[*The review I requested on March 30, 1984, was never held. I made the decision to leave NASA sometime in May [1984] and Jim Beggs (correctly) took me out of the decision loop. What happened afterwards is described on the next few pages. My intention in calling for the review was to stop flying and to fix the O-ring problem. As you can see, the review was held on August 19, 1985, and in spite of the problems, they kept flying.* Hans Mark.]

STS 41-C PROGRAMMATIC ACTION ITEM

(OUTSIDE THE FLIGHT READINESS REVIEW)

NUMBER:	3-30-4-2
INITIATOR:	DR. MARK
ACTION:	PERFORM A FORMAL REVIEW OF SRM CASE-TO-CASE AND CASE-TO-NOZZLE- JOINT SEALING PROCEDURES TO ENSURE SATISFACTORY CONSISTENT CLOSEOUTS.
ACTIONEE:	MSFC/L. MULLOY
DUE DATE:	MAY 30, 1984
CLOSEOUT:	

SUBMITTED: ----------

CONCURRENCE: ----------

CONCURRENCE: ----------
Glynn S. Lunney
Manager, NSTS Program

APPROVED: ----------
J. A. Abrahamson
Associate Administrator
for Space Flight
LMW 5 Apr 84

[*These charts show the final "Close Out" of the "Action Item" about the review of the seals and joints on the Solid Rocket Motors (SRM) of the Space Shuttle. The review was held on August 19, 1985, fourteen months after the due date that I had specified. Between May 30, 1984, and August 19, 1985, eight Space Shuttle missions were flown and four of these showed significant O-Ring damage. The recommendation to fly is highly qualified and the requirement that joints are "free of contamination" is impossible to verify after the assembly of the seals and joints. Another copy of my original "Action Item" is attached. These pages come from Appendix H of the Rogers Commission Report.* Hans Mark.]

Chart 189

STS 41-C L-1 ACTION ITEM

NUMBER: 3-30-4-2

INITIATOR:

ACTION: PERFORM A FORMAL REVIEW OF SRM CASE-TO-CASE AND CASE-TO-NOZZLE JOINT SEALING PROCEDURES TO ENSURE SATISFACTORY AND CONSISTENT CLOSEOUTS

ACTIONEE: L. HULLOY/MSFC

DUE DATE: MAY 30, 1984

CLOSEOUT:

MSFC PERFORMED A REVIEW OF SRM CASE-TO-CASE AND CASE-TO-NOZZLE JOINT SEALING PROCEDURES AS DIRECTED BY LEVEL I ACTION 3-30-4-2. AN SRM REVIEW IN PROCESS HAS EXPANDED AND FORMALIZED WITH A DETAIL PLAN OF ACTION, THR-14359, DATED MAY 4, 1984. THE PLAN AND REVIEW WERE DEVELOPED AND IMPLEMENTED IN CONJUCTION WITH MSFC SCIENCE AND ENGINEERING PERSONNEL. THE RESULTS OF THE REVIEW WERE REVIEWED PERIODICALLY WITH NASA-HQ PERSONNEL AND A DETAIL REVIEW HAS PRESENTED TO THE DEPUTY ASSOCIATE ADMINISTRATOR ON AUGUST 19, 1985.

SUBMITTED: _____
L. HULLOY
Manager, SOLID ROCKET BOOSTER PROJECT

CONCURRENCE: _____
S. R. REINARTZ
Manager, Shuttle Projects Office

CONCURRENCE: _____
Arnold D. Aldrich
Manager, National Space Transportation System

APPROVED: _____
Jesse H. Moore
Associate Administrator for Space Flight

Report of the PRESIDENTIAL COMMISSION on the Space Shuttle Challenger Accident, Volume 2: Appendix H [Chart 189] - Flight Readiness Review Treatment of O-ring Problems, http://history.nasa.gov/rogersrep/v2apph.htm

Chart 187

General Conclusions

- All O-ring erosion has occurred where gas paths in the vacuum putty are formed
- Gas paths in the vacuum putty can occur during assembly, leak check, or during motor pressurization
- Improved filler materials or layup configurations which still allow a valid leak check of the primary O-rings may reduce frequency of O-ring erosion but will probably not eliminate it or reduce the severity of erosion
- Elimination of vacuum putty in a tighter joint area will eliminate O-ring erosion if circumferential flow is not present - if it is present, some baffle arrangement may be required
- Erosion in the nozzle joint is more severe due to eccentricity; however, the secondary seal in the nozzle will seal and will not erode through
- The primary O-ring in the field joint should not erode through but if it leaks due to erosion or lack of sealing the secondary seal may not seal the motor
- The igniter Gask-O-Seal design is adequate providing proper quality inspections are made to eliminate overfill conditions

Report of the PRESIDENTIAL COMMISSION on the Space Shuttle Challenger Accident, Volume 2: Appendix H, [Charts 187-188] - Flight Readiness Review Treatment of O-ring Problems, http://history.nasa.gov/rogersrep/v2apph.htm

Chart 188

Recommendations

- The lack of a good secondary seal in the field joint is most critical and ways to reduce joint rotation should be incorporated as soon as possible to reduce criticality
- The flow conditions in the joint areas during ignition and motor operation need to be established through cold flow modeling to eliminate O-ring erosion
- QM-5 static test should be used to qualify a second source of the only flight certified joint filler material (asbestos-filled vacuum putty) to protect the flight program schedule
- VLS-1 should use the only flight certified joint filler material (Randolph asbestos-filled vacuum putty) in all joints
- Additional hot and cold subscale tests need to be conducted to improve analytical modeling of O-ring erosion problem and for establishing margins of safety for eroded O-rings
- Analysis of existing data indicates that it is safe to continue flying existing design as long as all joints are leak checked with a 200 psig stabilization pressure, are free of contamination in the seal areas and meet O-ring squeeze requirements
- Efforts needs to continue at an accelerated pace to eliminate SRM seal erosion

Report of the PRESIDENTIAL COMMISSION on the Space Shuttle Challenger Accident, Volume 2: Appendix H, [Charts 187 & 188] - Flight Readiness Review Treatment of O-ring Problems, http://history.nasa.gov/rogersrep/v2apph.htm