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# LP01 Hydraulic Fluid Contamination

OCCB - SR2820A 4-28  
PRCB - SR2820 4-28

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## Hydraulic Fluid Contaminated TPS

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### Issue

- Hydraulic Fluid MIL-H-83282 contaminated 18 FIB, 70+ tile, and 8 thruster thermal barriers
  - QD on TSM during hydraulic operation leaked into scupper then onto platform
    - High winds then swept fluid to Orbiter
    - Quantity unknown
    - 450 – 500 F ignition point – auto ignition slightly above 700 F
- IPR 114V-0321 and Flash Report 006401 were initiated
  - TPS PR # TLP01-34-2492 initiated from IPR

### Objective

- Determine remaining contamination quantity and potential effect on TPS components
- Provide recommendation for hardware acceptance
- Provide awareness to management that potential exists for a visible event to occur during ascent



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## Actions Taken – Tile and Thermal Barriers

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- Tile and thermal barriers wiped off with IPA dampened wipers
- Visually inspected all tile post clean up effort - CTD
  - Trace residue left on damages and on hairline coating cracks
  - No evidence of fluid remaining in tile gaps or on filler bar
    - Bottom of accessible gaps evaluated – no residue noted
    - Tiles acceptable per MLO601-0002 specification
  - G/F's have trace amounts on OML
- ✓ PRT has no issues with residual contamination on tile and gap filler OML surfaces
  - No evidence of hydraulic fluid contamination to SIP
  - Extremely small amounts of residual on gapfillers
  - No strength reduction of RTV if contaminated with hydraulic fluid
- Visually inspected the 8 thruster thermal barriers post clean up - CTD
  - No evidence of any contamination on fabric or RTV coated OML
- ✓ PRT has no issue with trace amounts left on RTV surfaces



## Actions Taken - FIB

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- Wiped excess fluid off FIB OML - Hydraulic Fluid remained in FIB outer cover fabric and C9 Coating
  - Needed to quantify remaining contamination amount on vehicle to correlate to testing being performed
    - Worst case FIB was cut open – no depth associated with penetration - batting was clean
    - Four (4) samples approximately 3 – 4 square inches removed from contaminated blanket OML's
    - Weighed and heat cleaned the samples to determine fluid content
  - 0.07 grams/inch\*2 worst case
  - 0.01 gram/inch\*2 best case when C9 coating was removed prior to HC
- Replacement FIB fabrication started at the TPSF concurrently with evaluation - (SLF satellite facility)
  - All 18 FIB are at the pad awaiting first prefit – if required
- Preliminary schedules and risk assessment developed in the event removal is required



## Radiant FIB Test - HB

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- FIB testing initiated at Huntington Beach radiant facility
  - Determine combustion potential
  - Quantify additional heating effect
- FIB test articles of same class as vehicle were tested up to 1200F for 120 seconds to match heating profile on ascent
  - 1200 F is combined radiant and convective ascent heat load
  - 120 seconds correlates to inadequate oxygen to support ignition
  - Test limitations were air flow rate, pressure, oxygen content, 0.05" thick graphite sheet utilized (STR is .019" face sheet with H/C core)
    - Aeothermal/thermal assessment of actual STR vs. test – I/W
- Results
  - 0.3 gram/inch\*2 had an increase in backface temperature of 111 F
    - Heating raised STR temp close to 250 F – cert limit for graphite epoxy
    - Article caught fire
  - 0.1 gram/inch\*2 had an increase in backface temperature of 70 F
    - Heating effect raised STR temp close to 212 F – below 250 F
    - Article smoked but no fire was visible



## Actions Taken - FIB

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- FIB absorptance and emittance properties were also measured on vehicle and on test specimens
  - Absorptance increased
  - Emittance mostly unaffected
- TCS group ran parametric study to assess potential impacts
  - Utilized bounding cases
    - Alpha – 100
    - E - .6
  - No issues were identified
- Additional Test readiness is I/W
  - 6 FIB will be shipped to Marshall early next week – TBD on actual test date
  - 4 Production Units shipped/being shipped to HB for additional radiant tests if required – TPSF
- Coating adherence test initiated on contaminated FIB with C9 removed – ECD 4/28 end of 2<sup>nd</sup> shift



## FIB Process Checks – OPO Tag-up

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- Quality process checks are required on the following steps for FIB installation:
  - Surface Prep
  - Air Dry
  - Dew Point Check
  - Primer Application
  - Vacuum Set-up – equipment functioning, bag set-up, no leak paths
  - RTV application – thickness/potlife/mixing
  - Pressure application
  - Pressure removal
  - Peel Test Coupon
- QA coverage is also on final step and gap and gap filler installations if required
- Salt spray after surface prep is an unknown prior to primer application



## FIB Replacement Risks/Concerns

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- Potential for debonds/subnominal bonds due to:
  - Out of station bonding
    - Limited pot life/cure times
    - Surface preparation contamination due to hydraulic fluid or other environmental contaminants
    - Potential for unstable pressure application
  - Difficult access
    - Vacuum bonding preferred.
    - Tooling required for 'closeout' bond. Difficult set up.
    - Limited area for movement: 2 – 3 feet distance from blanket OML to TSM.
    - Fall protection currently required on the platforms
      - Further limits movement
      - Working with high crew to establish sufficient access to delete this requirement
- Schedule risks: RTV Cure in uncontrolled environment
  - Extended cure could increase schedule risk
  - Short potlife could limit number of bonds per mix, increasing schedule risk.



## Summary/Recommendation

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### Summary

- Tests performed indicate sensitivity of temperature increase to amount of fluid absorbed
  - 0.1 g/inch\*2 test bounded worst contamination 0.07g/inch\*2 on vehicle
  - Approximate 212 resultant STR temp – below 250 F STR limit

### Team Recommendation

- Accept Tile, Thermal Barriers, and G/F's
- Accept FIB condition pending resolution of
  - Aerothermal/thermal validation of .05" thick graphite panel vs. structure configuration



## Options

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- Accept FIB with tests performed
  - Visible event likely during ascent
- Accept FIB with tests performed but remove coating
  - Need to assess coating test results
  - Provides additional margin
  - Visible event likely during ascent
- Perform additional Testing at Marshall - Accept pending results
  - Visible event likely during ascent
- Remove 5-7 worst case blankets
  - Acceptance rationale provided for FIB based on tests this week
  - Reduced likelihood of visible event during ascent
  - Schedule/Installation risk
- Remove all 18 blankets – Schedule/Installation Risk

