NASA

SECTION 40

STS-107
Pre-Launch Mission Management Team Review

Approach and General Description

S&MA held reviews in preparation for the STS-107 Flight Readiness Review on 20 December 2002, 7 January and 10 January 2003 and is ready to proceed toward launch countdown.

PMMT Briefing Overview

- **Significant Assessments – *discuss***
- **Following the STS-107 FRR:**
  - **No open NSRS items applicable to STS-107 have been identified.**
  - **No new accepted risk hazards have been identified.**
  - **No new criticality 1 CILs have been identified.**

Significant Assessments

ORBITER

- OV-103 BSTRA Crack

STS-107 Concurrence Statement

S&MA has reviewed the status of preparation for this mission and has performed an independent assessment of the readiness of the Space Shuttle program for the conduct of this mission. We are in concurrence with proceeding with this mission.

/s/ Yolanda Marshall
SR&QA Director, JSC

/s/ Shannon Bartell
Director, KSC Safety, Health and Independent Assessment

/s/ Amanda Goodson
S&MA Director, MSFC

/s/ Bill Higgins
Chief, Shuttle S&MA, KSC

/s/ Mark Erminger
SS SR&QA Manager

/s/ Mike Smiles
S&MA Manager, SSC

Mission Management Team L-1 Day Review
January 15, 2003

Agenda

Introduction	Manager, Launch Integration
Mission Operations	Director, Mission Operations APM, Flight Operations, SFOC
EVA	Manager, EVA Project
Flight Crew	Director, Flight Crew Operations
Space and Life Sciences	Director, Space and Life Sciences
Program Integration	Flight Manager Manager, Space Shuttle Systems Integration Manager, Space Shuttle Customer and Flight Integration Manager, Space Shuttle KSC Integration APM, Program Integration, SFOC
Payload Processing	Director of ISS/Payloads Processing
External Tank	Manager, External Tank Project
RSRM	Manager, Reusable Solid Rocket Motor Project
SRB	Manager, Solid Rocket Booster Project APM, SRB Element, SFOC
SSME	Manager, Space Shuttle Main Engine Project
Vehicle Engineering	Manager, Space Shuttle Vehicle Engineering APM, Orbiter Element, SFOC APM, FCE/EVA, SFOC
Ferry Readiness	Ferry Operations Manager
Shuttle Processing	Director of Shuttle Processing, KSC APM, Ground Operations, SFOC
Range	United States Air Force
DDMS	Commander, DOD, Manned Space Flight Support Office
Launch Weather	45th Weather Squadron
Landing Weather	National Weather Service
SS SR&QA	Manager, Space Shuttle Safety, Reliability & Quality Assurance
Readiness Poll	Manager, Launch Integration

EVA
PROJECT
OFFICE

Strontium Chromate in EMU Investigation Results

STS 107 L-1 Review

G. Allen Flynt
EVA Project Office
Johnson Space Center
1/15/03

EMU Systems Investigation

- **Background**
  - During life extension evaluation of the I-145 Relief Valve on the fleet leader EMU (19 years of age) approximately 0.25 mg of Strontium Chromate ($SrCrO_4$) was identified
  - Strontium Chromate is a carcinogen and poses a possible health risk if in the ventilation loop
  - This valve is connected to the ventilation loop, however is not in the direct flow path to the crewmember.
  - Strontium Chromate exists within the EMU System as a minor component (2%) of BR-127 Primer (MIL-P-23377)
  - BR 127 primer is utilized on the water tank structure and aluminum horn, both of which are exposed to the ventilation loop. The primer is then over-coated with PD George for corrosion prevention.
  - Over time water can leach $SrCrO_4$ out of exposed BR 127

EMU Systems Investigation

- **Findings associated with BR 127 use in the Water Tank**
  - Neoprene water bladders installed on EMUs prior to 1990 allowed water to leach into the water tank structure. Corrosion of the water tank and flaking of coatings was not uncommon
  - A flow path between the water tank and I-145 exists and would explain for the contamination exhibited on the EMU fleet leader (PLSS 1008)
  - Post 1990 installation of Flourel bladders eliminated water access to the water tank structure
  - All EMU water tanks are inspected every 2 years to ensure no exposure of BR 127
  - The migration of contamination into the ventilation loop is not considered possible
    - The I-145 Relief Valve is no longer functional during EVA operations and is not a functional part of the ventilation loop

EMU Systems Investigation

- **Findings associated with BR 127 use in the Aluminum Horn**
  - The Aluminum Horn is not considered to be a contamination source
    - This item is inspected every 2 years
    - No failure history associated with loss of coatings and exposure of BR 127

- **EMU Systems Conclusion**
  - Introduction of $SrCrO_4$ into the EMU ventilation loop during EVA is considered improbable

Toxicology Investigation of $SrCrO_4$

- **Toxicology Findings**
  - Strontium Chromate is a carcinogen and long term exposure above the industry standards is considered to increase the risk of cancer
  - Current industry standards for acceptable long term daily exposure to $SrCrO_4$ range from 0.002 mg/m^3 to 0.2 mg/m^3
  - JSC Toxicology has determined that in the improbable event that the 0.25 mg of $SrCrO_4$ found in the EMU fleet leader were released into the ventilation loop for the duration of a single EVA the crewmember would be exposed to the equivalent of 1 hour to 12 days of the daily limit for repeated long term career exposure

- **Toxicology Conclusion**
  - JSC toxicology has determined this type of exposure to be a minimal risk to crew health and does not represent an appreciable increase in risk in performing EVA operations

VEHICLE ENGINEERING

	Presenter:
	Organization/Date: Orbiter 01/15/03

ORBITER	To Be Presented
GFE	No Constraints
SOFTWARE	No Constraints
FCE	No Constraints
FLIGHT READINESS STATEMENT	To Be Presented
BACKUP	

STS-107
L-1 DAY REVIEW

January 15, 2003

ORBITER

AGENDA

Presenter: Doug White

Organization/Date: Orbiter 01/15/03

Waivers and Exceptions — **No Constraints**

Special Topics — **To Be Presented**

- **FRR CoFR Exception Resolution – BSTRA Ball Cracks**

	Presenter:
	Organization/Date: Orbiter 01/15/03

SPECIAL TOPICS

SPECIAL TOPICS FOR THE STS-107 L-1 DAY REVIEW

Presenter: Doug White

Organization/Date: Orbiter 01/15/03

Topic	Presenter
• BSTRA Ball Cracks	David Rigby

BSTRA Ball -
Assessment of Crack Offset/Step

Jan 14, 2003

M. Dunham

Background

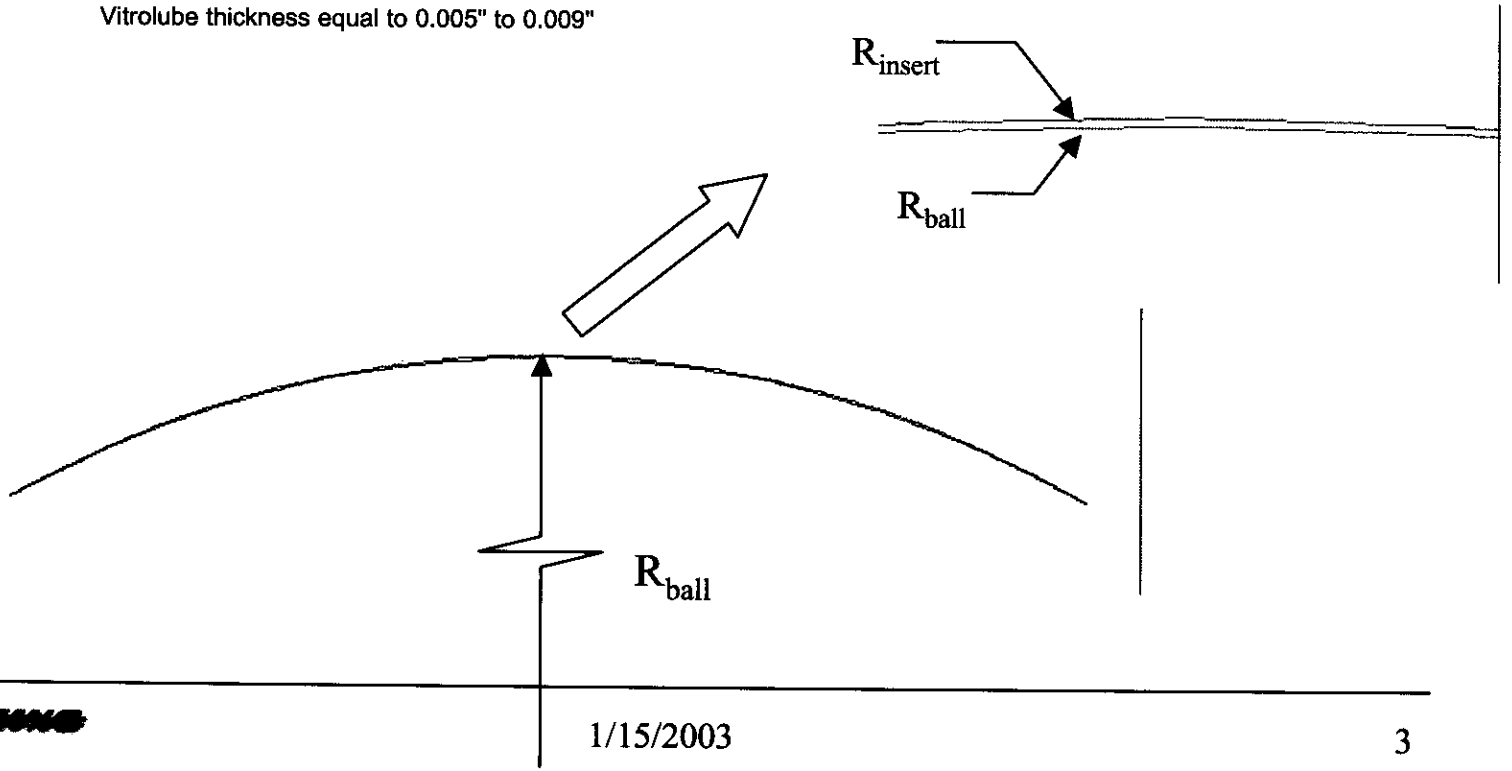
- Traction test was run on 2.24" severely cracked ball (HB#2a) with 0.450mil "step" with no increase in friction compared to uncracked ball
  - Within the original criteria of 0.500mil
- Subsequently, a 1.75" severely cracked ball was identified as having 0.970mil step
  - Ball cannot be tested as it was destructively sectioned
- BSTRA ball and insert (aka cup) are both treated with a baked-on coating of Vitrolube for lubrication
  - Each side has 0.5 to 0.9mil of Vitrolube
- Ball and insert have closely matched diameters with gap almost completely filled with Vitrolube
  - Edge of cup has a minimum of 10mil radius
- BSTRA team looked at range of expected step values
  - Increasing criteria from .5mil to 2mil considered sufficient to cover maximum step

Ball/Insert Dimensioning Provides Very Tight Fit

System	Line Type	Ball Diameter	Insert Diameter	Max Gap w/o Vitrolube	Min Gap w/o Vitrolube	Max Gap w/ Vitrolube	Min Gap w/ Vitrolube
LOX	I	2.2400 2.2398	2.2435 2.2432	0.0037	0.0032	0.0017	-0.0004
	II, III, IV	1.7500 1.7498	1.7535 1.7532	0.0037	0.0032	0.0017	-0.0004
LH2	I, II, III, IV	1.2500 1.2498	1.2535 1.2532	0.0037	0.0032	0.0017	-0.0004

Note

Vitrolube thickness equal to 0.005" to 0.009"



Kinematics of BSTRA Joint

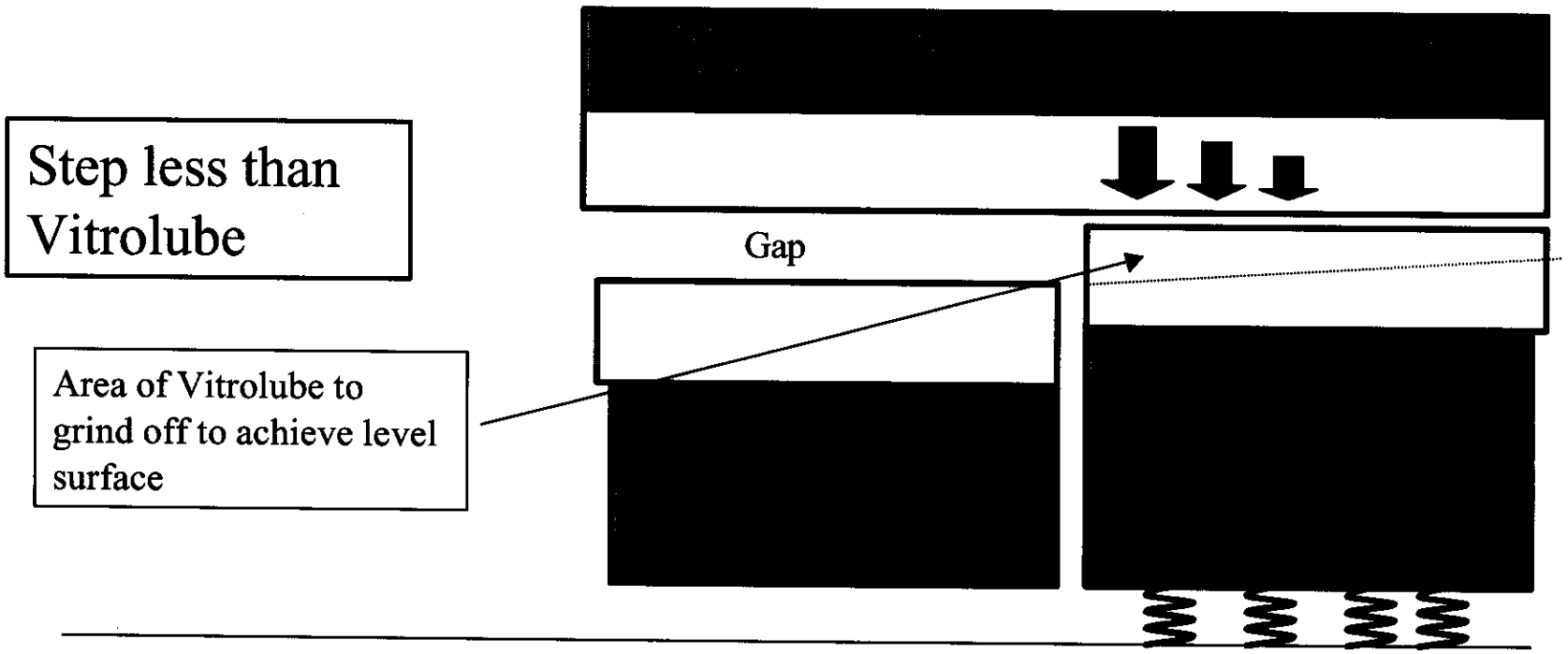
- Rotation of joint can be achieved by sliding on either cup side
  - Slip will occur normally on side with lower friction
  - Increasing friction on one surface only will not interfere with function
- Angulation of joint occurs only along "longitude" lines
  - Torsional motion is restrained by bellows
  - Cracks (with steps) that are aligned with longitude will provide minimal erosion or friction
- Crack step must be oriented UNDER the cup to affect friction
- Or, step must bear against edge of cup
  - Minimum edge radius should prevent step in open "equator" from hanging up cup

Crack Considerations

- Maximum offset or step height is expected away from crack tips – not a constant height
  - Between tips, especially near initiation point, is where crack is deepest, widest
  - Tips have continuity of material just beyond tip to minimize step
- Test crack steps are considered reasonable upper bound
  - Severe, deep cracking performed outside of cups
    - Cups produce smaller, shallower cracks and provide constraint against excessive step height
- Compressive forces normally found between tight fit cup and ball will be concentrated on higher side of step at a discontinuity
  - Elastic deformation will tend to close the crack and move toward smooth surface

"Step"/Vitrolube Interaction

- **Original criteria was simple (and conservative) as it allowed reduction of Vitrolube to achieve leveling of step without exposing bare ball to Vitrolube on the cup side (creating friction)**
- **Two ways available to close step**
  - **Force between cup and ball elastically deform ball**
  - **Same forces can grind some of vitrolube on high side of step**



Material Considerations

- **FOD Liberation**
  - Reason we are seeing fines at the crack face may be due to this offset.
  - Mechanism for FOD generation does not change
- **Material properties of Vitrolube**
  - Glass material applied at high temperature
    - Cracks with the ball
  - May grind off in very small pieces (no flaking), does not flow like plastic
  - Traction test of 0.45 mil step produced burnishing of Vitrolube only
- GALLING / WEAR: IF, surfaces wear through Vitrolube... Stoody #2 is designed for high wear and galling resistance.
  - Ball with 970 micro-inch offset was tested through 50 cycles at nominal load (without Vitrolube)... with cracks located randomly under cups. Inspection of the cups/ball did not show galling/chafing.

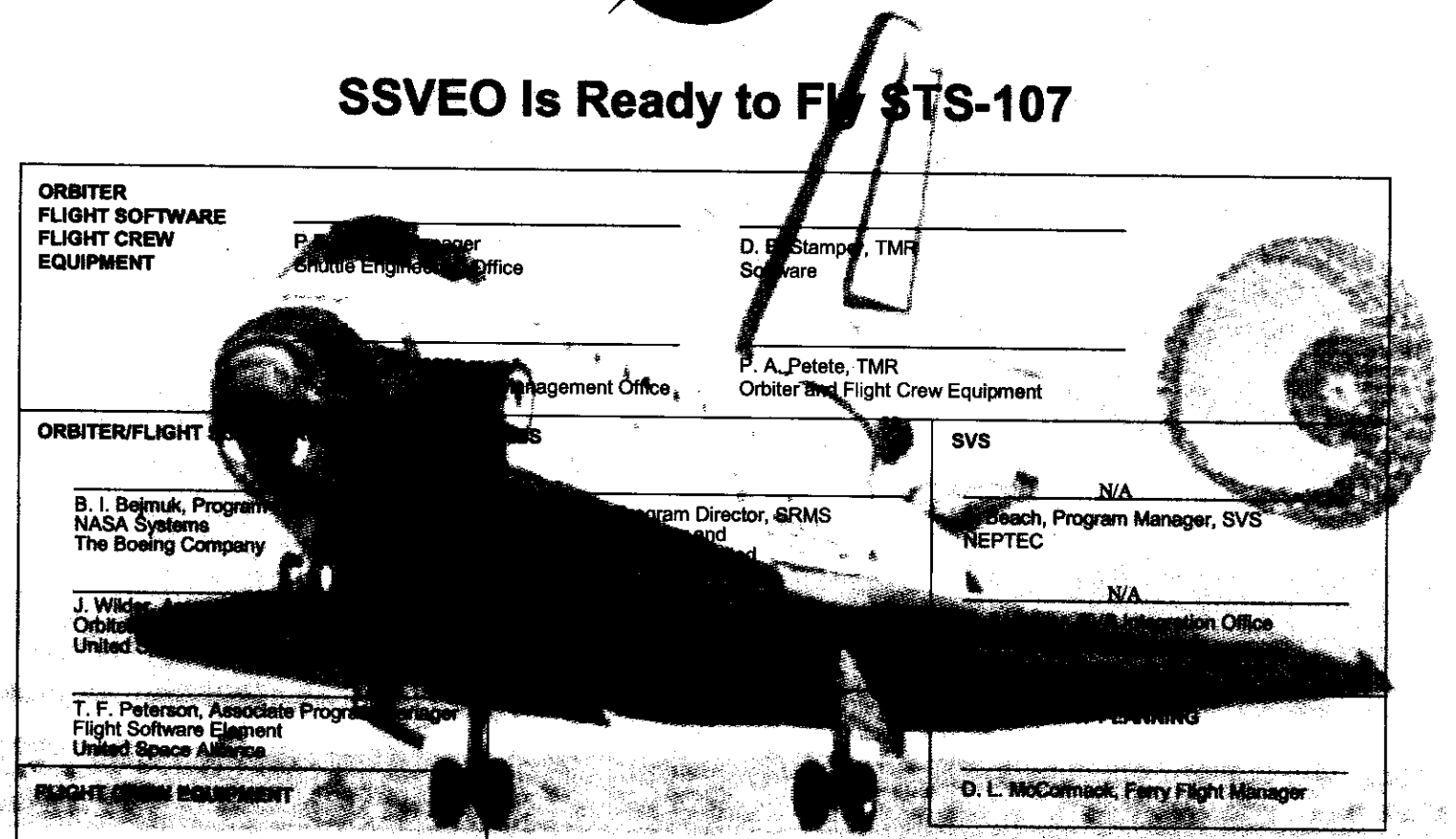
Allowable Step Criteria Increased to 2 Mil

- Elastic deformation of ball surface will provide for more than 1 mil of step
- Erosion of Vitrolube on both ball and cup is required prior to contact between Inconel cup and Stoody ball
  - Min of 1 mil (0.5 each side) to max of 1.8 mil (0.9 each)
    - Friction during erosion expected to be small
  - Stoody material selected to prevent galling
- Criteria of 2 mils selected as reasonable
  - Covers upper bound data of 0.97 mil from testing
  - Reasonable, conservative estimate in absence of hard test data

	Presenter:
	Organization/Date: Orbiter 01/15/03

FLIGHT READINESS STATEMENT

SSVEO Is Ready to Fly STS-107



ORBITER
FLIGHT SOFTWARE
FLIGHT CREW
EQUIPMENT

D. B. Stamper, TMR
Software

P. A. Petete, TMR
Orbiter and Flight Crew Equipment

ORBITER/FLIGHT

B. I. Bejmuk, Program
NASA Systems
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J. Wilder
Orbit
United

T. F. Peterson, Associate Prog
Flight Software Element
United Space Alliance

FLIGHT CREW EQUIPMENT

J. F. Buchli, FCE/EVA Associate
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United Space Alliance

SVS

N/A
Beach, Program Manager, SVS
NEPTEC

N/A

D. L. McCormack, Ferry Flight Manager

Ralph R. Roe, Manager
Space Shuttle Vehicle Engineering