LAUNCHING CUBESATS FROM VANDENBERG SFB

The Basics

Introduction

Purpose: This guide addresses requirements specific to granting Missile Systems Ground Safety Approval (MSGSA) for CubeSat missions processed or launched from Vandenberg SFB.

This chart is based on the following:

1. A certification is needed for CubeSat operations at Vandenberg SFB.
2. The MSGSA preparer has sufficient technical knowledge and management authority to prepare the safety certification for submission.
3. This chart specifies the actions needed for a singular CubeSat effort. Each singular CubeSat effort will need an approval prior to launch vehicle integration.

Organization

Overview: Vandenberg SFB is the primary launch site for polar orbiting satellites in the continental U.S. As part of the U.S. Space Force, there exists a hierarchical organization that ensures safety is the utmost consideration for all processing and launch activities.

Space Launch Delta 30 Safety: Safety is a key part of the Delta Commander's staff and is tasked with implementing safety requirements for all programs processing or launching from Vandenberg SFB. These requirements exist in AFSPCMAN 91-710, Volumes 1 through Volume 7.

Definitions and Terms

The following are key definitions and terms for this chart:

- **AFSPCMAN 91-710:** Known as the Range Safety User Requirements Manual. This document contains specific policies this chart is based upon. Of general interest will be Volume 1—Policy. Of specific interest will be Volume 3—Launch Vehicles, Payloads and Ground Support System Requirements, Volume 6 - Ground and Launch Personnel, Equipment, Systems, and Material Operations Safety Requirements, and Volume 7– Glossary of References, Abbreviations, and Terms.
- **System Safety:** The application of engineering and management principles, criteria, and techniques to optimize safety within the constraints of operational effectiveness, time, and cost throughout all phases of the system life cycle. This chart modifies, or tailors, the system safety process to the CubeSat hazard assessment process to obtain final safety approvals.

This Chart's Purpose

This chart modifies (i.e., tailors) Range Safety requirements for CubeSat processing and launch approvals at Vandenberg SFB. Clarifications and interpretations of the information contained in this chart need to be addressed to the cognizant SLD 30/SEAL System Safety Engineer (your POC) for the specific mission.

Participants

CubeSat Team: The agency responsible for the design, construction and eventual operation of the specific CubeSat.

Launch Agency: The organization responsible for placing the CubeSat into orbit.

Space Launch Delta 30 Safety: The office that ensures specific safety requirements are established for, and followed by, all programs. For CubeSat specific applications, the Launch Vehicle Safety office, SLD 30/SEAL, will be the primary contact. SLD 30/SEAL issues mission specific approval in the form of the MSGSA.

Background

As previously indicated , safety is the utmost consideration for all processing and launch activities at Vandenberg SFB. This has resulted in an outstanding safety record for all Vandenberg SFB activities that is the goal of all Space Force launch organizations.

The reason for this privileged record is based on a couple of key factors. First is the expertise and professionalism of the system safety engineers at SLD 30/SEAL. Couple that expertise with a thorough system safety hazard analysis process results in a thorough safety assessment process and an enviable safety record!

But the most important factor is you—the CubeSat Team. You're the one that's able to effectively provide understanding and insight into the system that you've developed.

System Safety
Hazard Analysis and Assessment

Applying System Safety Basics

What is System Safety?

System Safety is the application of engineering and management principles to identify and assess hazards that may result in any combination of hardware damage, personnel injury (or death) or both.

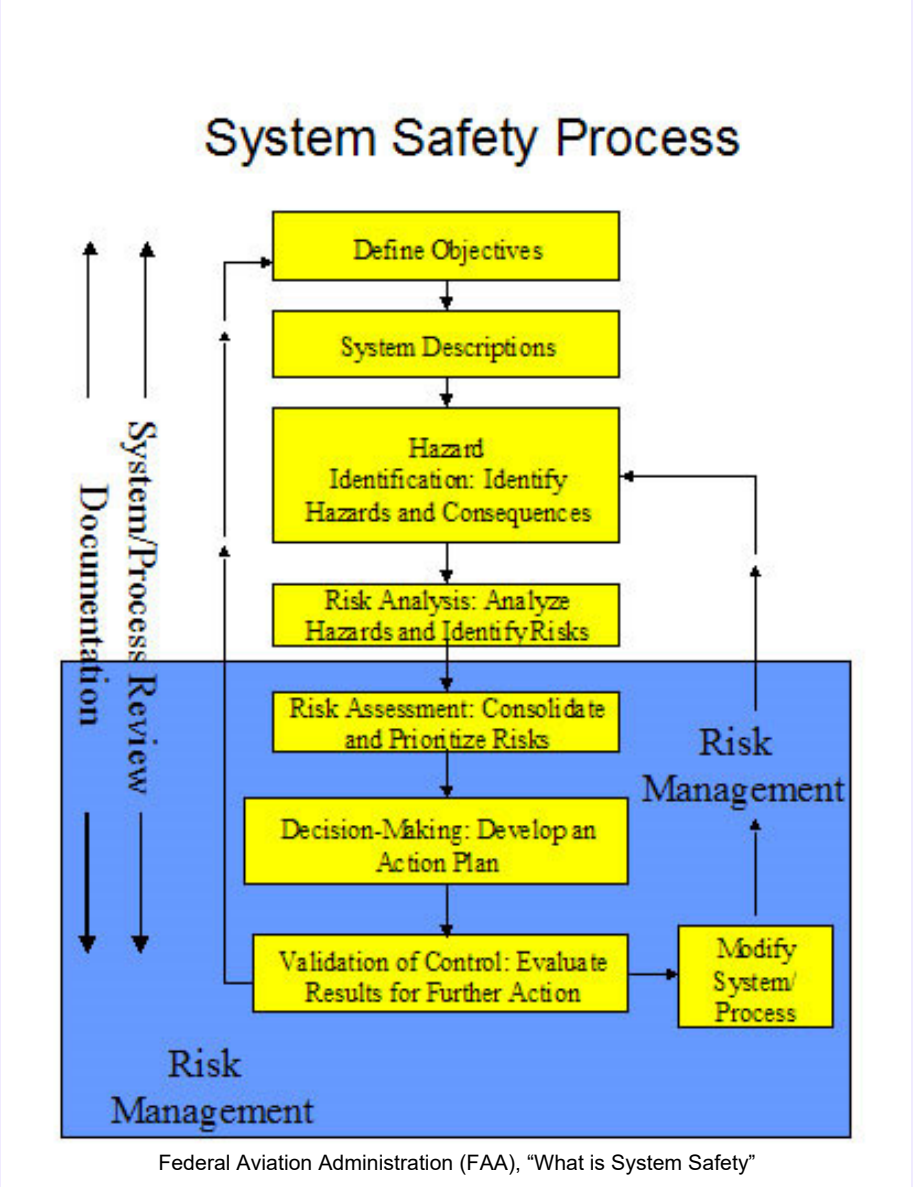
System Safety is a well defined process (see chart). The key part of this process is to identify **ALL HAZARDS** specific to your CubeSat. The table below identifies the more common hazards.

Hazards—What & How Much

- ⇒ ***Toxic Chemicals*** *(at or* above established IDLH or TLV limits)
- ⇒ Category I ***Ordnance***
- ⇒ *A* ***pressure source*** *above 150 psig or 14,240 ft-lbs*
- ⇒ **Acoustic sources** above occupational noise exposure levels
- ⇒ ***Non-ionizing radiation*** above established exposure limits
- ⇒ ANY ***ionizing radiation*** source
- ⇒ Class II and above ***LASERS***
- ⇒ Any ***Hazardous Materials***
- ⇒ *Electrical Contact* (**Shock)**
- ⇒ Any ***Batteries*** (combination of above hazards)
- ⇒ Items that deploy (**Mechanical Force**)

Anything Missing?

For anything **NOT** on the above list, contact your SLD 30/SEAL POC for help and guidance. Keep in mind you'll need in-depth technical and system safety information on the CubeSat to answer any questions that come up.



Federal Aviation Administration (FAA), "What is System Safety"

The Basic System Safety Process

The figure above, from the Federal Aviation Administration (FAA) website, identifies a number of key features inherent to system safety as done at Vandenberg SFB. When dealing with CubeSats, the most important attribute is ensuring hazards, and the associated risks, are communicated accurately and succinctly. Understanding and conveying this information is key to ensuring the CubeSat does not impact the primary mission and helps obtain Missile System Ground Safety Approval in a timely manner.

What to do if a risk does present itself and more importantly, who decides how to accommodate that risk, is addressed through the risk management process discussed in this guide. For convenience, those items are covered in the next portion of this chart. Risk acceptance is important, but the first step in the process is to identify the hazards to be assessed and mitigated.

Hazard Categories and Who Reports Them

Ensuring the right people are told the right thing at the right time

Who does what….

Exactly who does what to whom during the engineering life cycle is not always clear in the daily course of events—however, for the purposes of this discussion and, more importantly, to provide a pragmatic statement of policy, here's the best way to view the relationships for the typical CubeSat launch:

CubeSat Team (aka Principal Investigator) — The singular entity responsible for designing and constructing a specific CubeSat for a mission.

Integrator — Incorporates a group of CubeSats into a singular mechanical and electrical package to be attached to the launch vehicle.

Launch Vehicle — The Launch Vehicle Provider supplies the actual launch vehicle and specifies the means, and timing, of CubeSat deployments.

Range Safety — Implements operations and launch per government policy. Issues written approval and MSGSA.

The colored circles are discussed in the upcoming "Process" section on Page 4!

Reporting Levels

In most all CubeSat operations, the CubeSat itself is a quiescent object as is the associated hardware and deployment package. But the key perspective to keep in mind is that the safety of the CubeSat must be proven at every level of the approval process, especially the potential impact on other entities. Here's the relationship:

- Range Safety determines overall launch safety policy, background on that policy, and necessary operations and launch approvals. It's at this level the Launch Vehicle Provider receives approval for the launch to occur.
- The Launch Vehicle Provider wants to ensure the launch vehicle will be able to successfully complete the launcher's primary mission. *This is REALLY important!* The Launch Vehicle Provider needs insight into anything that might potentially impact this capability and possibly endanger people while processing and other activities are occurring.

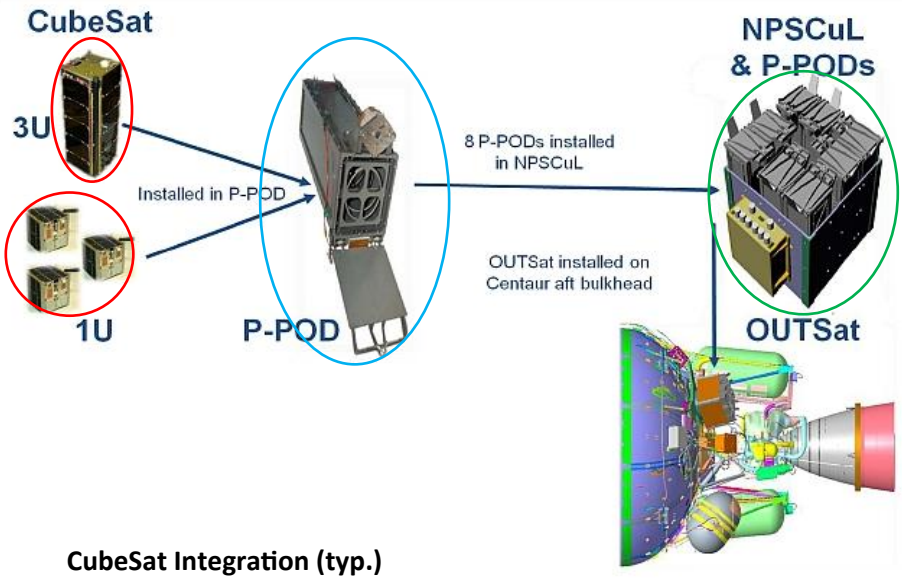
Reporting Levels (more)

- The Integrator is obliged to safeguard the release capability for the individual CubeSats until the appointed time in flight. Practically, anything that influences this success must be addressed.
- The CubeSat is where the "rubber meets the road" for the mission. While at the lowest level of integration, some parts of the CubeSat can have an impact on launch success and the safety people in and around the launch vehicle.

Level of Detail

Assessing risk is akin to the experience of the scientists in "*The Dermis Probe*" — each scientist offers a perspective based on their expertise and view of the problem. It's only apparent when the problem is seen in its entirety that the whole is greater than the sum of the parts. This "big picture" view is essential to understand, and manage, launch risk. Here are the different levels in our case:

- The Principal Investigator has the knowledge of CubeSat specific hazards and the controls.
- The Integrator ensures CubeSat risk doesn't go beyond the dispenser(s).
- The Launch Vehicle Provider ensures the primary mission is not affected.
- Range Safety approves the overall process through the MSGSA.



CubeSat Integration (typ.)

Documentation and Approvals

Missile System Ground Safety Approval (MSGSA)

Process

This is the last step of the approval process and arguably the most important. The end result of this process is information — the information needed to judge if the safety risk presented by the CubeSat (or the overall group of CubeSats) is reasonable and acceptable in terms of the overall launch.

The information that has to be conveyed is the answer to the question of how a failure will impact other items. So let's take a look at what that means. Recall that in the CubeSat Integration figure on the previous page, there are three circles that corresponded to the level of integration. The RED circle corresponds to the individual CubeSat and the BLUE defines the boundaries of the integrated P-POD. The final color, GREEN, is the interface between the final integrated CubeSat package and the launch vehicle provider.

The key is to assess the hazard's potential— especially it's potential to impact other CubeSats or the launch vehicle. The hazard analysis needs to reflect this potential and address the potential for harming personnel in the surrounding area.

When this analysis is complete, CubeSat team lead can request Missile System Ground Safety Approval (MSGSA) from SLD 30/SEAL.

The chart summarizes the process.

MSGSA

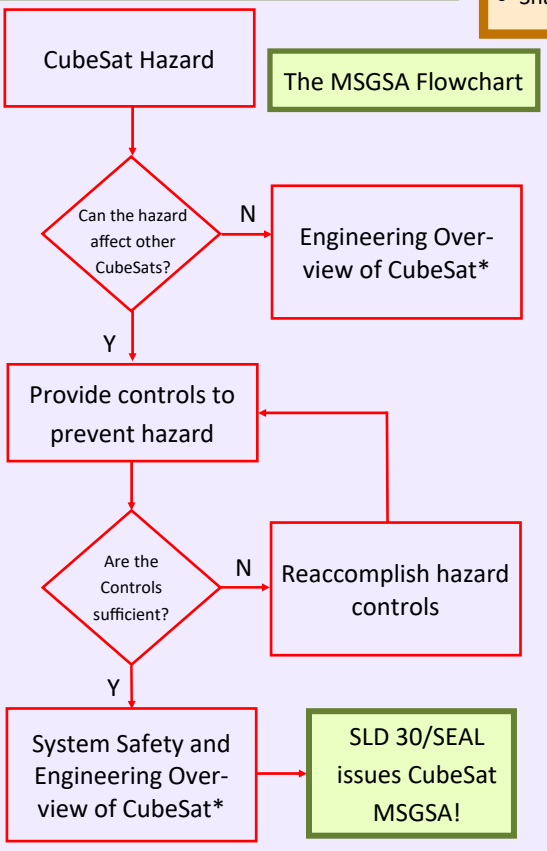
MSGSA is the final system safety launch approval issued by SLD 30/SEAL and is issued before launch and after the Pre-Ship Review (PSR). Approval is based on the following:

1. A summary statement that safety risk has been assessed and is reasonable given the design and controls in place. This document needs to be signed by the Program Manager.
2. An engineering document with sufficient level of detail to assess the system safety analysis.
3. A system safety analysis that traces the hazards from recognition to final control using an appropriate method.
4. A request by the program for launch MSGSA.

Sources

Would you like to know more? Consult the following references for more information!

- AFSPCMAN 91-710, Range User Safety Requirements Manual (most current version)
- Ericson, Clifton A. *Hazard Analysis Techniques for System Safety*, 2005.
- Leveson, Nancy. *Engineering a Safer World,* 2011.
- International System Safety Society (https://www.system-safety.org)
- CubeSat Concept (URL: https://directory.eoportal.org/web/eoportal/satellite-missions/c-missions/cubesat-concept)
- CubeSat Standards (https://directory.eoportal.org/web/eoportal/satellite-missions/c-missions/cubesat-concept#standards)
- FAA, "System Safety Handbook, Chapter 3: Principles of System Safety", December 30, 2000 (https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/risk_management/ss_handbook/)
- FAA, "System Safety Process", undated (https://www.faasafety.gov/gslac/alc/libview_normal.aspx?id=6877)
- Shah, Idries. The Dermis Probe, 1970.



The MSGSA Flowchart

See you at Vandenberg soon!

Forward comments or suggestions for improvement to:

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The attestation ties the system safety process to the MSGSA!

* In each case, a signed attestation that hazards have been identified, assessed and controlled is a prerequisite for obtaining final MSGSA.