NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
		490FM01		
BATTERY, ITEM 490 --- SV767789-12 (1) OR BATTERY, ITEM 490 --- SV819600-01 (1)	2/1R	Shorted to ground. Failure, electrical short of the battery elements. (wires, terminals, plates).	END ITEM: If EVA, increase in battery current consumption, internally dissipated. Loss of EMU power from the battery. Possible overdischarge of battery and generation of hydrogen gas and/or electrolyte sublimates to space. If preEVA or postEVA, hydrogen released and/or electrolyte spillage. GFE INTERFACE: Loss of EMU power to the Fan/Pump/Separator (123) results in: Loss of cooling capability, helmet fogging, and loss of CO2 removal capability. Possible ignition of hydrogen gas if ignition source is present. MISSION: Terminate EVA. Loss of use of one EMU.	A. Design - P/N SV767789-12 The cells of the battery have relief valves which will vent to prevent dangerous build up of hydrogen gas during high rate of discharge. Absorbent sponge pads are installed in each relief valve (two in series, set at 16-40 psig) and wicks are installed over the relief valves which will absorb leaked electrolyte. The cell stalks are potted to prevent internal battery shorting. The potted case prevents a shunt path of debris or contamination across the cell stack terminals. The cell stack separators provide isolation between plates. No single detectable credible failure or series of undetected credible failures will lead to the discharge of more than 150 scc of hydrogen concentration within the airlock, which would maintain the Hydrogen concentration below the lower explosion limit. P/N SV819600-00 The Enhanced Battery consists of 11 cells of polysulfone bonded together with EA 9360. The cells are two pieces: a five-sided polysulfone box and a glass-filled polysulfone top ultrasonically welded together. AMS 5643 or AMS 5604 steel reinforcing plates are bonded onto each end. The cells are installed in a battery case made of 6061 aluminum, and potted on five sides and the buss bar surface. Each cell has a single stage relief valve set to relieve at 32 -40 pig. A 304 CRES sintered wire .030" mesh screen is installed directly over each relief valve to preclude wicking material from entering the valves if they open. The screens are held in place by Teflon caps. The wicking material is installed alongside and above the relief valves. The wicking material will absorb 150% of all the electrolyte fluid in the battery if released through the relief valves. The battery is designed for a maximum normal operating pressure of 40 psig, a proof pressure of 60 psig, and a burst pressure of 80 psig. The minimum structural factor of safety of the battery is the bending stress at the hinge plate webbing from the external airlock launch loads. It is a yield strength factor of safety of 1.5. The cell top to box weld joint has a 3.76 yield strength factor of safety against bending stress at 60 psid proof pressure. The battery Hydrogen discharge of 2448 cc within the airlock volume in a 30-day period would maintain the concentration below of the explosion limit. B. Test - Component Acceptance Test - Battery delivered as an incomplete component, but is subjected to the following PDA tests. PDA Test - P/N SV767789-12 An insulation resistance test performed per SEMU-60-006 verifies no shorts exist in the battery wiring. The battery must meet a minimum insulation resistance requirement of 100 megohms at 500 VDC. An internal leakage test is done to the battery per SEMU-60-006, Section 4.2. After activation of the battery, these same tests are performed in addition to the electrical performance tests. P/N SV819600-00 An insulation resistance test performed per SEMU-60-021 verifies no shorts exist in the battery wiring. The battery must meet a minimum insulation resistance requirement of 100 megohms at 500 VDC. A leakage test is done to the battery per SEMU-60-021, Section 4. After activation of the battery, these same tests

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				are performed in addition to the electrical performance tests.
			CREW/VEHICLE: None for single failure. Possible loss of crewman with loss of SOP or if ignition occurs.	Certification Test - P/N SV767789-12 The item completed the 15 year structural vibration and shock certification requirement during 10/83. This item was certified for insulation resistance. The results of this certification test are in SEMU-46-008, Attachment 2A, Page 1B.
				P/N SV819600-00 The item completed structural vibration and shock requirements by test during 9/98. This item was certified for insulation resistance by test during 5/98. The results of these tests are found in EMU1-13-035. The item has completed all certification requirements.
			TIME TO EFFECT /ACTIONS: Seconds. If EVA, turn off battery by switching to SCU power, open the purge valve to activate the SOP, and terminate EVA, return to vehicle. If preEVA or postEVA do not use battery.	C. Inspection - A visual inspection is performed on all terminals, wires, connectors and connector pins to ensure proper seating prior to potting. Reinforcing plates, battery spacers and mono blocks (for P/N SV767789-12), cell blocks (for P/N SV819600-00)and buss bars are inspected for proper assembly, orientation and location. All internal wires are visually inspected. External inspections are performed to ensure proper pin location, alignment of connectors to battery container. Terminal lugs are visually inspected to verify that they are not touching the container walls.
			TIME AVAILABLE: Minutes.	D. Failure History - P/N SV767789-12 B-EMU-490-A002 (1/19/89), B-EMU-490-A003 (1/31/89). Battery S/N1152 and S/N1150 failed the 100 megohm insulation resistance test after activation. The battery vendor (Whittaker-Yardney) confirms 100 megohms is correct for a dry (unactivated) battery, but 5 megohoms is the wet battery (activated) insulation resistance. EC 163402-276 changes the S/AD wet (activated) insulation resistance from 100 megohms to 5 megohms minimum.
			TIME REQUIRED: Seconds.	B-EMU-490-A012 (2/9/93) - Battery S/N 1197, bonded with EC2216 epoxy failed the 5 megohm min. insulation test after activation (Act: less than 1 megohm). No failure investigation or corrective action taken.
			REDUNDANCY SCREENS: A-PASS B-PASS C-PASS	B-EMU-490-A023 (3/21/94) and B-EMU-490-A024 (3/29/94) - A black tar-like substance, later identified as uncured stycast, was observed seeping from the cases of battery S/Ns 1262 and 1259. Investigation at HS/WL revealed that insufficient mixing of the epoxy stycast 1090 SI with catalyst #24LV will result in incomplete curing of the mixture. Battery assembly Op sheets have been revised to specify the mix quantities and tolerances by weight of the two-part stycast. Also, notes have been added to emphasize a complete and thorough mixture of the stycast. In addition, a vacuum test has been added to verify that the stycast has cured.
				P/N SV819600-00 None
				E. Ground Turnaround - Tested per FEMU-R-001, Battery Activation or Preflight Recharge.

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F. Operational Use -
Operation Effects - Crew Response - PreEVA: Trouble shoot problem. Perform in suit battery swap using spare battery. Continue prep.
EVA/PostEVA: When CWS data confirms loss of voltage and comm/fan are degraded, terminate EVA.

Training - Standard EMU training covers this mode.

Operational Considerations -
Flight rule A15.1.2-2 of "Space Shuttle Operational Flight Rules", NSTS-12820 defines go/no go criteria related to EMU battery power. Generic EVA Checklist, JSC-48023, procedures Section 3 (EMU Checkout) and 4 (EVA prep) verify hardware integrity and systems operational status prior to EVA. Real Time Data System allows ground monitoring of EMU systems.

EXTRAVEHICULAR MOBILITY UNIT

SYSTEMS SAFETY REVIEW PANEL REVIEW

FOR THE

I-490 BATTERY

CRITICAL ITEM LIST (CIL)

EMU CONTRACT NO. NAS 9-97150

Prepared by: _____
HS - Project Engineering

_____
HS - Reliability

_____
HS - Engineering Manager

Approved by: _____ 5/24/02
NASA ~~SFA~~/SSM
ES5

_____ 5/21/02
NASA ~~EMU~~/SSM

_____ 5/30/02
NASA ~~S & MA~~

_____ 5-30-02
NASA ~~MOD~~

_____ 6/04/02
NASA ~~Crew~~

_____ 6/3/02
NASA ~~Program~~ Manager