D. Kennedy Space Center (KSC)

In addition to hosting the NASA Range Safety Staff, KSC has its own Center 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 and range safety requirement tailoring support to new projects and programs and support to ELV launch operations at multiple locations. The following articles provide a brief summary of these activities.

1. Rocket University

Rocket University (Rocket U) develops flight-systems engineering skills and expertise by exposing NASA engineers to coursework and hands-on activities involving many aspects of flight systems engineering. Rocket University has partnered with different NASA Centers, several universities, and external partners to provide mentoring and expertise to the program.

NRS ensures the Rocket U program meets the range safety requirements of NPR 8715.5A, FAA 14 CFR Part 101, Memorandum of Agreement (MOA) KCA-4397, and AFSPCMAN 91-710 when operating balloons, UASs, and rockets on or off KSC property.

a. Unmanned Aerial System (UAS) Program

Rocket U's UAS program develops UAS skills by conducting flight operations with a 12-pound winged UAS, named Genesis, in a section of the restricted airspace on KSC property. These tests include three major flight modes:

- Phase A: Operate Aircraft in Remote Control mode only; loss of communication verification; UAS launcher tests complete.
- Phase B: Semi-autonomous operations in which the aircraft remains within visual range; demonstrate successful transition from manual to autopilot and perform autopilot tuning...
- Phase C: Fully autonomous operation in which the aircraft will demonstrate waypoint navigation and the imaging of objects of interest (e.g., wildlife) in the flight operations area.

Working with NRS, the Rocket U team was able to accomplish Phase A and B. The NRS team helped define the programs flight test plan, flight test envelope, and review operational documents. NRS provided approval for flight along with the KSC Flight Operations team to certify the Genesis UAS to fly over KSC property. The NRS team provided support and guidance to the UAS team by reviewing presentations and operational plans to fly their UAS at KSC. The RSO function during UAS flights was performed by the qualified KSC UAS Pilot with support from NRS. NRS supported the three successful flights of their Genesis UAS from a camera site North of Pad 39B.

b. Balloon Program

In 2013, NRS supported four Rocket U Near-Space Environments Balloon operations. The role of the NRS team in supporting the balloon program is to review and independently validate the program's flight trajectory analysis. The NRS team also reviews vehicle design and mission parameters to ensure mission objectives can be accomplished without increasing the risk to the KSC workforce and the general public. During the review process, NRS ensures regulations and requirements from the USAF, 45 SW, the FAA, and NASA Range Safety are met.

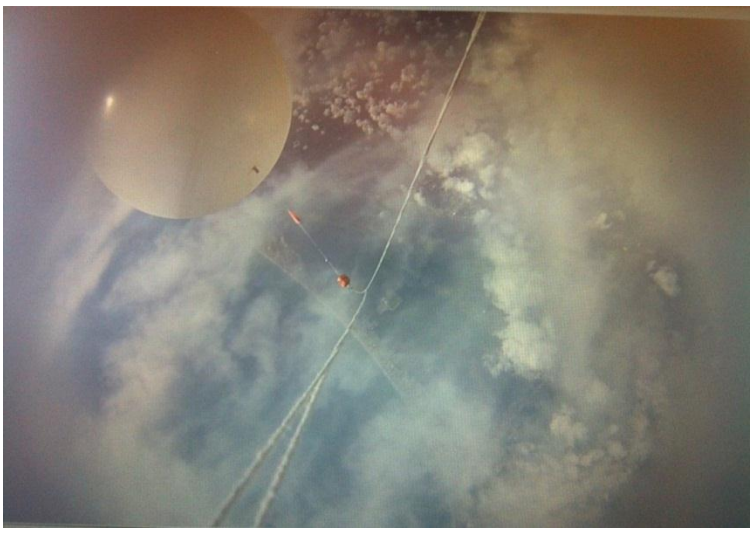

FIGURE 21: ROCKET U NEAR-SPACE ENVIRONMENTS BALLOON

The four small-scale balloon releases between April and June 2013 that NRS supported were geared to supporting the Maraia balloon release taking place in New Mexico in August 2013. The Rocket U team's objective was to release a small scale version of the Maraia capsule to record aerodynamic effects of the capsule falling through the atmosphere. NRS worked with the balloon program to verify and redesign the release mechanism which had failed in previous missions.

c. Rocketry Program

Rocket U's Rocketry Program builds a broader understanding of flight systems engineering and development by designing, building, analyzing, testing, and flying High Powered Rockets. This year NRS has supported four (update with new launches as they happen) launches from KSC. KSC must comply with the MOA KCA-4397 between NASA and the 45 SW which allows NRS the responsibility of ensuring public, workforce, and property safety on KSC during these launches if the launches are contained within KSC's boundaries. The NRS group reviews and comments on each teams' Concept of Operations (ConOps), launch procedures, flight safety Hazard Analysis (HA), launch and landing area predictions, failure mode analysis, and launch trajectory models. Each team must complete all documentation before getting permission to launch.

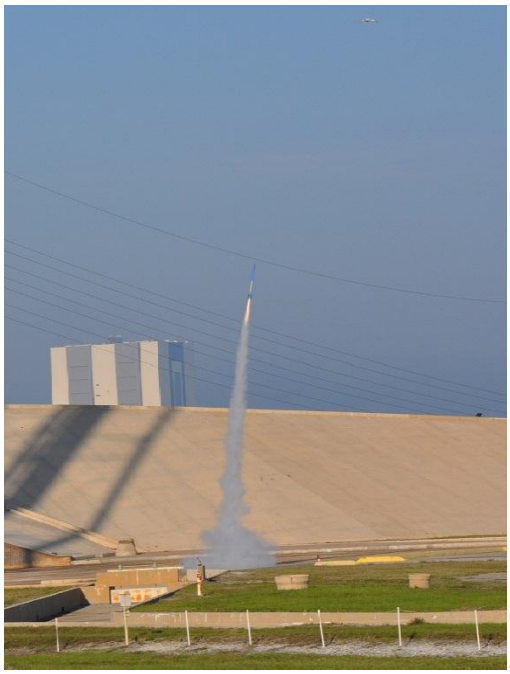

FIGURE 22: ROCKET U ROCKETRY PROGRAM LAUNCH FROM KSC

NRS physically supports each launch campaign with a GO/NO-GO" call to the Rocket U Chief Engineer prior to each launch attempt. The NRS team works with each team to calculate and verify landing predictions

based on launcher elevation angle launch azimuth, wind speed, and wind direction. NRS does this to ensure maximum probability of the rocket landing in an unpopulated area away from the launch team, spectators, or facilities in the area. NRS also developed an Amateur High Power Rocket checklist for future Rocket U teams along with outside business wanting to use KSC for testing their amateur rockets.

The NRS team supported four launch attempts for a one-stage amateur rocket with a "K" motor and the team also supported one launch attempt for an amateur two-stage rocket using "G" motors.

2. Unmanned Aerial System (UAS) Competition

FIGURE 23: KSC TEAM LAUNCHING GENESIS UAS

NASA's inaugural AS competition was held at KSC from September 10-12, 2013. Flight operations took place at KSC's Shuttle Landing Facility (SLF) on September 11, 2013. Teams from KSC, MSFC, and JSC provided their own UASs for the competition, while personnel from DFRC, LaRC, and ARC supported as judges for the competition. The purpose of this competition was to have various NASA centers design or modify a UAS to operate in autonomous mode while performing search patterns over a mock crash site to identify wreckage and survivors. Each team was tasked to gain an airworthiness certification for their vehicle from their respective centers.

NRS worked with Rocket University's UAS program, the KSC Aviation Working Group (KAWG), and KSC Flight Operations to review and approve the various competitors' UAS submissions prior to any team flying at the SLF. NRS attended the Flight Readiness Reviews (FRR) for the MSFC, JSC, and KSC teams as they presented their UAS's respective capabilities and functionalities to the judges. Some of NRS's responsibilities were to work with the various UAS centers ensuring KSC's concerns were being addressed during airworthiness approval processes at different NASA centers. NRS also worked to ensure containment steps were addressed by each team. NRS also ensured proper mitigation steps were in place in the event of an UAS anomaly ensuring KSC personnel and property would remain undamaged. The RSO function during all UAS flights at KSC was performed by the qualified KSC UAS Pilot with support from NRS.

FIGURE 24: JSC TEAM FLYING HELICOPTER UAS AT THE SLF

FIGURE 25: MSFC TEAM MEMBER WITH HEXACOPTER UAS AT THE SLF

3. Morpheus Operations

JSC brought their Morpheus lander vehicle back to KSC in late November 2013 for flight test operations and to demonstrate the capability of the ALHAT instrument. KSC constructed a hazard field at the end of the SLF runway to help simulate a lunar landing environment for Morpheus operations. JSC developed a Morpheus Range Safety Plan for flight operations at KSC which covered everything from vehicle description to flight ops to Contingency Management System (CMS) functions. This document was coordinated with the KSC Range Safety Representative and concurred on by the NASA Range Safety Manager. It was also approved by the KSC Center Director and the Morpheus Project Manager. The RSO function for operations at KSC was performed by JSC personnel due to their familiarity with the Morpheus vehicle and training with Morpheus tethered test operations at JSC. The RSO worked with the KSC Range Safety Representative to establish boundaries and conditions for CMS activation.

Operations began with a successful tethered flight to verify all systems were functional after transport from JSC. This was followed by a short free flight test to 15 meters in altitude. This test was the first test from the newly constructed transportable concrete launch pad with the integrated flame trench. This was constructed to help reduce liftoff environments which were determined to be a cause of the test failure for the Morpheus vehicle at KSC in 2012. Then, one additional free flight was conducted which expanded the altitude to 50 meters and the distance travelled to 47 meters. This concluded the first flight campaign at KSC. JSC plans to conduct additional flight campaigns at KSC during early 2014.

FIGURE 26: MORPHEUS 1.5B TETHERED FLIGHT AT KSC

FIGURE 27: MORPHEUS 1.5B FREE FLIGHT TEST AT KSC

4. KSC Aviation Working Group (KAWG)

The KAWG met several times during 2013 to discuss several new projects with proposals to conduct flight operations at KSC and to discuss the KSC airworthiness process. There was a KSC project reviewed by the KAWG for quad-copter and hexacopter operations at KSC. This proposal was allowed to move forward and eventually received KSC airworthiness board approval. Also, there was a project for the BBC to do some documentary filming over KSC in an airship. This operation was allowed to move forward as well. KSC Range Safety participated in these meetings and gave concurrence for these operations to concur.

5. Launch Operations Support

NASA/KSC Range Safety supported 13 launches this year. There were eleven launches from the Eastern Range (two NASA-sponsored expendable launch vehicle and nine non-NASA launches supported for KSC risk assessment). The remaining launches were NASA-sponsored expendable launch vehicles from the Western Range at VAFB.

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 Murrell Operations Center (MOC) at CCAFS and in the Western Range Operations Control Center (WROCC) at VAFB for the NASA sponsored launches. NRS personnel ensured any range safety-related activities that could have an impact on NASA launch criteria were communicated to the NASA Safety and Launch Service Program decision makers to ensure safe flight and compliance with requirements identified in NASA Range Safety directives.

Eastern Range and Western Range				
Mission	**Vehicle**	**Launch Site**	**Launch Date**	**Responsible Org**
TDRS-K	Atlas V	CCAFS	1/30/13	NASA
LDCM	Atlas V	VAFB	2/11/13	NASA
CRS-2	Falcon 9	CCAFS	3/1/13	Commercial
SBIRS-GEO2	Atlas V	CCAFS	3/19/13	DoD
GPS IIF-4	Atlas V	CCAFS	5/15/13	DoD
WGS-5	Delta IV	CCAFS	5/24/13	DoD
IRIS	Pegasus XL	VAFB	6/27/13	NASA
MUOS-2	Atlas V	CCAFS	7/19/13	DoD
WGS-6	Delta IV	CCAFS	8/7/13	DoD
AEHF-3	Atlas V	CCAFS	9/18/13	DoD
MAVEN	Atlas V	CCAFS	11/18/13	NASA
SES-8	Falcon 9	CCAFS	12/3/13	Commercial
THIACOM	Falcon 9	CCAFS	12/30/13	Commercial

FIGURE 28: EASTERN AND WESTERN RANGE SUPPORTED BY KSC IN 2013

We look forward to 2014 and supporting the numerous ELV launches at both the Eastern and Western Ranges.

6. Range Safety Launch Support Policy

a. KSC Flight Risk Assessment Process

In response to an IAOP by NASA Headquarters, KSC Range Safety updated the KSC Space Flight Risk Assessment Process. This process specifically covered NASA sponsored Space flight launch operations from KSC or CCAFS and needed to be updated to reflect the current and future flight operations that will take place on KSC. The title was changed to KSC Flight Risk Assessment Process and includes all flight or launch operations on KSC or CCAFS. The main reason for updating this process was to ensure that the risk assessment process on KSC included UAS operations which just began at KSC during 2013.

b. MOA between KSC and 45 SW for Eastern Range Related Operations

In 2012 the 45 SW and KSC started a working group to help better identify the types of operations that could be occurring on KSC in the future and what level of review/approval would be needed by the 45 SW for those activities. This culminated in 2013 with an MOA signed by the KSC Center Director and the 45th SW Commander. The types of operations on KSC that were specified in the MOA were UAS, amateur rockets and balloons that are covered by CFR Part 101, and vertical lift and landing rockets. These operations were broken down into four criteria sets:

- 45 SW Notification or Approval not required
- 45 SW Notification only
- 45 SW Coordination and Approval is required [Letter Program Introduction (PI) only)]
- 45 SW Coordination and Approval is required (Formal PI required)

Definitions and guidelines were provided for each of these types of operations and the applicable criteria set. This agreement provides KSC Range Safety with the ability to review and approve certain types of flight operations occurring on KSC where the risk is contained on KSC. The MOA was signed by the KSC Center Director and the 45 SW Commander in June 2013.