Track: Process Makes Perfect

Requirements Management

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PM Challenge 2008

TacSat-2 Launch From NASA WFF

- **Challenge:**

  6/20/06: USAF requested that NASA Wallops support the launch the TacSat-2 spacecraft on a Minotaur I launch vehicle in November 2006 by providing:

  – Launch pad at Wallops
  – Payload processing facilities
  – Launch vehicle processing facilities
  – Range safety
  – Range instrumentation: telemetry, radar, communications
  – Weather forecasting
  – Physical security

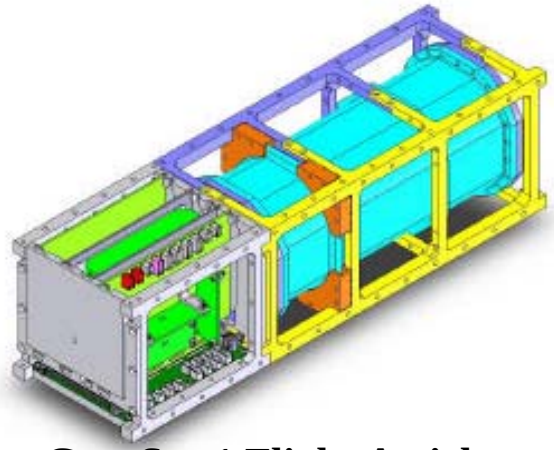
Primary Spacecraft: TacSat-2

TacSat-2 Arrives at NASA Wallops

TacSat-2 mated to Minotaur Stage 4

370 kg spacecraft

Secondary Spacecraft: ARC GeneSat



GeneSat-1 Flight Article
(solar panels removed)
10 inches long

PPOD

Launch Vehicle: Minotaur I

- Minotaur I on Wallops Pad 0B
- Stages 1 & 2:

  Minuteman II (M55A1 & SR19)
- Stage 3 & 4:

  Orbital Sciences Corp's Orion 50 XL & Orion 38

Upper Stack Emplacement on 11/28/06

Roll Transfer of Stages 1 & 2

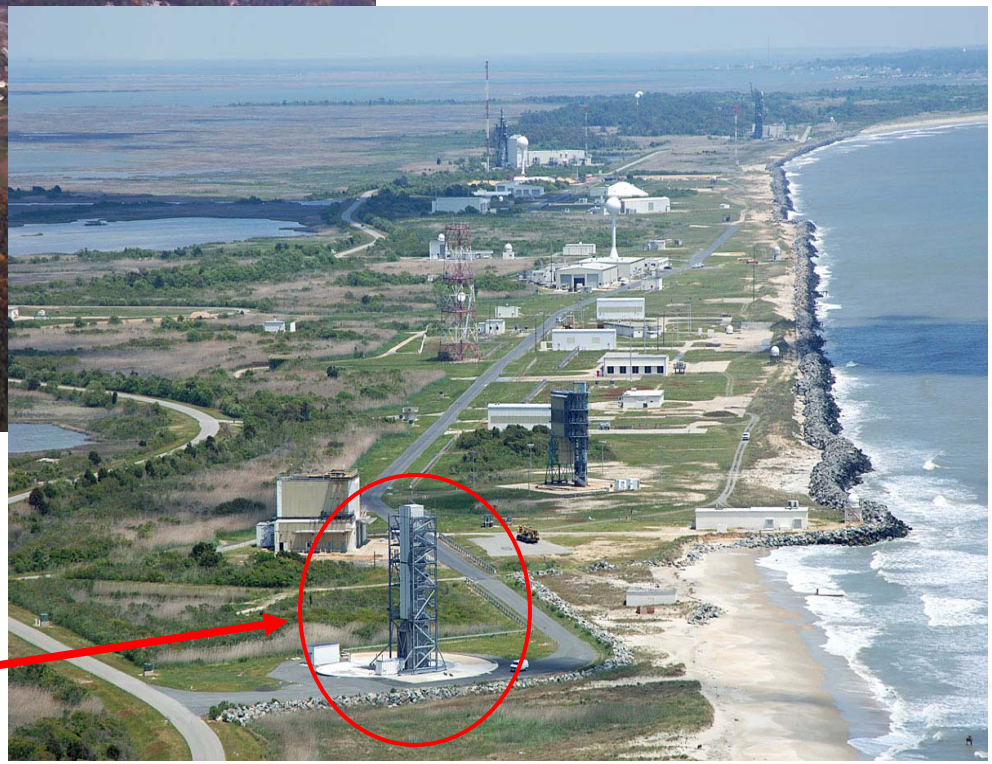
11/7/2006

Launch Vehicle: Minotaur I

NASA Wallops

Main Base

Wallops Island

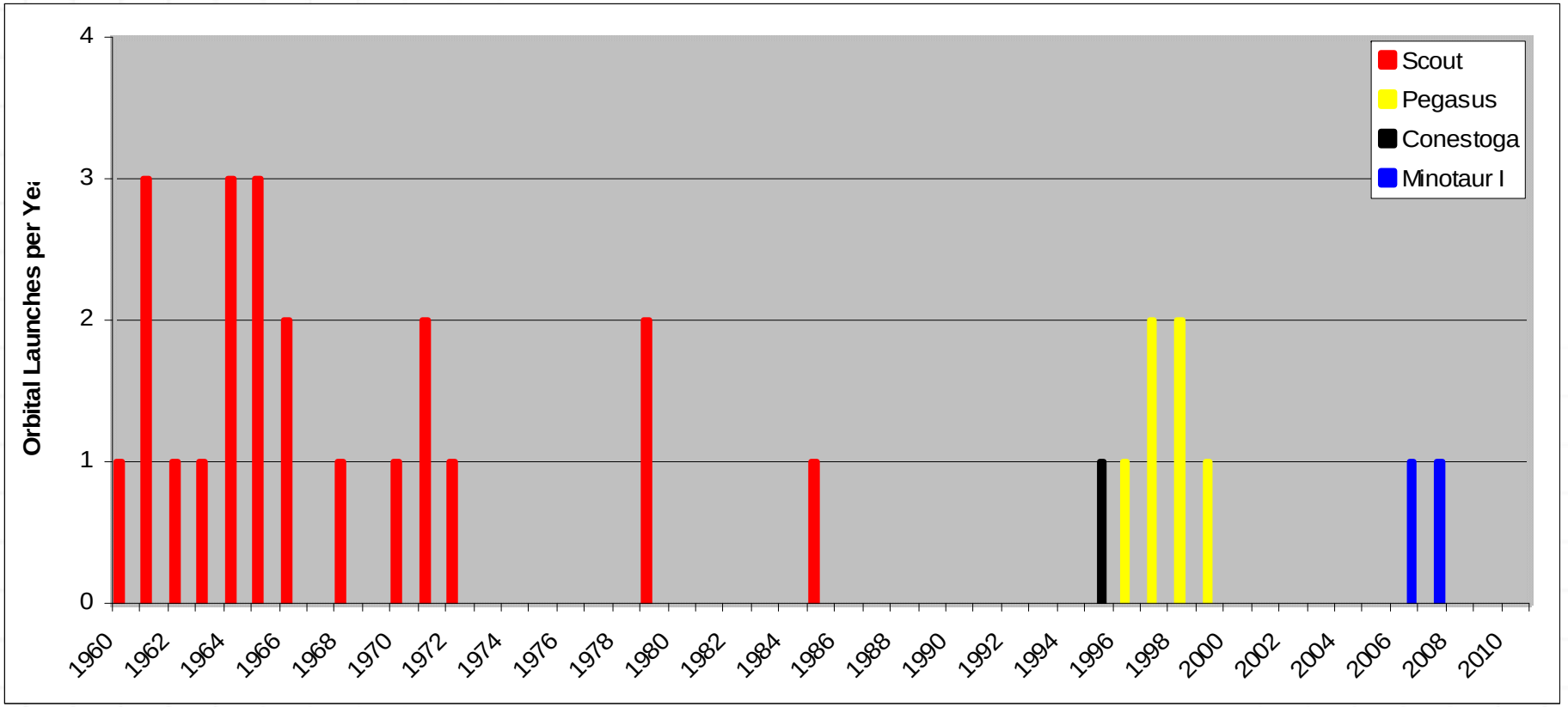


Mid-Atlantic
Regional Spaceport (MARS)
Pad 0B

Transportable Grd Station at Coquina, NC

NASA Wallops Orbital Launches

31 orbital launches between 1960 and 1999



Importance of Requirements Documents

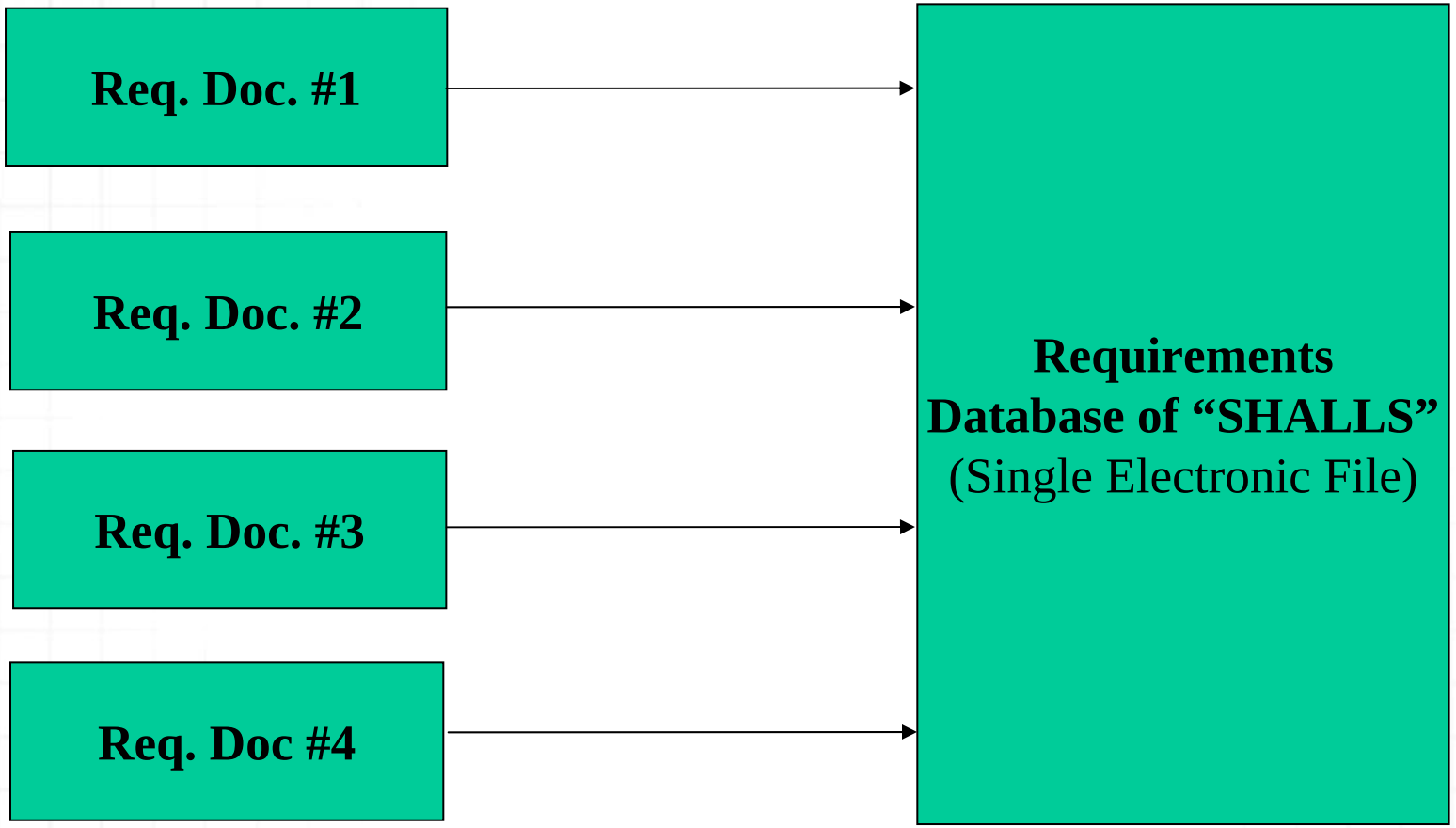
- Formally documents customer's needs
  - the "what" of the solution
  - not the "how" to design that solution
- Key input into establishing the system technical baseline
- Essential when specific requirements are flowed-down (linked) to:
  - elements of the system
  - organizational owners
- Provides a traceability path to verify that the design solution satisfies all of the customer's needs

TacSat-2 Customer Requirements

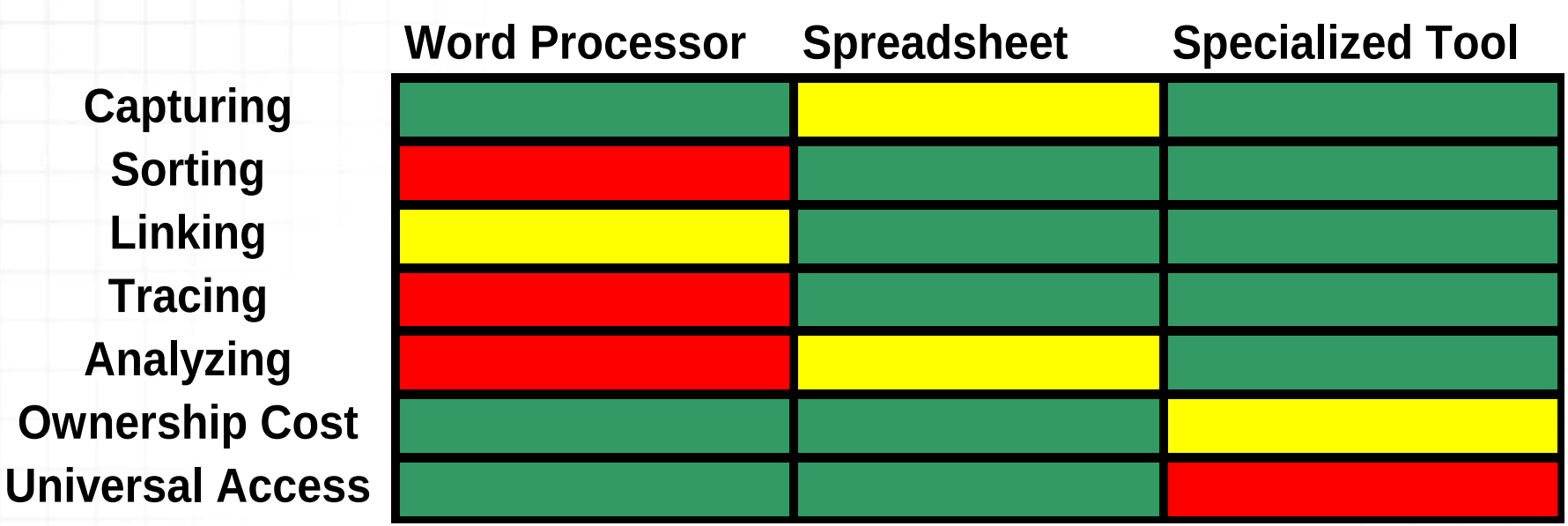
Minotaur WFF Facilities Req. Doc (FRD)	Minotaur Program Req. Doc (PRD)	Minotaur START TM Collection Plan	TacSat-2 SV Facilities Req. Doc (FRD)
•OSC doc •65 pages	• OSC doc •190 pages • UDS Format	• AF SDTW doc • 31 pages	• AF AFRL doc • 24 pages

677 Requirements Total

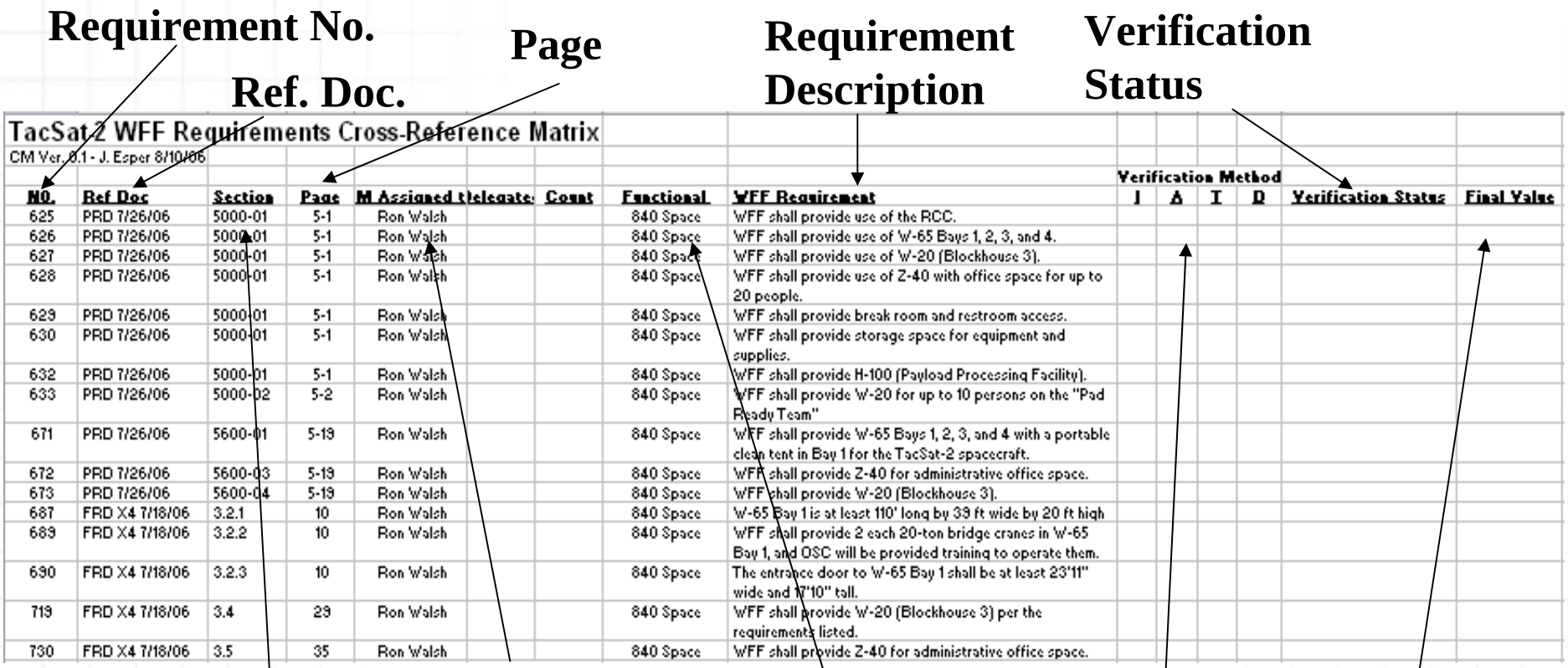
Requirements Management Database



Requirements Management Tools



Requirements Database Format



TacSat-2 WFF Requirements Cross-Reference Matrix

CM Ver. 0.1 - J. Esper 8/10/06

NO.	Ref Doc	Section	Page	M Assigned t	Delegate	Comm	Functional	WFF Requirement	Verification Method I	A	T	D	Verification Status	Final Value
625	PRD 7/26/06	5000-01	5-1	Ron Walsh			840 Space	WFF shall provide use of the RCC.						
626	PRD 7/26/06	5000-01	5-1	Ron Walsh			840 Space	WFF shall provide use of W-65 Bays 1, 2, 3, and 4.						
627	PRD 7/26/06	5000-01	5-1	Ron Walsh			840 Space	WFF shall provide use of W-20 (Blockhouse 3).						
628	PRD 7/26/06	5000-01	5-1	Ron Walsh			840 Space	WFF shall provide use of Z-40 with office space for up to 20 people.						
629	PRD 7/26/06	5000-01	5-1	Ron Walsh			840 Space	WFF shall provide break room and restroom access.						
630	PRD 7/26/06	5000-01	5-1	Ron Walsh			840 Space	WFF shall provide storage space for equipment and supplies.						
632	PRD 7/26/06	5000-01	5-1	Ron Walsh			840 Space	WFF shall provide H-100 (Payload Processing Facility).						
633	PRD 7/26/06	5000-02	5-2	Ron Walsh			840 Space	WFF shall provide W-20 for up to 10 persons on the "Pad Ready Team"						
671	PRD 7/26/06	5600-01	5-19	Ron Walsh			840 Space	WFF shall provide W-65 Bays 1, 2, 3, and 4 with a portable clean tent in Bay 1 for the TacSat-2 spacecraft.						
672	PRD 7/26/06	5600-03	5-19	Ron Walsh			840 Space	WFF shall provide Z-40 for administrative office space.						
673	PRD 7/26/06	5600-04	5-19	Ron Walsh			840 Space	WFF shall provide W-20 (Blockhouse 3).						
687	FRD X4 7/18/06	3.2.1	10	Ron Walsh			840 Space	W-65 Bay 1 is at least 110' long by 39 ft wide by 20 ft high						
689	FRD X4 7/18/06	3.2.2	10	Ron Walsh			840 Space	WFF shall provide 2 each 20-ton bridge cranes in W-65 Bay 1, and OSC will be provided training to operate them.						
690	FRD X4 7/18/06	3.2.3	10	Ron Walsh			840 Space	The entrance door to W-65 Bay 1 shall be at least 23'11" wide and 17'10" tall.						
719	FRD X4 7/18/06	3.4	29	Ron Walsh			840 Space	WFF shall provide W-20 (Blockhouse 3) per the requirements listed.						
730	FRD X4 7/18/06	3.5	35	Ron Walsh			840 Space	WFF shall provide Z-40 for administrative office space.						

Example of Capturing a Requirement

USAF PRD Section 2200, Item #5:

All launch vehicle telemetry data and video signals will be transmitted in real-time to the Bldg. W-20 LCR and the RCC (Bldg. E-106) for Range Safety processing and to allow video output to project displays in the Bldg. W-20 LCR, RCC, and to TM Readout. Best source data and video are required to monitor the Minotaur during launch and vehicle flight for all links. The predicted transmitter ON/OFF times are listed below:

RF Link	Transmitter ON Time	Transmitter OFF Time	Notes
Link 88 LV Telemetry	T - 4 hours	T - 3 hours	Pre-Launch Open Loop RF Checks
Link 88 LV Telemetry	T - 1 hour	T - 50 minutes	Terminal Count Open Loop RF Checks
Link 88 LV Telemetry	T - 30 minutes	Loss of Signal	Launch Operations
Link 40 Video Telemetry	T - 30 minutes	T + (S3 Separation)	Launch Operations

Resulting Entry in NASA's Requirements Matrix:

Requirement #	Ref Doc	Section	Page	Assigned to	Area	Comments
360	PRD 7/26/06	2200-05	2-9	Scott Schaire	Telemetry	WFF shall transmit Minotaur telemetry and video in real-time to Blockhouse 3.
361	PRD 7/26/06	2200-05	2-9	Scott Schaire	Telemetry	WFF shall transmit Minotaur telemetry and video in real-time to the RCC for Range Safety processing.
362	PRD 7/26/06	2200-05	2-9	Scott Schaire	Telemetry	WFF shall transmit Minotaur video to Blockhouse 3.
363	PRD 7/26/06	2200-05	2-9	Scott Schaire	Telemetry	WFF shall transmit Minotaur video to the RCC.
364	PRD 7/26/06	2200-05	2-9	Scott Schaire	Telemetry	WFF shall transmit Minotaur video to the TM Readout.
365	PRD 7/26/06	2200-05	2-9	Scott Schaire	Telemetry	WFF shall provide best source data during the launch and vehicle flight.
366	PRD 7/26/06	2200-05	2-9	Scott Schaire	Telemetry	WFF shall provide best source video during the launch and vehicle flight.
367	PRD 7/26/06	2200-05	2-9	Scott Schaire	Telemetry	WFF shall receive Minotaur telemetry and video at the times listed.

Frequent Requirements Problems

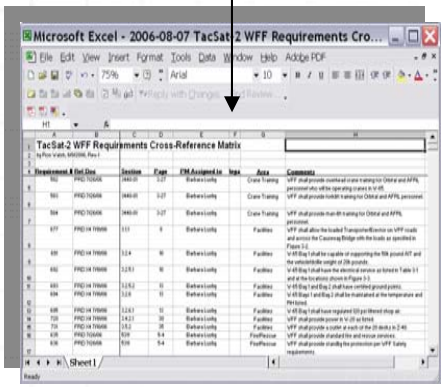
- Ambiguous – leads to misinterpretations
- Incorrect – system probably will not work
- Unnecessary repetition – can lead to contradiction
- To restrictive – specifies the “HOW” not the “WHAT’
- Unrealistic - the technology just isn’t there
- Inconsistent – not possible to do both
- Antiquated – referencing superseded document
- Unverifiable – no way to determine the requirement is met
- Extraneous information included – not useful
- Missing requirements – when are they discovered?
- Not freezing requirements – shooting at a moving target
- Changing requirements – how to manage?

Requirements Management Process

PRD – V.7/26/06

FRD – Rev.X4

Customer Documents



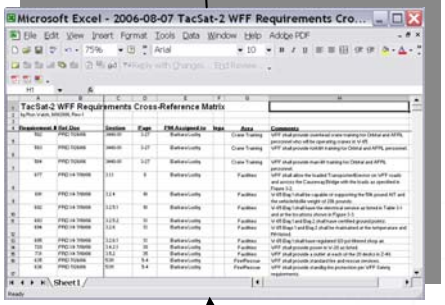
Initial Database Compilation– Under SE CM

Team members assigned requirement responsibility (by PM) comment, ask for clarification and provide a status during Systems Requirements Review. (8/15)

Systems Engineering request requirement clarification, and provides feedback to Customer.

Customer Response

New Database Release – Under Project CM



Requirements Freeze (After official signed customer and NASA requirements documents are finalized, and comment period ends)

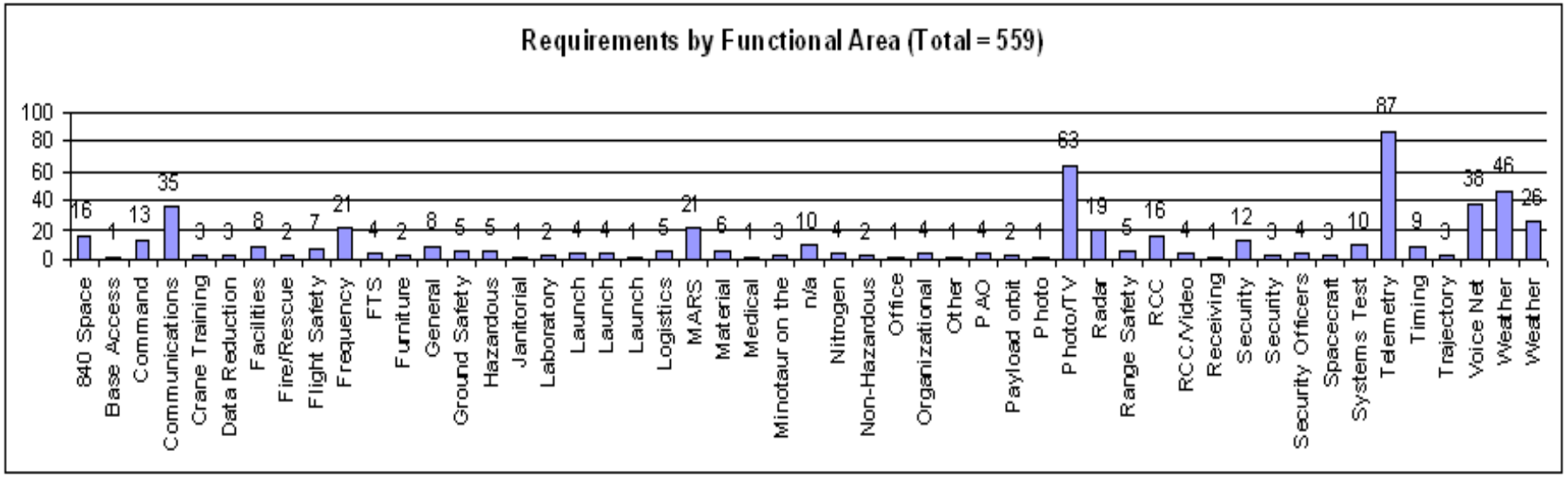
Requirement Functional Areas

- Six major functional areas, with 51 sub-fields:
  - 7 Administrative
  - 18 H&S
  - 7 Comm. & Logistics
  - 5 Ground & Pad Ops.
  - 3 Weather related
  - 11 Launch & Flight

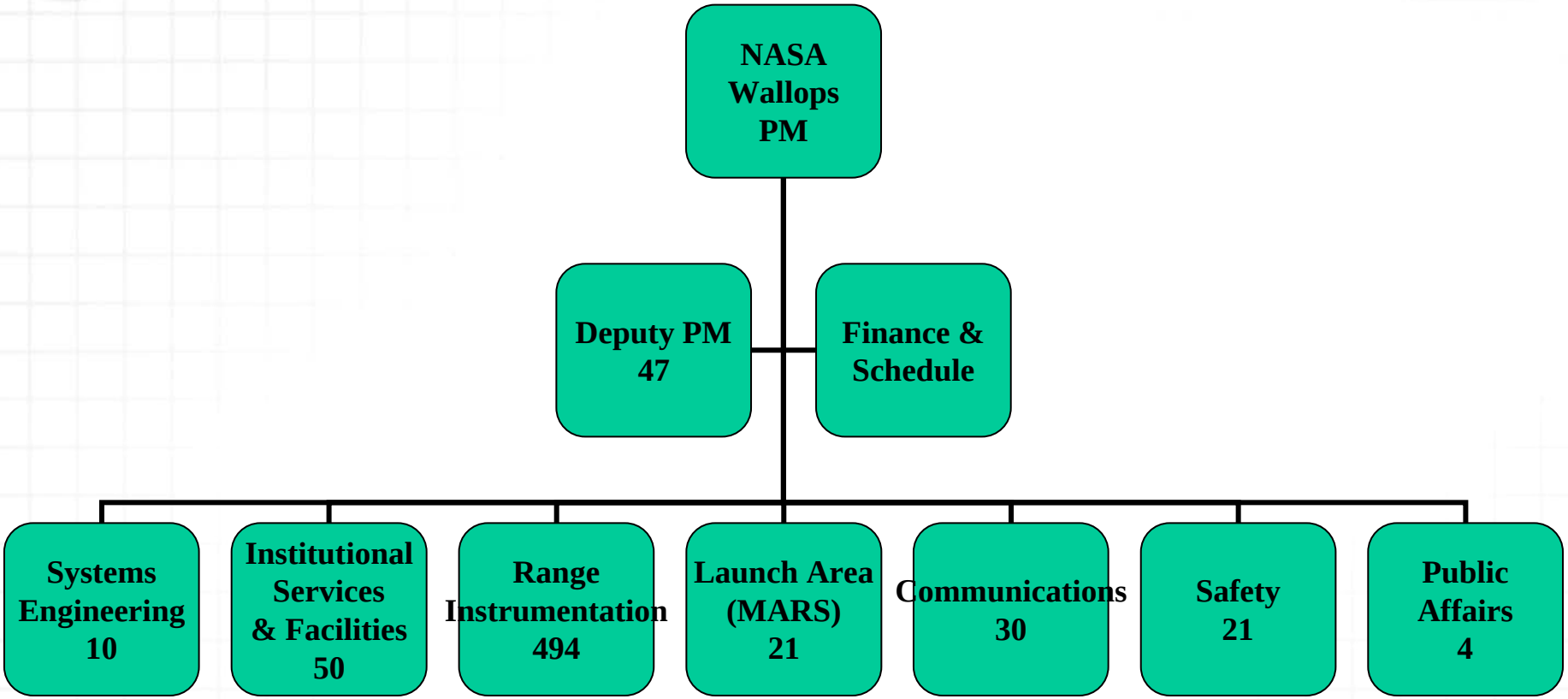
840 Space . Base Access . Furniture . General . Janitorial Services . n/a . Office Equipment .	**1. Administrative**
Command Destruct . Fire/Rescue . Flight Safety . Frequency Coordination . FTS . Ground Safety . Hazardous Waste . Launch Constraints . Material Handling . Medical . Nitrogen . Non-Hazardous Waste . Other . Range Safety . Security . Security Classification . Security Officers . Systems Test .	**2. Mission Health & Safety**
Communications . Data Reduction . Logistics . Organizational Relationships . PAO . Receiving . Voice Net .	**3. Communications & Logistics**
Crane Training . Facilities . Laboratory . MARS . Minotaur on the Pad .	**4. Ground Support & Pad Operations**
Launch .down . Weather . Weather Balloons .	**5. Weather**
Launch . Payload orbit . Photo . Photo/TV . Radar . RCC . RCC/Video . Spacecraft . Telemetry . Timing . Trajectory .	**6. Launch & Flight**

Detailed Requirement Decomposition

- Within the 6 major functional areas, there are a total of 559 sub-field entries. These are under review here.

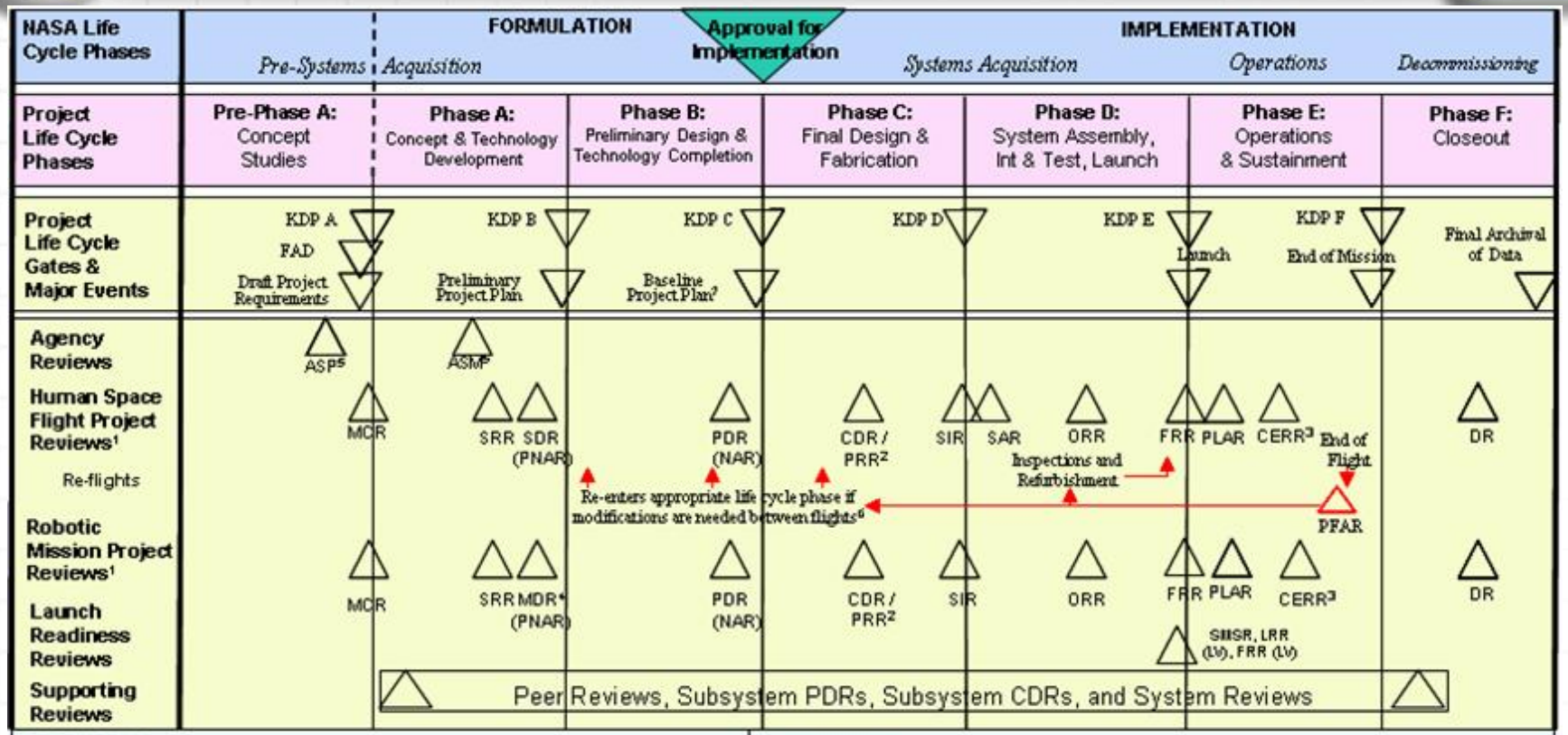


Project Organization



677 Customer Requirements Tracked & Allocated

NASA Project Life Cycle



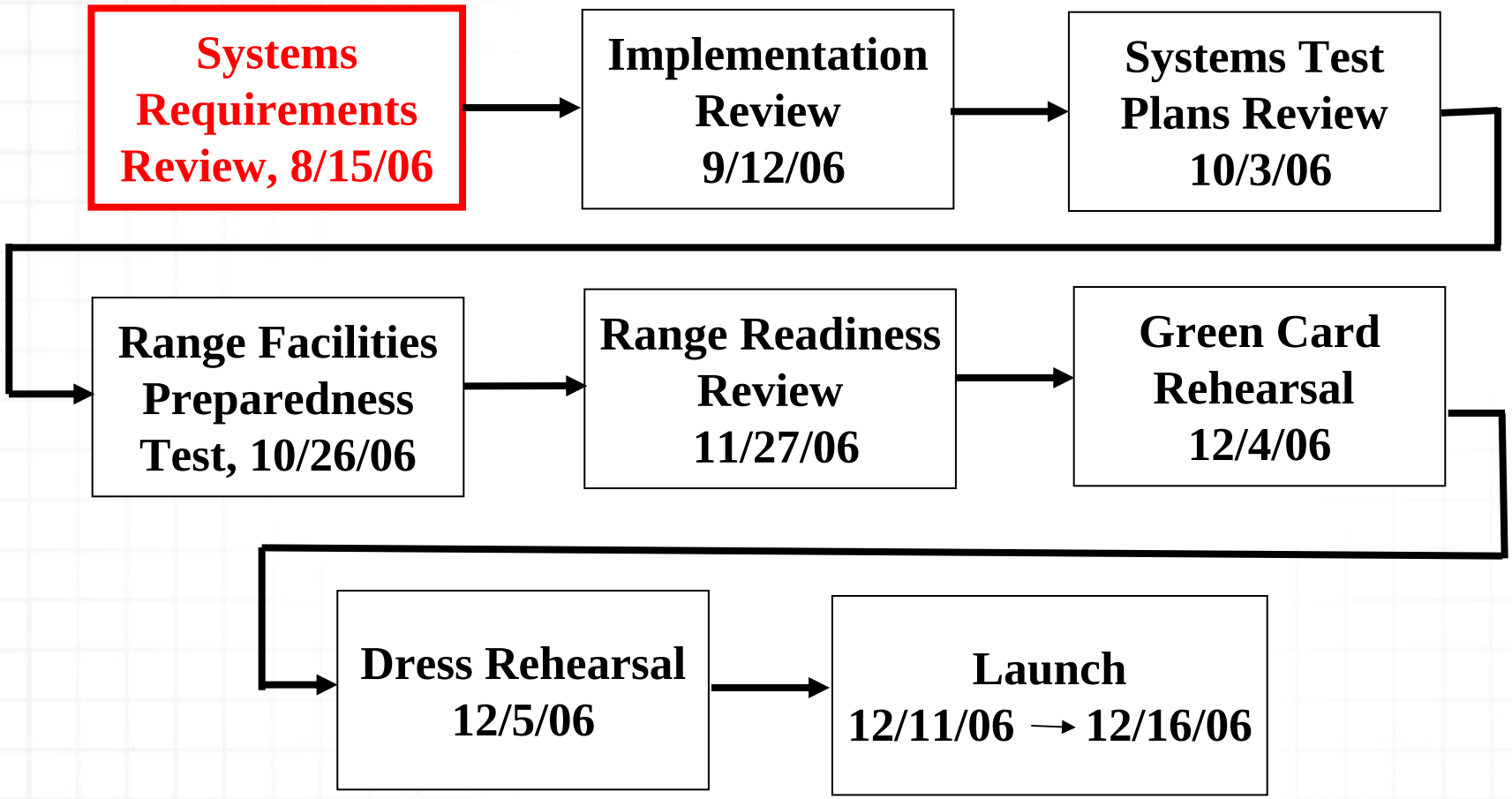
FOOTNOTES

1. Flexibility is allowed in the timing, number, and content of reviews as long as the equivalent information is provided at each KDP and the approach is fully documented in the Project Plan. These reviews are conducted by the project for the independent SRB. See Section 2.5 and Table 2-6.
2. PRR needed for multiple (≥4) system copies. Timing is notional.
3. CERRs are established at the discretion of Program Offices.
4. For robotic missions, the SRR and the MDR may be combined.
5. The ASP and ASM are Agency reviews, not life-cycle reviews.
6. Includes recertification, as required.
7. Project Plans are baselined at KDP C and are reviewed and updated as required, to ensure project content, cost, and budget remain consistent.

ACRONYMS

ASP—Acquisition Strategy Planning Meeting
ASM—Acquisition Strategy Meeting
CDR—Critical Design Review
CERR—Critical Events Readiness Review
DR—Decommissioning Review
FAD—Formulation Authorization Document
FRR—Flight Readiness Review
KDP—Key Decision Point
LRR—Launch Readiness Review
MCR—Mission Concept Review
MDR—Mission Definition Review
NAR—Non-Advocate Review
ORR—Operational Readiness Review
PDR—Preliminary Design Review
PFAR—Post-Flight Assessment Review
PLAR—Post-Launch Assessment Review
PNAR—Preliminary Non-Advocate Review
PRR—Production Readiness Review
SAR—System Acceptance Review
SDR—System Definition Review
SIR—System Integration Review
SMSR—Safety and Mission Success Review
SRR—System Requirements Review

Tailored Project Process



Guidance to SRR Presenters

Highlight “Shalls” that:

- Should be reassigned to others
- Are accepted as within my area of responsibility
- Need clarification
- Contain errors or inconsistencies
- Are missing and need to be added
- Will be difficult to satisfy
- Will be difficult to test compliance
- Have high risk to achieve (schedule, cost, or technical)

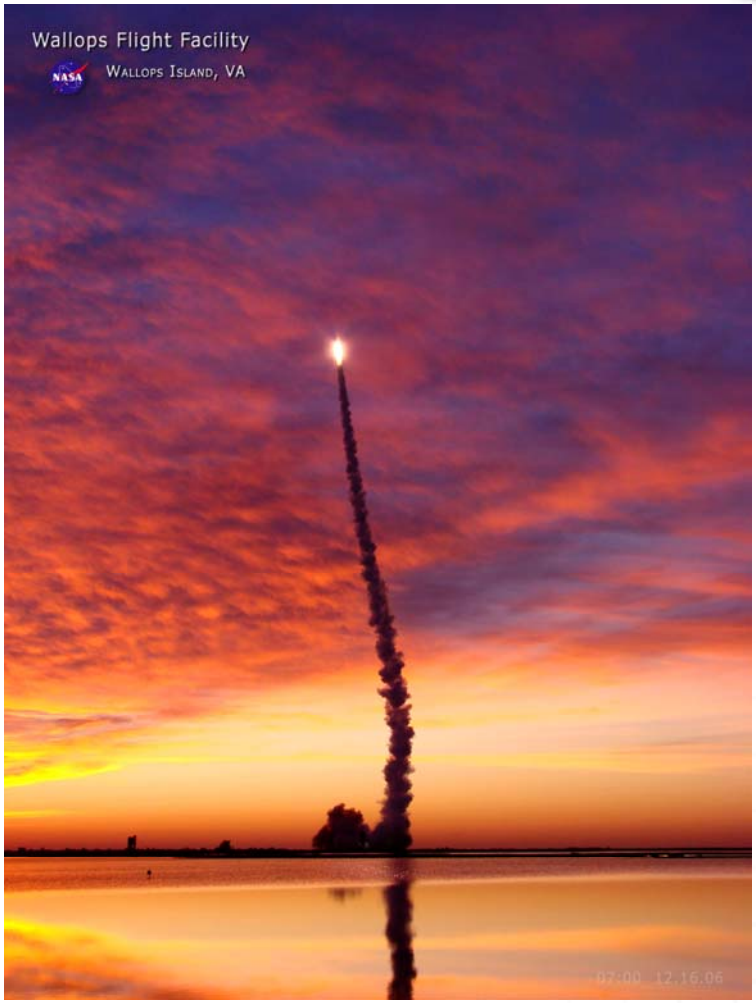
Do not describe intended implementation at the SRR review

Verification Methods (I-A-D-T)

- Inspection
- Analysis
- Demonstration
- Test

Mission Patches

Launch: 12/16/06 0700 Local Time



Launch Video

Video length: 3 minutes & 12 seconds