by Wallops and Vandenberg Flight Safety) to meet the requirements of the NASA Range Safety Program.

6. Flight Facility Infrastructure Improvements

Preparations are underway for substantial improvements to the WFF Launch Range infrastructure that will add the capabilities to support medium-class expendable launch vehicles. Construction of a new Horizontal Integration Facility, redevelopment of Launch Complex 0A, establishment of new vehicle liquid fueling capabilities, and improvements to the existing Payload Processing Facility and hypergolic fueling facilities will be completed soon. These facilities will initially accommodate the new Taurus II launch vehicle and support the NASA Commercial Orbital Transportation System (COTS) and Commercial Resupply of Station (CRS) programs. Vehicle testing began in late 2010 and initial launch is scheduled for mid-2011. Nine Taurus II launches are already manifested. The WFF Safety Office has been heavily engaged in supporting the design and construction oversight of the new facilities, as well as in the vehicle review, testing, mission planning, and hazardous procedure approval for the upcoming COTS/CRS missions.

Taurus II (Artist Rendition)

FIGURE 19: TAURUS II (ARTIST RENDITION)

DATE	VEHICLE	ACRONYM	LOCATION	RESULT
10/13/2010	Viking 300 UAV		Wallops Island, VA	S
10/7/2010	Viking 300 UAV		Wallops Island, VA	S
9/21/2010	41.082 GT SubTEC III	Sub-Orbital Technology Experiment (SubTECIII)	Wallops Island, VA	S
9/29/2010	Viking 300 UAV		Wallops Island, VA	S
9/10/2010	Viking 300 UAV		Wallops Island, VA	S
8/23/2010	36.219 US Terrier Black Brant	Rapid Acquisition Imaging Spectrkograph Exerpiment (RAISE)	White Sands Missile Range, NM	S
8/22/2010	Viking 300 UAV		Wallops Island, VA	S

DATE	VEHICLE	ACRONYM	LOCATION	RESULT
8/20/2010	Viking 300 UAV		Wallops Island, VA	S
8/4/2010	12.073 GT Black Brant X		Wallops Island, VA	S
8/4/2010	Viking 300 UAV		Wallops Island, VA	S
8/3/2010	Viking 300 UAV		Wallops Island, VA	S
7/30/2010	36.213 NS Terrier MK70-Black Brant MK1 (MOD2)	Solar Ultraviolet Measurement Investigaiton (SUMI)	White Sands Missile Range, NM	S
7/11/2010	36.265 UG Terrier Black Brant	Cosmic Infrared Background ExpeRiment (CIBER)	White Sands Missile Range, NM	S
6/24/2010	41.088 UO Terrier-Improved Orion	RockOn	Wallops Island, VA	S
5/21/2010	36.270 UG Terrier Black Brant	Difuse Interstellar Cloud Experiment (DICE)	White Sands Missile Range, NM	*F
5/3/2010	36.258 UE Terrier Black Brant		White Sands Missile Range, NM	S
5/3/2010	36.248 DR Terrier Black Brant	Missile Alternative Range Target Instrument (MARTI)	San Nicholas Island	S
3/27/2010	12.067 GT Terrier MK-70 Improved Malemute		Wallops Island, VA	S
2/15/2010	40.025 UE Black Brant XII	Correlation of High Frequency and Auroral Roar Measurements (CHARM-2)	Poker Flat Research Range, AK	S
2/12/2010	36.251 DR Terrier Black Brant	Missile Alternative Range Target Instrument (MARTI)	San Nicholas Island	S
2/9/2010	41.084 UE Terrier MK_70 Improved Orion		Poker Flat Research Range, AK	S
2/4/2010	36.250 DR Terrier Black Brant	Missile Alternative Range Target Instrument (MARTI)	San Nicholas Island	S
1/10/2010	36.247 DR Terrier Black Brant	Missile Alternative Range Target Instrument (MARTI)	San Nicholas Island	S
12/17/2009	41.086 UE Terrier-Improved Orion	High Altitude Resolution of Hydroxyl (HAROH)	White Sands Missile Range, NM	S
12/16/2009	12.068 GT Black Brant X		Wallops Island, VA	S
11/14/2009	36.252 UH Terrier Black Brant	Cygnus X-ray Emission Spectroscopic Study (CyXESS)	White Sands Missile Range, NM	S

*Experiment Failure

FIGURE 20: WALLOPS MISSIONS

D. Dryden Flight Research Center

The Dryden Flight Research Center (DFRC) located at Edwards Air Force Base, California, is NASA's primary installation for flight research and flight testing. Projects at Dryden over the past 64 years have led to major advancements in the design and capabilities of many civilian and military aircraft. In the past, DFRC has also conducted tests in support of the Agency's space programs.

The Center supports operations of the Space Shuttle and development of future access-to-space vehicles, conducts airborne science missions and flight operations, and develops piloted and uninhabited aircraft test beds for research and science missions.

Range Safety operations at Dryden are managed by the Range Safety (RS) Office. The RS Office was established by the Dryden Center Director under an alliance agreement with the Air Force Flight Test Center (AFFTC) to provide independent review and oversight of Range Safety issues. The RS Office supports the Center by providing trained Flight Termination System (FTS) engineers, Range Safety risk analysts, and Range Safety Officers to provide mission and project support for Unmanned Aircraft System (UAS) Projects. The DFRC/AFFTC Range Safety Alliance allows both RS offices to work with each other on projects that the other office may not otherwise experience.

1. Enhanced Flight Termination System

The DFRC/AFFTC Range Safety Alliance has installed and certified for operation a fixed Enhanced Flight Termination System (EFTS) transmitter site. The EFTS transmitter site has been used successfully to support two current, flying UAS projects. Modifications are being planned to address the needs of upcoming flight projects. Dryden also continues to support flight projects with Inter-Range Instrumentation Group (IRIG) Flight Termination Receivers.

2. Orion

The Orion Project is an element of the Agency's Constellation Program. The Orion Project consists of the Crew Module (CM) and the Launch Abort System (LAS). Dryden conducted a flight test to demonstrate proper operations of the LAS and CM recovery systems in response to abort events initiated on the launch pad and during the initial ascent phase of flight. Pad Abort 1 (PA-1) was successfully conducted at U.S. Army's White Sands Missile Range (WSMR) in New Mexico on 6 May 2010. All systems for steering, separation, stabilization, parachute deployment, and landing worked as planned. The PA-1 test involved the first American application of a human-rated, reverse flow rocket motor.

Range Safety for PA-1 was a collaborative effort between the Dryden RS Office, various organizations at Johnson Space Center (JSC), and the WSMR Flight Safety Branch. The RS Office tailored NPR 8715.5, "Range Safety Program," for PA-1 and verified compliance. No waivers were written. The RS Office also reviewed range safety products supplied by the participating JSC organizations.

JSC prepared range safety products including the errant LAS analysis, the flight dynamics Range Safety data package, and the probabilistic risk assessment report. The WSMR Flight Safety Branch provided final review and approval for Range Safety and provided real-time operational support for the launch.

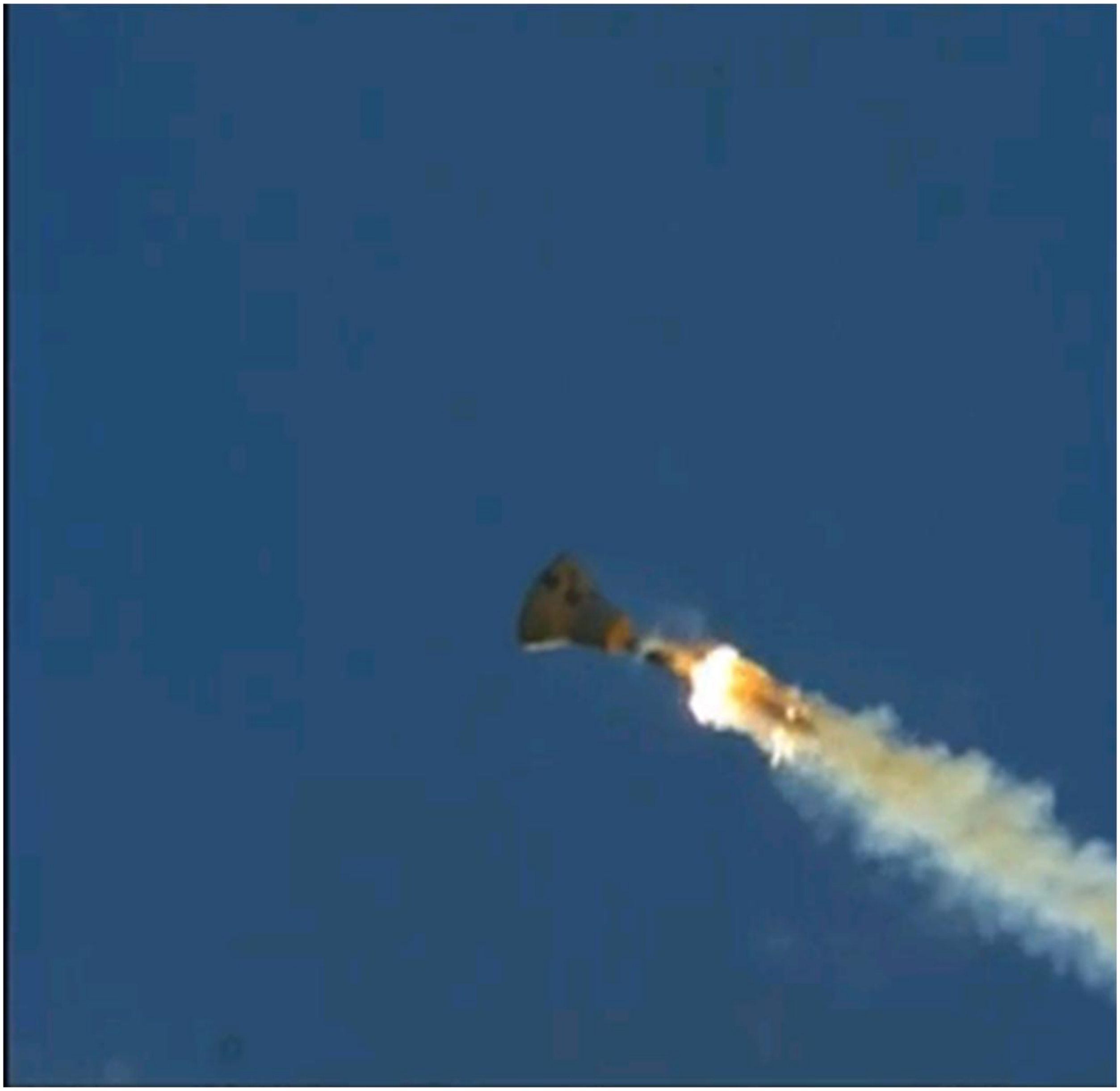


FIGURE 21: PA-1

The video can be viewed at: http://www.youtube.com/watch?v=shKuaWHjLhA

Dryden continues to support the testing of a wide range of UASs. The UASs that were flown with Dryden assistance include:

3. Small UASs

Small Unmanned Aircraft Systems (sUAS) are in the model-type classification of flight vehicles. Dryden has established an area that offers sUAS projects a unique opportunity to conduct flights within the restricted airspace. Dryden has also established a streamlined flight approval process for sUASs that makes the airworthiness and safety review quicker and easier than those performed for larger UASs. Using this process, Dryden has successfully supported many hours of operations on multiple platforms from different manufacturers.

4. Blended Wing Body Low Speed Vehicle

The Blended Wing Body (BWB) Low Speed Vehicle (LSV) UAS, also known as X-48B LSV Project, is a dynamically scaled version of the original concept vehicle. The X-48B LSV Project is a partnership between NASA, Boeing, USAF Research Laboratory, and Cranfield Aerospace. The primary goals of the test and research project are to study the flight and handling characteristics of the BWB design, match the vehicle's performance with engineering predictions based on computer and wind tunnel studies, develop and evaluate digital flight control algorithms, and assess the integration of the propulsion system to the airframe. The BWB testing will address several key goals of NASA's Environmentally Responsible Aviation (ERA) Project, namely noise reduction, emissions reduction, and improvement in fuel economy. Industry studies suggest that because of its efficient configuration, the BWB would consume 20% less fuel than jetliners of today, while cruising at high subsonic speeds on flights of up to 7,000 nautical miles. To date, the Project has conducted 86 successful flights, all with LSV #2.

The Project has reached a milestone by successfully completing Phase 1. After several more flights, LSV #2 will be modified to make the vehicle quieter. The modifications include reducing the number of engines from three to two, the installation of noise-shielding vertical fins, and the removal of the winglets. The designation for this new configuration is X-48C. First flight is expected to be in mid 2011.

5. NASA Global Hawk

Dryden has acquired two former United States Air Force (USAF) Advanced Concept Technology Demonstration (ACTD) Global Hawk UASs. These pre-production Global Hawks were built by Northrop Grumman for the purpose of carrying reconnaissance payloads. The vehicles will begin a new life as a supplement to NASA's Science Mission Directorate by providing a high altitude, long endurance airborne science platform. The vehicle has an 11,000 nautical mile range and 30+ hour endurance at altitudes above 60,000 feet MSL. To date, NASA Global Hawks have flown 9 successful flights with NASA 871 and 20 successful flights with NASA 872. NASA Global Hawks supported two successful earth science campaigns this year: Global Hawk Pacific (GloPac 2010) and Genesis and Rapid Intensification Processes (GRIP 2010).

FIGURE 22: GLOBAL HAWK

The Range Safety Office supported flight planning and risk analysis tasks in support of FAA Certificate of Authorization (COA) applications as well as real-time operations support.

6. Ikhana

NASA's Ikhana UAS is a General Atomics Predator-B modified to support the conduct of Earth science missions for the Science Mission Directorate. The aircraft is designed to be disassembled and transported in a large shipping container aboard standard military transports.

Ikhana has been registered with the FAA and given the tail number N870NA.

The Range Safety Office has supported flight planning and risk analysis tasks in support of FAA Certificate of Authorization (COA) applications as well as real-time operations support. The vehicle has flown 21 flights this year.

Dryden Flight Research Center Missions 2010				
Date	**Project Name**	**Mission**	**Location**	**Mission Result**
02/02/10	X-48B LSV (Blended Wing Body)	Flight # 73	Edwards AFB	Success
02/03/10	Ikhana	Flight # 91; Pilot Proficiency Flight	Edwards AFB	Success
02/04/10	X-48B LSV	Flight # 74	Edwards AFB	Early RTB
02/17/10	Ikhana	Flight # 92; Pilot Proficiency Flight	Edwards AFB	Success
02/23/10	X-48B LSV	Flight # 75	Edwards AFB	Success
02/25/10	X-48B LSV	Flight # 76	Edwards AFB	Success
03/03/10	NASA Global Hawk (872)	Flight # 6; Functional Check Flight	Edwards AFB	Success
03/05/10	NASA Global Hawk (872)	Flight # 7; Functional Check Flight	Edwards AFB	Success
03/11/10	Ikhana	Flight # 93; Pilot Proficiency Flight	Edwards AFB	Success
03/11/10	NASA Global Hawk (872)	Flight # 8; Functional Check Flight	Edwards AFB	Success
03/11/10	X-48B LSV	Flight # 77	Edwards AFB	Success
03/12/10	X-48B LSV	Flight # 78	Edwards AFB	Success
03/17/10	X-48B LSV	Flight # 79	Edwards AFB	Success
03/19/10	X-48B LSV	Flight # 80	Edwards AFB	Success
03/24/10	Ikhana	Flight # 94; Pilot Proficiency Flight	Edwards AFB	Success
04/02/10	NASA Global Hawk (872)	Flight # 9; GloPac FCF	Edwards AFB	Success
04/07/10	Ikhana	Flight # 95; Pilot Proficiency Flight	Edwards AFB	Success
04/07/10	NASA Global Hawk (872)	Flight # 10; GloPac Flight #1	Edwards AFB	Success

04/13/2010-04/14/2010	NASA Global Hawk (872)	Flight # 11; GloPac Flight #2	Edwards AFB	Success
04/23/2010-04/24/2010	NASA Global Hawk (872)	Flight # 12; GloPac Flight #3	Edwards AFB	Success
04/30/10	NASA Global Hawk (872)	Flight # 13; GloPac Flight #4	Edwards AFB	Early RTB
05/17/10	Ikhana	Flight # 96; Pilot Proficiency Flight	Edwards AFB	Success
05/27/10	NASA Global Hawk (871)	Flight # 1; Checkout Flight	Edwards AFB	Success
06/15/10	Ikhana	Flight # 97; Pilot Proficiency Flight	Edwards AFB	Success
06/15/10	NASA Global Hawk (871)	Flight # 2; Pilot Proficiency Flight	Edwards AFB	Success
06/15/10	NASA Global Hawk (871)	Flight # 3; Pilot Proficiency Flight	Edwards AFB	Success
06/22/10	Ikhana	Flight # 98; Pilot Proficiency Flight	Edwards AFB	Success
06/22/10	Ikhana	Flight # 99; Pilot Proficiency Flight	Edwards AFB	Success
06/22/10	NASA Global Hawk (871)	Flight # 4; Pilot Proficiency Flight	Edwards AFB	Success
06/22/10	NASA Global Hawk (871)	Flight # 5; Pilot Proficiency Flight	Edwards AFB	Success
06/29/10	NASA Global Hawk (871)	Flight # 6; Pilot Proficiency Flight	Edwards AFB	Early RTB
06/30/10	Ikhana	Flight # 100; Pilot Training	Edwards AFB	Success
07/08/10	Ikhana	Flight # 101; Pilot Training	Edwards AFB	Success
07/08/10	Ikhana	Flight # 102; Pilot Training	Edwards AFB	Success
08/05/10	Ikhana	Flight # 103; Pilot Training	Edwards AFB	Success
08/12/10	Ikhana	Flight # 104; Pilot Training	Edwards AFB	Success
08/12/10	Ikhana	Flight # 105; Pilot Training	Edwards AFB	Success
08/15/10	NASA Global Hawk (872)	Flight # 14; GRIP Functional Check Flight	Edwards AFB	Success
08/24/10	NASA Global Hawk (872)	Flight # 15; GRIP Payload Test Flight	Edwards AFB	Success
08/26/10	Ikhana	Flight # 106; Payload Test Flight	Edwards AFB	Success
08/28/10	NASA Global Hawk (872)	Flight # 16; GRIP Flight #1	Edwards AFB	Success
08/31/10	Ikhana	Flight # 107; Pilot Training	Edwards AFB	Success

09/01/2010-09/02/2010	NASA Global Hawk (872)	Flight # 17; GRIP Flight #2	Edwards AFB	Success
09/02/10	Ikhana	Flight # 108; Payload Test Flight	Edwards AFB	Success
09/12/2010-09/13/2010	NASA Global Hawk (872)	Flight # 18; GRIP Flight #3	Edwards AFB	Success
09/16/2010-09/17/2010	NASA Global Hawk (872)	Flight # 19; GRIP Flight #4	Edwards AFB	Success
09/21/10	X-48B LSV	Flight # 81	Edwards AFB	Success
09/23/2010-09/24/2010	NASA Global Hawk (872)	Flight # 20; GRIP Flight #5	Edwards AFB	Success
09/28/10	X-48B LSV	Flight # 82	Edwards AFB	Success
09/29/10	X-48B LSV	Flight # 83	Edwards AFB	Success
09/29/10	X-48B LSV	Flight # 84	Edwards AFB	Success
09/30/10	Ikhana	Flight # 109; Pilot Proficiency Flight	Edwards AFB	Success
10/06/10	X-48B LSV	Flight # 85	Edwards AFB	Success
10/06/10	X-48B LSV	Flight # 86	Edwards AFB	Success
10/13/10	Ikhana	Flight # 110; Pilot Proficiency Flight	Edwards AFB	Success
10/13/10	NASA Global Hawk (871)	Flight # 7; Pilot Proficiency Flight	Edwards AFB	Success
10/13/10	NASA Global Hawk (871)	Flight # 8; Pilot Proficiency Flight	Edwards AFB	Success
10/21/10	NASA Global Hawk (871)	Flight # 9; Pilot Proficiency Flight	Edwards AFB	Success

FIGURE 23: 2010 DRYDEN MISSIONS

E. Johnson Space Center

1. Constellation Range Safety Panel

The Launch Constellation Range Safety Panel (LCRSP) manages launch range safety matters for Constellation Program vehicles, including specifying key interfaces with the Department of Defense (DoD) for launch range safety. This report summarizes the work conducted through the LCRSP and its chartered working groups.

a. Air Force Space Command Manual (AFSPCMAN) 91-710 Requirements Tailoring

With the assistance of the 45th Space Wing (45 SW) and several NASA Centers, a tailored version of AFSPCMAN 91-710 was compiled for the Ares-Orion vehicle configuration. This document accurately captured the latest developments of the range safety requirements for the Constellation Program. In its current state, the tailored document can serve as a baseline for any launch vehicle or program architecture that NASA chooses to adopt in the future. Open items and areas for future investigation were documented during the tailoring process, and the team was able to make considerable progress toward mapping the tailored requirements to specific tasks that are being executed by various organizations throughout the Agency.

b. Ares I-X Post-Flight Data Report

Led by the Ares I-X trajectory team at Langley Research Center (LaRC), an in-depth post-flight analysis and trajectory reconstruction process was completed for the Ares I-X test launch on 28 October 2009. The post-flight and Best Estimated Trajectory (BET) data, methodology, and results were reviewed by the LCRSP and the product customer, the 45th Space Wing (45th SW). A thorough range safety post-flight data report was compiled by the team at LaRC and subsequently delivered to the Air Force.

c. Range Safety and Ascent Abort Debris Risk Assessments

In conjunction with the Constellation Integrated Aborts Team (CIAT), the LCRSP reviewed and coordinated numerous risk assessment activities related to the ascent debris environment for launch vehicle failure scenarios. To ensure proper coordination between the range safety and ascent abort communities, a two-day Technical Interchange Meeting (TIM) was held at Marshall Space Flight Center (MSFC) in February 2010 to discuss the various debris risk assessment techniques, debris catalog development work, and Flight Termination System (FTS) architectures. At the conclusion of the TIM, the ascent abort and range safety communities came to an agreement on a strategy for merging and improving the existing debris catalog efforts while preserving the technical advantages of each unique methodology.

The LCRSP team also addressed several concerns that were raised by the 45 SW regarding FTS sequencing and integrity. The LCRSP's current and future work in FTS sequencing and integrity will improve future FTS design solutions for Ares or any other future launch vehicle.

d. Orion Launch Abort System (LAS) Flight Termination System (FTS) Determination Analysis

In support of future Orion test flights where an active Launch Abort System (LAS) may be employed, the LCRSP has begun to identify key range safety requirements, deliverables, and processes that will be evaluated to determine the risks associated with LAS malfunctions. The data inputs and corresponding risk assessment results will determine whether a FTS is warranted for the future test flights utilizing a LAS. A high-level strategy was developed to address each of the requirements specified in AFSPCMAN 91-710 for this unique vehicle component. Also, the need for additional requirements related to the LAS debris risk analysis were identified and discussed with the 45 SW. The plan forward was developed to be applicable to any launch vehicle configuration.

2. Shuttle Range Safety Panel

In 2010, the number of topics dealt with by the Space Shuttle Range Safety Panel decreased due to the impending retirement of the Space Shuttle. At the time of this report, only three topics of consequence, described below, had been discussed. In addition, the Launch Collision Avoidance (COLA) Process which was discussed in the 2009 annual report is updated.

a. Shuttle Limit Lines

Although the Shuttle uses two solid rocket motors and Ares 1 uses a single motor, both vehicles use the same motors. When Ares 1-X Range Safety Analysis generated impact dispersions that were noticeably different than the Shuttle impact dispersions, there was some concern. Since impact dispersions are used to compute the destruct limit lines for Shuttle, and the impact dispersions generated for Ares 1-X were significantly different than what would be predicted based on Shuttle impact dispersions, identifying the cause of this difference was important to ensure the safe flight of the Shuttle.

Investigation revealed that the differences were due to improvements in analysis techniques and computational methods since the Shuttle analysis was initially performed (~1980). However, even though the “improved” destruct lines were visibly different, the same analysis showed that no statistically significant improvement in safety would result from their incorporation for two reasons. First, destruct lines are a tertiary backup to the primary and secondary debris footprint impact predictors, so they are unlikely to be used. Second, the only limit line changes occurred in areas that can’t be reached by any imaginable Shuttle trajectory.

Given the substantial cost and negligible benefit of the change, the Range Safety Panel requested that the Shuttle limit lines not be changed since implementing the proposed changes would have required updating and recertifying the Day of Launch I-Load Update (DOLILU) software, and this would be time consuming and expensive.

45th Space Wing approved a waiver to their requirements effective for the life of the Shuttle Program based on an equivalent level of safety as provided by the existing limit lines (see Launch Safety Requirements Relief Request, 45-NASA-NASA-2010-02-03, dated 2 March 2010).

b. Solid Rocket Booster Linear Shaped Charge Vibration Qualification

The Marshall Space Flight Center (MSFC) used modern instrumentation, analysis techniques, and computational resources to develop new vibration acceptance testing environments for the five-segment solid rocket motor intended to be used for the Ares-1 booster. These new environments were found to exceed the environments used for acceptance testing of all prior four-segment Shuttle Solid Rocket Boosters (SRBs) in certain frequencies and locations.

MSFC prudently decided to use the new environments to re-analyze the Shuttle SRB acceptance tests. The SRB acceptance tests proved to be adequate with the exception of the Range Safety System Linear Shaped Charge, which was only tested to 3 dB of margin versus the required 6 dB in the radial and longitudinal directions. This information came to light very close to the STS-131 launch. Because of the limited time available, the issue was worked directly between the SRB Project, KSC Range Safety, and the 45th Space Wing Range Safety technical experts.

After careful review of the data, the technical experts judged existing Linear Shaped Charges to be safe for flight, stating:

> "Flight performance (130 missions, including STS-51L) and post-flight inspection since STS-1 demonstrate the integrity of the hardware following exposure to ascent, descent, and water impact environments. Additionally, qualification (8-foot drop and 40-foot drop) and off-nominal standoff test provides additional assurance regarding the robustness of the hardware."

The results of analysis and the recommendation of MSFC and the 45th Space Wing were documented in MSFC Memorandum MP92-038-10, which was transmitted to all SSP Range Safety Panel representatives. The participants were polled, and all members concurred with the recommendations contained in the memo.

c. FOV1 Software Version 2.5

In the second half of the year, the 45th Space Wing intended to upgrade the version 2.4 FOV1 (Flight Operations Version 1) software to version 2.5 in order to remove software modules required for hardware which had long since been removed. This would improve the speed of certain file transfers and would reduce the number of false failure alarms.

In the normal course of events, discussion regarding the new version of FOV1 would not have come to the Space Shuttle Range Safety Panel, since it would have been used first for a Delta IV launch, then briefed at the STS-133 Flight Readiness Review, and finally used for all of the STS-133 prelaunch checks prior to the STS-133 launch. However, about one month prior to STS-133, the Delta IV launch slipped to a date occurring after the STS-133 launch.

Normally, the 45th Space Wing uses a new FOV1 version on an ELV launch before it is used for a Space Shuttle launch. The slip of the Delta IV left the Wing with a choice to follow the standard process by reverting to version 2.4, or to go ahead and have the first flight use of version 2.5 on STS-133. After careful consideration, the Wing elected to recommend proceeding with the first use of version 2.5 on STS-133. This decision was based on the size and nature of the software change, the amount and success of testing already performed, and the fact that installed and tested hardware would have to be reconfigured in order to revert to version 2.4. The 45th Space Wing requested the Space Shuttle Range Safety Panel review their decision and recommendation.

Because the issue was only of interest to a part of the normal SSP Range Safety Panel participants, a splinter telecon was held to present the 45th Space Wing recommendation. Johnson Space Center participation included representatives of the Flight Director Office, Flight Dynamics Division, Ground Control Office, and Navigation. Representatives of the Spaceflight Meteorological Group and the DOLILU Working Group declined to participate after determining that they were not impacted.

The 45th Space Wing presentation was well received, and the only reservations expressed were from the Navigation organization who felt that an end-to-end test with their systems was required prior to STS-133. Fortunately, the 45th Space Wing was able to incorporate the use of the 2.5 version of the FOV1 software into a previously scheduled Navigation test, allowing the requested end-to-end test to be completed in a very timely fashion. After reviewing the results of the test, Navigation was satisfied that there would be no impact to the use of FOV1 version 2.5 during the STS-133 launch, and Range Safety Panel concurred with the 45th Space Wing's recommendation.

The STS-133 launch was subsequently delayed until after the Delta IV launch, and this work around was not required. However, the process implemented above is indicative of the responsiveness and can-do attitude of the 45th Space Wing and the SSP Range Safety Panel.

d. Launch Collision Avoidance (COLA) Process

As a follow up to the 2009 Space Shuttle Range Safety report, 2010 began with the Air Force intending to implement their new Launch Collision Avoidance process for STS-130 and considering the Space Shuttle Program request for an 8 x 30 x 30 km screening volume. The Air Force did grant that request (8 x 30 x 30 km screening volume), but for various reasons, the new process was not fully implemented for any of the Space Shuttle launches through STS-132. At the time of this writing, the process is scheduled to be first used for STS-133.

F. Ames Research Center

Ames Research Center (ARC) has established ranges at Moffett Field, Crows Landing, and San Bernabe Vineyard for the flight testing of NASA, university, and private company Unmanned Aircraft Systems (UAS) operating as public aircraft under FAA Certificates of Waiver or Authorization (COA). UAS operations also take place in the restricted airspace of Camp Roberts McMillan Airfield and Fort Hunter Liggett Garrison. Other domestic and international sites are selected to support specific program objectives.

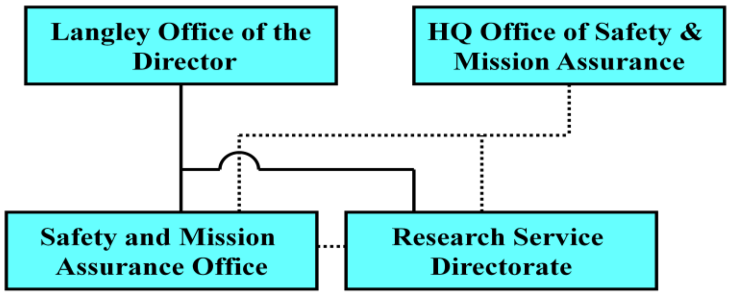
ARC operates or oversees the operation of a variety of UAS for earth science missions, flight controls research and technology demonstration. The largest ARC UAS is the Science Instrumentation Evaluation Remote Research Aircraft (SIERRA), which has a wingspan of 20 feet and a takeoff gross weight of 370 pounds with a payload capacity up to 100 pounds. The endurance is over 10 hours at a cruise speed of 55 knots. Recent missions have included the Characterization of Arctic Sea Ice Experiment (CASIE) deployment to Svalbard, Norway and synthetic aperture radar (SAR) imaging of test sites at Fort Hunter Liggett in support of NASA's Soil Moisture Active-Passive (SMAP) mission.

Operations typically involve the participation of an independent Designated Range Safety Officer (DRSO) who oversees the range and ground safety aspects of the flight testing. The DRSO verifies the airspace is clear of obstacles, coordinates the use of visual observers, and verifies that the flight commit criteria are met. The DRSO ensures compliance with NPR 8715.5 and with the provisions of the FAA COA and has the authority to order activation of the Contingency Management System (CMS) or Flight Termination System (FTS) to keep the UAS in the authorized flight area.

FIGURE 24: TACSAT-3

G. Langley Research Center

In October 2009, LaRC added a full time Range Safety Officer (RSO) in response to the increasing need for programs and projects to fly Small Unmanned Aircraft Systems (sUAS) weighing less than 100 pounds supported by various labs at Langley Research Center (LaRC). Figure 25 shows the relationship between the Safety and Mission Assurance Office and the Research Services Directorate where the Range Safety Program and the Range Safety Officer reside within the LaRC Safety Organization. These roles and responsibilities include independent oversight for all UAS operations at LaRC or LaRC UAS that are flown in the National Air Space (NAS) or at any government facility utilizing restricted air space.



- Research Services Directorate (RSD) provides aviation safety for Langley.
- Personnel in this organization.
  - Les Kegey, Aviation Safety Manager
  - Noel West, Risk Analayst
  - Jeff Hill, Range Safety Officer
- Two key safety committees in this area are: Aviation Safety Review Board and Aviation Safety Working Group

FIGURE 25: LARC SAFETY ORGANIZATION

During 2010, LaRC Range Safety provided oversight for sUAS flight operations in National Airspace and Restricted Airspace. LaRC Range Safety continued to work closely with the Federal Aviation Administration (FAA) Unmanned Aircraft System (UAS) Program Office and with the organizations managing Restricted Air Space. The primary goals of this effort were to maintain safety of flight for the public, public property, and test personnel and to ensure that NASA Range Safety requirements were in alignment with NPR 8715.5, “NASA Range Flight Safety Program.”

LaRC currently maintains Certificates of Authorization (COAs) to fly in the National Air Space at Blackstone Army Airfield / Allen C. Perkinson Airport (BKT) and at Aberdeen Field Airport (31VA), Smithfield, Virginia. Operations in Restricted Airspace include Finnegan Field at Fort A.P. Hill, near Bowling Green, Virginia; Wallops Flight Facility on Wallops Island, Virginia; and at the Naval Outlying Field, Webster Field, Maryland. A total of 84 deployment days were logged across these facilities that included requirements for UAS pilot flight training / proficiency and for programmatic experimental flight research support.

1. Airborne Subscale Transport Aircraft Research (AirSTAR) Project

The Airborne Subscale Transport Aircraft Research (AirSTAR) project completed all its phase IV major milestones via deployments to Blackstone Army Airfield / Allen C. Perkinson Airport, Blackstone, Virginia. The project is funded by the Aviation Safety Program and focuses on research flight testing of various flight control algorithms developed by NASA, industry, and academia for monitoring the health of vehicle flight control systems, the study of flight control system failures, and control recovery in commercial aircraft.

The AirSTAR sUAS consists of a Mobile Operations Station (MOS) and a dynamically scaled, fully instrumented 5.5 percent scale Generic Transport Model (GTM) (shown in Figure 26). The current Concept of Operation (CONOPS) is to fly within the visual line of sight of an external safety pilot (EP) who monitors nominal flight conditions as research flight tests are performed by an internal research pilot (IP) stationed inside the MOS. If an off-nominal event should occur, the external safety pilot, pilot in command, has full authority to take control and safely land the vehicle. A Range Safety Officer (RSO) resides within the AirSTAR project team to monitor the safety of the flight operations and ensure compliance with the safety requirements of the Fort Pickett Range Safety Organization.

FIGURE 26: AirSTAR MOS, TEST TEAM, AND GENERIC TEST VEHICLES

2. SUAVELab

The Small Unmanned Aerial Vehicle Laboratory (SUAVELab) provides low-cost, experimental test platforms for an array of various NASA, DoD, and industry-funded projects. The laboratory has the capability to design, develop, and deliver prototypes of state-of-the-art UAS system solutions to projects of critical and/or national importance. Deployments to Fort A. P. Hill, Virginia were focused on maintaining pilot training and proficiency requirements along with project flight tests associated with the development of a Long Endurance Electric sUAS platform (shown in Figure 27). This platform is intended for use in test verification and validation of customer requirements to develop state-of-the-art fuel cell technologies. The flight test team interfaced daily with the Fort A. P. Hill Range Safety Office as part of the required operation procedures and safety guidelines.

FIGURE 27: LONG ENDURANCE ELECTRIC SUAS PLATFORM

3. FLiC

The Flying Controls Testbed (FLiC) lab provides low-cost sUAS for experimental flight control testing like those shown in Figure 28. The flight campaigns include evaluation of various commercial-off-the-shelf (COTS) UAS autopilot systems with the capability to operate in either manual or the full autonomous flight modes of operation. The experimental flight controller capability can be tailored to include auto takeoff, auto landing, and variable waypoint mission profiles along with lost link return home preprogrammed commands.

The flight operations took place at the Naval Outlying Field, Webster Field, Maryland, and included pilot training and proficiency in both manual and autonomous flight modes as well as specific experimental flight control campaigns. Safety of flight and airspace management was conducted through the interface of the Navy Range Safety Office and NASA flight operation.

FIGURE 28: JET POWERED (JFLIC) AND INTERNAL COMBUSTION POWERED (FLIC), FLYING CONTROL TEST BEDS WITH GROUND CONTROL STATION IN BACKGROUND

4. Rapid Evaluation Concept (REC)

In-flight airframe damage assessment and mitigation techniques are vital to survivability of modern and future aircrafts. Engineers, under the auspices of the Integrated Vehicle Health Management (IVHM) Project, are researching techniques for diagnosing airframe state and applying mitigating measures in the presence of damage to aid in extending the life of the aircraft.

The three questions driving this research are:

- Can a sensor system be used to determine the location and extent of structural damage in a dynamic flight environment?
- Can structure response be modeled using statistical and physics-based techniques with sufficient fidelity to perform damage diagnosis?
- Can IVHM developed damage diagnosis technologies be incorporated into control parameter adjustments to mitigate further damage?

To answer these questions, a low cost subscale aircraft sUAS (Figure 29) was instrumented to acquire structural load measurements at key points on the airframe. Structural loading data were captured for flights of undamaged vehicles as well as vehicles subjected to certain fault injection scenarios, including weakening the wing spar tube. By measuring the loads in these cases, correlations can be made with other aircraft sensors to determine the state of the structure and mitigate further damage. Mitigating measures under consideration include augmented control mechanisms to shift load away from damaged components to help improve survivability.

Initial flights with the undamaged spar were conducted in the NAS at Aberdeen Field Airport (31VA), Smithfield, Virginia. After thorough testing and evaluation of a weakened spar was conducted in the lab by the test team, a Flight Safety Release was granted by the NASA LaRC Airworthiness and Safety Review Board (ASRB) along with concurrence from the NASA LaRC RSO to conduct test flights in the restricted airspace at Fort A. P. Hill, Virginia. All flights were successfully completed and data analysis is being progressed for publication.

FIGURE 29: RAPID EVALUATION CONCEPT (REC) OF A LOW COST INSTRUMENTED SUAS

H. Stennis Space Center

Stennis Space Center 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 (see Figure 30). The Stennis International Airport (HSA) resides inside of the Buffer Zone along the Eastern boundary. The Department of the Navy (DoN) has purchased approximately 5,520 acres of land to the west of the Fee Area which is now considered the “Western Maneuvering Area” (WMA). All occupants of the Buffer Zone must comply with the restrictive easement provisions established for the Buffer Zone.

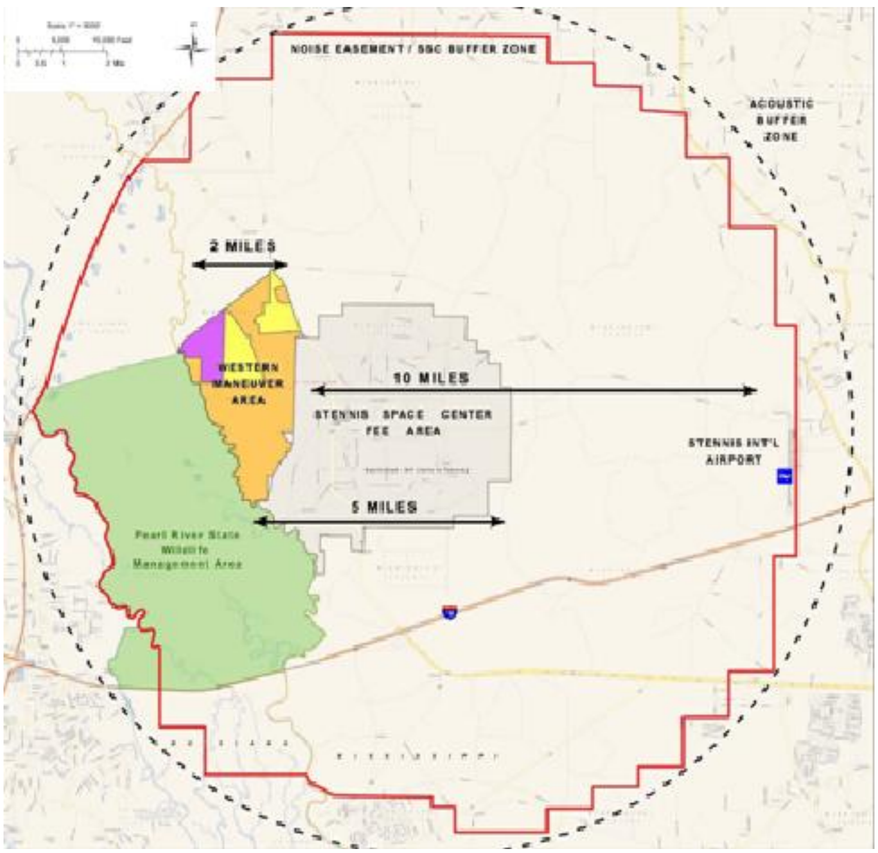


FIGURE 30: JOHN C. STENNIS SPACE CENTER

As a result of the engine testing, the Buffer Zone at SSC has resulted in a Federal City capable of facilitating activities which require privacy and primacy. As such SSC has created a Range Safety Position within the Office of Safety & Mission Assurance and Katie Carr has joined the NASA Range Safety Team as the Range Safety Representative for SSC. The Range Safety Representative at Stennis Space Center plays an active role in securing the appropriate air space for the expanded, more aggressive engine test programs. In addition to the NASA mission, Ms Carr also assures the Tenets within the Federal City the greatest opportunities for mission success as outlined in the host tenant agreement.

1. Engine Testing

Stennis Space Center is NASA's primary center for testing and certifying rocket propulsion elements and systems for the Human Space Flight Program. With more than three decades of experience in engine testing, SSC provides rocket test services to commercial and other government entities engaged in exploiting and exploring outer space. SSC has tested all Space Shuttle Main Engines (SSME) as well as commercial engines like the RS68 rocket engine shown in Figure 31.

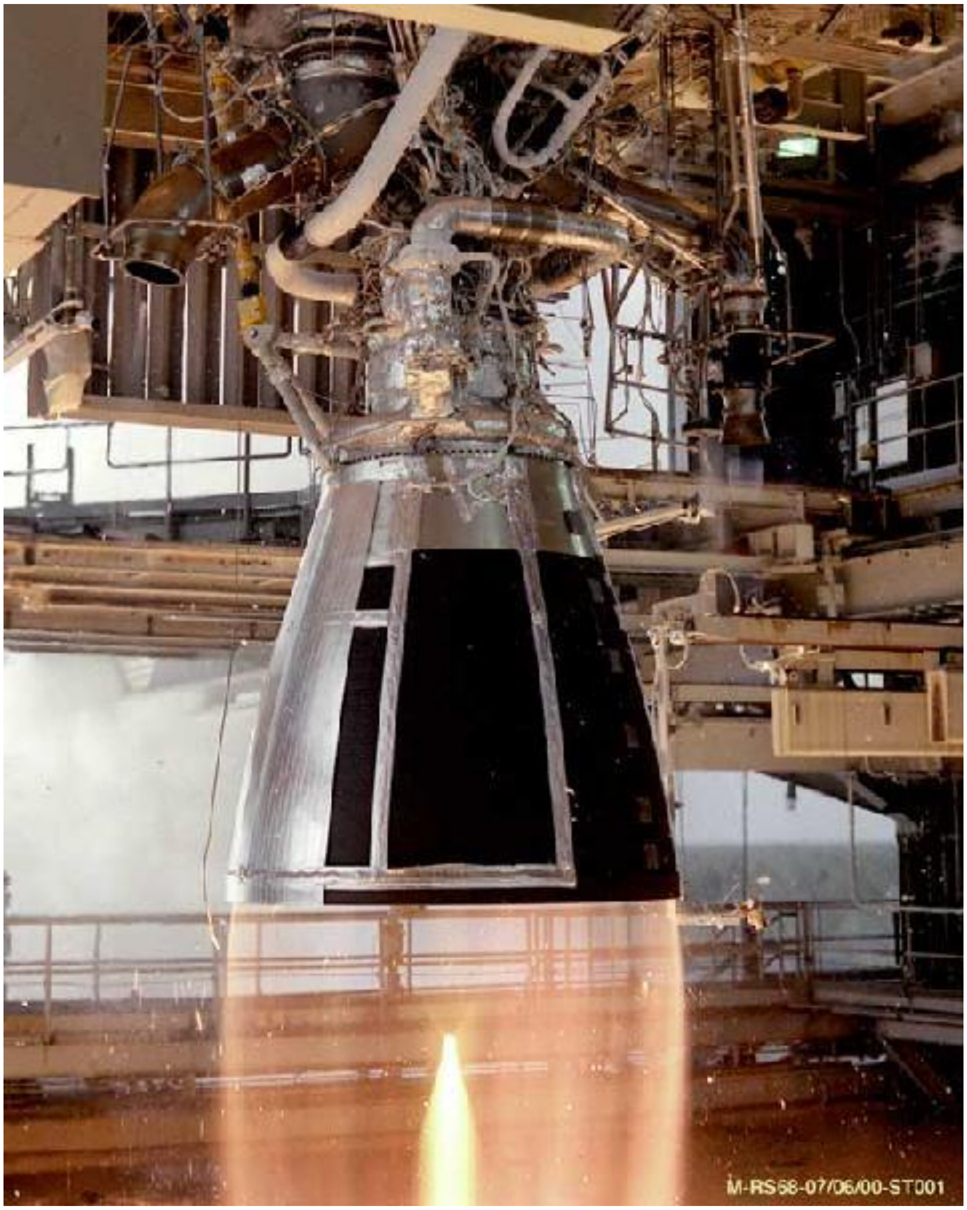


FIGURE 31: RS68 ENGINE TEST AT NASA SSC B-1 TEST STAND

The NASA SSC Engineering and Test Directorate maintains full-scale rocket test facilities. These facilities are comprised of two single-position large scale engine test stands, one dual-position large scale engine and stage test stand, and the E-Complex for testing of both engines and components. The Directorate also maintains engineering services capabilities including modeling and technology for propulsion testing applications.

As a safety precaution to general aviation in the immediate airspace, Restricted Airspace R-4403, is activated during engine testing. Between 1 January 2010 and 1 October 2010, R-4403 was activated 18 times for RS68 engine testing.

2. Small Arms Range

The DoN has established a Naval Special Operations Forces for riverine and jungle training in the WMA. As of 22 March 2010, the DoN recognizes the Small Arms Range and the associated WMA training grounds to be in conformance with its certifications for specified weapons to be fired from boat, land, and helicopters. In accordance with DoN requirements, weapons and ammunitions are limited to:

- 5.56 mm, 7.62 mm, and a .50 caliber Short Range Training Ammunition (SRTA) with a maximum range of 700 meters or less
- Non-lethal ammo or "simunutions"
- Blanks
- Other weapons/ammunition as approved

Currently, NASA SSC does not participate in the Small Arms Range Safety Program despite the fact that the Small Arms Range resides in the Fee Area. The DoN is responsible for all range safety, coordination, and monitoring as a result of the custodianship bestowed on the DoN by NASA via Memorandum of Agreement between NASA and the DoN dated June 2006.

To augment the Small Arms Range training program, the Naval Special Warfare Command (NSW) has plans of expanding the Small Arms Range from its current foot print of 551,279 square feet by adding an additional 1,311,300 square feet bringing the total range facility to 1.9 million square feet. The Stennis Range trained 2803 personnel from February 2010 through September 2010.

3. Special Forces IntegratedTraining

As a result of the training opportunity the NSW and in particular Special Boat Team 22 (SBT22) has created at Stennis Space Center, other government agencies have approached NASA to enter into similar agreements.

One such agency is the Air Force Special Operations Command (AFSOC). AFSOC conducts a unified training event annually which incorporates multiple locations and numerous agencies to first educate the AFSOC community and secondly certify them for war. Stennis Space Center has been chosen to participate in the 2011 Emerald Warrior exercise as a dry fire event.

To prepare for this event, AFSOC and the NSW teams have conducted integrated training missions at Stennis Space Center to validate the feasibility of the activity. Understanding the restrictions and limitations which are inherent to Stennis Space Center is a corner stone to a successful exercise.

On 27 May 2010, an air-to-ground operation was successfully preformed. The Concept of Operations (CONOP) was provided to NASA SSC. NASA SSC routed the CONOP to the Aircraft Division at NASA Headquarters and other key NASA personnel for a risk assessment and safety evaluation prior to providing AFSOC with permission to proceed.

4. Stennis International Airport

Stennis International Airport (HSA) is located inside the buffer zone. Hancock County Development Commission is owner and operator of the facility and is responsible for all safety considerations at the airport.

Total Aircraft Operations	175 per Day
General Aviation – Local	25.2%
General Aviation – Itinerant	64.4 %
Military	10.2 %

FIGURE 32: OPERATIONAL STATISTICS FOR 2008 – 2009

5. Unmanned Aerial Vehicles - Certificate of Authority

Unmanned Aircraft Systems (UAS) require a Certificate of Authority (COA) from the Federal Aviation Administration (FAA) for operation in the National Airspace. COA are available to public entities such as government agencies, local law enforcement, and state universities for research and development, market surveys, and crew training. Most COAs are issued for a specified time and require visual contact with the vehicle when operated outside of restricted airspace.

Currently, the Department of Defense Special Operations Command (SOCOM) is the only operating agency of UASs at Stennis Space Center. The COAs for SOCOM are:

- WASP, 2009-ESA-37, effective 22 March 10 to 21 March 11.
- Raven, 2009-ESA-36, effective 21 July 10 to 20 July 11.
- Puma, 2009-ESA-40, also effective 21 July 10 to 20 July 11.

V. EMERGING TECHNOLOGY

A. Autonomous Flight Safety System (AFSS)

The long awaited second sounding rocket flight test of the Autonomous Flight Safety System (AFSS) took place on 21 September 2010 at Wallops Flight Facility (WFF) on a two-stage Terrier Improved Orion rocket.

This was the third major flight test of AFSS. This flight included a Kalman-filtered Global Positioning System / Inertial Navigation System (GPS/INS) solution, redundant flight processors, separate AFSS battery power, improved safety algorithms, an ordnance simulator, and the Low-Cost Telemetry Transceiver (LCT2) in receive mode for the first time. Multiple flight rules were tested such as liftoff detection, over flight of exclusion zones and moving performance gates.

All the flight rules performed as expected. The accelerometers in the IMU failed at T+20 s and the Kalman filter subsequently rejected this data and continued to produce a valid navigation solution using the GPS data—just as it should have done. The gyros were undamaged and continued to supply valid attitude data for the rest of the flight. The LCT2 did not receive commands until the payload was descending on the parachute. The reasons for both of these anomalies are under investigation. Otherwise, all the success criteria were met. The payload was retrieved undamaged.

AFSS began the Independent Verification and Validation (IV&V) process this year in conjunction with NASA's IV&V facility. The initial assessment is underway, and the final decision about continuing this effort to completion will be made early in 2011.

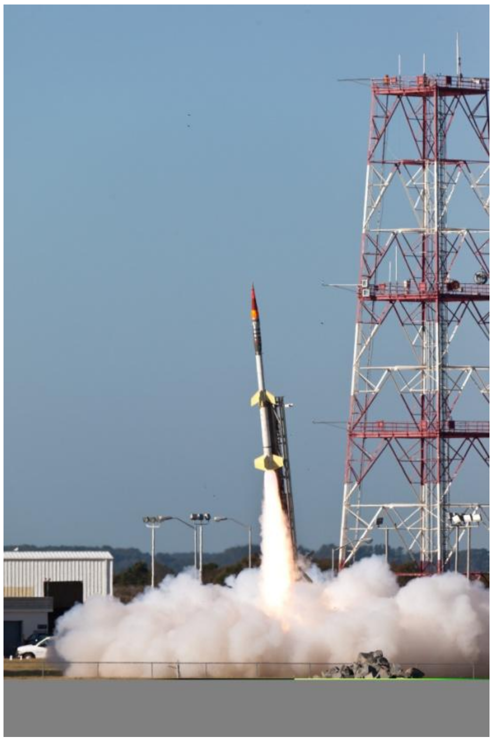


FIGURE 33: AFSS FLIGHT TEST, 21 SEPTEMBER 2010

B. Joint Advanced Range Safety System (JARSS)

The Joint Advanced Range Safety System (JARSS) began as a collaborative effort between Dryden Flight Research Center and the Air Force Flight Test Center at Edwards Air Force Base to develop a state-of-the-art mission planning, risk analysis, and government-owned risk management tool for range safety. In the past year, Kennedy Space Center (KSC) adopted JARSS to accomplish range safety risk analysis. Range Safety organizations from all Major Range and Test Facility Bases are being asked to support the development, testing, and operation of unmanned aircraft systems (UAS), expendable launch vehicles (ELV), and reusable launch vehicles (RLV). The objective of JARSS is to provide range safety support for these types of missions.

JARSS consists of two primary elements: a Mission Analysis Software Tool and the Real-Time Operations Tool. The JARSS Mission Analysis Software Tool is also known as JARSS Mission Planning (JARSS-MP). The Real-Time Operations Tool is known as JARSS-RT.

The Mission Analysis Software Tool quantifies range safety risk for a given flight path and its associated vehicle parameters using a computerized method. This method streamlines range safety analysis by providing a consistent, high fidelity solution in less time than previously required by historical methods of analysis. Figure 34 presents an example probability of impact contour generated by JARSS-MP.

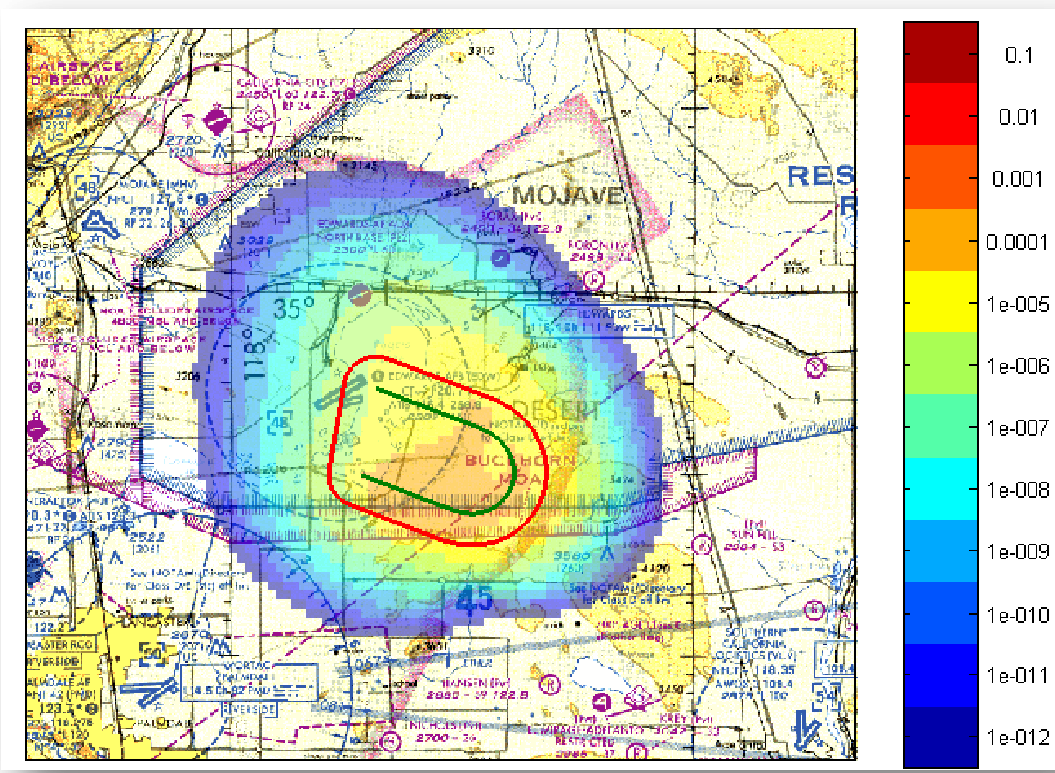


FIGURE 34: EXAMPLE PROBABILITY OF IMPACT CONTOURS

The Real-Time Operations Tool provides Range Safety Officers with near real-time assessment of the range safety risks during flight. This capability has many possible applications to the UAS or RLV operator such as: assessment of UAS overflight of populated areas, allowing extended flight of an anomalous vehicle, recovery of an off-nominal vehicle at an alternate landing site, or selection of an alternate flight or entry path. The JARSS-RT display for an example RLV re-entry is shown in Figure 35

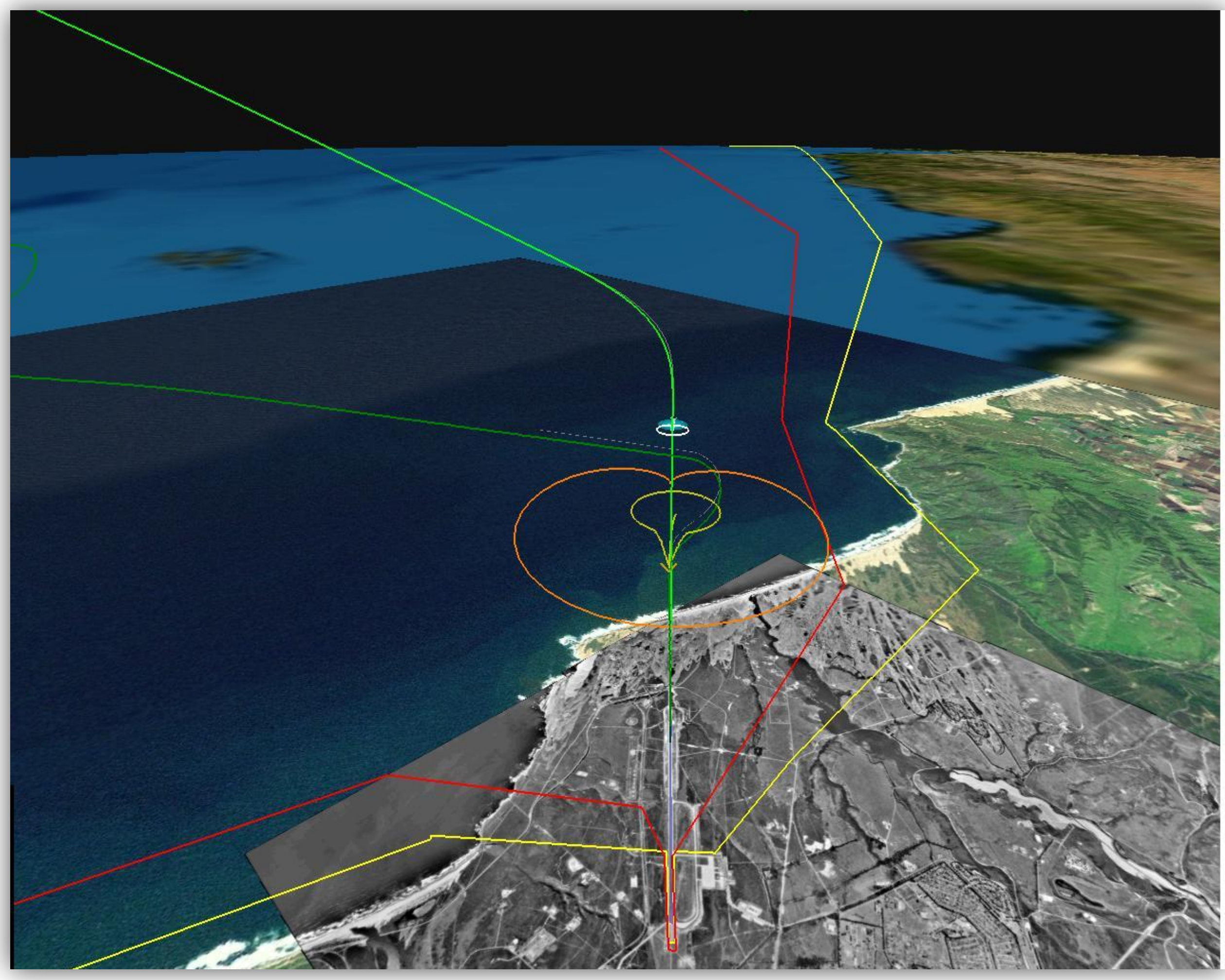


FIGURE 35: JARSS-RT EXAMPLE RLV RE-ENTRY

Major accomplishments this year include using JARSS Mission Planning to calculate range safety risk for on-site operations. Dryden Flight Research Center used JARSS-MP paired with KSC geography and population data to analyze the contingency landing of NASA's Global Hawk at KSC (see Figure 36). KSC Range Safety analyzed requests by the Department of Homeland Security, Customs and Border Protection, to perform both a weather divert of their Predator UAS to KSC's Shuttle Landing Facility and an orbit to altitude maneuver over KSC property (see Figure 37). KSC Range Safety also used JARSS-MP to estimate preliminary range safety risks for various UAS projects desiring to conduct operations on-site. The United States Air Force Operationally Responsive Space (ORS) is working closely with Range Safety personnel from both Wallops Flight Facility (WFF) and Ronald Reagan Test Site (RTS) to modify JARSS-MP for use during Minotaur launches.

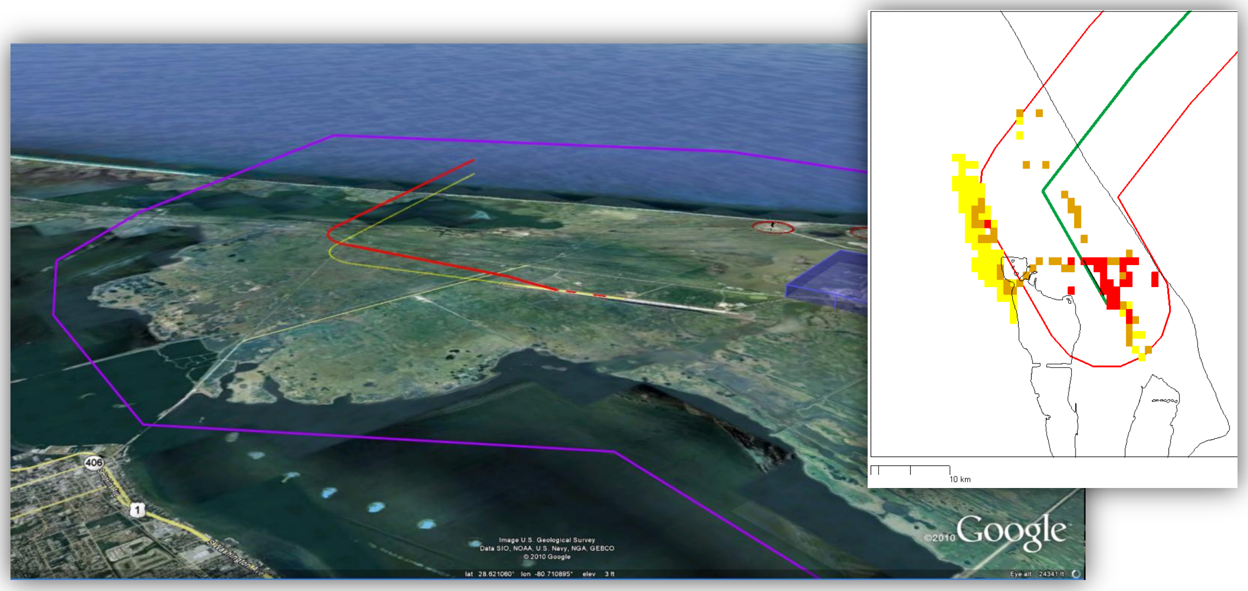


FIGURE 36: PACE-MP EXAMPLE GLOBAL HAWK APPROACH AND LANDING

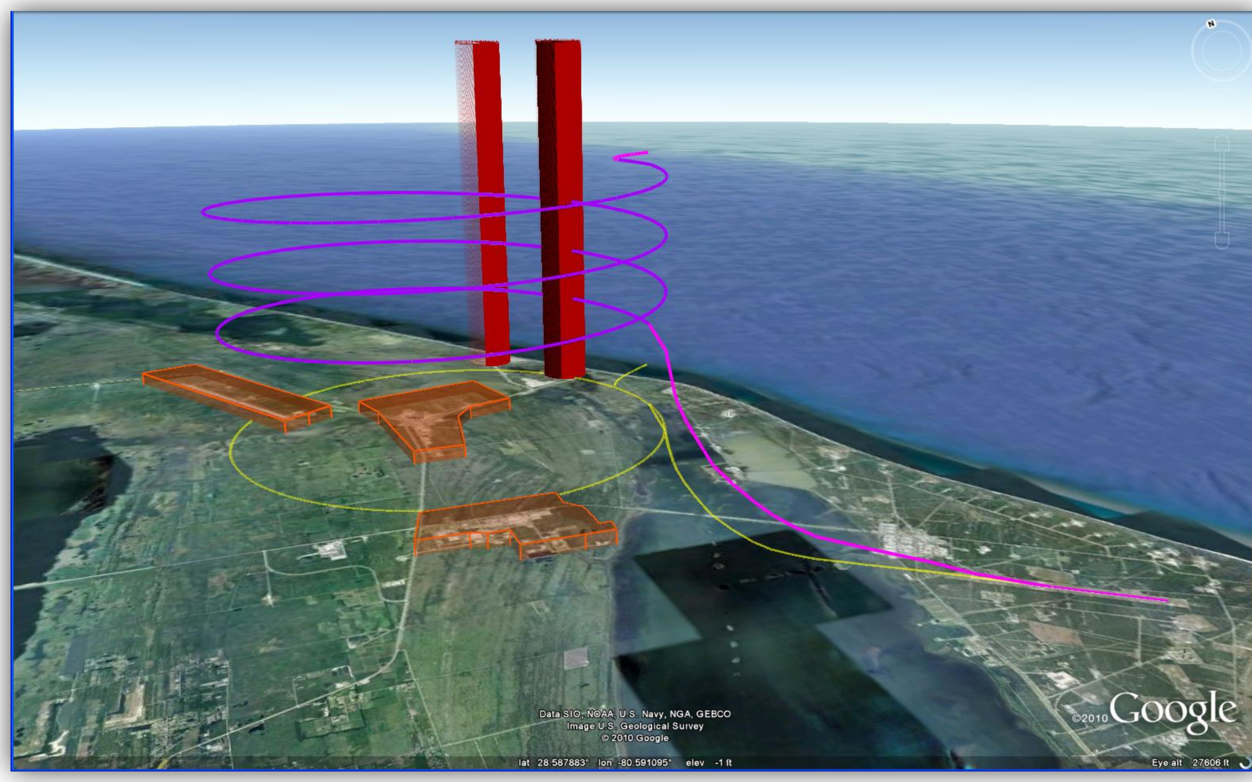


FIGURE 37: JARSS-MP EXAMPLE PREDATOR ORBIT UP AND EXIT CCAFS AIRSPACE

VI. SPECIAL INTEREST ITEMS

A. Expendable Launch Vehicle (ELV) Payload Safety Program

1. AFSPCMAN 91-710(T)

Expendable Launch Vehicle (ELV) Payload Safety Program is completing the ELV Payload Safety Program tailoring of the AFSPCMAN 91-710, which is a joint effort with the Air Force (30th Space Wing and 45th Space Wing) and applicable NASA Centers (JPL and GSFC). This tailored document, AFSPCMAN 91-710(T), infuses applicable NASA, industry, and Air Force Range Safety requirements into a single standard for NASA expendable launch vehicle payload projects. This methodology provides a single baseline requirements document that the Payload Project Office will tailor for Air Force and NASA acceptance and approval. AFSPCMAN 91-710(T) should be completed by the spring of 2011, at which point it will be turned into a NASA standard called “NASA ELV Payload Safety Requirements Standard (NASA-STD-8719.2X).”

2. Mars Science Laboratory (MSL) Pyrovalve Waiver

The Program continues to analyze and assist the Mars Science Laboratory (MSL) Payload Safety Working Group (PSWG) and JPL in processing the MSL Pyrovalve Waiver. This waiver is necessary because the spacecraft is in violation of the EWR 127-1 requirements which state, “If a system failure may lead to a catastrophic hazard, the system shall have three inhibits,” and, “A pressure system shall be dual fault tolerant if the failure of two components could result in a catastrophic hazard.”

The MSL Descent Stage Propulsion subsystem utilizes eight Pyrotechnic Isolation Valves (Pyrovalves) as flow control devices between the propellant tanks and the Mars Lander Engines (MLE). Because the MLE throttle valves are launched in the open position, each pyrovalve provides only single fault protection (two inhibits) against propellant (hydrazine) release and a potentially catastrophic exposure to personnel, critical hardware, and facilities. The use of single string pyrovalves does not provide the MSL DS MLE propulsion system with the required number of three mechanical inhibits against potential leakage of hydrazine as stipulated in the above requirements.

JPL and ELV Payload Safety intend to establish the acceptability of the pyrovalves in their current configuration by obtaining this waiver. Rigorous qualification and acceptance testing has demonstrated that each valve has an internal flow barrier fabricated from a continuous, non-welded parent metal. This is similar to tubing and other component housings. Given this, JPL considers the risk of leakage through this type of flow barrier to be non-credible.

The ELV Payload Safety Program has obtained the assistance of the NASA Engineering and Safety Center (NESC) to evaluate the reliability of parent metal pyrotechnic-operated valves (pyrovalves) in preventing leakage or uncommanded valve activation in payload propulsion systems that use hazardous commodities such as hydrazine or nitrogen tetroxide. The primary concern is the safety of personnel and resources during ground processing of NASA ELV payloads. The ELV Payload Safety Program is assisting with this analysis and evaluation with the intent of using these results to create policy for all NASA payloads regarding pyrovalves within a spacecraft.

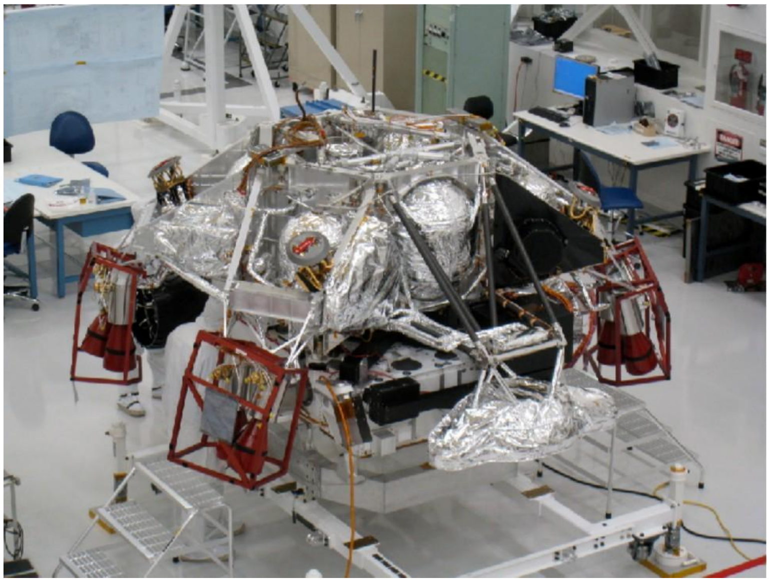


FIGURE 38: MSL POWERED DESCENT STAGE VIBRATION TESTING PHOTOS (PYROVALVES LOCATED IN DESCENT STAGE)

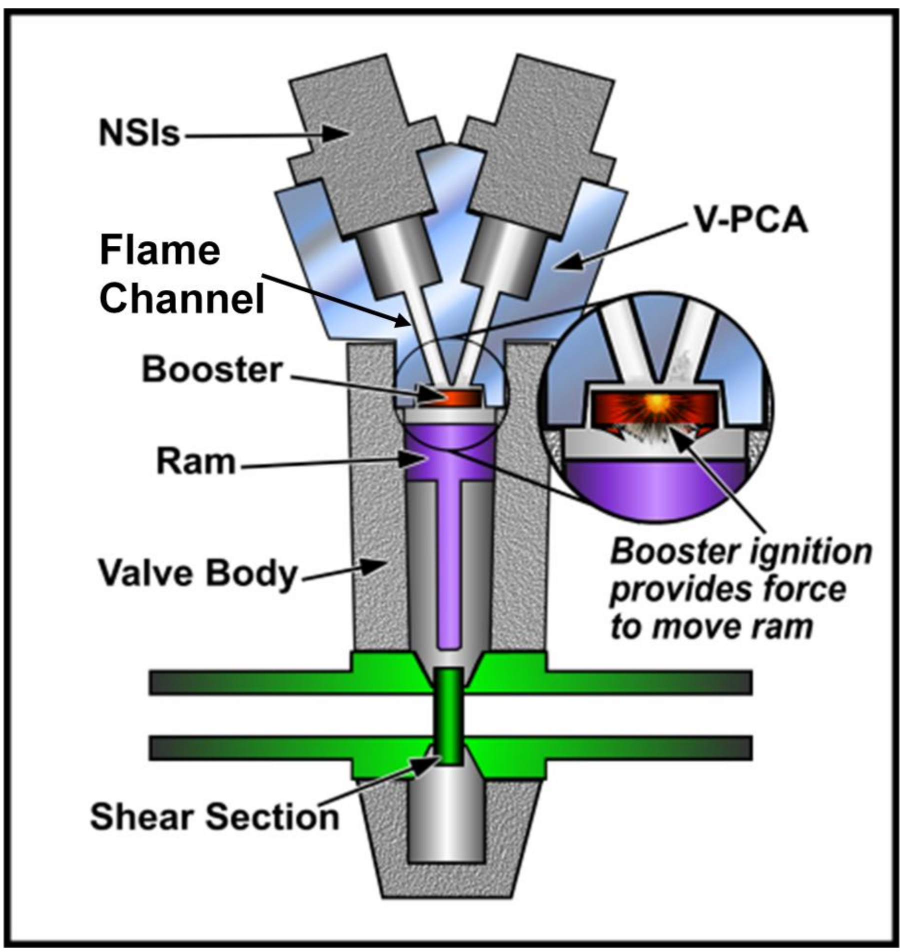


FIGURE 39: ILLUSTRATION OF PYROVALVE

3. ELV Payload Safety Program Training Course

An ELV Payload Safety Program Training Course is being created to benefit all participants in the ELV Payload Safety community. It will be a computer-based training program available on NASA's SATERN database, making it easily accessible to all safety engineers and project managers, as well as any additional project engineers or personnel who will need to be familiar with the NASA Payload Safety Process. Currently, the NASA Safety Center has been contacted by the Program and is providing assistance. Additional video has been received by the NASA Press Site for the training course. This training course should be completed during the spring of 2011.

B. Falcon 9 Launches

The first Falcon 9 rocket launched from Cape Canaveral Air Force Station (CCAFS) on 4 June 2010. Although the launch was initially aborted just prior to ignition due to a pressure glitch in one of the first stage engines, SpaceX engineers determined the problem wasn't serious and successfully launched 75 minutes later. Then, on December 8 2010, the SpaceX Falcon 9 COTS Demonstration 1 was successfully launched from CCAFS carrying its Dragon spacecraft. Three hours later, Dragon splashed down in the Pacific Ocean on target. The Falcon booster is one of two commercial systems that will provide cargo services to the International Space Station as part of NASA's Commercial Orbital Transportation Services (COTS).

FIGURE 40: FALCON 9 LAUNCH FROM CCAFS

Since KSC is the final decision authority regarding risk mitigation actions employed on KSC, KSC Range Safety reviewed the launch risk to the KSC population (employees and public) prior to launch, helped develop contingency mitigation plans, and were present in the 45th Space Wing Risk Assessment Center (RAC) during the launch to initiate any required mitigation actions. Although debris risks are generally contained on CCAFS property, hazards such as toxics and distant focusing overpressure (DFO) can pose potential risk on KSC property. When risk criteria are violated or a concern for a particular hazard is identified, the KSC Range Safety representative in the RAC reviews the risk and provides mitigation recommendations if required.

The video can be viewed at: http://www.youtube.com/watch?v=Q-ci9xIgNZM

C. Julier Uhlmann - Improvements to Statistical Techniques for Range Safety Analysis

NASA Range Safety commissioned a special study to compare the Julier-Uhlmann (JU) transform, a nontraditional range safety technique to determine debris impact dispersion, with the commonly-used technique of performing Monte Carlo simulations.

One limitation of the Monte Carlo analysis technique is the sheer number of runs required to develop a solution which truly converges. In the past, this method presented limitations to range safety organizations by requiring tradeoffs between fidelity of results versus the time required to obtain them. It is not uncommon to require tens of thousands of Monte Carlo runs to obtain a 5% error in impact variance and are typically not repeatable due to the random nature of the simulations results.

The technical report resulting from this study provides an introduction to the JU transform, a historical perspective on the use of JU and Monte Carlo techniques, extensive verifications of the JU technique to include regression tests, and comparisons against NASA and third-party operational tools.

The report highlights testing which shows that Monte Carlo approaches require 7,500 to 50,000 times the computational effort of the JU technique when estimating the variance in impact dispersion within ±1% for a six-degree of freedom drag integration to impact. Even if a much lower variance estimation accuracy of ±10% can be accepted, the speed advantage of the JU technique still ranges from 75 to 350 times faster. More concretely, when a JU approach was tested to replace the Monte Carlo technique used by traditional Shuttle risk analysis tools, the projected run time on a 22-CPU tower was reduced from 96 hours to 2 hours.

Figure 41 summarizes the efficiency and accuracy of these techniques for the case of a 6-degree-of-freedom drag integration to impact considering initial state uncertainty. The JU technique yields more accurate estimates at computational costs that are orders-of-magnitude lower.

Method	Integrations to Impact	Error in Variance
Standard Julier-Uhlmann	13	<1%
One-Sided Julier-Uhlmann	7	<3%
Latin-Hypercube Monte Carlo	1,000	~8.2%
	10,000	~2.5%
	100,000	~1%
Simple Random Sampling Monte Carlo	1,000	~17%
	10,000	~5.1%
	100,000	~2.1%
	(est) 643,000	~1%

FIGURE 41: EXAMPLE RELATIVE PERFORMANCE

In summary, the JU technique is widely applicable to problems within the range safety domain, and it provides accurate and repeatable answers in a fraction of the time of Monte Carlo methods. When operational timelines require much quicker assessments than traditionally allowed, the JU technique may be the only way to meet required levels of performance.

The report detailing these findings is government-owned and is available upon request through the NASA Range Safety Manager.

SUMMARY

Range Safety was involved in a number of exciting and challenging activities and events in 2010 involving the development, implementation, and support of range safety policies and procedures.

The completion of the latest revision of NPR 8715.5, “Range Flight Safety Program,” in 2010 was a significant achievement. Changes implemented included measures to incorporate lessons-learned, clarify the waiver process, and adopt emerging trends seen in the Range Safety community. Policy work also included launch support policy and agreements updates to the KCA-1305, “KSC/45 SW/SSP Memorandum of Agreement (MOA) for Range Safety,” and KCA-1308, “KSC/45 SW Joint Operating Procedure (JOP) for Safety,” which were scheduled for triennial review. KCA-1305 was finalized on 14 September 2010, and KCA-1308 is expected to be approved early in CY2011. Progress was also made toward the anticipated 2011 completion of AFSPCMAN 91-710(T), a tailored document combining applicable NASA, industry, and Air Force Range Safety requirements into a single standard for NASA expendable launch vehicle payload projects.

Range Safety representatives took part in a number of panels and councils, including the Range Commanders Council Range Safety Group and its subgroups. Range Safety representatives from NASA HQ Office of Safety and Mission Assurance, KSC, DFRC, and WFF are actively supporting the Range Safety Group.

Advancing our effort to provide training at various levels of Range Safety, NASA Range Safety has conducted over 40 training courses for NASA, DoD, FAA, and contractor personnel. Over 800 students have participated to date, with 588 students participating in 22 Range Safety Orientation courses. NASA Range Safety is currently working to revamp the Range Flight Safety Analysis Course and is preparing to transfer instruction of the Range Safety Operations course to WFF in 2011.

Range Safety also participated in the evaluation of several emerging technologies, including the Autonomous Flight Safety System (AFSS) for expendable launch vehicles. The second sounding rocket flight test, which represents the third major flight test of the AFSS, was accomplished successfully during the last year. The Joint Advanced Range Safety System (JARSS) also continues to make progress toward achieving its goal of supporting Unmanned Aircraft Systems and Reusable Launch Vehicles at all ranges. In the past year, Kennedy Space Center (KSC) adopted JARSS to accomplish range safety risk analysis.

We hope you found our web-based format for the Range Safety Annual Report to be usable and informative. As we move into 2011, we look forward to the opportunities and challenges of ensuring the safety of NASA activities and operations.

Anyone having questions or wishing to have an article included in the 2011 Range Safety Annual Report should contact Alan Dumont, the NASA Range Safety Program Manager located at the Kennedy Space Center, or Michael Dook at NASA Headquarters.