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MARTIN,J.B. Region 5, Ofc of the Director

SUBJECT: Forwards reliability evaluation of exide power supplies,per 900621 telcon w/NRC.

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WILLIAM F. CONWAY
EXECUTIVE VICE PRESIDENT
NUCLEAR

161-03294-WFC/RAB
June 23, 1990

Docket Nos. STN 50-528/529/530

Mr. John B. Martin
Regional Administrator, Region V
U. S. Nuclear Regulatory Commission
1450 Maria Lane, Suite 210
Walnut Creek, CA 94596-5368

Reference: Letter to J. B. Martin, NRC, from W. F. Conway, APS, dated June 19, 1990; Subject: Emergency Lighting (161-03288).

Dear Mr. Martin:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2 and 3
Emergency Lighting - Exide Power Supplies
File: 90-019-026; 90-056-026

As requested by Mr. R. Huey, of your staff, in a phone call held on June 21, 1990, concerning the referenced letter, APS is providing a reliability evaluation of the Exide Power Supplies. The results of this evaluation, as provided in the attachment, demonstrate that these power supplies are performing reliably. Additional data, from an eight hour discharge test being performed on June 23, 1990 will be provided prior to entry into Mode 2 on Unit 1.

If you have any questions concerning this information, contact Mr. R. A. Bernier, at (602) 340-4295.

Sincerely,

WFConway

WFC/RAB

Attachment

cc: Document Control Desk
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IE01

bcc:	E. C. Simpson	(1962)
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	J. M. Levine	(6125)
	J. E. Allen	(1875)
	G. R. Overbeck	(6102)
	W. F. Quinn	(1502)
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	R. J. Adney	(6915)
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	M. L. Hypse	(1885)
	J. C. Samuels	(6008)
	K. L. M. Clark	(1515)
	E. E. Van Brunt	(1922)

ATTACHMENT

EXIDE UNINTERRUPTIBLE POWER SUPPLY RELIABILITY EVALUATION
PVNGS UNITS 1, 2, AND 3

APS has performed an evaluation of the Exide Uninterruptible Power Supplies (UPS) to assess their ability to provide reliable lighting should they be called upon to do so. This evaluation was performed by reviewing the current condition of each UPS, the result of the most recent eight hour discharge test, and the list of component failures for each UPS that was provided to your staff in a meeting on June 14, 1989. This evaluation is summarized in this attachment along with a brief description of the equipment and the maintenance program that is currently in place.

DESCRIPTION OF EXIDE UNINTERRUPTIBLE POWER SUPPLY

The Exide UPS is made up of: a charger, twenty batteries (three cells each), an inverter, an automatic transfer switch, and a minimum voltage disconnect relay. The UPS is designed to supply power to the emergency fluorescent lighting in the Control Room. The Control Room lighting is normally fed from the Class 1E Buses through regulating transformers. The automatic transfer switch will transfer from the regulating transformer to battery power when power is lost to its respective bus and will transfer back when restored by either the Emergency Diesel Generator or restoration of off-site power.

The UPS consists of twenty wet cell batteries (6 volt) with three cells each, for a total of 60 cells. These twenty batteries are connected in a series configuration to supply 120 VDC to the Exide inverter which will supply 118 VAC to the fluorescent lighting in the Control Room. The UPS is also equipped with a constant voltage charger which is adjustable to allow for either float charging or equalize charging. The UPS also has a minimum voltage disconnect relay which operates to disconnect the batteries from the load at 87.5% of nominal battery voltage. This prevents the batteries from operating in a deep discharge condition.

The current loads and the available capacity at minimum operating temperature for each Exide UPS is summarized in the table below:

TYPICAL FOR ALL THREE UNITS

	LOAD (WATTS)	UPS CAPACITY (%)
QDN-N01,F01	913	119.6%
QDN-N02,F02	913	119.6%

The available UPS capacity was calculated using design values of: inverter efficiency of 80% and a temperature derating factor for the batteries of 91% at 60° F.

The table below presents the dates when the batteries were last replaced in each of the Exide UPSs and the date of the most recent eight hour discharge test. Figures 1A, 1B and 1C illustrate the results of the discharge test.

The data presented for battery bank 1EQDN-F01 in Unit 1 (Figure 1A) shows only seven and one-half hours of data even though the written comments by the technician indicate that the battery bank and inverter did supply power for the full eight hours before the minimum voltage disconnect relay actuated. Subsequent examination has indicated that the setpoint for this relay was high. This relay will be reset and the eight hour burn PM repeated prior to entry into Mode 2. Unit 1 battery bank 1EQDN-F02 successfully passed its discharge test. Both Unit 2 battery banks successfully passed their discharge tests.

The discharge curves for the Unit 3 battery banks show a voltage two to four volts lower than the Unit 1 and 2 battery banks when compared at the start of the discharge test. This is explained by the difference in voltage drops caused by different lengths of cable runs in each Unit between the UPS and its batteries as well as different locations for measuring voltage as explained below. Other indicators of battery condition such as the monthly specific gravity tests and cell voltage measurements of pilot cells indicate no problems. A review of the previous eight hour burn test on 3EQDN-F01 performed six months earlier indicated a similar initial voltage, indicating little degradation of the battery bank over time. The upward deflection in the discharge voltage curve between four and one-half and five hours occurred at a shift change, with a change in personnel. The deflection could be explained by taking voltage readings at different locations, i.e., the battery or the inverter. The PM task does not specify the location for taking voltage readings.

UNIT 1

	Date Batteries Were Last Replaced	Date of Last Eight Hour Discharge
QDN-F01	12/88	2/28/90
QDN-F02	10/88	2/28/90

UNIT 2

	Date Batteries Were Last Replaced	Date of Last Eight Hour Discharge
QDN-F01	Have not been replaced	1/3/90
QDN-F02	Have not been replaced	3/12/90

UNIT 3

	Date Batteries Were Last Replaced	Date of Last Eight Hour Discharge
QDN-F01	6/87	3/2/90
QDN-F02	Have not been replaced	8/1/89

EXIDE PM PROGRAM

The preventive maintenance (PM) program for the Exide inverters and batteries provides instructions for the inspection, maintenance, and testing of the UPS. There are five PM tasks: a monthly PM task, a quarterly PM task, an annual UPS PM, an annual battery inspection, and an annual eight hour discharge test PM.

The monthly PM task consists of the following:

1) Perform an equalizing charge if required by pilot cell voltage, specific gravity or the average specific gravity criteria.

2) Add water to batteries, clean battery jars, clean flame arrestors, and clean battery rack.

3) Correct specific gravity for electrolyte temperature and electrolyte level for pilot cells.

4) Verify battery room ventilation operable.

5) Inspect battery room and ensure proper storage of maintenance equipment. Clean as necessary.

6) Inspect battery jars for cleanliness, cracks, crazing, and electrolyte leaking. Clean as necessary.

7) Ensure the UPS is functional and ensure the output frequency meets acceptance criteria.

8) Record data from the indicating meters on the UPS panel.

The quarterly inspection PM task consists of the following:

1) Perform an equalizing charge if required by individual cell voltage, specific gravity, or the average specific gravity criteria.

2) Add battery water, clean battery jar, clean flame arrestors, and clean battery rack.

3) Correct specific gravity for electrolyte temperature and electrolyte level.

4) Verify battery room ventilation operable.

5) Inspect battery room and ensure proper storage of maintenance equipment. Clean as necessary.

6) Inspect battery jars for cleanliness, cracks, crazing, and electrolyte leaking. Clean as necessary by approved methods.

7) Ensure the UPS is functional and ensure the output frequency meets acceptance criteria.

8) Record data from the indicating meters on the UPS panel.

The annual PM task on Exide UPS consists of the following:

1) Record data from the indicating meters located on the UPS front panel.

2) Verify parameters of charger section of the UPS.

3) Inspect internal components.

4) Inspect inside enclosure for general physical condition and cleanliness. Clean as necessary.

5) Visually check capacitors for bulging, leaking oil, and other signs of damage.

6) Inspect insulators and barriers for cracking and overheating.

7) Check diodes, transformers, etc.

8) Inspect all accessible bolt and screw connections.

9) Inspect current carrying components for overheating or other signs of dielectric breakdown.

The annual inspection of batteries consists of the following:

1) Establish acceptance criteria for various values taken during the inspection.

2) Verify operation of the battery room ventilation.

3) Visually inspect cell/battery jars.

4) Visually inspect terminals, connectors, and conductors for corrosion, arcing, and other degradation.

5) Measure and record battery room temperature, battery terminal voltage, and charger output.

6) Measure and record battery specific gravity, electrolyte temperature, and electrolyte level.

7) Add water to batteries.

8) Clean and dry battery jars.

9) Inspect battery cells for excessive sediment accumulation and/or plate growth.

10) Clean and/or replace cell flame arrestors.

11) Measure intercell connection and bank to bank resistances.

12) Inspect battery rack for cleanliness and structural integrity.

The eight hour discharge test consists of the following:

1) Inspect the fixtures powered from the Exide inverter for extinguished lamps.

2) Record initial UPS output voltage.

3) Establish the control room lighting to simulate emergency light conditions to record illumination levels.

4) Measure and record the illumination levels inside and outside the "Horseshoe" area at the initiation of the test, at the four hour and eight hours time frames of the test.

5) Measure and record initial battery bank terminal voltage (BBTV).

6) Initiate discharge test by opening inverter supply breaker.

7) Measure and record initial BBTV.

8) Conduct tours in thirty (30) minute (minimum) intervals to document battery bank terminal voltages and to replace lamps, as necessary.

9) Terminate the test upon reaching a BBTV of less than 105 volts or upon completion of eight (8) hours of burn time with design load.

10) Initiate "Equalizing" task for restoring the batteries to normal condition.

11) Restore inverter and control room to normal operating condition.

FAILURE DATA REVIEW

A total of 21 component failures were reported in the six UPSs during the period of June 1987 through March 1990. These were reviewed to determine if the specific component failure would have resulted in loss of capability of the lights to illuminate for eight hours following loss of 1E bus voltage. Of the 21 component failures, seven resulted in actual loss of lighting capability. This data is presented in a timeline for each of the six UPSs (Figure 2).

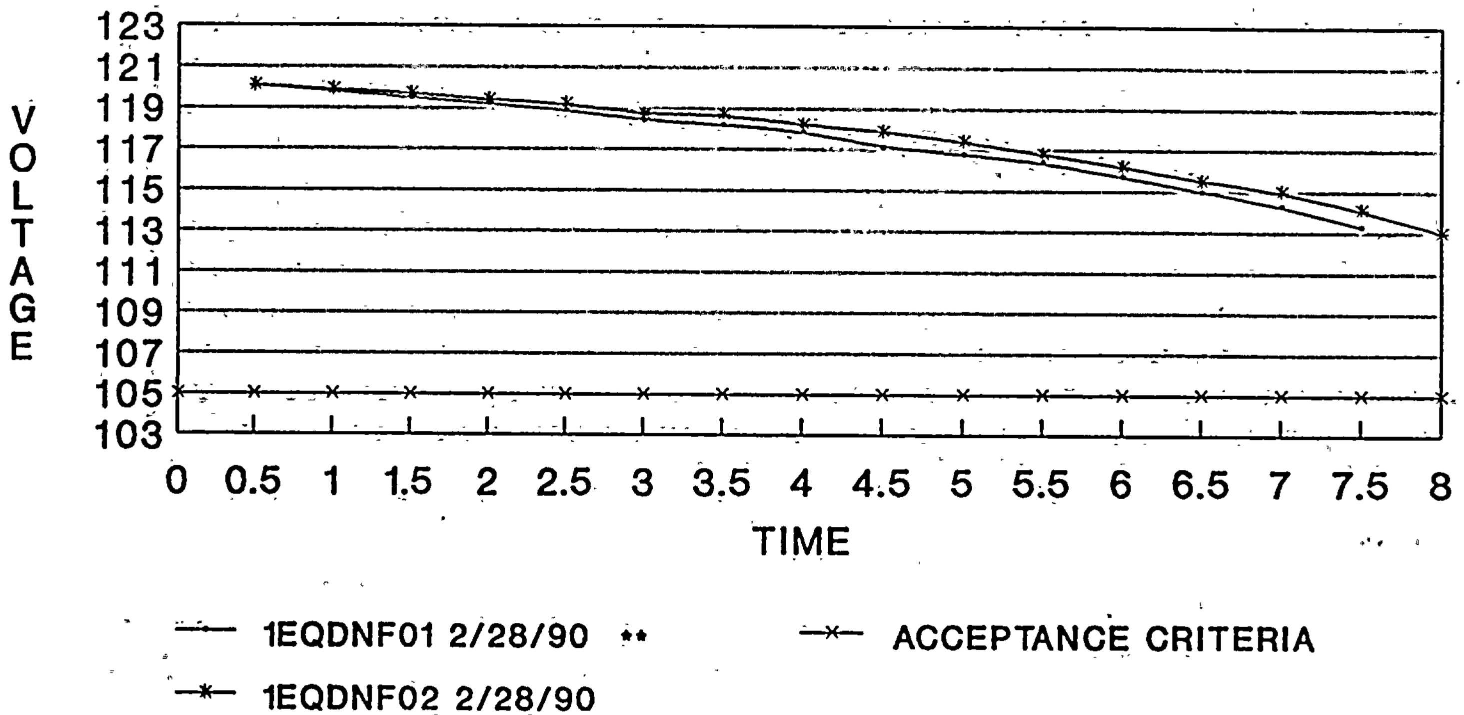
The attached timeline graphically depicts component failures from June 1987 to March 1990. The timeline also shows whether the indicated component failure would have affected the ability of the UPS to meet its eight hour discharge requirement.

The seven failures experienced may be divided into two groups, battery failures and inverter failures. Four of the failures were battery failures, three in Unit 1 and one in Unit 3. In all cases, the entire battery bank has been replaced since the failures, and no failures have occurred since which would have prevented the batteries from lasting eight hours. The remaining three failures were all failures of the battery low voltage cutout relay. The cause of these relay failures is under investigation. A summary of each of the failures evaluated is provided in Appendix A.

CONCLUSION

The Exide Uninterruptible Power Supplies are operating reliably at this time. The current Preventive Maintenance Program is adequate to ensure the batteries will remain in good condition. The implementation of capacity testing and trending of the results will provide added assurance that any future degradation of the batteries will be identified prior to failure of a battery bank.

1EQDNF01,1EQDNF02 DISCHARGE TEST



** NOTE: TEST WAS TERMINATED PRIOR TO ILLUMINATON READING BEING TAKEN

FIGURE 1A

2EQDNF01,2EQDNF02
DISCHARGE TEST

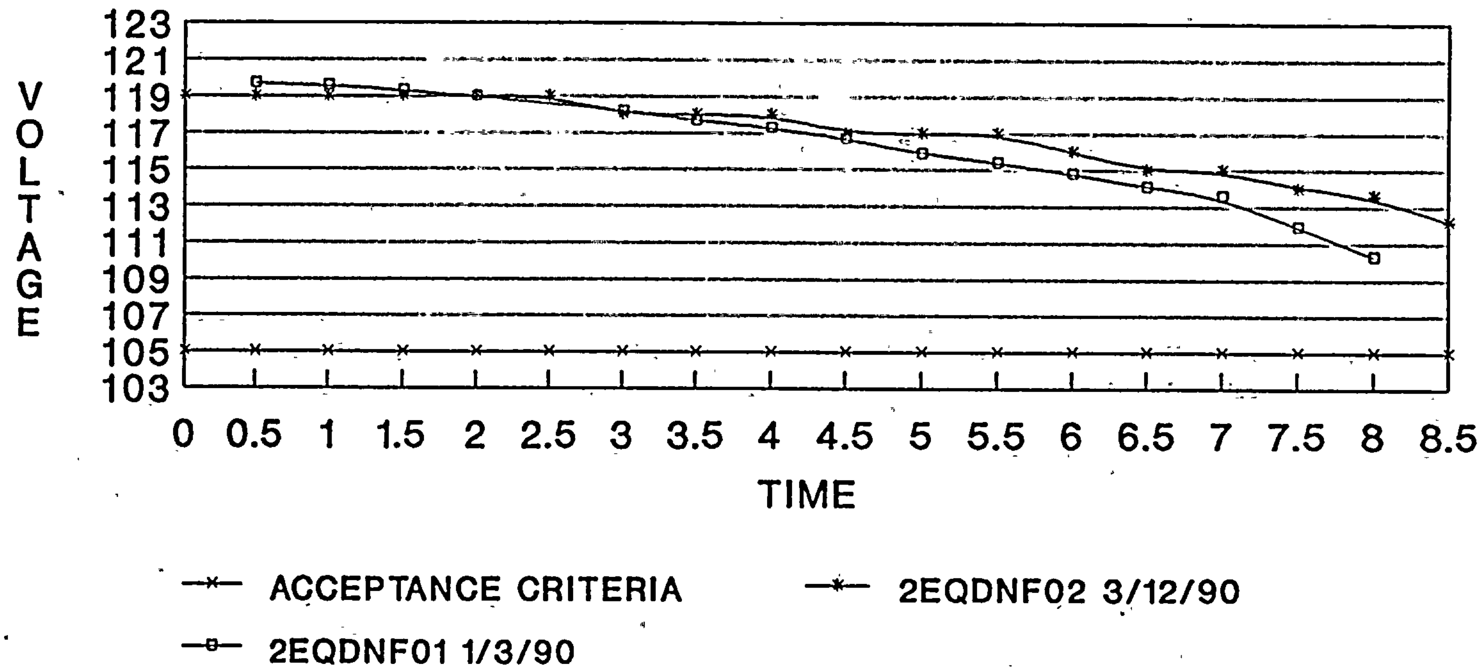


FIGURE 1B

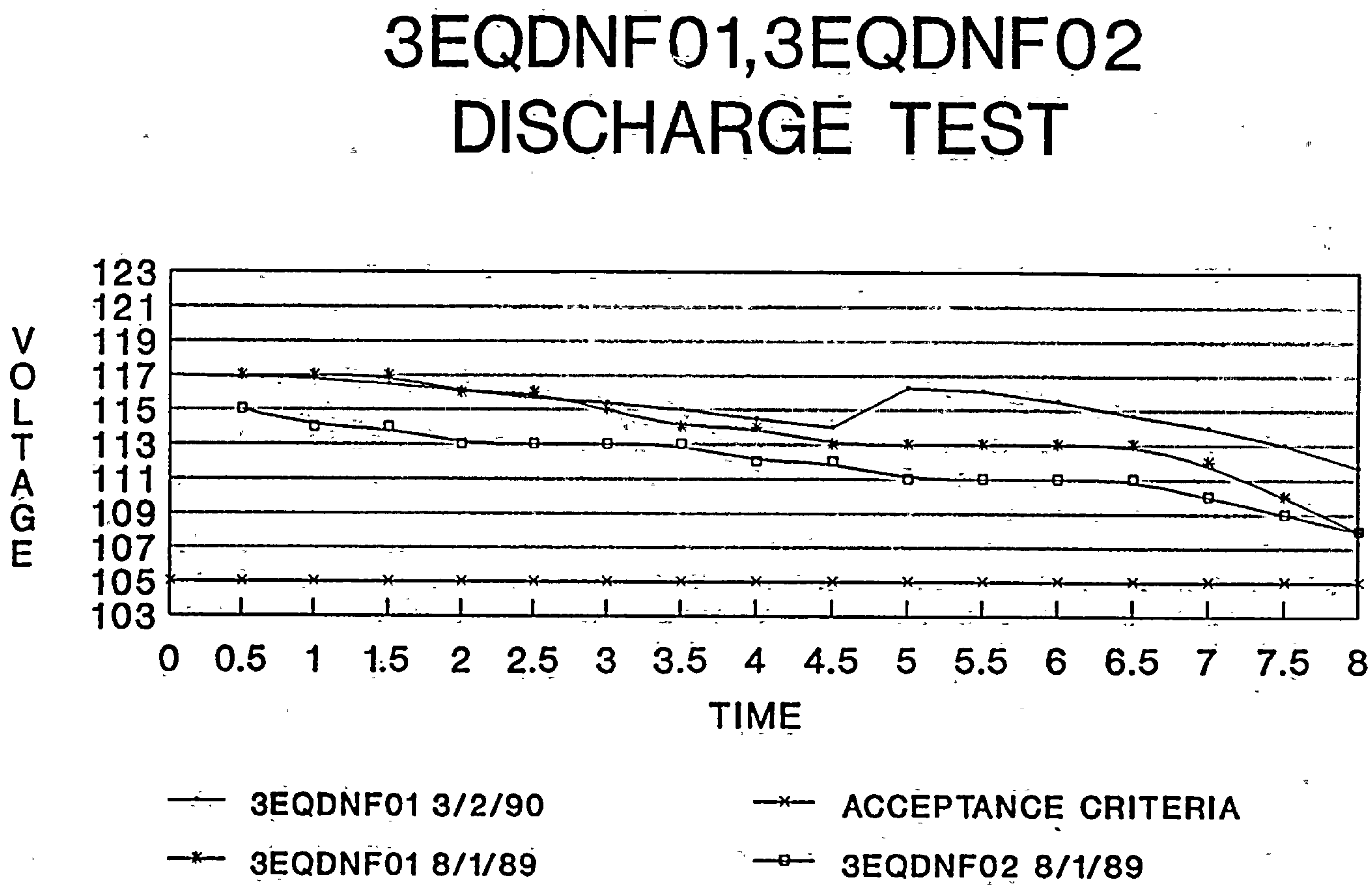

3EQDNF01,3EQDNF02
DISCHARGE TEST
VOLTAGE
123
121
119
117
115
113
111
109
107
105
103
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
TIME
3EQDNF01 3/2/90
ACCEPTANCE CRITERIA
3EQDNF01 8/1/89
3EQDNF02 8/1/89

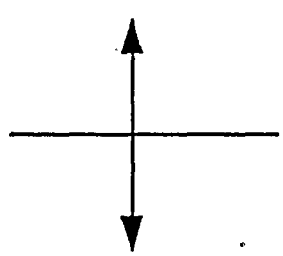
FIGURE 1C

Figure 2

Unit 1,2 & 3
Exide Component Failure
Time-line

1987-1990

LEGEND

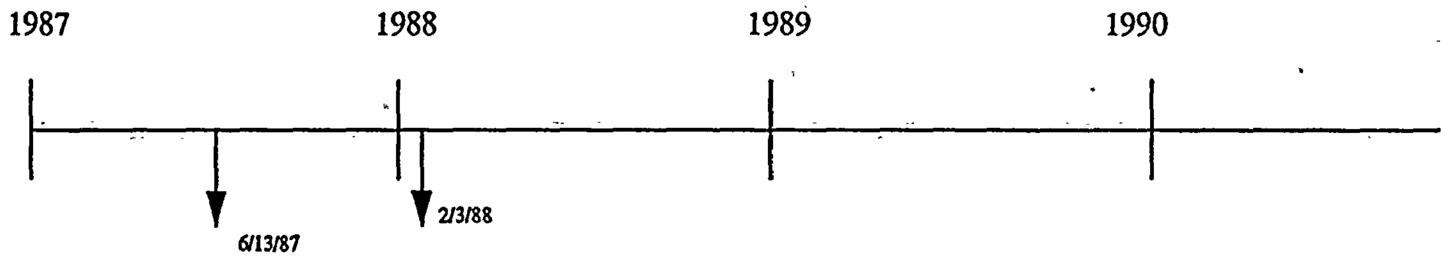


Arrows above line represent failures which would not have affected power station's ability to perform 8-hour discharge test

Arrows below line repesent failures which would have affected power station's ability to perform 8- hour discharge test

UNIT 1
EXIDE COMPONENT FAILURE TIME-LINE

UPS & BATTERY
1E-QDN-N01 & 1E-QDN-F01



UPS & BATTERY
1E-QDN-N02 & 1E-QDN-F02

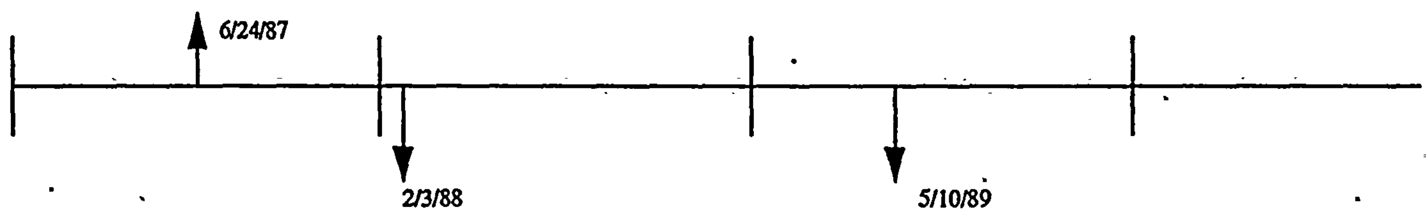
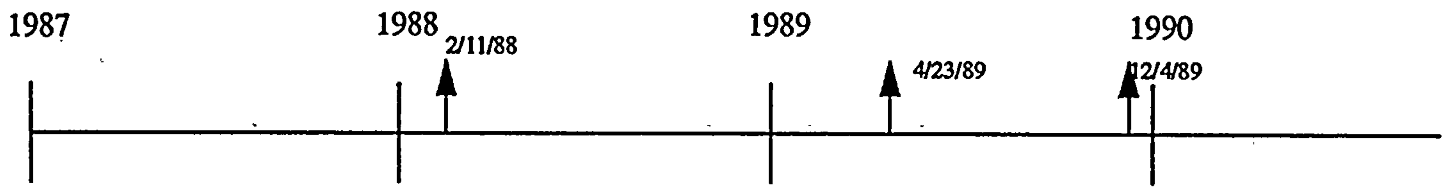


Figure 2a

UNIT 2
EXIDE COMPONENT FAILURE TIME-LINE

UPS & BATTERY
2E-QDN-N01 & 2E-QDN-N01



UPS & BATTERY
2E-QDN-N02 & 2E-QDN-F02

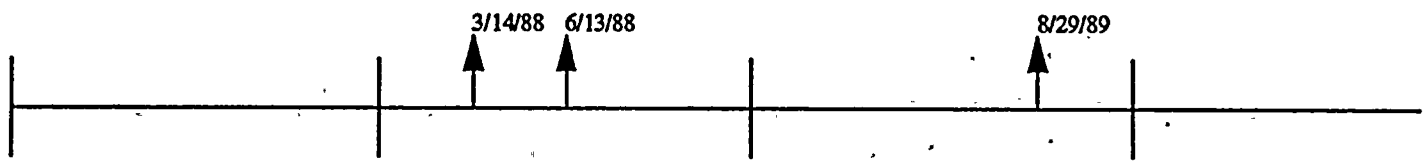
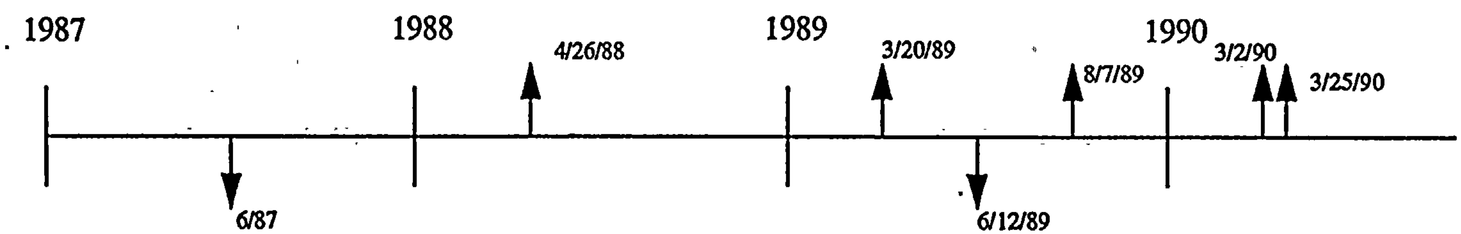


Figure 2b

UNIT 3
EXIDE COMPONENT FAILURE TIME-LINE

UPS & BATTERY
3E-QDN-N01 & 3E-QDN-N01



UPS & BATTERY
3E-QDN-N02 & 3E-QDN-F02

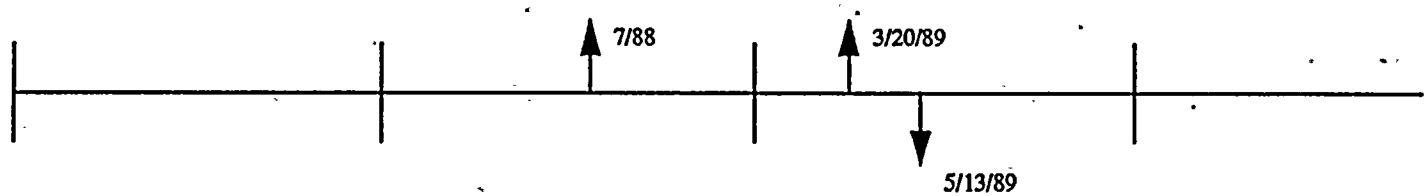


Figure 2c

APPENDIX A

Exide Failure Evaluation
Unit 1

QDN-F01 & QDN-N01

DATE	EVALUATION SUMMARY
06/13/87	Two cells had low electrolyte specific gravity. Insufficient information was available to determine whether lights would have burned for 8 hours. Therefore, this is considered a failure.
02/03/88	Low electrolyte specific gravity was found for the complete bank. The bank was replaced. This condition would have prevented the lights from burning for eight hours.

<u>Exide Failure Evaluation</u>
Unit 1

QDN-F02 & QDN-N02

DATE	EVALUATION SUMMARY
06/24/87	Low electrolyte specific gravity was found in one cell, one cell had a broken flame arrestor and one cell had a broken case. Two cells and the flame arrestor were replaced. These conditions would not have prevented the lights from burning 8 hours.
02/03/88 (OPENED) 10/03/88 (CLOSED)	Battery would not hold charge and specific gravity was low. The complete battery bank was replaced. These conditions would have prevented the lights from burning 8 hours. *
05/10/89	The inverter input breaker tripped. This condition would have prevented the lights from burning for 8 hours. The breaker was replaced.

* This failure was counted in FDT as two failures due to an error in the FDT showing both the "Opened" date and the "Closed" date.

Exide Failure Evaluation
Unit 2

QDN-F01 & QDN-N01

DATE	EVALUATION SUMMARY
02/11/88	The low battery warning lamp was burned out. This condition would not have prevented the lights from burning for 8 hours. The lamp was replaced.
04/23/89	Low electrolyte specific gravity was found in cell 53. This condition would not have prevented the lights from burning for 8 hours. The battery was replaced.
12/04/89	Wrong lamps were installed and failed to meet illumination criteria. This condition would not have prevented the lights from burning for 8 hours. Lamps were replaced with correct lamps and the test was successfully reperformed.

QDN-F02 & QDN-N02

DATE	EVALUATION SUMMARY
03/14/88	Corrosion was found on intercell connections. This condition would not have prevented the lights from burning for 8 hours. The intercell connections were cleaned and reinstalled.
06/18/88 (OPENED) 09/23/88 (CLOSED)	A cracked post on one battery. This condition would not have prevented the lights from burning for 8 hours. The battery was replaced. *
08/29/89	Float/equalize charge switch was performing intermittently. This condition would not have prevented the light from burning for 8 hours. Switch was replaced.

* This failure was counted in FDT as two failures due to an error in the FDT showing both the "Opened" date and the "Closed" date.

Exide Failure Evaluation
Unit 3

QDN-F01 & QDN-N01

DATE	EVALUATION SUMMARY
06/87	Batteries had low electrolyte specific gravity. The battery bank was replaced. This condition would have prevented the UPS from burning for 8 hours.
04/26/88	The flame arrestor was defective. This condition would not have prevented the UPS from burning for 8 hours. The flame arrestor was replaced.
03/20/89	The charger voltage sensing circuit failed. The UPS was operable. This condition would not have prevented the UPS from burning for 8 hrs.
06/12/89	The inverter input breaker tripped. The UPS was repaired. This condition would have prevented the UPS from burning for 8 hours.
08/07/89	Low electrolyte specific gravity was found. A successful 8 hour discharge test was performed six days earlier. Batteries were put on equalize charge and all electrolyte specific gravities were found acceptable.
03/02/90	UPS passed the 8 hour discharge test but electricians did not take final illumination reading, therefore was recorded as a failure. The lights burned for 8 hours.
03/25/90	Charger failure light did not illuminate. This would not have prevented the UPS from burning for 8 hours.

Exide Failure Evaluation
Unit 3

QDN-F02 & QDN-N02

DATE	EVALUATION SUMMARY
07/88	The flame arrestor was broken. This condition would not have prevented the lights from burning for 8 hours. The flame arrestor was replaced.
03/20/89	The battery charger indication was not illuminated. The sensing circuit was incorrectly adjusted. The battery voltage sensing potentiometer was adjusted. This condition would not have prevented the charger or inverter from performing properly.
05/13/89	Failure of the input breaker. This is a failure of the UPS. This condition would have prevented lights from burning for 8 hours. The inverter logic card was replaced.