SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Turbine Assembly

PART NO.: 734563
752370(Alt.)

FM CODE: A03

ITEM CODE: 20-01-21

CN 038

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Seconds

NO. REQUIRED: 2

DATE: March 31, 2000

CN 038

CRITICAL PHASES:Final Countdown, Boost

SUPERCEDES: March 31, 1997

CN 038

FMEA PAGE NO.: A-64

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SHEET 1 OF 5

APPROVED: S. Parvathaneni

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FAILURE MODE AND CAUSES: Fracture of APU turbine wheel and/or shaft caused by:

- o Material defects
- o Manufacturing defects
- o Turbine blade failure
- o Contaminated lube oil/Loss of lubrication
- o Turbine wheel unbalance
- o Impact from particles
- o Turbine overspeed

FAILURE EFFECT SUMMARY: Fire and explosion will result in loss of mission, vehicle and crew.

REDUNDANCY SCREENS AND MEASUREMENTS: N/A

RATIONALE FOR RETENTION:

A. DESIGN

- o The Turbine Assembly is designed and qualified in accordance with end item specification 10SPC-0050. (All failure causes)

- o Turbine wheel is designed to sustain speeds up to 108,000 RPM (one hundred fifty percent) without rupture. Maximum specification operation is 86,400 RPM (one hundred twenty percent). (Turbine Blade Failure, Turbine Wheel Unbalance)

- o Turbine shaft has designed safety factors of 1.1 for yield and 1.5 for ultimate. (All Failure Causes)

- Shaft material per AMS 5712. (Material Defects)

- Materials are selected per MSFC-SPEC-522A. (Material Defects)

- Turbine wheel material is solution heat treated and precipitation hardened Rene' 41 with 170 KSI ultimate tensile strength. (Material Defects, Turbine Blade Failure, Impact from Particles)

- All new and reused turbine wheels are mapped for blade cracks by Sundstrand and accepted per CP16.25-02. The inspection interval is 16 hot starts maximum. Turbine wheel is to be scrapped if any crack 0.088" or longer is detected in the tip or root of any blade. New production turbine wheels (no run time) shall be rejected if any blade contains a crack. Turbine wheel shall be rejected for bent blades, or cracks detected on the shaft, disk, rim or shroud. (Turbine Blades Failure)

- Balance assembly is dynamically balanced to .001 in-oz. (Turbine Wheel Unbalanced)

- Turbine blade tip stresses reduced with 45 blade tips. (Turbine Blades Failure)

- Turbine design provides for GN2 spin capability for operational checks and tests without having to hot fire the APU. (All Failure Causes)

- Qualification testing verified design requirements as reported in Sundstrand Qualification Test report AER-1539-6 Rev. B. (All Failure Causes)

- APU surfaces exposed to lube oil are cleaned to level 300 of MA0110-301. (Contaminated Lube Oil/Loss of Lubrication)

- Oil injectors are provided to direct a lube oil spray on the bearings. The lube oil is filtered, which will prevent the oil injectors from failing due to contamination. (Contaminated Lube Oil/Loss of Lubrication)

- Fluid procurement is controlled per SE-S-0073. (Contaminated Lube Oil/Loss of Lubrication)

- Intentional overspeed test was performed with notched turbine wheels. Failure of wheel occurred at 138.5 percent (99,700 RPM) and 117 percent (84,240 RPM). Turbine wheels notched (flawed) in three areas. (All Failure Causes)

B. TESTING

- Acceptance testing is performed per Sundstrand ATP TS 2409 on all new flight units. This includes GN2 spin and hotfire functional tests with start time and horsepower requirements which are checked and verified and gearbox lube oil is checked for contamination. (All Failure Causes)

- During refurbishment and prior to reuse, the turbine assembly is inspected and subjected to the same ATP, TS2409, as new units. (All Failure Causes)

- o GN2 (influent) cleanliness and composition (purity and particulate count) are verified per 10REQ-0021, para.2.3.2.2. (Contaminated Lube Oil/Loss of Lubrication)

- o Lube oil (influent) is verified for cleanliness and composition (purity and particulate count) per 10REQ-0021, para. 2.3.2.3. (Contaminated Lube Oil/Loss of lubrication)

- o Functional test is performed during hotfire operations per 10REQ-0021 which includes: (All Failure Causes)

  - Low speed GN2 spin, para. 2.3.11
  - High speed GN2 spin, para. 2.3.15
  - Hotfire, para. 2.3.16

- o Gearbox lube oil post hotfire composition verification is performed per 10REQ-0021, para. 2.3.16.5.e.1 (Contaminated Lube Oil/Loss of Lubrication)

C. INSPECTION

VENDOR RELATED INSPECTIONS

- o Source Inspection Plan verifies proper manufacturing and assembly per SIP 1408 and SIP 1128 by USA SRBE PQAR. (All failure causes)

- o Verification of material certification per SIP 1408 by USA SRBE PQAR. (Material Defect)

- o Verification of turbine wheel penetrant inspection per SIP 1408 for new wheels and per SIP 1128 for reused wheels by USA SRBE PQAR. (Manufacturing Defect)

- o Verification of shaft sleeve assembly and final machining penetrant inspection per SIP 1408 by USA SRBE PQAR. (Manufacturing Defect)

- o Verification of weld x-rays per SIP 1408 by USA SRBE PQAR. (Manufacturing Defect)

- o Balance assembly is checked for dynamic drag and freedom from localized roughness per Sundstrand drawing 734564 by vendor and verified by USA SRBE-PQAR per SIP 1128. (Turbine WheelUnbalance)

- o Balance assembly seals are checked for zero leakage at 25 psig before and after balancing per Sundstrand drawing 734564 by vendor and verified by USA SRBE-PQAR per SIP 1128. (MaterialDefects and Manufacturing Defects)

- o Verification of turbine wheel mapping per CP16.25-02. (Turbine Blades Failure)
- o Verification of shaft and O-ring installation per SIP 1128 by USA SRBE PQAR. (Turbine Wheel Unbalance)
- o Witnessing of final acceptance test per SIP 1128 by USA SRBE PQAR. (All Failure Causes)
- o Vendor inspection and test records are verified per SIP 1128 and SIP 1408 by USA SRBE PQAR. (All Failure Causes)
- o Verifications that are required on new units are performed on the refurbished units per SIP 1128 by USA SRBE PQAR. (All Failure Causes)
- o Critical processes/Inspections:

	Procedure
- Welding	CP 05.15-02, CP05.17-01 (EBW)
- Penetrant	CP16.03-01, CP16.04-01
- Ultrasonic	Inspection CP16.06-03-01
- Heat treat	MIL-H-6875
- Precipitation harden	MIL-H-6875

KSC RELATED INSPECTIONS

- o GN2 (influent) cleanliness and composition (purity and particulate count) are verified per 10REQ-0021, para. 2.3.2.2. (Contaminated Lube Oil/Loss of Lubrication)
- o Verification of lube oil (influent) cleanliness and composition (purity and particulate count) per 10REQ-0021, para. 2.3.2.3. (Contaminated Lube Oil/Loss ofLubrication)
- o Proper function of TVC system is demonstrated during hotfire operations per 10REQ-0021 to include: (All Failure Causes)
  - Low speed GN2 spin, para. 2.3.11
  - High speed GN2 spin, para. 2.3.15
  - Hotfire Sequence, para. 2.3.16
- o Verification of post hotfire gearbox lube oil composition per 10REQ-0021, para. 2.3.16.5.e.1 (Contaminated Lube Oil/Loss of Lubrication)

D. FAILURE HISTORY

- o Failure Histories may be obtained from the PRACA database.

E. OPERATIONAL USE

- o Not applicable to this failure mode.