

Shaping NASA's Kennedy Space Center Safety for the Future

Paul Kirkpatrick⁽¹⁾, Laura McDaniel⁽²⁾, Maynette Smith⁽³⁾

⁽¹⁾NASA Kennedy Space Center, Mail Code SA-B, Kennedy Space Center, Florida 32780 USA

Email: paul.kirkpatrick@nasa.gov

⁽²⁾NASA Kennedy Space Center, Mail Code SA-G, Kennedy Space Center, Florida 32780 USA

Email: laura.m.mcdaniel@nasa.gov

⁽³⁾NASA Kennedy Space Center, Mail Code SA-B, Kennedy Space center, Florida 32780 USA

Email: Maynette.e.smith@nasa.gov

Introduction

With the completion of the Space Shuttle Program, the Kennedy Space Center (KSC) safety function will be required to evolve beyond the single launch vehicle launch site focus that has held prominence for almost fifty years.

This paper will discuss how that evolution is taking place. Specifically, we will discuss the future of safety as it relates to a site that will have multiple, very disparate, functions. These functions will include new business; KSC facilities not under the control of NASA; traditional payload and launch vehicle processing; and, operations conducted by NASA personnel, NASA contractors or a combination of both. A key element in this process is the adaptation of the current KSC set of safety requirements into a multi-faceted set that can address each of the functions above, while maintaining our world class safety environment. One of the biggest challenges that will be addressed is how to protect our personnel and property without dictating how other Non-NASA organizations protect their own employees and property.

The past history of KSC Safety will be described and how the lessons learned from previous programs will be applied to the future. The lessons learned from this process will also be discussed as information for other locations that may undergo such a transformation.

The Past

Kennedy Space Center, located on 131 mi² (340 km²) of land on the east coast of Florida, was established in 1962 as the site for NASA's Apollo Moon Program. In conjunction with Cape Canaveral Air Force Station, the two facilities formed the infrastructure basis of the United States manned space program. With plenty of room to grow, unique processing and launch complexes were constructed to support the then current

Program and its associated launch vehicle. Of course much of this room was in reality buffer zones as the vehicles became more powerful. KSC evolved into two areas some 8 miles apart, Launch Complex 39 (LC-29) to the north and the Industrial Area to the south. LSC-39 consisted primarily of the two launch pads, the Vehicle Assembly Building and Launch Control Center. The Industrial Area primarily consisted of the Headquarters Building, the Operations and Check-out Building and numerous support buildings. These facilities served the Apollo Program through the conclusion of the Program in 1975 with the Apollo-Soyuz Test Project.

In 1972, NASA announced that KSC would be the initial launch site of the Space Shuttle (the Department of Defense added Vandenberg AFB at a later date). Many of the Apollo-era facilities were re-used with appropriate modifications. The most significant additions to the facility list were the building of the Orbiter Processing Facilities and Solid Rocket Booster processing facilities in LSC-39. In the Industrial Area, existing buildings were modified to process payloads and Orbiter systems.

The next major program to impact KSC was the International Space Station (ISS). While initially planned to be a ship and shoot process with minimal ground effort, the ISS Program eventually opted for a more traditional ground processing model that included testing. To accomplish this, the Space Station Processing Facility (SSPF) was built in the Industrial Area. With the completion of the SSPF in 1994 along with the Canister Rotation Facility (CRF) previously in 1993, new major facility construction came to an end.

The next major event in KSC facility history was the preparations that began in support of the Constellation Program. The Constellation Program was the result of the Vision for Space Exploration (VSE) announced by President George W. Bush in January 2004. Constellation consisted of a new launcher project (Ares), a new crew vehicle (Orion)

and robotic precursors. No new facilities were being built in support of these Projects; however, significant modifications were undertaken including returning LC-39 Pads A and B to a "clean" configuration (as they were during Apollo) and the turnover of the O&C high bay and the CRF (still in work) to the Project Orion Prime Contractor (Lockheed-Martin (LM)). However, the VSE also called for the retirement of the Space Shuttle in 2010.

Up to this point in time, KSC Safety and Mission Assurance (S&MA) was staffed to support these very large programs which were the primary focus of KSC activities. The KSC S&MA requirements were written on a "how to" basis reflecting the specifics of applicable programs and lesson learned through years of processing. Over the years several reviews were undertaken of the requirements which lead to updates being issued; however the underlying basis remained.

The turn-over of the O&C and the CRF to LM, a commercial entity, presented KSC with its first opportunity to explore the benefits as well as pitfalls of turning a government owned facility completely over to a non-NASA entity. It also challenged KSC S&MA to try a different approach. This process was accomplished through the use of a Facility Usage Permit (FUP). The FUP spelled out the responsibilities of each party. Additionally, the concept for this facility was titled "Industrial Operations Zone" (IOZ). LM then proceeded to completely refurbish the Apollo era facility. During this refurbishment, LM was completely responsible for the safety of the construction activities including mishaps. During this process, there were minor jurisdictional disputes between NASA and LM safety organizations; but all were quickly resolved. Once IOZ refurbishment was complete, the IOZ became operational and LM has begun manufacturing and processing hardware. Per the FUP, LM remains responsible for safety activities in the IOZ unless the operation contained enough energy, that in event of a failure, the energy would propagate outside the IOZ boundary. In this scenario, NASA would review LM's hazard analysis and controls and concur on their adequacy. This process has yet to be exercised. As production gears up, the number of non-LM personnel in the IOZ will increase. Regardless of their affiliation, these personnel's safety is the responsibility of LM. Ironically, the concepts developed during this process, would serve as a basis for future non-NASA facility utilization at KSC.

The Present

On April 15, 2010, President Barack Obama set out a new Space Policy for NASA. The primary impact on KSC was the cancellation of the Constellation Program. This, in conjunction of the fly out to the Space Shuttle Program in 2011, leaves a tremendous infrastructure over capacity at KSC. Although the 2010 Space Policy calls for a new Heavy Lift Vehicle (announced in September 2011), many shuttle-era facilities and others do not have a future. This includes the Shuttle Landing Facility, the Orbiter Processing Facilities and other dedicated shuttle facilities. Even the relatively new SSPF will be underutilized as all the large ISS structural elements have been processed. Overarching this situation is the constrained budget environment NASA faces.

The Future

To prepare KSC for the future, a new paradigm is being established. This paradigm will move KSC from almost complete dependence on NASA programs to a site containing multiple NASA and non-NASA entities. These partnerships with non-NASA organizations will be used to take advantage of available KSC facilities and infrastructure.

Transitioning from a site that supported one or two major programs to one that supports a multi-user environment will require a new approach to how safety requirements are developed and implemented. Kennedy Space Center (KSC) Safety and Mission Assurance (SMA) will play a vital role in the success of KSC evolving from strictly government processing and acquisition activity to accommodating full life cycle support of diverse government and commercial operations. The old approach to requirements of one-size fits all will no longer be feasible. This new approach will also transfer the responsibility for safety from the Center safety organization to the operating organizations, both NASA and non-NASA. A description of this new approach discussed next.

The Philosophy

In the new approach, Federal, State, and local laws still apply for all activities at KSC. Each entity conducting operations on KSC will have full responsibility for compliance with the appropriate laws and the safety of its own employees and that of others who may be impacted by the condition of the properties and the execution of associated operations.

All hazards that are introduced on KSC property shall be controlled. Since controls are based on the specific hazard and the specific hardware/processes introducing the hazard, the responsibility for

controlling the hazards will be on the organization introducing the hazard. However, there will be some Center mandated hazard controls to ensure the safety of the personnel and property across the Center. The core ground safety requirements are minimal and allow operators the flexibility to develop their own methods and processes to comply with the requirements and ensure protection of their personnel and property.

Since NASA is still responsible for the safety of the NASA/NASA contractor operations, the number of requirements on NASA/NASA contractor operations will be higher than those placed on commercial companies who have their own responsibilities. As part of this effort to update the requirements, KSC will differentiate between the applicability of safety requirements to civil servants/NASA contractors, and commercial operations on KSC property.

All entities conducting operations on KSC property (including NASA programs and projects) will have to provide KSC SMA the concept of operations, hazards and controls. For NASA programs/projects, there will be an approval process to ensure the hazards are appropriately identified and controlled. For non-NASA programs/projects, KSC SMA will evaluate the entity's hazard controls to determine their effectiveness in protecting personnel and property outside the pre-determined asset perimeter.

The Process

This philosophy was really refined over the months of document review and re-write. There were a few initial driving factors to start the re-write of the Kennedy Space Center Ground Safety Requirements. These factors included feedback from the users/implementers of the requirements, and also the changing environment at KSC, as discussed earlier in the paper. These led to high level goals: provide rationale for safety requirements, eliminate unnecessary requirements, better define requirements, define applicability, and add anything that is missing.

A team was formed internal to the Safety and Mission Assurance Organization. The first accomplishment of team was to develop clear objectives. The team used the high level goals and input from management and stakeholders to develop the primary objectives. One of the primary goals of the team was to limit the number of "how

to's" in the document; however, the "how to's" in the document are great lessons KSC has learned over the years, so the team wanted to preserve them. This led to the development of a Users Guide to go along with the requirements document.

After the first few meetings to set the ground rules, the team got to work on reviewing the requirements. One by one the team discussed each individual requirement: why is it here, should it still be here in the future, where does it fit in. The more requirements that were discussed, the more the team settled into our document philosophy. There were definitely times when team members stepped back and questioned the direction we were headed. There were multiple times when we had to set the requirements aside and re-address the objectives and philosophy. The biggest concern that kept coming up was how different this was going to be and how difficult it would be to implement. In the end, there are still concerns, but everyone agrees that this is the best approach to work towards.

We are now getting to the point where we will see what our final document will actually look like. We have gone through the requirements individually, and made our decision on whether they need to stay, change, or move. We have yet to see what that all means collectively. This is a critical point in our process. The next critical point will be to show the new document to the implementers, and get their response. Then the final critical point will be the actual implementation of the new document.

In conclusion

Every organization has hazards that need to be controlled. Every organization has to a safety program with safety requirements. KSC has been able to have very descriptive safety requirements in the past because we had routine operations. As the environment changes, how we handle safety has to change with it. This does not mean we take safety any less seriously. It is just necessary to provide the flexibility in how hazards will be controlled not providing flexibility in the *goodness* of the controls.

While the scale of our requirements update is extreme, the process used can be used for much smaller scale reviews. Some of the lessons that were learned throughout the process include: make

sure to have diversity on the team (it is important to have members who have worked the requirements and also those who have not), establish team objectives and revisit them throughout the process, allow conversation/ disagreements, talk with a solution in mind when possible otherwise bring up a concern and discuss solutions.

While re-writing of the ground safety requirements for KSC has been difficult, the implementation of the new requirements will be even harder. The safety personnel will have to be involved early on in the program/project/operation to help establish appropriate controls, but they will always have access to the lessons learned of our former programs and projects.



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Introduction



- With the completion of the Space Shuttle Program, how will KSC evolve beyond the single launch vehicle launch site focus that has held prominence for almost fifty years?
- This presentation will talk about how the NASA KSC Safety organization is meeting that challenge.



The Past



- History
 - East coast of Florida on 131 mi² (340 km²) of land
 - Established in 1962 alongside the Cape Canaveral Air Force Station in support of Apollo
 - Two main areas
 - LC39 – with the launch pads and the VAB
 - Industrial Area – Headquarters and processing areas
 - Supported Apollo through 1975 with ASTP



The Past



- Space Shuttle initial launch site announced in 1972 as KSC
 - Re-use of Apollo-era facilities with modifications
 - Added Orbiter and Booster processing buildings

- International Space Station
 - Originally envisioned with minimal processing
 - Ship and Shoot
 - Change required new facilities
 - Space Station Processing Facility
 - Canister Rotation Facility

- Last major construction



The Past



- Constellation Program
 - Vision for Space Exploration – 2004
 - No new facilities but major mods to Pads
 - Turnover of facilities to Prime Contractor
- Safety Organization
 - Staffed to support very large programs
 - Requirements written on a “how-to” basis
 - Specifics of applicable programs
 - Lessons learned
 - Updated but underlying basis remained



The Past



- Industrial Operations Zone
 - Turn-over of O&C High Bay to Orion/MPCV Prime Contractor
 - Use of a Facility Utilization Permit
 - Contractor completely responsible for safety within the walls during construction and production
 - Sufficient energy to propagate outside the walls requires NASA review
 - Future basis for other facilities



The Present



- 2010 Space Policy for NASA
 - Cancellation of Constellation
 - Project Orion retained
 - Now a Program
 - Space Launch System (Heavy Lift)
- Large infrastructure overcapacity/underutilization
- Constrained budgets



The Future



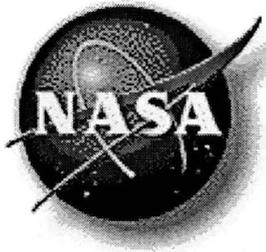
- New Paradigm
 - From complete dependence on NASA Programs
 - To multiple NASA and non-NASA entities
- New approach to safety requirements development
 - From strictly government processing and acquisition
 - To diverse government and commercial full life cycles
- No more “One size fits all”
- Transfer of responsibility



The Philosophy



- All Federal, State and local laws apply to all activities
- Entities responsible for compliance
 - Own Employees
 - Others that may be impacted
- All hazards shall be controlled
 - Controls based on specific analysis
 - Some Center mandated controls



The Philosophy



- NASA personnel and NASA contractors
 - NASA responsibility
 - More controls than on commercial entities
 - Requirements will have different applicability
- All entities required to submit concept of operations, hazards and controls
 - For NASA, review and approve by NASA SMA
 - For non-NASA, NASA SMA review hazards to ensure controls are appropriate to keep hazards from extending outside perimeter



The Process



- Based on user input and the changing environment, new goals were established:
 - Provide rationale for existing requirements
 - Eliminate unnecessary requirements
 - Better define requirements
 - Define applicability
 - Close any gaps



The Process



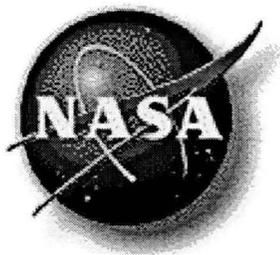
- Formed an internal SMA Team
 - In addition to the high level goals, the Team also determined to limit “how to’s”
 - “How to’s” – design solutions or proscriptive behavior
 - “How-to’s” usually based on lessons learned
 - Retain in User’s Guide
 - Each existing requirement reviewed
 - Why is it there
 - Should it be retained
 - Applicability



The Process



- Fits and re-starts
 - Questioning Philosophy
 - Implementation
- Currently at Critical Point
 - All requirements scrubbed
 - Moving from individual requirements to the collective result
- Non-SMA input to be sought
- Final implementation



Conclusion



- Changing environment requires changing processes
 - From routine to diverse
 - From descriptive to flexible
 - Organization that owns hazards, owns the controls
- Process lessons
 - Diversity – implementers and non-implementers
 - Establish objectives and revisit them
 - Allow conversations and disagreements
 - Look for solutions



Conclusion



- Re-writing has been hard
- Implementation will be harder
 - Culture change
- Early involvement of safety personnel to advise and assist
- Remember the lessons of the past