E. Kennedy Space Center (KSC)

In addition to hosting the NASA Range Safety Staff, KSC has its own Center-level KSC Range Safety Representative 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 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 (HQ, KSC, JSC, MSFC, GRC, WFF), several universities (University of Central Florida, Embry Riddle University, Virginia Tech, Sand Diego University), and external partners (Space Florida, Florida Space Institute, National Association of Rocketry) to provide mentoring and expertise to the program.

NASA Range Safety ensures the Rocket University program meets the range safety requirements of NPR 8715.5A, FAA 14 CFR Part 101, and AFSPCMAN 91-710 when operating balloons, UAS, and rockets on and off KSC property.

a. Balloons Program

The purpose of the near-space environments labs (high-altitude balloons, as shown in Figure 27) is to further develop NASA engineers skills in flight systems engineering, launch operations, avionics, structures, and flight dynamics. A secondary purpose is to provide a low-cost, high altitude platform for demonstrating technology or researching the near-space environment.

To date, NRS has supported three Rocket U Near-Space Environments Balloon operations. Two of the balloon operations were moored balloons. These operations were mainly for experience purposes, learning different components and interfacing with the 45th Space Wing. During NRS's inspection of the moored balloons, it was noted that pursuant to FAA regulations 14 CRF Part 101Subpart B, a rapid deflation device was required to be added to the moored balloons in case the tether should fail.

FIGURE 27: NEAR-SPACE ENVIRONMENT LABS PAYLOAD

FIGURE 28: MARAIA PAYLOAD AT ALTITUDE

The third balloon operation was for a small-scale Maraia capsule test. This balloon operation released a high-altitude weather balloon with two payloads that would be released at different times and heights. NRS worked with the flight team to determine if the risk levels at KSC and CCAFS associated with the proposed flight plans would be acceptable. NRS worked to review the proper FAA, AF, and NASA regulation that would have to be met in order to approve the flight. Due to time constraints, this mission was launched outside of KSC property with a planned capsule drop off KSC and Air Force property.

b. Unmanned Aircraft System (UAS) Program

Rocket University's UAS training project is designed to develop UAS skills by conducting flight operations off of KSC property. These tests include three major flight modes:

- Remote Control (RC) within operator visual range similar to recreational model aircraft activities.
- Semi-autonomous operations in which the aircraft remains within visual range but is under partial control of the onboard autopilot.
- 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

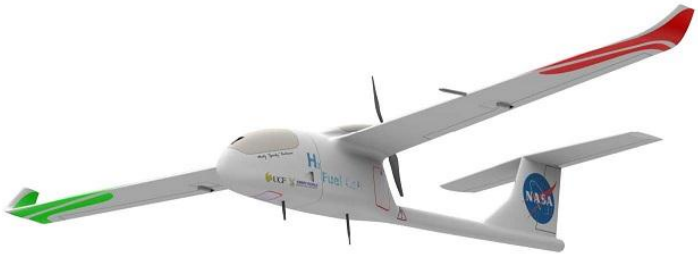

FIGURE 29: UAS TRAINING VEHICLE

NRS has worked with Rocket U and the 45th SW to go over the criteria in RCC 323-99 to ensure proper provisions are taken before any UAS activity can precede at KSC. NRS and the KSC Aviation Working Group identified key facilities that have been made "no-fly zones" inside the area of operations. NRS will review the proposed Op Plan for the first UAS planning to fly out of the SLF in January, and then the KSC Airworthiness Flight Safety Review Board will give final approval for this certification flight.

c. Rocketry Program

Rocket University's Rocketry Program builds on a broader understanding of flight systems engineering and development by designing, building, analyzing, testing, and flying High Powered Rockets.

At the FAA approved launch site in Bunnell, FL, Rocket U participants have launched several successful amateur rockets that reach up to 10,000 feet above ground level (AGL) using level 2 K and L motors. Engineers are now setting their sights on launching from LC-39A in hopes of reaching up to 15,000 feet AGL, with planned future flights up to 150,000 feet AGL using level 3 O motors.

FIGURE 30: SMALL SCALE ROCKET

Once Rocket U made the decision to launch from KSC property, NRS reviewed the proposed flight package and identified additional concerns that had to be addressed before concurring with plans to launch from LC-39A. After collaborating with several NASA directorates and several Air Force organizations, it was determined that Rocket U could proceed with these launches as long as the program was compliant with FAA 14 CFR, Part 101C for Unmanned Rockets and National Fire Protection Association (NFPA) 1127 guidelines for High Power Rocketry.

NRS has worked with the four different rocket teams to review their analyses to ensure these rockets cannot create a hazard outside KSC property. NRS has also worked with KSC Safety and Mission Assurance to develop a flight hazard analysis to capture different possible failure scenarios and also to develop a Launch Commit Criteria for launch day. Rocket U expects to launch their first rocket in 2013.

FIGURE 31: SMALL SCALE ROCKET DEPLOYING CHUTE

2. Space Florida Balloon Operations

The Space Academy is a joint venture between Space Florida and the NASA/Florida Space Grant Consortium. This program hosts Florida undergraduates, teachers, middle school, and high school students in a range of scientific and hands-on activities at KSC Visitors Complex Education Center. The program is specifically designed to focus on engineering and science in ways not currently addressed by existing curricula and to encourage students to continue their studies in science-based programs at their college or university through continuing studies, KSC internships, and science-based research programs.

The scientific balloon activity is a good example of the type of project conducted with participants and is an activity that involves coordination with NASA Range Safety. The scientific balloons are designed to climb to an approximate altitude of over 100,000 feet carrying small payloads to relay back to the students pictures taken at high altitude showing the curvature of the Earth as well as the blackness of space. The students launch scientific balloons with the following payloads on board:

- A ”live” camera relaying pictures to a ground receiver and monitor
- A GPS designed to chart the flight pattern of the balloon

FIGURE 32: SCIENTIFIC BALLOON RELEASE

Prior to balloon release, NASA Range Safety, Air Force 45th Space Wing, and the FAA inspect all payloads to ensure requirements and common sense practices are satisfied. Those include:

- Any individual payload package weighing over 4 pounds must have a surface density of less than 3 ounces per square inch
- Any individual payload package must weigh less than 6 pounds
- The total payload must weigh less than 12 pounds (Space Florida payloads usually weigh less than 1 pound)

These are the same requirements used for the daily weather balloon releases by the 45th Space Wing at CCAFS Weather Facility. Balloons flown under these requirements are exempt from notification to FAA control facilities, but Space Florida makes pre-launch courtesy notifications to the Kennedy Space Center Shuttle Landing Facility/Military Radar Unit and to the 45th Space Wing, 1st Range Operations Squadron, since the release location is inside restricted airspace under their control. Once all of these requirements and notifications have been satisfied, the 45th Space Wing Safety Office issues an approval letter with concurrence from NASA Range Safety to Space Florida to conduct their balloon release. NASA Range Safety supported one Space Florida balloon release this year.

3. Morpheus Operations

JSC brought their Morpheus lander vehicle (Figure 33) to KSC in July 2012 for flight test operations and to demonstrate the capability of the Autonomous Landing and Hazard Avoidance Technology instrument. KSC constructed a hazard field at the end of the SLF runway (Figure 34) 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.

FIGURE 33: MORPHEUS TETHERED FLIGHT AT KSC

Operations began with a successful tethered flight to verify that all systems were functional after transport from JSC. This was to be followed by free flight hops which would increase in distance upon each successful flight culminating with a final flight test that would cover a 1.1 kilometer distance along the runway with a landing in the hazard field. The first free flight test was soft-aborted autonomously by the Morpheus vehicle when it detected an abnormal condition and shut down only several inches off of the ground. The abnormal condition was determined to be a software issue and no hardware problems were identified, so the Morpheus vehicle team pressed on with the next free flight test. During this test, the Morpheus vehicle lifted off the ground and then experienced a hardware component failure which prevented it from maintaining stable flight. It crashed on the launch pad area. There were no injuries and the fire was contained in the launch pad area. The failure investigation determined the leading cause to be hardware component failure, possibly due to launch vibration.

FIGURE 34: HAZARD LANDING FIELD AT KSC SLF

JSC is currently building an updated version of the Morpheus vehicle which is planned to be back at KSC for flight testing in mid-2013. KSC Range Safety will continue to provide support for future Morpheus operations at KSC in 2013.

To view the flight: http://www.youtube.com/watch?v=-hvlG2JtMts&feature=player_detailpage

4. Range Architecture Study

The goal of the KSC GSDO Program's Future State Definition (FSD) project is to develop the products necessary to help modernize the Nation's space launch bases and ranges. Three focus areas were defined: Architecture Focus Area (AFA), Policy Focus Area (PFA), and Concept of Operations Focus Area (CFA). The purpose of the FSD AFA is to develop a strategic vision for current and future range capabilities at the Eastern Range and KSC. This vision will encompass both near term (year 2015) and far term (year 2025) range architectures.

The FSD AFA Integration and Management team designated four sub teams for the near term architecture activities: Communications and Timing, RF and Optics, Tools and Processes, and Weather. KSC Range Safety provided leadership and technical support to the Tools and Processes sub team in 2012. This sub team addressed the range safety, data handling, surveillance, and scheduling super systems along with customer interface processes. Two long term recommendations were developed by the Tools and Processes sub team. The first dealt with testing and support for AFSS development. The second involved the acquisition of a next generation Range Safety Display System that would have easily upgradeable, open system architecture to support future architecture needs. These recommendations were coordinated with the Eastern Range Safety Office and vetted by the AFA Integration Management.

5. Launch Operations Support

NASA/KSC Range Safety supported 11 launches this year. There were ten launches from the Eastern Range (one NASA-sponsored expendable launch vehicle and nine non-NASA launches supported for KSC risk assessment). The remaining launch was a NASA-sponsored expendable launch vehicle from the Kwajalein Missile Range at the Reagan Test Site.

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 DoD counterparts in the Morrell Operations Center and Hangar AE at CCAFS 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 Kwajalein Missile Range				
Mission	**Vehicle**	**Launch Site**	**Launch Date**	**Responsible Org**
WGS-4	Delta IV	CCAFS	1/20/12	DoD
MUOS-1	Atlas V	CCAFS	2/24/12	DoD
AEHF-2	Atlas V	CCAFS	5/4/12	DoD
Dragon C2	Falcon 9	CCAFS	5/22/12	Commercial
NuSTAR	Pegasus XL	KMR	6/13/12	NASA
NROL-38	Atlas V	CCAFS	6/20/12	NRO
NROL-15	Delta IVH	CCAFS	6/29/12	NRO
RBSP	Atlas V	CCAFS	8/30/12	NASA
GPS 2F-3	Delta IV	CCAFS	10/4/12	DoD
Dragon CRS-1	Falcon 9	CCAFS	10/7/12	Commercial
OTV-3	Atlas V	CCAFS	12/11/12	DoD

FIGURE 35: EASTERN RANGE AND KWAJALEIN (KMR) MISSILE RANGE SUPPORTED BY KSC IN 2012

We look forward to 2013 and supporting the numerous ELV launches at both the Eastern and Western Ranges.