Goddard Open Learning Design (GOLD) Rules

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GOLD Rules Overview

- **GOLD Rules**
  - Describe the Goddard best practices from various engineering disciplines for successful missions that require management **visibility** when deviated from
  - Provide closed loop process to capture new knowledge and lessons learned
- **All GOLD Rules are requirements at Goddard**
  - Describe foundational, general “principles” that work without defining implementation “philosophy”
    - e.g., Safe Hold Mode: principle of independent power-positive control mode versus implementation of separate processors
  - The “Rule Statement” gives the requirement
  - The “activities” for each phase are best practices for guidance only
- **Required for all Goddard projects and evaluated along project’s lifecycle**
- **Management Insight Process**
  - Communicates progress of project’s execution
  - Visibility up to Goddard Center Director

GOLD Rules Overview, cont'd

- **"Most important" GSFC standard practices**
  - What are the GSFC "norms" for any given discipline
  - Critical things that have made GSFC missions successful in the past
  - Standard processes and practices maintained by disciplines within the GSFC engineering community
- **Not the only way to solve any engineering problem/GOLD Rule compliance should not trump sound engineering**
  - Project unique applications
  - Revised or new methodologies for analyzing problem
  - New hardware or systems
  - Responsible engineer must clearly document rationale for an approach that deviates from the GSFC "norm" and why deviation from the "GSFC norm" doesn't result in unacceptable risk

GOLD Rules Overview, cont'd

- **Revision E of GOLD Rules introduced Mission Exception List (MEL)**
  - An a priori list proposed at the start of a Program and/or Project, to highlight rules which may not apply
  - If a MEL is submitted and approved, waivers will not be required for exceptions covered by the MEL unless changes occur to the underlying basis for exception
- **Relationship between GOLD Rules and Goddard Environmental Verification Standard (GEVS), GSFC-Std-7000**
  - GEVS, although classified as a "standard" is intended to be more of a "handbook"
    - No requirements, just guidelines
    - Those "guidelines" that the various Goddard engineering disciplines consider to be "requirements" are captured in the GOLD Rules
  - GOLD Rules are both a superset and subset of GEVS (GOLD has requirements outside environmental verification, GEVS has guidelines that are not necessarily GOLD Rules)

GOLD Rules Overview, cont'd

- **GOLD Rules authority:**
  - Owner of GOLD Rule Content: Engineering and Technology Directorate (Code 500)
  - Owner of GOLD Rule Configuration Management: Safety and Mission Assurance Directorate (Code 300)
  - Owner of GOLD Rule Implementation: Flight Projects Directorate (Code 400)
  - Waiver review and concurrence: Code 300, Code 400, Code 500 members of the Goddard Technical Standards Committee (GTSC) or designee of the respective Director Of, and GSFC Chief Engineer
  - Waiver approval: Director of Safety and Mission Assurance

GOLD Rule Application

- **Provides framework for many responsible GSFC institutions to assess and communicate progress**
  - Multiple stakeholders with own interests & priorities
  - Rules broadly embedded in project management & review process
  - Apply to all space flight products, regardless to implementation approach or mission classification (see later slides for Class D and below)
  - Apply to in-house and out-of-house developments (GSFC project office held accountable for out-of-house development compliance)
  - Apply over program/project life cycle

GOLD Rule Construct

Rule #	Title						Discipline
Rule	Rule Statement – The requirement.						
Rationale:	Statement(s) providing justification, clarification and/or context.						
Phase:	<A	A	B	C	D	E	F
Activities:		Rule-associated best practices, within each phase, to ensure compliance (guidance only)					
Verification:		Rule-associated best practices, within each phase, to ensure compliance (guidance only)					
Revision Status: When implemented/modified		Owner: Subject Matter Expert / Technical Authority					Reference: Supporting Materials

Some Examples

1.09	Test as You Fly				Systems Engineering		
Rule:	All GSFC missions shall follow a, "Test as You Fly (TAYF) - Fly as You Test" approach, throughout all applicable life cycle phases. Each deviati this approach, along with the rationale for the deviation, shall be documented and a waiver submitted. Note: A waiver or exception to this rule wi based only on the specific elements that appear and are approved in the request and is not a global approval to waive TAYF for all elements.						
Rationale:	Testing of all critical mission-operation elements as they will be flown greatly reduces the risk of encountering negative impacts upon Mission suc from partial to full loss of mission capability.						
Phase:	**<A**	**A**	**B**	**C**	**D**	**E**	**F**
Activities:		1. Develop the preliminary test plan employing a TAYF philosophy.	1. Develop final test plan, employing a TAYF philosophy. 2. Develop a preliminary list of TAYF exceptions and discuss with rule owners.	1. Develop test procedures employing a TAYF philosophy.	1. Perform testing per plan / procedures.	N/A	N/A
Verification:		1. Verify at MDR.	1. Verify at PDR.	1. Verify at CDR.	1. Verify at PER.	N/A	N/A

Revision Status:	**Owner:**	**Reference:**
Rev. F, Updated Rev G	Mission Engineering and System Analysis Division (590, Primary) and Instrument Systems and Technology Division (550)	

Some Examples

2.01	Flight Electronic Hardware Operating Time				Electrical		
Rule:	One thousand (1000) hours of operating/power-on time shall be accumulated on all flight electronic hardware (including all redundant hardware) to launch The last 350 hours of operating/power-on time shall be failure-free, of which at least 200 hours shall be in vacuum. For Class D and be only the failure-free and vacuum requirements shall apply.						
Rationale:	Accumulated power-on time that demonstrates trouble-free parts performance helps reduce the risk of failures after launch.						
Phase:	**<A**	**A**	**B**	**C**	**D**	**E**	**F**
Activities:	N/A	1. Draft test plan.	1. Approve test plan.	1. Update test plan.	1. Conduct 1000 hours of testing of all flight hardware and spares. The last 350 hours shall be trouble-free. At least 200 shall be in vacuum.	N/A	N/A
Verification:	N/A	1. Verify at MDR.	1. Verify at PDR.	1. Verify at CDR.	1. Verify at PSR that testing has been conducted. 2. Verify at PER that the test plan is sufficient for completion of required hours.	N/A	N/A
Revision Status: Rev. F		**Owner:** Applied Engineering and Technology Directorate (500) and Electrical Engineering Division (560, Primary)				**Reference:** GEVS 2.3.4	

Some Examples

4.12	Structural Proof Testing					Mechanical	
Rule:	Primary and secondary structures fabricated from nonmetallic composites, beryllium, or containing bonded joints or bonded inserts shall be proof tested in accordance with GSFC-Std-7000 Section 2.4.1.4.1.						
Rationale:	The mechanical strength of the above items is dependent on workmanship and processing and can only be verified by proof testing.						
Phase:	**<A**	**A**	**B**	**C**	**D**	**E**	**F**
Activities:	N/A	N/A	1. Identify structure requiring proof testing.	1. Develop test methods and plans for performing proof testing.	1. Perform proof testing to verify mechanical strength.	N/A	N/A
Verification:	N/A	N/A	1. Verify that all structural elements requiring proof testing have been identified.	1. Verify that approach for proof testing appropriate structural elements has been defined.	1. Verify that proof testing has been performed.	N/A	N/A
Revision Status: Rev. E, Updated Rev. G		**Owner:** Mechanical Systems Analysis and Simulation Branch (542)				**Reference:** GEVS 2.4.1.4.1	

Waiver Process

- **GPR 8070.4 defines application and process**
  - Currently at Rev C
  - Rev. C includes explicit relief for higher risk posture projects (more later) and clarifies the process for projects that are outside of GSFC, under a GSFC program office.
- **Rules can be waived with appropriate rationale and concurrence**
- **Waiver should be generated as soon as the responsible engineer determines a waiver is necessary**
  - Use good engineering judgment when evaluating rules
  - Waiver may not be necessary for "normal way of doing GSFC business". (For example, prop systems are never loaded with hydrazine in t-vac so a waiver to test-as-you-fly GR not required)
  - Ensure discussion with rule owner or GSFC engineering community
- **Rationale should document the "team discussion" and engineering to justify the planned approach**

Waiver Process cont'd

- **GOLD Rule Revision compliance**
  - Version in effect at Mission Confirmation Review
  - Use entire applicable version, not select from previous revisions
  - Compliance reviewed early in project life-cycle
- **Waiver generated by "responsible" engineer**
  - Either discipline or systems engineer
  - Documentation of on-going technical discussions
  - Entire project team (engineers, SE, Project, SMA, etc) should be part of the discussion for submitting a waiver
- **GPR 8070.4 requires a waiver "indicate the concurrence or non-concurrence of the GOLD Rule's Subject Matter Expert"**
  - In reality this means the waiver documentation should be reviewed by and input obtained from
    - Discipline engineer(s) – (e.g. Lead Instrument Engineer)
    - Subject Matter Expert (SME)- (e.g. senior technical expert or Engineering Division Chief Engineer)
    - Branch Head or Division CE – (i.e. rule owner)
    - Project Lead System Engineer
    - Project Management
  - The SME concurrence should be included as part of the submitted waiver package
  - It would be rare to approve a waiver without SME concurrence.

"Formal" Waiver Submittal

- **Goddard Safety and Mission Assurance Directorate performs configuration management for the waiver process**
- **Waiver package submitted to Safety and Mission Assurance:**
  - **AFTER** obtaining Project & Goddard Flight Projects Directorate signatures
  - The waiver package includes memos, emails, engineering analysis, etc (all supporting information including concurrence of the waiver by the Rule Owner)
  - Formal processing of waiver does **not** start until S&MA receives signed waiver and logs it into the system, but the more important, engineering work is as documented above.
- **Safety and Mission Assurance will send waiver package to remaining reviewers**
  - Reviewed by Goddard, Engineering Directorate and S&MA Directorate Chief Engineers
  - Final waiver approval by Director of SMA (Code 300)

“Formal” Waiver Submittal, cont’d

- **Responsible engineer should work with S&MA Configuration Management Office and other reviewers to answer any questions and complete review in timely manner**
- **Comments and/or actions from reviewers are included in final package**
- **Note: Concern has been raised that the process is burdensome. The process itself is fairly benign, but discussions can be very lengthy with detailed technical arguments for unique situations that deviate from GSFC’s standard practices, in particular those that are historically based.**
  - Minimum thermal cycles
  - Number of testing hours

Applicability for Class D and below

- **GOLD rules apply flexibly and judiciously to projects Class D and below (those following NPR 7120.8 and "do no harm")**
- **No waivers are required**
- **GOLD rule compliance matrix is submitted**
  - Reviewed at a single meeting chaired by Engineering Directorate or GSFC Chief Engineer, involving Subject Matter Experts and S&MA
  - Compliance matrix held under CM by the owning directorate

GOLD Rule Revision Process

- **GOLD Rules is a living document**
  - Current Revision, Rev G, was released June 2016
  - Periodically assessed and updated to improve clarity of purpose and effectiveness
  - Capture new knowledge and lessons learned
  - Intent is to improve GOLD Rules over time on a roughly 2 year revision cycle
- **Suggested revisions to any GOLD Rule submitted by rule owner to Engineering Directorate**
- **Revision G was a major revision:**
  - Removed rules that don't belong or are better covered elsewhere
  - Clarified ambiguous wording and combined duplicate rules
  - Added rules to areas that were missing in previous revs (e.g., optics area)
- **Revision H is in work and is synchronized with the current GEVS update to capture GEVS requirements**

Additional Information

- **Link to GOLD Rules: https://standards.nasa.gov/center-specific-standards**
  - Then select GSFC-STD-1000

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