

## II. AGENCY RANGE SAFETY PROGRAM

### A. Range Safety Training 2013

To date, the NASA Range Safety (NRS) team has conducted 55 training courses with participants from NASA, Department of Defense (DoD), Federal Aviation Administration (FAA), and NASA contractors. Figure 1 shows the total number of classes and students taught since the inception of the NRS training program in 2004.

Courses	# Classes	# Students
Range Safety Orientation	26	684
ELV Flight Safety Analysis	9	155
NASA Range Flight Safety Systems	2	37
Flight Safety Systems	13	194
Range Safety Operations	5	30

**FIGURE 1: TOTAL NUMBER OF CLASSES AND STUDENTS TAUGHT**

Due to Federal Budget constraints this year, the NASA Safety Training Center (NSTC) was unable to fund any Range Safety classes. Therefore, the three range safety classes taught in 2013 were funded by the Agency Range Safety Program. The Range Safety Operations (RSO) course was conducted at Wallops Flight Facility (WFF) and two NASA Range Flight Safety Analysis (NRFSA) classes were conducted and videotaped at Kennedy Space Center (KSC) for inclusion in the online System for Administration, Training, and Educational Resources for NASA (SATERN) training courses catalog. The dates of these courses are listed below in Figure 2.

Course	Date	Location
NASA Range Flight Safety Analysis	4-8 Feb	KSC
NASA Range Flight Safety Analysis	25-29 Mar	KSC
Range Safety Operations	29 July-2 Aug	WFF

**FIGURE 2: 2013 NRS PROGRAM FUNDED COURSES**

While the NRS team has provided excellent training for the Range Safety Community, the Agency routinely looks for ways to improve course content as well as methods of delivery. The following are descriptions of the Range Safety courses. The NSTC catalog denotes updates and improvements where applicable.

## 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 presented at the Eastern Range. If you wish to discuss presenting the class at your location, please contact the NSTC staff or the NRS Manager, Alan Dumont, via email at [Alan.G.Dumont@nasa.gov](mailto:Alan.G.Dumont@nasa.gov).

### Target Audience:

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

## Range Safety Orientation

Day 1	Day 2
<ul style="list-style-type: none"><li>• Intro &amp; Range Safety Missions</li><li>• Range Safety Organization</li><li>• Policies, Standards, Directives</li><li>• Launch &amp; Test Facilities</li><li>• Flight Analysis</li><li>• Flight Termination Systems</li><li>• Tracking &amp; Telemetry</li><li>• Range Safety Operations</li></ul>	<ul style="list-style-type: none"><li>• Ground Safety</li><li>• Frequency Management</li><li>• UAS Operations</li><li>• The Way Ahead</li><li>• Hangar AE Tour</li><li>• Morrell Operations Center Tour</li><li>• Summary</li><li>• Critiques</li></ul>

## FIGURE 3: RANGE SAFETY ORIENTATION COURSE OUTLINE

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

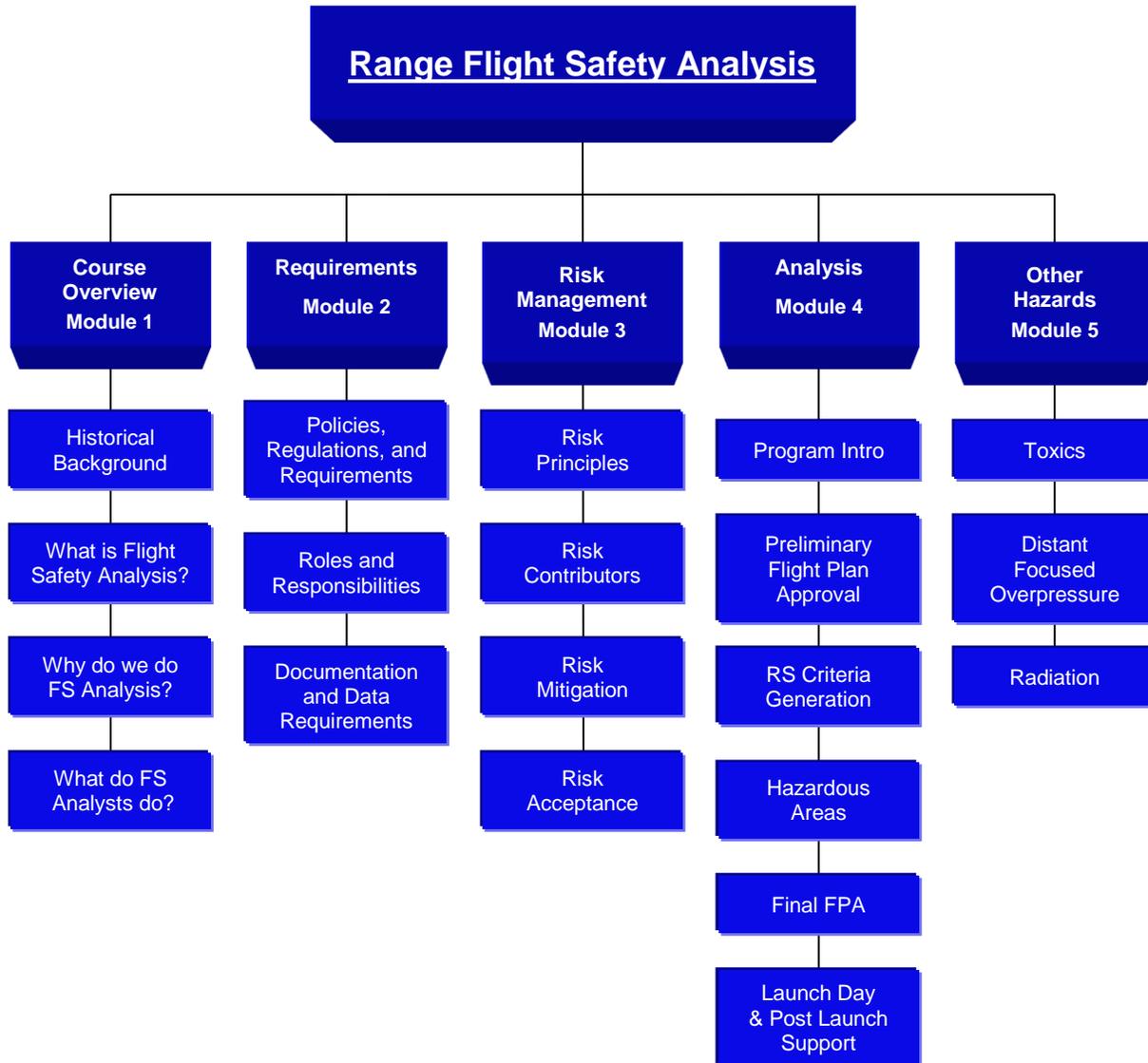
The original Flight Safety Analysis (FSA) course, based primarily on United States Air Force (USAF) procedures at the Eastern Range, was not taught in 2013. However, it will continue to be offered for DoD and FAA customers on an as-requested basis. It includes NASA, DoD, and FAA requirements for FSA; a discussion of range operations hazards, risk criteria, and risk management processes; and in-depth coverage of the vehicle containment and risk analysis methods performed for expendable launch vehicles (ELVs) at the Eastern Range.

*Prerequisite:* Completion of SMA-SAFE-NSTC-0074, Range Safety Orientation, or equivalent experience – engineering degree and a familiarity with range safety.

*Target Audience:*

- NASA, FAA, and DoD Range Safety Analysts in training
- Range safety personnel in other disciplines
- Program/project managers and engineers who design potentially hazardous systems to operate on an Air Force Space Command (AFSPC) range
- Personnel who conduct hazardous operations on an AFSPC range

An outline of the ELV Flight Safety Analysis course structure is shown in Figure 4.



**FIGURE 4: CURRENT ELV FSA COURSE OUTLINE**

### 3. NASA Range Flight Safety Analysis (KSC-SA-NRFSA)

NRS was pleased to finalize and debut the new NRFSA Course in 2013. The new course was developed with contributions from several NASA centers including KSC, WFF, Goddard Space Flight Center (GSFC), and Dryden Flight Research Center (DFRC).

The NRFSA course is designed to give the student a fundamental understanding of NASA Range Flight Safety with its associated policies and guidelines, requirements, and analysis processes as applied to a wide variety of Agency vehicles. The course provides a broad understanding of Range Flight Safety considerations pertinent to NASA from the perspective of the NASA ranges.

While touching on FAA and DoD requirements, this course focuses on NASA requirements and highlights unique Range Safety processes used at several NASA ranges. It presents NASA, DoD, and FAA requirements for flight safety analysis and examines how these requirements interact. The course also includes a discussion of range operations hazards, risk criteria, and risk management processes and of the containment and risk management analyses. In addition to discussing ELV methods [also known as guided launch vehicles (GLVs)], the new NASA-centric FSA course covers methods used for unguided launch vehicles (ULV) (also called sounding rockets) as well as UASs, Reusable Launch Vehicles (RLVs), balloons, and other unique flight vehicles flown at NASA Centers. Figure 5 outlines the new NRFSA course structure.

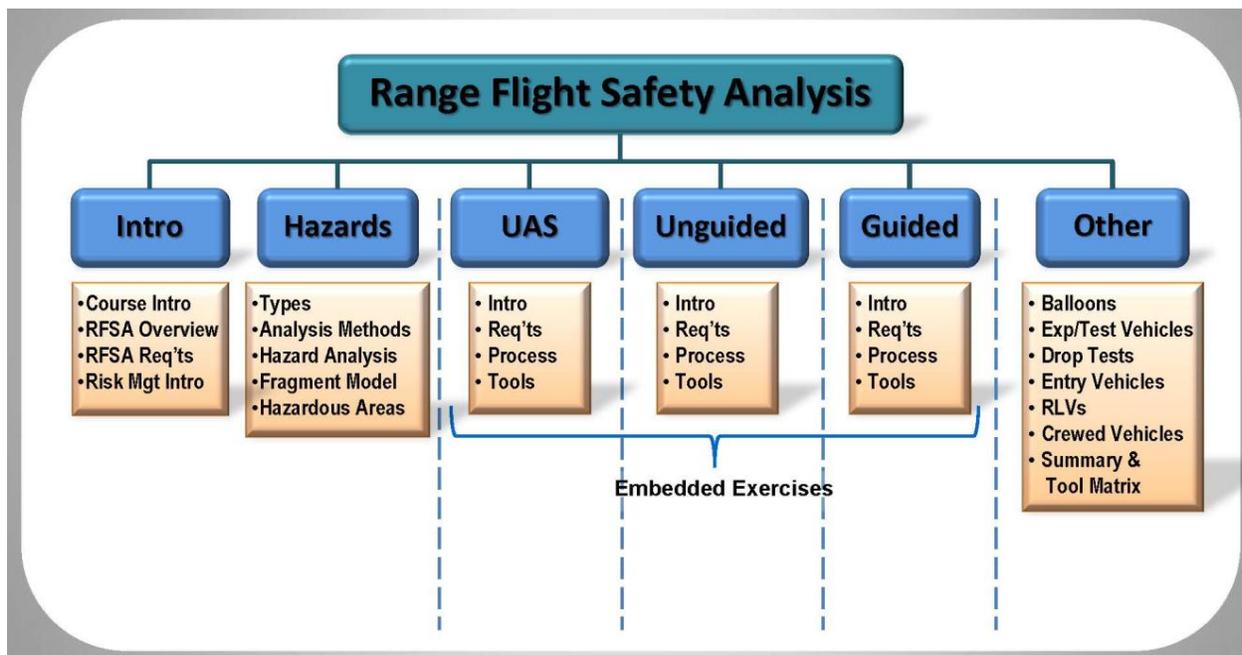


FIGURE 5: KSC NASA FSA COURSE OUTLINE

The NRFSA course contains a general overview of range flight safety issues, including the history and development of range safety practices in the United States, overarching NASA range safety requirements, and an introduction to risk management. The course concentrates on debris hazards and analyses but includes an overview of toxic, blast, and radiation, as well as analysis methods for examining each of these hazards. The course presents an overview of

hazard analysis methods and fragmentation model development with an emphasis on containment (deterministic) methods as a first line of defense and the use of risk assessment (probabilistic) in protecting against unavoidable hazards. Class demonstrations and exercises are used throughout the course (as shown in Figure 5) to present key aspects of FSA in a way that helps students absorb the information in a more practical manner.

The course was videotaped for incorporation into SATERN while it was presented at KSC during the week of March 25-29, 2013. The videotape will form the foundation of an online SATERN course. The online version of this course will be available to SATERN users before the end of 2Q FY14.

*Prerequisite:* Completion of NSTC Course 0074, Range Safety Orientation, or equivalent experience engineering degree and a familiarity with range safety.

*Target Audience:*

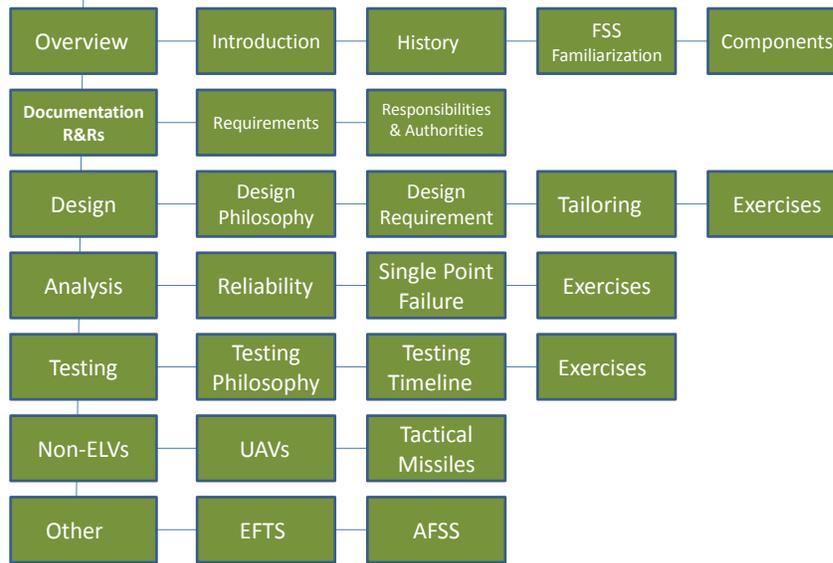
- NASA, FAA, and DoD Range Safety analysts in training
- Range Safety personnel in other disciplines
- Program/project managers and engineers who design potentially hazardous systems to operate on a NASA range
- Personnel who conduct hazardous operations on a NASA range

#### **4. 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 UAS 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 KSC.

The course was videotaped for incorporation into SATERN on August 21-22, 2012 at KSC. NRS reviewed the raw video files, aligned the video and course materials, and incorporated in-class exercises to prepare the course for online delivery via SATERN. The online version of this course was made available in May 2013. The course outline is provided below in Figure 6.

### Range Flight Safety Systems



**FIGURE 6: RANGE FLIGHT SAFETY SYSTEMS COURSE OUTLINE**

Prerequisites:

1. Completion of NSTC 0074, “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:

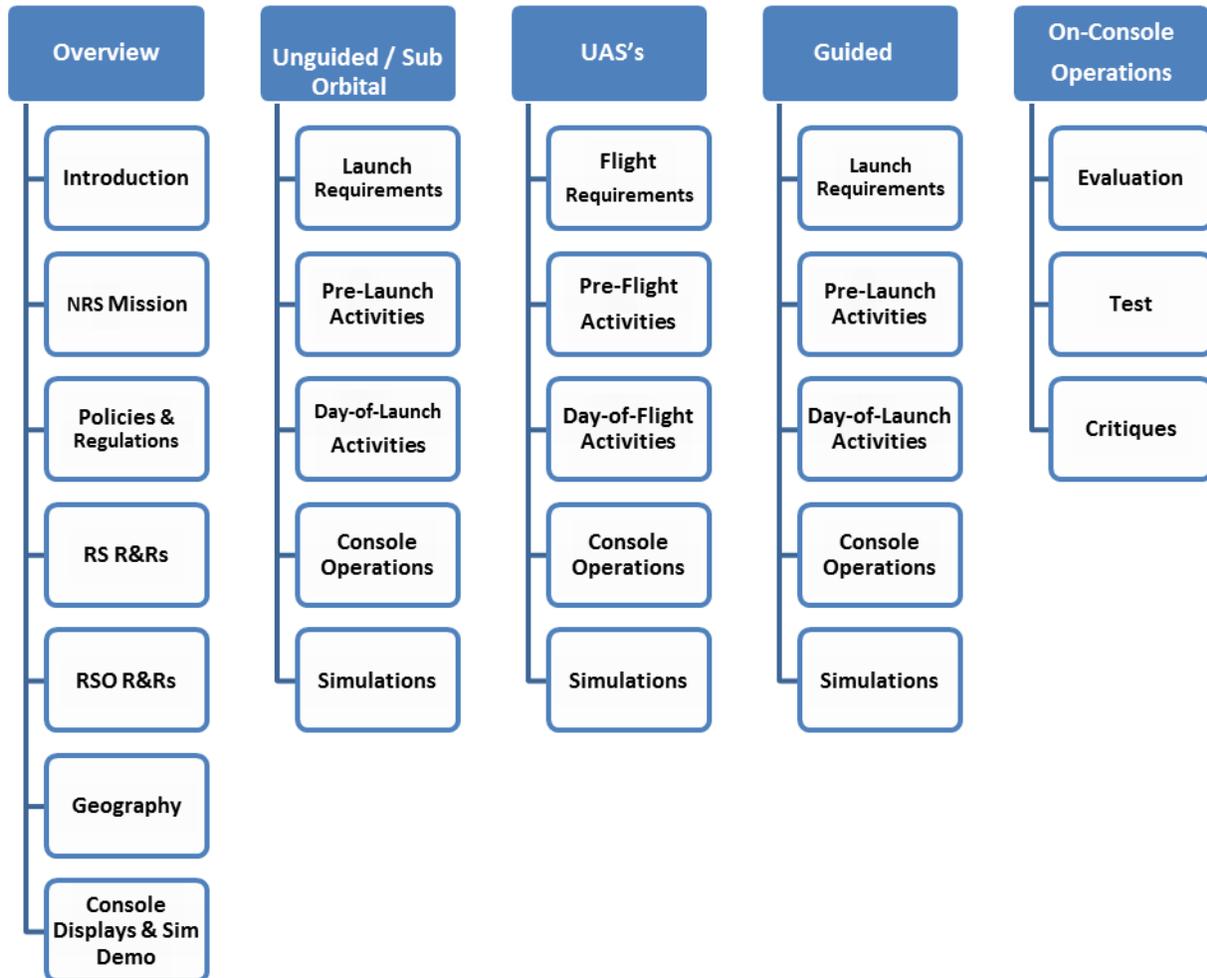
- NASA, FAA, and DoD Range Safety Personnel working Flight Safety Systems issues
- Range Safety personnel in other disciplines
- Program/project managers and engineers who design potentially hazardous systems to operate on a range
- Personnel who conduct hazardous operations on a range

**5. 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 Safety 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 will receive hands-on training and exercises to reinforce the instruction and will be provided with a WFF range tour of the instrumentation sites used to support a rocket

launch such as radars, telemetry and command systems to include fix and mobile assets. Figure 7 outlines the Range Safety Operations course structure.

## Range Safety Operations



**FIGURE 7: RANGE SAFETY OPERATIONS COURSE OUTLINE**

This course is only presented at WFF and is limited to six participants. The course material was updated this year and taught July 29 through August 2, 2013. The six participants came from different NASA Centers: two each from KSC and WFF and one each from Stennis Space Center (SSC) and Langley Research Center (LaRC). The two-person instructor team was made up of a WFF RSO and the NASA Range Safety Manager. In the future, we hope to mentor another instructor to have additional flexibility in the teaching arena. The long term plan is to reduce cost and increase course availability with the goal of having WFF personnel instruct this course.

The NASA Range Safety Office will continue to review and control the course content to ensure its applicability across all Centers.

Prerequisites:

1. Completion of NSTC course 0074, "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
- NASA, FAA, and DoD Range Safety Personnel working Range Safety Operational Systems issues

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

## **B. Development, Implementation, Support of Range Safety Policy**

### **1. Range Commanders Council (RCC) Range Safety Group (RSG)**

The Range Commanders Council (RCC) was founded in 1951 in order 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 Headquarters (HQ), KSC, DFRC, SSC, and WFF actively support the RSG and its subcommittees on a regular basis. Vandenberg Air Force Base (VAFB) is currently the Flight Termination Systems Committee (FTSC) Chair with KSC acting as the Co-Chair. FAA Headquarters is currently the Risk Committee (RC) Chair, and NAVAIR Pt. Mugu is the Directed Energy Committee Chair. White Sands Missile Range (WSMR) became the RSG Chair in 2013.

One RSG meeting was held during 2013: the 112<sup>th</sup> Range Safety Group Technical Interchange Meeting (TIM). Due to federal budget constraints this year, the 112<sup>th</sup> RSG meeting was held via Defense Connect Online (DCO) and telecon. The meeting was spread over the afternoons of June 4-5, 2013. While this was a challenge and did not allow for the face to face interactions which normally benefit these proceedings, the 112<sup>th</sup> RSG Meeting remained a productive forum. The RSG Main Committee, FTSC, and RC met to discuss current issues and reviewed ongoing tasks.

### **a. Main Committee**

In the main committee, range reports from each of the ranges participating in the RSG were presented to the group. NASA headquarters briefed the Main Committee on lifting device standards at test ranges. At the conclusion of the RSG, each committee briefed the Main Committee on accomplishments from the sub-committee meetings, and go-forward plans for future RSGs.

### **b. Flight Termination Systems (FTS) Committee**

The current main task for the FTSC is the rewrite of RCC-319-12, Flight Termination Systems Commonality Standard. The FTSC reviewed various change comments the FAA, NASA, and DoD members for the new revision of RCC 319-12. The discussion mainly involved the change proposals for all sections of the RCC-319 document in an effort to reach a consensus as a committee. While discussions of various sections of RCC-319 were conducted during this meeting, the FTSC has asked the RCC for an extension on the due date for the rewrite of RCC 319-12.

Additionally, the FTSC discussed FTS component failures at the various ranges to identify crossover between ranges. Beneficial discussions took place between WFF, DFRC, WSMR, and the 30th Space Wing (30 SW) regarding component failure and component vendors. The FTSC continues to conduct weekly telecoms to continue discussing comments and revising RCC 319-12.

### **c. Risk Committee (RC)**

The agenda for the RC included the following presentations: "Status and Plan for Ship Protection Task," by Dr. Erik Larson; "Benchmark Flight Safety Analyses," by Dr. Paul Wilde; and "Significant Figures in Expected Casualty (EC) Results for Decision-makers," by Dr. Paul Wilde.

The Ship Protection task is just getting started. Its goals are to reduce conservatism, provide practical, logical framework for defining surveillance and Notice to Mariner (NTM) region, identify alternatives to manned aircraft surveillance, and define vulnerability models that match potential vessel hazard mechanisms. Funding has been established for this task, and an approach has been developed for creating the recommended changes.

The Benchmark Flight Safety Analyses task goals are to develop guidelines and provide data to compare model results to actual results and to facilitate comparisons between results computed by various models and actual data. This will aid the RCC in establishing the credibility of risk model predictions and provide a means to identify model uncertainty while establishing confidence in flight safety analysis results. Progress has been made using data from the [International Association for the Advancement of Space Safety](#) (IAASS) workshops which produced results on three cases: one upper-stage, one satellite random reentry, and one launch with European overflight. This effort is seeking more empirical data.

The presentation of Significant Figures in EC Results for Decision-makers tried to make a case for the FAA to use only one significant figure as the default for reporting EC results to a decision-maker. The presentation provided a background, discussion of epistemic uncertainties, and an example. There was some discussion of the applicability and the safety

impact of the proposal during the RC meeting, so RSG RC members will continue to review and discussed these issues into the next RSG meeting.

For more background and information on the Range Commanders Council and the Range Safety Group, [click here](#).

## **2. Common Standards Working Group (CSWG)**

The Common Standard Working Group (CSWG) functions to implement provisions of U.S. Space Transportation Policy directing coordination between the USAF, FAA, and NASA to establish common public safety requirements for space transportation. NASA formally joined the CSWG in 2010, and a revised CSWG Charter was signed by all three agencies in 2012. The CSWG activities and products prescribed in the Charter are focused on protecting the public from hazards associated with space launch and reentry events. A primary objective is to develop, document, and maintain common safety standards that provide a stable framework for the U.S. space launch industry while minimizing implementation and administrative burdens. Each agency has designated a co-chair to the CSWG. The NASA Co-Chair is currently located within the WFF Range Safety Organization. The CSWG co-chairs met by phone periodically throughout 2013 and continued to establish and manage various CSWG sub-working groups as needed to implement the objectives of the CSWG Charter.

During the past year, the CSWG made significant progress on developing a consistent approach for determining the Probability of Failure (PoF) for new launch vehicles. This PoF is a critical input to safety risk assessments and other range safety analyses. The CSWG sub-working group developed new PoF guidelines and standards using a statistical approach and worldwide historical launch vehicle data. The FAA contracted for an independent peer review of the new approach. The draft standard underwent a final review by all three agencies at the end of 2013 and is expected to be published early in 2014.

## **C. Inter-Center Aircraft Operation Panel (IAOP)**

NASA Range Safety supports NASA HQ assessments on a regular basis, including Institutional/Facility/Operational (IFO) audits and Inter-Center Aircraft Operations Panel (IAOP) reviews.

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, Agency-wide policies, procedures, and guidelines. The primary focus of the Agency Range Safety Program during IAOP reviews is on the application of range safety requirements and techniques to NASA operations involving 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: Ames Research Center (ARC), DFRC, LaRC, and GSFC)/WFF. KSC, Johnson Space Center (JSC), and Marshall Space Flight Center (MSFC), are new players in this arena, and SSC has also expressed interested in flying or hosting such operations. 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.

NASA Range Safety participated in two IAOP reviews, one at DFRC in February and another at KSC in May 2013.

During the DFRC review, it was noted that noncompliance documentation had not been updated to capture recent revisions in NPR 8715.5. A template was provided to DFRC to help develop a standalone form for Range Safety noncompliances. In addition, it was noted that a recurring training plan for key Range Safety personnel had to be developed, and a Risk Assessment process needed to be documented for small UASs. Lastly, one of the Range Safety Analysts was commended for her role in helping to develop the UAS module of a new Agency course covering Flight Safety Analysis.

During the KSC review, it was noted that the risk assessment process only captured spaceflight activities and needed to be updated to include UAS activities. In addition, it was noted that the noncompliance process also needed to include UAS activities. Lastly, it was recommended to add Range Safety personnel to handle increased UAS activities.

Range operations other than UAS operations are subject to IFO audits led by the NASA Safety Center (NSC) and also supported by NASA Range Safety. Such operations include space launch/entry, scientific balloon, and sounding rocket operations. At this time, those centers with such range operations include KSC and GSFC/WFF. Range Safety findings during IFO audits and associated center corrective actions are documented and tracked using IFO systems and processes established by the NSC. No IFO audits were supported in 2013.