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 STN-50-529 Palo Verde Nuclear Station, Unit 2, Arizona Publi 05000529  
 STN-50-530 Palo Verde Nuclear Station, Unit 3, Arizona Publi 05000530  
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 MARTIN, J.B. Region 5, Ofc of the Director

SUBJECT: Responds to Insp Repts 50-528/90-25, 50-529/90-25 & 50-530/90-25 re safe shutdown emergency lighting.

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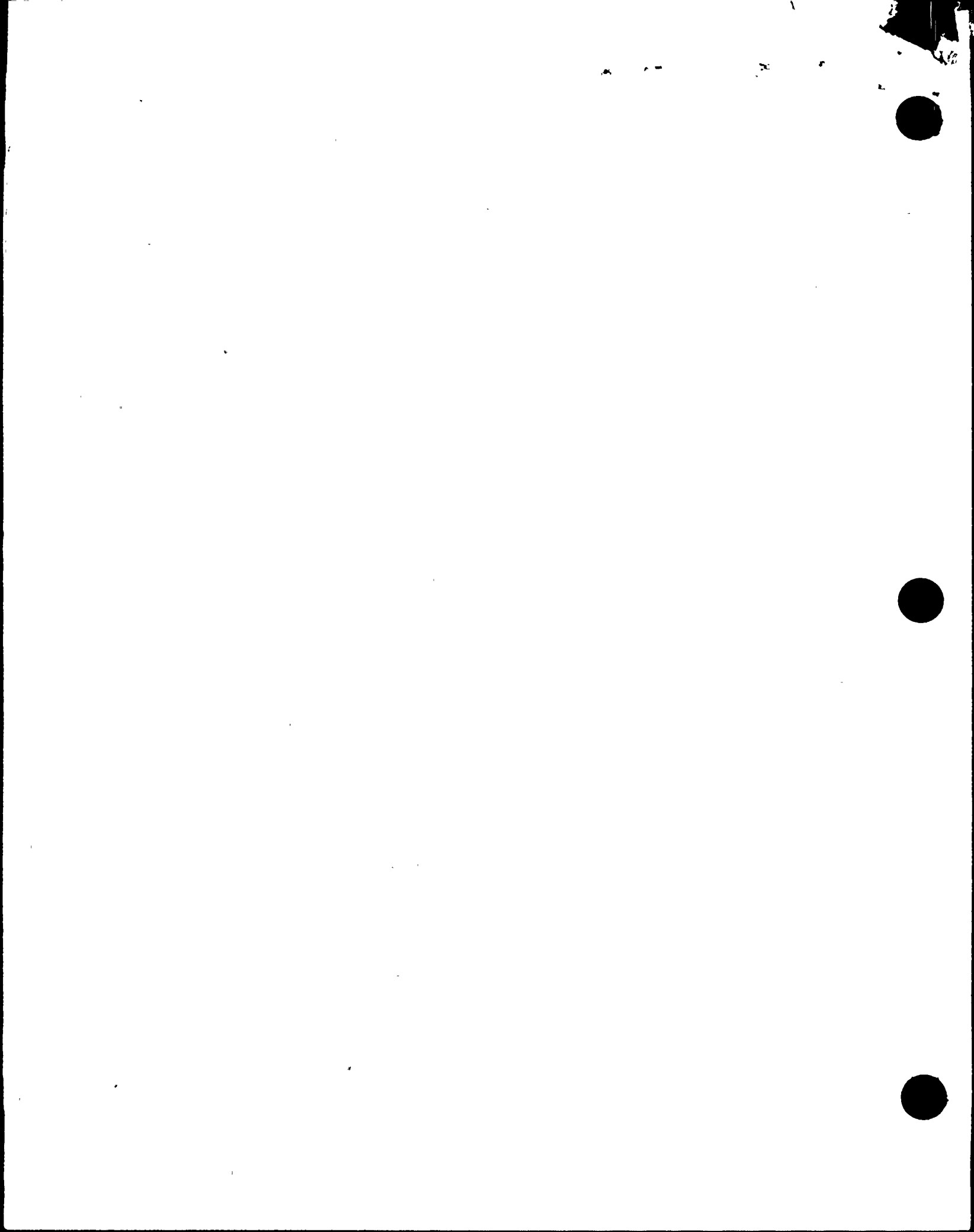
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WILLIAM F. CONWAY  
EXECUTIVE VICE PRESIDENT  
NRC/CAF

161-03373-WFC/WFQ  
August 1, 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

- References: 1) Letter from R. P. Zimmerman, NRC, to W. F. Conway, APS, dated July 5, 1990; Subject: NRC Inspection of Palo Verde Units 1, 2 and 3. Inspection Report Nos. 50-528/90-25, 50-529/90-25 and 50-530/90-25.
- 2) Letter to J. B. Martin, NRC, from W. F. Conway, APS, dated July 20, 1990; Subject: Evaluation of the Fire Protection System Equipment (161-03349).

Dear Mr. Martin:

Subject: Palo Verde Nuclear Generating Station (PVNGS)  
Units 1, 2 and 3  
Response to NRC Inspection Report Nos. 50-528/90-25,  
50-529/90-25 and 50-530/90-25 - Safe Shutdown Emergency  
Lighting  
File: 90-019-026; 90-056-026

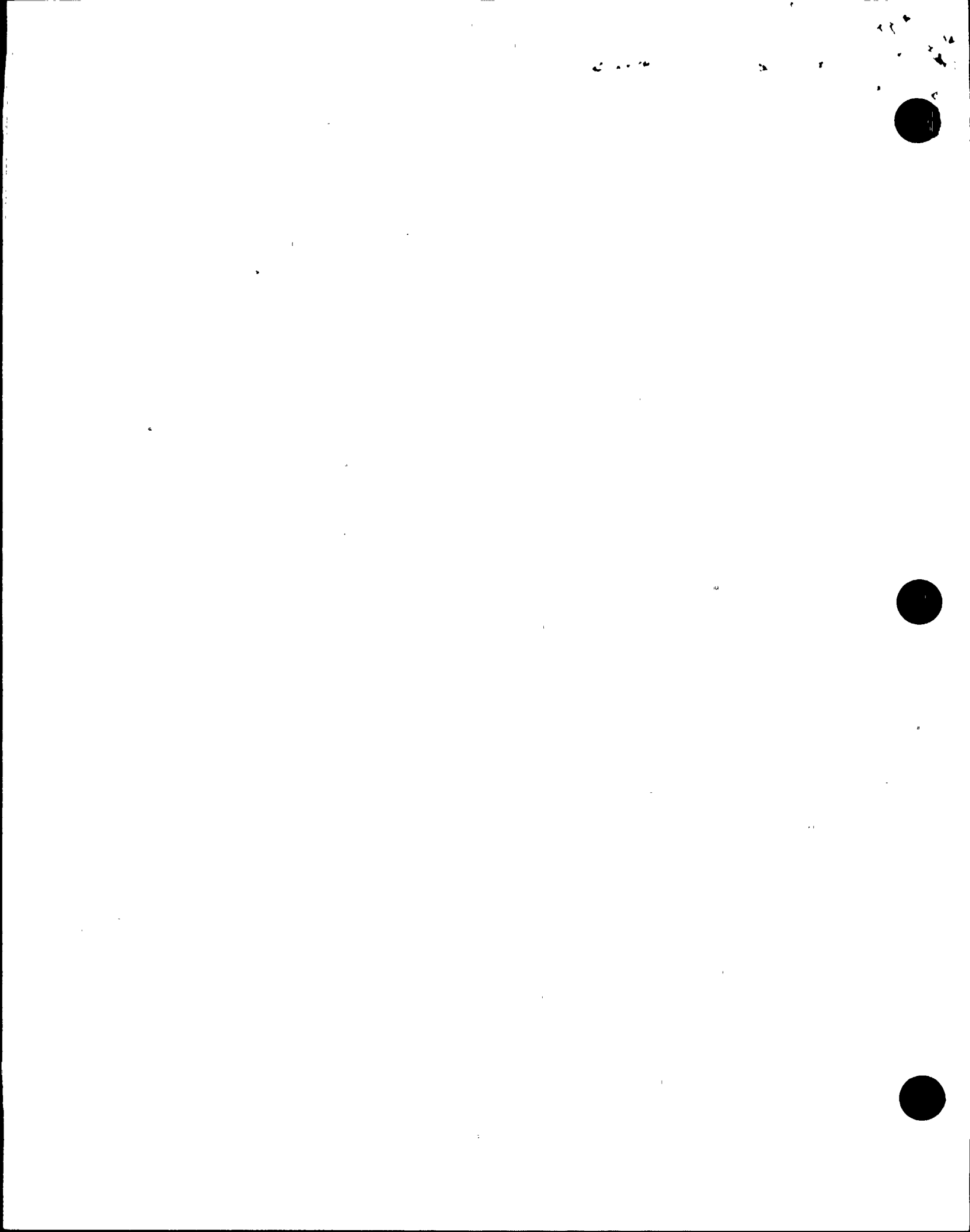
At the July 10, 1990 enforcement conference concerning the results of NRC Inspection Report 90-25 on emergency lighting, APS requested an opportunity to furnish additional information in writing. The conference was scheduled for July 10, 1990, and the Inspection Report was received July 6, 1990. Accordingly, APS expressed the need for additional time to adequately prepare for the meeting. In addition, an independent consultant's review of the emergency lighting issues, which was scheduled to be received on July 20, 1990, was expected to provide information that would assist APS' response. The NRC consented to APS' request, and this document is submitted pursuant to that understanding. APS appreciates the Commission's consideration in this matter.

The cover letter transmitting Inspection Report 90-25 notes that emergency lighting has been the subject of communications between APS and the NRC for some time.<sup>1</sup> Although this is true in a general sense, and is a matter of personal concern to me, the nature of the issues has shifted over time. The record shows that different, singular problems of emergency lighting have been discussed over

<sup>1</sup>Attachment A to the Enclosure lists a chronology of recent inspection activities related to this subject.

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the past eighteen months. This matter is discussed further in the Enclosure. While we believe that all matters involving emergency lighting must be addressed promptly, we do not view the history of this issue as an example of a persistent single problem of a continuing nature.

Apparent Violation 90-25-01:

APS and the NRC have conducted discussions on the adequacy of various types of emergency lighting over the past several months, and the Commission has expressed concerns during this interval over problems in certain types of lighting which comprise parts of the 10 CFR Part 50, Appendix R emergency lighting system. Many of these concerns were clearly correct and required corrective actions.

Inspection Report 90-25, however, reflects a broader judgment and, for the first time, a formal determination that the emergency lighting is "unreliable". This is the central finding in support of Apparent Violation 90-25-01. The determination is based on a statistical "reliability" analysis which, in our view is fundamentally flawed. Its unstated premise is that a light may be deemed "unreliable" if it experiences a single failure to burn on demand, notwithstanding many other successful "burns". Reliability may be assessed in this manner for some purposes, but in the context of emergency lighting, it produces a purely academic result. If a fixture burns successfully on 19 of 20 occasions, it has an extremely high probability of providing the light necessary to achieve and maintain a safe shutdown in an Appendix R scenario -- in fact, a 95% probability. We believe that the more meaningful measure of the adequacy of emergency lighting under Appendix R is the probability of a successful burn -- in effect, availability -- rather than "reliability" as that term is used in the Inspection Report.

The regulatory requirements applicable to emergency lighting are not based on any notion of "reliability", but rather a combination of design and procurement criteria (e.g. "8-hour burn"), maintenance, testing and related activities, all of which are aimed at assuring the adequacy of lighting in the Appendix R scenario. Thus, there is no violation if lighting has been procured to applicable criteria and related activities (e.g. maintenance, testing) have been performed in accordance with regulatory commitments. It is this combination of activities which provides reasonable assurance that lighting will be available to assist in achieving and maintaining safe shutdown.

As noted above, an analysis which assesses reliability in terms of the availability of lighting is a more meaningful measure of the effectiveness of an Appendix R lighting system. APS' analysis, done on this basis, shows that compliance with objective regulatory requirements for maintenance, testing, design, procurement, etc. can provide a system which may be depended upon to provide the lighting necessary to meet an Appendix R fire scenario.

This is not to say that APS' performance in the general area of emergency lighting has been entirely satisfactory or that APS' diligence can be credited for whatever degree of success has been attained. Emergency lighting has been characterized by several different types of problems (location, failure to meet PM schedules and a variety of equipment problems). Too often, in the past, the essential stimulus for insights to problems and corrective action has been the result of the NRC's vigorous oversight and enforcement. Based on our review of these issues, and input from our independent consultant, we believe that timely additional corrective action is essential, and these measures are outlined in the Enclosure.

Apparent Violation 90-25-02:

The failure to fully apply the PVNGS Quality Assurance Program to emergency lighting can be traced to an ambiguity in the PVNGS UFSAR that resulted in inconsistent application of the QA criteria. As noted in the JCO transmitted to the NRC in Reference 2, however, many of the QA requirements which should have been applied to emergency lighting have, as a practical matter, been compensated for by other procedures and programs. Nevertheless, certain QA deficiencies remain. None of these remaining deficiencies compromise the ability to achieve and maintain safe shutdown in the event of a fire. However, as detailed in the Enclosure, a number of corrective actions have been planned and taken. In particular, APS has upgraded the quality classification of emergency lighting, an activity which had been initiated but not fully implemented at the time of the inspection.

Apparent Violation 90-25-03:

APS believes that the discussion of this violation may reflect a misunderstanding of events and PVNGS actions. The record, as reflected in the Enclosure to this letter, shows that a timely review of the Pre-Fire Strategies Manual (PFSM) was conducted in 1988, and that concerns identified in that review were addressed as they were identified. Nevertheless, as part of its Design Basis Review, APS has undertaken a complete review of the Spurious Actuation Studies which form the basis for the Spurious Actuation Evaluation section of the PFSM.

Apparent Violation 90-25-04:

When APS designed and purchased the Emergi-Lite outdoor emergency lights in 1989, it relied on the requirements of NRC Branch Technical Position (BTP) 9.5-1 and the National Electric Code which we believe were correctly interpreted. Apparent Violation 90-25-04 is based on a different NRC interpretation of BTP 9.5-1 and Code requirements. APS was not aware of this NRC interpretation before Inspection 90-25. Regardless of which interpretation is correct, however, APS is not satisfied with the performance of these lights in service and is replacing them.

Mr. John B. Martin  
U.S. Nuclear Regulatory Commission  
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August 1, 1990

Apparent Violation 90-25-05:

Finally, we urge reconsideration of Apparent Violation 90-25-05. Based upon a review of NRC practice, it is clear that the NRC does not normally cite a licensee for an underlying violation and also for failure to report that violation. The basic principle is set forth in 10CFR Part 2, Appendix C:

"A licensee will not normally be cited for a failure to report a condition or event unless the licensee was actually aware of the condition or event which it failed to report".

While APS was aware of certain facts noted in the apparent violations, the characterization of those facts, as set forth in Inspection Report 90-25, and the conclusions reached by the NRC based on those facts cannot be fairly imputed to APS retroactively. APS should not be cited for failing to understand that the emergency lighting could, at some point, be determined "unreliable" or that the QA program was not being applied to the extent APS, in good faith, thought it was applicable. As to both matters, active communication was in progress between APS and the NRC, and there were good faith differences regarding the underlying facts and their interpretation. In these circumstances, it would not be consistent with NRC policy to cite APS for both an underlying violation and the failure to report. We think this reasoning is particularly applicable in the context of Technical Specification 6.9.3 which clearly requires an awareness on the part of the licensee, not only of the facts, but also that (1) a violation of the Fire Protection Program has occurred, and (2) the violation would adversely affect the ability to achieve and maintain safe shutdown of the plant in the event of a fire.

Independent Review


As mentioned above, in evaluating the status of PVNGS' emergency lighting system, APS commissioned an independent review of the NRC requirements, the status of APS implementation of these requirements, and related matters. APS contracted with ABB Impell Corporation (Impell) to conduct this review. The result of Impell's study is reflected in the Enclosure where relevant to the apparent violations and is summarized in Attachment C to the Enclosure. Specific issues raised in response to identified NRC concerns have also been evaluated by Impell and included as "Additional Discussion" in Attachment D to the Enclosure.

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U.S. Nuclear Regulatory Commission  
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August 1, 1990

Although in this letter and Enclosure we have taken issue with certain factual matters and conclusions reached in the NRC Inspection Report, I wish to assure you that lessons have been learned from this experience; APS has a firm grasp of the scope of problems involving emergency lighting; and corrective action will be prompt and dispositive.

Sincerely,



WFC/WFQ  
Enclosure

cc: Document Control Desk  
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ENCLOSURE



RESPONSE TO NRC

INSPECTION REPORT NO. 90-25



I.

INTRODUCTION

APS has reviewed NRC Inspection Report 90-25 on emergency lighting and the results of an independent study by its consultant, ABB Impell Corporation (Impell). APS is submitting this response to the Inspection Report to supplement the information furnished at the July 10, 1990 enforcement conference.

The issues raised in the Inspection Report are complex and have evolved and changed over time in the course of extensive discussions and meetings between APS and the NRC, a chronology of which is provided in Attachment A. The NRC cover letter transmitting Inspection Report 90-25 notes that emergency lighting has been the subject of communications between APS and the NRC for some time. Although this is true in a very general sense, the nature of the problems identified has shifted over the years. While it is clear that all issues involving emergency lighting must be addressed promptly and dispositively, we do not view the history of this matter as an example of a persistent single problem of a continuing nature. For example, the 1986 Licensee Event Report (LER 86-059) addressed problems involving testing acceptance criteria which were corrected and have not recurred. The Enforcement Action in 1989 (EA 89-88) involved the identification of plant areas requiring Appendix R emergency lighting and the inappropriate waivers of preventive maintenance tasks. Emergency lights were added to the areas where needed, prior to restart of the Palo Verde Units following the March 3, 1989 event at Unit 3. APS has also taken actions to assure preventive maintenance tasks are completed and not inappropriately waived. Obviously, NRC has been a major stimulus in connection with many of these corrective measures.

This document discusses each of the apparent violations, and includes attachments consisting of a chronology of inspection activities and meetings (Attachment A); a collection of comments and corrections on Inspection Report 90-25 (Attachment B); a summary of Impell's report on emergency lighting (Attachment C); an analysis by Impell of APS' responses to NRC concerns and APS resolution of Impell recommendations (Attachment D); and an updated failure summary resulting from further research and evaluation (Attachment E).

With respect to the apparent violations, APS concludes in summary<sup>1</sup>:

(1) Apparent Violation 90-25-01: It is inappropriate to issue a citation based upon the alleged "unreliability" of the emergency lighting. This is not the applicable regulatory standard and, in any event, is based on a flawed statistical analysis. While improvements are needed to assure continued adequacy of service, the

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<sup>1</sup>A more complete analysis of the rationale for APS' position on each Apparent Violation will be found in Section II of this Enclosure.



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lighting meets applicable regulatory requirements. Analysis shows that the lighting has generally attained high availability factors, although it is acknowledged that vigorous NRC oversight and enforcement have been a major factor in this regard.

(2) Apparent Violation 90-25-02: QA requirements for emergency lighting were incorrectly applied by APS owing in part to internal inconsistencies in the UFSAR. Nevertheless, other measures, as documented in APS' July 20, 1990 letter, have been applied to emergency lighting since April 1990 such that most of the QA requirements of BTP APCS 9.5-1 have been satisfied. Although a few deficiencies remain, none compromise the ability to achieve and maintain safe shutdown in the event of a fire.

(3) Apparent Violation 90-25-03: Certain misunderstandings are reflected in the Inspection Report concerning the annual update of the Pre-Fire Strategies Manual as documented in Section II.C. In fact, the 1988 review of the manual did include operator actions.

(4) Apparent Violation 90-25-04: This apparent violation hinges on a difference between APS and NRC in interpreting the requirements of Branch Technical Position (BTP) 9.5-1 and the National Electric Code. Regardless of this interpretive difference, APS is replacing the lights in question because the company is not satisfied with their maintainability and performance.

(5) Apparent Violation 90-25-05: For reasons set forth in Section II.E., citing APS for failing to report the identified Apparent Violations in Inspection Report 90-25 is inappropriate in light of the reporting criteria of Technical Specification 6.9.3; it is also inconsistent with NRC policy.

APS appreciates the opportunity to respond in writing to the Inspection Report. In some areas, issue is taken with certain factual matters and conclusions. We believe, however, that the information in this enclosure will facilitate a better mutual understanding of these matters.

## II.A.

### ADEQUACY OF EMERGENCY LIGHTING

#### Summary of NRC Finding:

Inspection Report 90-25, on page 3, describes an NRC concern that a high failure rate of installed emergency lights indicates the lighting units had not been properly designed or maintained. The report goes on to describe data APS provided to the NRC that indicated a number of light failures. On pages 4 and 5, the report presents some numerical percentages characterized, on page 8, as demonstrating a high failure rate. The Inspection Report concludes that "failure to provide reliable emergency lighting as required by the Facility Operating License to support safe shutdown in the event of a fire is considered to be an apparent violation of Facility Operating License Nos. NPF-41, NPF-51 and NPF-74."

#### Summary of APS Position:

With the limited exceptions discussed below, the emergency lights at PVNGS have complied with applicable regulatory requirements, admittedly owing in significant part to corrective measures resulting from vigorous NRC oversight and enforcement. The system used to assure emergency lighting when required depends on implementation of applicable design, procurement, installation, maintenance (both corrective and preventive), testing and corrective action programs, rather than assessments of equipment "reliability." As with most equipment, neither reliability nor availability is normally quantified at PVNGS nor, to our knowledge, at other commercial nuclear power plants. APS has evaluated the availability of the Holophane, Exide and Emergi-Lite systems. The evaluation shows that this equipment has generally had high availability over the past year. Therefore, APS asks that apparent violation 90-25-01 be withdrawn.

#### Outline of Presentation:

Section II.A.1 of this response explains regulatory requirements applicable to PVNGS emergency lighting and describes the PVNGS program for meeting regulatory requirements applicable to emergency lighting. Section II.A.2 indicates results of availability calculations applied to emergency lighting; and Sections II.A.3, and II.A.4 provide corrective actions and conclusions based on the preceding sections.

### II.A.1.

#### APPLICABLE REGULATORY REQUIREMENTS

##### Introduction

The adequacy of PVNGS emergency lighting is not assured by imposing quantified reliability standards, nor do NRC regulations establish such requirements. Rather, adequacy is assured by implementing regulatory requirements for design, procurement, installation, maintenance (both corrective and preventive), testing and corrective action. These requirements are documented in PVNGS UFSAR Section



9.5; PVNGS unit license conditions which cover the Fire Protection Program; and, in plant procedures which comprise parts of the approved Fire Protection Program. APS has implemented many measures in an effort to meet its commitments for emergency lighting and additional measures are being taken, several in response to NRC observations and findings. These measures are described in subsequent sections of this report. They provide reasonable assurance that emergency lighting performs its intended function, a conclusion borne out by the availability analysis in section II.A.2.

#### Design, Procurement and Installation Requirements

The APS program for equipment design, procurement and installation is established to assure that equipment installed in the plant meets design and functional requirements for the affected system(s). Additionally, a design control program is established to ensure that: (1) equipment is readily maintainable, and (2) that changes to the equipment design are made in a way which assures that system design and functional requirements are maintained.

APS' review of the Unit 3 March 3, 1989 unusual event indicated the need to improve emergency lighting in selected areas. These changes added Emergi-Lite units to address Appendix R requirements in certain areas, to enhance lighting in other areas, and to replace one Dual-Lite model identified as having undesirable failure frequencies. Since that event, with minor exception (see letter dated June 19, 1990), the design, procurement and installation process for emergency lighting at PVNGS has been generally effective.

#### Maintenance and Testing Requirements

The purpose of the PVNGS Preventive Maintenance (PM) Program is to provide assurance that structures, systems and components are maintained in a condition to perform their design functions and ensure adequate equipment reliability and availability. Preventive Maintenance at PVNGS encompasses periodic and planned maintenance activities, performed with the intent of maintaining equipment operable. The PM Program applies to emergency lighting at PVNGS.

The PM Program for emergency lighting also includes requirements for testing the lighting as part of the periodic PM activities. PM testing of emergency lights prior to June 1990 provided for completion of various PM tasks prior to testing. The reasonableness of that approach is discussed further in this section and in response to Apparent Violation 90-25-02. In response to concerns expressed by the NRC during the inspection, APS is revising PM procedures to require that the 8-hour discharge tests of Appendix R emergency lighting be tests of the "as found" condition.

While preventive maintenance cannot preclude all equipment malfunctions, frequent preventive maintenance can increase the likelihood of satisfactory performance during operation. The preventive maintenance frequency for certain emergency lights in

selected areas has therefore been increased following special tests in March 1990. A pilot testing program is being developed to determine whether additional improvements in preventive maintenance tasks will further enhance lighting availability.

#### Corrective Action Requirements

System engineers provide technical support for plant activities that monitor the performance of emergency lights and other plant systems and equipment, and identify the need for corrective actions. One important information source used by the engineers to assess emergency lighting performance is the Failure Data Trending (FDT) system. FDT is a computer based summary of corrective and preventive maintenance data designed for use in identifying trends in equipment failure.

When deficiencies in emergency lighting are identified, they are required to be documented and corrected. Changes in the applicable procedures during the past year, previously described to the NRC, further increased the level of controls which assure that conditions adverse to the quality of emergency lighting are promptly corrected and that the root cause of significant adverse conditions is determined and actions are taken to prevent recurrence.

In the past, the backlog of corrective maintenance work may have contributed to lower than desired emergency lighting unit availability. Corrective action to address this problem required reduction of the backlog of work orders and work requests relating to Fire Protection.

In addition, corrective action has included an interim action to raise the priority of work on the emergency lighting system. The non-conformance reporting process has been applied to the system since April 1990.

#### Conclusion

The activities involving design, procurement, installation, maintenance (preventive and corrective), testing, and corrective action, while not always properly implemented, have generally been sufficiently effective in assuring that the emergency lighting system was capable of performing its intended function. Often, however, this has required the stimulus of NRC observations and findings. The results of these efforts, if effective, should be apparent in high availability factors. The analysis performed to establish the effectiveness of these programs is described in the following section.



## II.A.2. ANALYSIS OF LIGHTING AVAILABILITY

### II.A.2.a. Purpose

This section describes a method of evaluating the availability of standby equipment and provides the results of such an evaluation for emergency lighting.

### II.A.2.b. Method of Evaluation

An availability indicator was developed to quantify the readiness of Emergi-Lite, Holophane and Exide units to respond to situations in which they would be required. The availability indicator for each component (or group of components) is calculated for a specific period by dividing the number of available days by the number of days in the period. Thus, an availability value of one for a component means the component was always available. A value of zero means a component was never available. This method is basically the method employed by INPO to monitor the readiness of important safety systems to respond to off-normal events or accidents.

Pages five and six of the Inspection Report provide failure data on Holophane, Exide and Emergi-Lite units. The data is presented as a reliability indicator, e.g., 4 of 4 Holophane units failed in 1988 which made the Holophane units appear 100% "unreliable". While the numbers are accurate, this method of portraying failures is misleading. Unreliability is a useful measure for continuously functioning systems, where there is no possibility of repair. In that limited circumstance, the unreliability measure predicts the likelihood that a system will fail to fulfill its design basis requirement.

For standby systems, such as emergency lighting, diesel-generators, auxiliary feedwater and safety injection systems, where routine maintenance and testing can enhance performance, the availability measure is a more appropriate predictor of the actual likelihood that the component/system will work. For example, consider an emergency light that is subjected to 20 demands during a year, and experiences 19 successful burns and one failure. The unavailability may be calculated to be 5%, while the unreliability, as that term is used in the Inspection Report, would be 100% (calculated using a failure of a single unit in the year). The actual likelihood that the light is not going to burn, on demand is 5%, not 100%. APS analyzed the emergency lighting failure data and presents the results below in terms of availability.

This analysis requires the development of known and estimated unavailable periods. The known unavailable periods are the times a component is not available for service when the beginning and ending times of the unavailability are known. The estimated unavailable periods are the average times a component was in a failed state before discovering a failure during preventive maintenance or demand. This time is estimated as one-half the time since the



component was last known not to be in the failed state. Thus, for a component which failed an 8-hour discharge test, the estimated unavailable time is one-half the time since the last successful 8-hour discharge test for that component. A more recent preventive maintenance date would be used if a determination could be made that the specific failure mode would have been detected at that time through maintenance. The unavailable times described earlier are only those stemming from events judged to be system failures. The analysis includes a light as having failed the 8-hour discharge test if the light burned for less than 8-hours, or if it burned for the 8-hour period but did not meet the acceptance criterion for minimum voltage at the end of the discharge test.

The data used to determine unavailable periods is based on a review of available corrective and preventive maintenance work orders for the Holophane, Exide and Emergi-Lite units. This review involved retrieving a complete copy of each work order and reviewing it to determine what problem was corrected and its effect on the capability of the equipment to function. PM tasks were reviewed to identify new failures that may not have been reported previously. Examples of the results of this review are described in greater detail in Attachment E. The availability evaluation extends from June 29, 1989 to June 30, 1990. Although selection of this period is based on time and resource constraints, a one year period is believed to be representative of lighting performance during the inspection and its current condition.

#### Preconditioning

A question has been raised concerning the effect of preventive maintenance performed prior to the 8-hour functional tests. It was postulated that this practice biased the results of the 8-hour testing, making the results appear better than they were. A corollary question was raised concerning APS' ability to reconstruct the facts as to what work had been performed under Preventive Maintenance work orders because of a perceived lack of a requirement to document the work.

If a PM task required adding electrolyte to a battery when the level was low, it is correct that there may have been no way to determine from the records whether the level was low. The technician would perform the step and sign it off as completed. If the step required recording the as-found level first, it would be recorded as required. The salient point is that plant personnel are required to follow procedures. If additional work is performed under the PM work order, the work order must be amended to reflect the additional scope. It is then possible to determine whether additional work was performed by reviewing the work order.

The effect of this PM activity or "preconditioning" on the 8-hour tests varies for the different types of lights. The Emergi-Lites have no possible adjustments and use dry cell batteries that do not require maintenance. Any preconditioning would minimally impact the test.

The Holophane and Exide batteries are in controlled environments and have a monthly PM task that requires inspection of the batteries and the inverters. These tasks are frequent enough to ensure good condition of the equipment without relying on preconditioning. Specifically the Holophane PM allows cleaning of battery terminals and adjustment of float voltage before an 8-hour test. The float voltage is also adjusted monthly, which is more than sufficient to stay within the specification.

The test procedures for Exide units were revised during the period of concern. The initial version did not require adjustments to the units prior to discharge, but did require checking the charging current to verify the batteries were not subject to a high charging current. A high charging current is indicative of a problem and would have to be corrected prior to the test. This corrective maintenance would be documented in the PM work order, or as a separate Corrective Maintenance (CM) work order and would be identified as a failure. The more recent version of the test provides for adjustment of the float voltage, but neither directs nor precludes an additional charging period prior to discharge.

We also note that the independent study by Impell indicates that "[t]here are no formal NRC requirements to perform 'as found' testing."

Although, preconditioning may have affected test results, we believe the results are nevertheless representative and, in the absence of any other analyses, constitute the best evidence of the actual availability of the lighting.

#### II.A.2.c. Results

The following table presents the results of the evaluation. The numbers provided are calculated average availabilities using the method described above.

	UNIT 1	UNIT 2	UNIT 3	PLANT
EMERGI-LITE	95%	88%	100%	94%
EXIDE	93%	40%	88%	74%
HOLOPHANE	99%	94%	87%	93%

The results fall into two ranges. The Emergi-Lites and Holophanes are in the range of 93% availability, while the Exides show roughly 74% availability.

The lower availability of the Exide Uninterruptible Power Supplies (UPS) is due to a problem with the low voltage disconnect relay setpoint which was discussed in previous correspondence and corrective action is being taken. A failure in the Unit 2 inverter QDN-F01 that had not been reported previously, was discovered during this work order review. This failure resulted in the UPS tripping after 7 1/2 hours of service during a January 1990 test. Even though the availability was low in Unit 2, the UPS would have provided 7 1/2 hours of light during most of the unavailable periods.

Corrective action for this type of failure has been developed and the setpoints for all low voltage disconnect relays for Exide UPSs will be lowered.

Functionally, the emergency diesel generators provide the control room lights with a redundant power source. In most Appendix R events (loss of offsite power and fire), the emergency diesels and the Exides may be assumed to be available to provide emergency lighting in the control room. APS views the cause of the low availability on the Unit 2 Exide UPS as being a failure to take prompt corrective action.

Further information regarding the methodology of this analysis and related data is provided in Attachment E.

### II.A.3. CORRECTIVE ACTIONS

APS is taking further action to ensure the continued availability of the Emergency Lighting System at PVNGS including:

#### Changes to design:

Emergi-Lites will be replaced with Holophane Modular Power Stations (MPS) and fluorescent fixtures. This modification is expected to be complete in August 1990.

Holophane MPS's will be upgraded to larger capacity units by the end of October 1990. See additional discussion in the APS response to Concern 10 in Attachment D.

The low voltage disconnect relay setpoint will be lowered on all Exide Uninterrupted Power Supply (UPS) by the end of August 1990, contingent upon material availability.

#### Changes to the Test Program:

Preconditioning has been removed from the 8-hour discharge tests that are approved for use.

Capacity Discharge Tests will be written and implemented to measure battery capacity.

A review will be performed of the controls applied to emergency lighting to determine if additional controls are required. This review will be completed by December 31, 1990.

#### Changes to the Preventive Maintenance Program:

On selected lighting units, the quarterly preventive maintenance (PM) interval will be changed to monthly in a pilot program to determine if further enhancements to availability result. See Additional Discussion for Concern 15 in Attachment D, which provides the results of Impell's independent review of emergency lighting.



APS is undertaking a major program to review and upgrade the quality of the Preventive Maintenance Program, and PM tasks. As part of this effort, the basis for the content and frequency of PMs will be documented.

**Changes to the Corrective Maintenance Program:**

The priority of emergency lighting work orders has been raised to Priority 2 as an interim measure. APS is currently evaluating this measure with the intent of focusing its efforts on the fire protection related work orders associated with systems/components which provide protection for safety-related areas or equipment.

**Changes to Engineering Evaluations:**

An on-site Fire Protection Engineering Group is being established within the new Site Technical Support organization to improve coordination and focus of fire protection engineering support.

**Changes to Failure Data Trending (FDT) Program:**

Changes to the content and frequency of the quarterly FDT reports and creation of a new Component Engineering Section to coordinate component performance monitoring are expected to improve the analysis of failure data information and identify corrective actions.

**II.A.4. CONCLUSION**

The programs to ensure the availability of emergency lighting, while still subject to further improvement, have nevertheless proven their worth. In effect, programs adopted by APS to comply with applicable regulatory requirements for design, procurement, installation, maintenance, testing, and corrective action, have provided, with limited exceptions, emergency lighting that has a high degree of availability.

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II.B.

ADEQUACY OF QUALITY ASSURANCE PROGRAM

1. Summary of NRC finding:

Prior to August 1989, the APS Operations Quality Assurance Criteria Manual (OQACM) had not been applied to all fire protection activities. At the time of the inspection, emergency lighting components were classified as Quality Augmented but the QA requirements had not been fully implemented. Consequently, the quality of design, procurement, installation and testing had not been verified. The failure to properly implement the required QA Program appears to have contributed to inadequate corrective actions, inadequate testing and inadequate preventive maintenance intervals.

2. Summary of APS Position:

Through an error during the transition from construction to operations, APS did not properly classify the Appendix R emergency lighting system important-to-safety. In 1989, APS reclassified the Appendix R emergency lighting as important-to-safety, and initiated action to make emergency lighting subject to the QAG (Quality Augmented) Program. At the time of the inspection, APS had not yet fully implemented the QAG program for emergency lighting. At the present time, APS has identified and documented known QA Program implementation deficiencies for emergency lighting and is pursuing implementation of corrective actions to address those deficiencies. Where applicable, interim corrective measures are in place. The Inspection Report states that the classification error apparently contributed to three deficiencies, inadequate corrective actions, testing and preventive maintenance intervals.

II.B.1

APS RESPONSE

The NRC, during review of the application for Operating Licenses for PVNGS Units 1, 2 and 3, asked APS Question 260.10 to clarify an apparent inconsistency between FSAR Tables 17.2-1 and 3.2-1. Table 17.2-1 indicated that the Fire Protection Quality Assurance Program is met as part of the Quality Assurance Program under 10CFR Part 50, Appendix B. Table 3.2-1 indicated that the Quality Assurance Program did not apply to the Fire Protection systems. In response to this question, APS amended Table 3.2-1, Section 17.2.2.2 and Table 17.2-1 and provided the following answer to NRC Question 260.10:

Amended table 17.2-1 indicates that the Quality Assurance program during the operations phase complies with the Quality Assurance Program guidelines of Appendix A to (BTP) APCSB 9.5-1. Application of the Quality Assurance Program to Fire Protection Program activities is described in amended paragraph 17.2.2.2. Amended table 3.2-1 indicates that the pertinent requirements are applied to Fire Protection Program activities during the operations phase.





Amended Table 3.2-1 listed certain fire protection system components, but did not include emergency lighting components other than supports and hangers.

In the design and construction phase, PVNGS used a classification system of "Q", "R" and "S" to define the application of Quality Assurance Program requirements. Items classified as "Q" were considered safety related and required full application of the 10CFR50, Appendix B, QA program. Class "R" was used to identify those items considered important to reliability and certain quality assurance controls were applicable. Class "S" identified the remaining items which were designed, procured and installed in accordance with industry practice. The Emergency Lighting System was classified as quality class "S" during the design and construction phase of Palo Verde.

During the transition from construction to operations, the APS Operations Quality Assurance Program was implemented and the quality classification system was modified to allow proper application of the QA program to operations phase activities. Items previously classified as "Q" became "SR" and were subject to the full 10CFR50, Appendix B, QA program. Items previously classified "R" or "S" were reclassified Important-to-Safety ("ITS") only if a specific commitment was identified in Table 3.2-1 requiring application of the QA Program. When developing and implementing this methodology for reclassification, it was not recognized that other UFSAR commitments (e.g. Sections 9.5 and 17.2) should also be used when classifying plant components. As a result, the emergency lighting system (except supports and hangers) was classified as non-quality related (NQR).

As operational experience increased, APS recognized the need for a more detailed classification for systems, structures and components that documented the classification basis. In 1988, a new classification procedure was adopted and a project was initiated which provided for a detailed evaluation of major components in the PVNGS equipment database. The component contribution to safety was defined and the basis for classifying the item as safety related ("Q"), quality augmented (QAG) or non-quality related (NQR) was established. The new classification process ultimately determined that the emergency lighting required to meet 10CFR50, Appendix R, should be classified QAG.

Corrective Action Report (CAR) 90-10, initiated on March 19, 1990, identifies deficiencies in the timeliness of completing procedure changes and other implementing document changes associated with classifying the system QAG. The CAR also specifically cites failure to include maintenance and procurement activities associated with emergency lights under the QA program. Following completion of the corrective actions prescribed by this CAR and associated corrective action documents, the QA program will be applied to the Emergency Lighting System to the full extent required by APS commitments.

At the enforcement conference on July 10, 1990, APS was asked to prepare a Justification for Continued Operation (JCO) addressing the application of the QA Program to fire protection equipment, including Appendix R emergency lighting. The JCO, which was transmitted to the NRC by letter dated July 20, 1990, compared the QA requirements of BTP APCS 9.5.1, Appendix A with the administrative control procedures implemented by APS. As documented in the JCO, the review concluded that the controls provided for systems such as Appendix R emergency lighting, which had until recently been classified as NQR, had some of the elements of those for QAG equipment. The APS Quality Assurance organization had performed periodic audits and monitoring of NQR portions of the Fire Protection Program. These audits generally confirmed that the administrative controls were effective and properly executed. Based on the results of the review, the JCO concluded that the fire protection systems and equipment (including the Appendix R emergency lighting) are adequate to support continued safe operation of PVNGS.

The Impell independent review concluded, on the basis of the language of the PVNGS license conditions and UFSAR QA commitments, that emergency lights could be logically required to be classified QAG. Impell recommends that the implementing procedure be revised to ensure QA commitments are being satisfied. APS will implement these recommendations. (See Attachment C, at pages 1 and 2.)

The Inspection Report states that the failure to properly implement the required QA Program appears to have contributed to:

a) Inadequate corrective actions

APS recognizes that in hindsight it should have been more effective in identifying the need for corrective actions and more timely in their implementation. Nevertheless, APS did implement corrective actions, including actions to prevent recurrence of various failures of emergency lights. Examples of such actions are presented in Attachment B on page 1.

b) Inadequate testing

The NRC concern regarding the adequacy of testing relates to the use of preconditioning prior to testing. However, the testing of emergency lights was a part of the Preventive Maintenance Program, and not considered to be surveillance testing. Since it is not improper for testing to be included as a final step in a preventive maintenance task, it is unlikely that QA review would have identified any problem with the use of preconditioning. However, proper implementation of QA criteria governing tests/test control would have resulted in a formal test program for emergency lighting. In any event, as shown in the response to Apparent Violation 90-25-01, the preconditioning is unlikely to have had a significant effect on the overall test results.

c) Inadequate Preventive Maintenance intervals

As discussed in response to Apparent Violation 90-25-01, the preventive maintenance intervals were based on vendor recommendations, and have been largely demonstrated to be successful. During the inspection, based on the results of special tests, APS did decide to shorten the preventive maintenance intervals for the Emergi-Lite units.

II.B.2. CORRECTIVE ACTION

As stated earlier, emergency lighting has been classified as QAG and the QA Program for the emergency lighting systems and equipment is in the process of being implemented as discussed in Reference 2. Known deficiencies have been documented on appropriate corrective action documentation. Interim corrective actions, where necessary, are in place and resolutions are being tracked by QA. Plant personnel have been made aware of the changed quality classification and the actions to be taken have been outlined in a letter from the Vice President-Nuclear Production to all plant personnel.

II.B.3. CONCLUSION

The failure to fully apply APS QA Program to emergency lighting can be traced to an ambiguity and inconsistency in application of the PVNGS UFSAR when developing the quality classification for certain plant equipment. As described in our July 20, 1990, JCO, many of the QA requirements which would have otherwise been applied were in fact compensated for by other procedures and programs and none of the QA Program implementation inadequacies on emergency lighting compromised the ability of PVNGS to achieve and maintain safe shutdown in the event of a fire.

## II.C.

### PRE-FIRE STRATEGIES MANUAL REVIEW AND UPDATE

#### Summary of NRC finding:

The Inspection Report states that, although a formal engineering review of the Pre-Fire Strategies Manual (PFSM) was performed in 1988, this review only addressed fire fighting concerns. It concludes that APS' failure to perform an annual review of the Pre-Fire Strategies Manual is considered to be an apparent violation of Technical Specification 6.8.2.

#### II.C.1

#### RESPONSE TO INSPECTION REPORT CONCERNS

A careful review of Apparent Violation 90-25-03 indicates that there may be some misunderstanding as to the actions taken by APS to fulfill the requirement that the PVNGS PFSM be reviewed every 12 months. In 1988, as part of the resolution of a Corrective Action Report (CAR CE86-0203), APS performed a complete review of the PFSM and included the requirement for annual review of the manual in Procedure 01AC-0AP02. Procedure 01AC-0AP02 requires review of the PFSM to assure that plant design changes and operating practice revisions made in the period since the previous annual review are captured in periodic revisions. Annual reviews are not required to encompass technical re-evaluation of the design basis.

There may also be some misunderstanding concerning the scope of the PFSM review performed in 1988. That review was accomplished over the time period from about February to April 1988. This was a complete review of the PFSM, not just the firefighting concerns, with participation from the onsite Fire Department personnel and the offsite Nuclear Engineering Department (NED). As part of the review, and contrary to the statement in Inspection Report 90-25 (page 11), NED did review the effect of design changes on the Spurious Actuation Evaluation Concerns section of the PFSM.

During the 1989 annual review, which was conducted during a period from May to July 1989, potential questions were identified with respect to the original Spurious Actuation Studies which are the basis for the Spurious Actuation Evaluation Concerns section of the PFSM. As a result, the annual update and resolution of these questions were included as a task under the Fire Protection Design Basis Review (DBR). When the DBR task is completed, the results will be incorporated in a future revision of the PFSM. Discrepancies that impact operator actions are corrected as they are identified.

In summary, (1) a procedure requirement for annual reviews was implemented in 1988; (2) these annual reviews are updates and do not require technical re-evaluation of the design basis of the PFSM and; (3) as a result of questions raised in 1989, such a re-evaluation task is now underway as a part of the Design Basis Review Program.



The Inspection Report discusses several specific concerns identified by APS regarding the PFSM (paragraph nos. 2 and 3 on page 11). As the following discussion demonstrates, those concerns were self-identified by APS and appropriate actions were taken to correct them. To the extent that the Inspection Report implies from these concerns that the 1988 review of the PFSM was of inadequate scope, it is mistaken. The concerns do not arise from any design or operational change made prior to the 1988 review. Rather, they are based on the questions identified concerning the original Spurious Actuation Studies, which are now being handled under the DER.

The concern listed on page 11, paragraph number 2, of the Inspection Report is associated with the accessibility to perform manual operator actions as described in the PFSM for fire zones 42B and 47A. This item was identified by APS, on 12/19/89, as a result of research (unrelated to annual reviews) being performed to support the Fire Team Advisor training program. The PFSM was found to contain an error in that an operator action was required to be performed within the fire zone in which the fire is postulated. This action was included in the original Spurious Actuation Study and therefore would not have been identified during a normal annual review of plant changes which could affect the PFSM. A Quality Deficiency Report (QDR 89-0125) was initiated on 12/19/89. Corrective Action for this item was to revise the PFSM and to identify operator actions remote from the postulated fire. Subsequently, a revision to the PFSM was issued on 2/23/90 (approximately 60 days after initiation). As interim corrective action, prior to PFSM revision, the onsite Shift Technical Advisor was advised of the concern by phone and also through a Problem Resolution Sheet (PRS). The PRS was issued by Engineering which provided the corrected actions for fire zones 47A and 42B to PVNGS Unit Operations.

The following chronology, which was requested during the Enforcement Conference, provides completion dates for actions associated with resolving QDR 89-0125:

- 12/19/89      Problem initially identified by Corporate Fire Protection Engineer. Fire Department Supervisor notified by meeting and NED fire protection engineer notified by phone.
- 12/20/89      (1)    STA group contacted by phone to advise of problem.
- (2)    PRS (PRS No. 573) issued by NED Mechanical Engineering with alternate compensatory measures identified in the immediate corrective action section.
- (3)    QDR-0125 issued by Site Fire Department to track resolution of deficiency.

- (4) Fire impairments issued by Site Fire Department against pre-fire strategies manual for affected fire zones in all units. Impairment forms require Shift Supervisor or Assistant Shift Supervisor approval. Additional fire hose station capability provided for each zone as compensatory measure.

12/28/89

Letter issued from NED to Emergency Planning and Fire Protection Department which provided corrections to the pre-fire strategies manual. Corrections requested were consistent with initial corrective action. Copy provided to each plant manager.

02/23/90

Revision to fire zones 42B and 47A issued to revise manuals.

The second concern identified on page 11 of the Inspection Report (paragraph number 3) relates to fourteen (14) other APS identified concerns with respect to accessibility to perform operator actions. These concerns were identified by the Nuclear Engineering Department during the course of the Design Basis Review (DBR) review of the Spurious Actuation Studies and documented in QDR 90-0175. As mentioned previously, this review was initiated by APS in connection with the 1989 annual PFSM update, not as a result of this NRC inspection. It should be kept in mind that these concerns arose from questions concerning the original studies and do not reflect on the adequacy of the required annual review; that is, it does not suggest that the review failed to capture design and operational changes issued between the original studies since the 1988 annual review. The concern will be resolved as part of the review and update of the Spurious Actuation Studies.

Another matter mentioned in the Inspection Report (second paragraph of Section C, page 10) relates to "an apparent inconsistency" between the PFSM and the Spurious Actuation Study for Fire Zones 42B and 47A. APS has reviewed the Spurious Actuation Studies and the PFSM for Fire Zones 42B and 47A and found that, notwithstanding differences in the wording, the meaning and intent are the same.

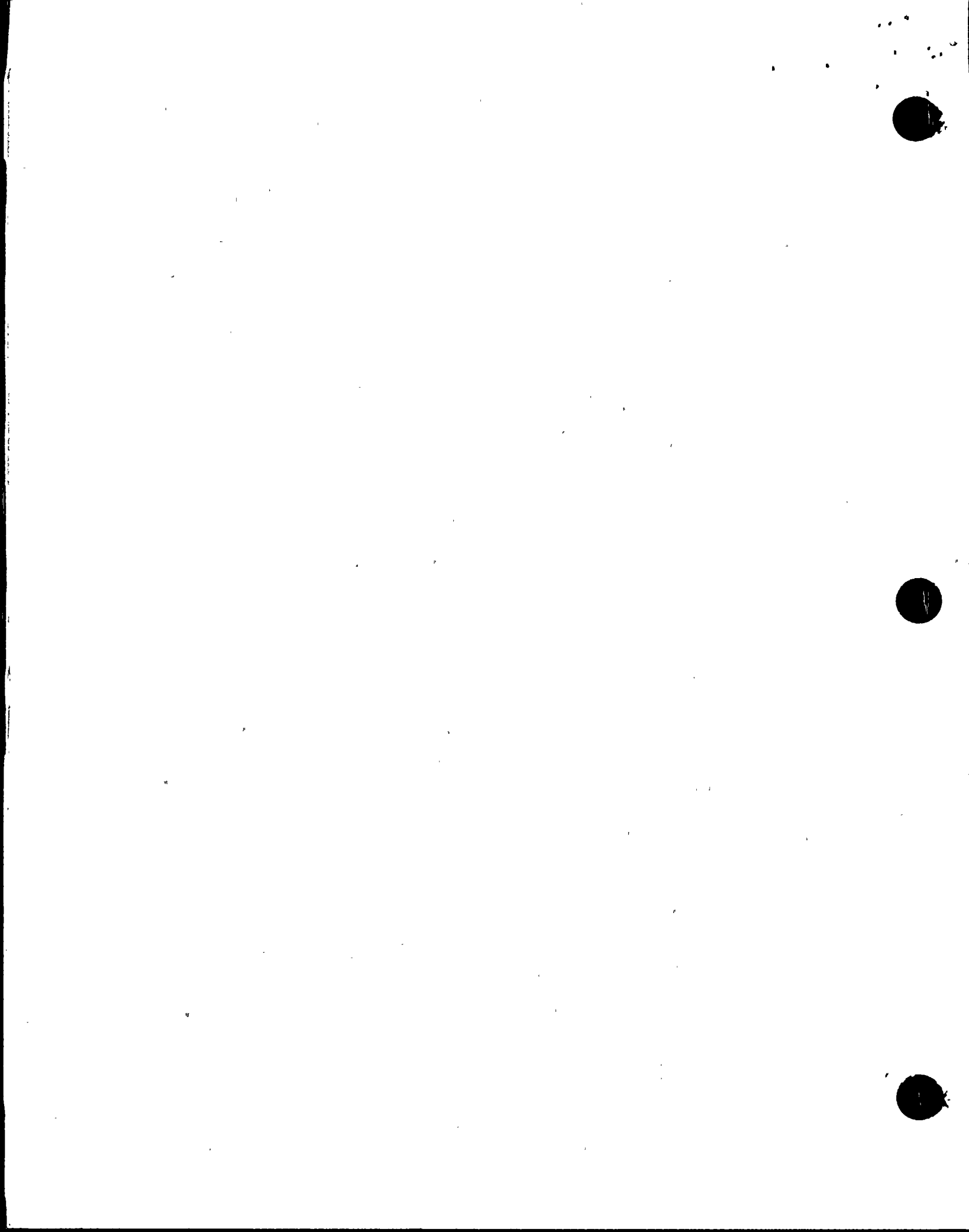
The Impell independent review concluded that APS was responsive to the NRC Concern on this matter.

## II.C.2.

### CONCLUSION

At the time of the NRC inspection, APS was performing annual reviews and updates of the PFSM in accordance with Administrative Procedure 01AC-OAPO2 and therefore was in compliance with Technical Specification 6.8.2. The discrepancies discussed in the Inspection Report regarding the Spurious Actuation Evaluation Concerns Section of the PFSM, were identified by APS and appropriate corrective actions were taken.

The actions to address the remaining PFSM deficiencies mentioned above are documented on CAR 90-014, which will track these issues to resolution.





II.D.

ADHERENCE TO DESIGN CODE REQUIREMENTS

Summary of NRC finding:

Section 4 of the Inspection Report (page 11) states that Appendix R Emergi-Lite units installed in an outdoor, damp location were not tested and approved for use in outdoor wet or damp locations as required by Article 410-4 of NFPA 70-1975 and the facility operating licenses. Appendix A of the Inspection Report implies that PVNGS license conditions, interpreted in conjunction with NFPA 70-1975, require that emergency lighting used outdoors be tested by a nationally recognized testing laboratory.

The Inspection Report concludes that "Failure to provide emergency lighting of approved design for outdoor use to support safe shutdown is considered to be an apparent violation of Facility Operating License Nos. NPF-41, NPF-51 and NPF-74."

Summary of APS Position:

The Emergi-Lite units were designed, purchased and installed in accordance with NFPA 70-1975. NFPA 70-1975 does not, by Article 410-4 or any other article, require that emergency lighting be tested by a nationally recognized testing laboratory. NRC BTP 9.5-1, when read in conjunction with NFPA 70-1975 and other PVNGS licensing commitments, does not indicate that testing by a nationally recognized testing laboratory is required or recommended for emergency lighting. The selection of the Emergi-Lite units was based on careful consideration of the environmental conditions, the applicable code and regulatory requirements and the characteristics of the lighting units. After receipt of the Emergi-Lite units, APS decided to replace them with a centralized inverter system, due to concerns about excessive maintenance that would be required over the long term. The replacement is expected to be completed by the end of August 1990.

II.D.1.

APPLICABLE REGULATORY REQUIREMENTS

The sections of the UFSAR which provide design criteria for the emergency lighting system required by Appendix R are given below:

Section 9.5.1.1.1.R. "Safety Design Basis Eighteen"

"Emergency lighting systems shall be provided in accordance with the guidance provided in NRC Branch Technical Position APCSB 9.5-1 (revised February 2, 1977) and 10CFR50, Appendix R, Section III.J (issued September 1, 1982), in areas needed for operation of safe shutdown equipment and in access and egress routes thereto."



### Section 9.5.3.1.3 - "Codes & Standards"

"Design and Installation of the plant lighting systems use guidance provided by the National Electrical Code (NFPA No. 70-1975/ANSI CI-75) and the Handbook of the Illuminating Engineering Society."

Thus, APS chose to use industry guidance (the NEC and the IES Handbook) to design and install the emergency lighting system. This is consistent with the NRC staff guidance in NUREG-0800, Section 9.5.3., which states that emergency lighting systems are acceptable if they conform to the IES Handbook as related to system design and illumination levels "as recommended for industrial facilities."

The NEC provides guidance to ensure the "practical safeguarding of persons and property, from hazards arising from the use of electricity" (NEC 1975, article 90-1.(a)). The guidance for emergency lighting systems is found in Article 700-3 of the NEC, which requires that the equipment be approved by stating that "all equipment shall be approved for use on emergency systems." Article 410-4 of the NEC provides guidance as to wet location applications by stating that "fixtures installed in wet or damp locations shall be approved for the purpose and shall be so constructed or installed that water cannot enter or accumulate in wireways, lampholders or other electrical parts." Article 100 of the NEC defines "approved for the purpose" as "approved for a specific purpose, environment, or application described in a particular Code requirement." Article 100 defines "approved" as "acceptable to the authority having jurisdiction." In applying the NEC, APS looked to the NRC as the "authority having jurisdiction" over PVNGS 8-hour emergency lighting. The NRC guidance in Branch Technical Position APCS 9.5-1 concerning acceptable emergency lighting provides considerable latitude in the design of emergency lighting. It provides:

1. Section C.4.e. - "Suitable fixed and portable emergency lighting... should be provided..."
2. Section C.4.e.(1) - "Fixed self-contained lighting ... with individual 8-hour minimum battery power supplies should be provided in areas that must be manned for safe shutdown and for access and egress routes to and from all fire areas."
3. Section C.4.e.(2) - "Suitable sealed-beam battery powered hand lights should be provided for emergency use by the fire brigade and other operations personnel required to achieve safe plant shutdown."
4. Section C.2.e.(1) - "Successful firefighting requires testing and maintenance of... emergency lighting ..."

There are no other requirements for testing or labeling, given in the BTP for emergency lighting.

Section 4 of BTP 9.5-1 states "For the user's convenience, some of the terms related to fire protection are presented below with their definitions as used in this BTP." The BTP defines "approved" as:

"tested and accepted for a specific purpose or application by a nationally recognized testing laboratory."

However, the sections describing the requirements for the emergency lighting system do not use the term "approved", but rather, that term is used in other sections of the BTP. For example, Section C5.b.(1) requires that sectional control valves be "approved." By express use of the term "approved" in some sections of BTP 9.5-1 and conspicuous omission of the term in the section for emergency lighting, the BTP 9.5-1 indicates clearly that testing for a specific purpose by a nationally recognized testing laboratory is not required or recommended for emergency lighting.

APS applied the UFSAR commitments, the BTP guidance, and the NEC in providing suitable Appendix R emergency lighting.

The NEC also requires that units used in wet environments be marked "suitable for wet locations" (NEC 1975, article 410-4.(a)). The Emergi-lite Units are marked with an industrial code that signifies that the unit will perform in a wet environment. The lighting units are marked with the NEMA 4X code. Emergency lighting units manufactured to NEMA 4X standards are suitable for use in wet and outdoor locations. Marking the units with the NEMA 4X code informs personnel that the units are "suitable for wet locations." This marking is sufficient to meet the intent of NFPA 70-1975, article 410-4(a).

The Impell independent study concluded that the Emergi-Lite units are suitable for use in outdoor "wet" locations. Impell's review also found no requirement to perform laboratory testing of emergency lighting.

#### II.D.2. DESIGNED FOR ACTUAL ENVIRONMENT

At the enforcement conference, APS was asked to describe the process used to design, purchase and install the Emergi-Lite units.

##### Environmental Conditions

The Emergi-Lite Units are located outdoors in the Turbine Building breezeway and on the outside wall of the MSSS. For the MSSS application, the lamp heads are located remotely from the battery/charger units inside the MSSS to illuminate the ADV's. The Emergi-Lite units were procured based on a maximum outdoor temperature per UFSAR Table 3E-1. The temperature specified in the UFSAR for outdoor use is 116 degrees F. For conservatism, the basis for acceptance of the Emergi-Lite units was 120 degrees F. The units also had to be of an outdoor weather resistant design.

### Determination Of Suitable Vendor

Addition of emergency lighting was among the Units' restart items following the March 1989 event. An aggressive schedule was assigned to install suitable 8-hour lighting prior to restart of the Units. Due to these schedule restraints, APS initially ruled out complex designs, to provide the required additional lighting. It was determined that self contained battery units that could be fed by the available local essential power were the only fixtures that could meet our schedule and the applicable technical requirements.

APS contacted the vendors which were recommended from industry contacts. Emergi-Lite was the only vendor that could provide a light with an 8-hour duration at 120 degrees F ambient, for outdoor use in a NEMA 4X cabinet. The Emergi-Lite units used high temperature batteries and temperature compensated chargers, which provided APS additional confidence that the units were suitable for this application.

At the time the Emergi-Lite Units were procured, the scope of the UL 924 standard for testing and listing emergency light integral Units did not include outdoor applicability. Hence, UL approved integral lighting units could not be obtained for outdoor use. On 2/27/90, UL informed APS that they had now started listing outdoor integral emergency lighting units. However, UL 924 had not been revised. The outdoor listing is done only on specific request by a vendor.

When initially received in 1989, to confirm the vendor's claim of 8-hour duration at 120 degrees F ambient, APS placed an Emergi-Lite unit in an oven at 120 degrees F and then allowed the unit to discharge. Although this test was not formally documented, the discharge time exceeded the 8-hour requirement.

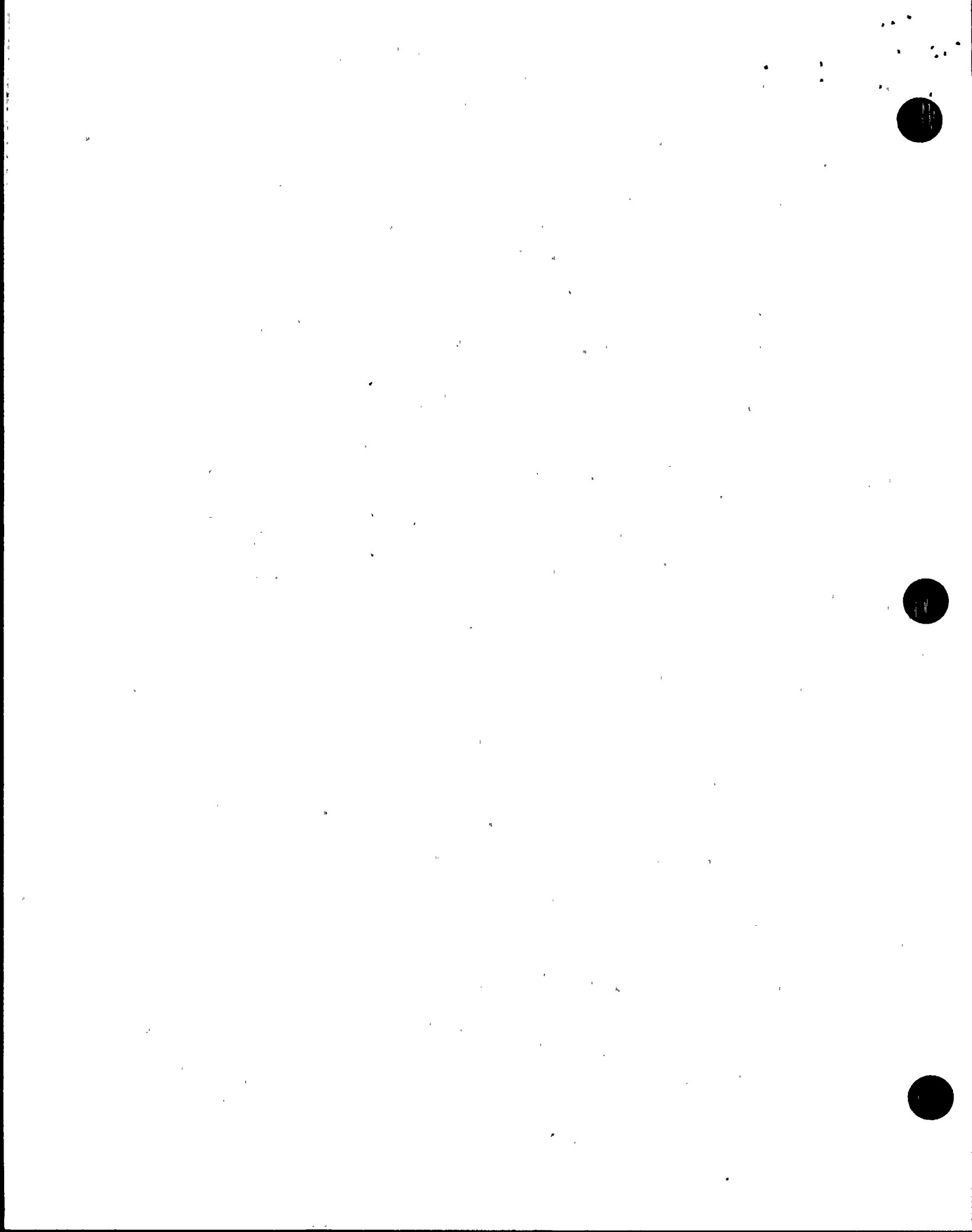
### Basis for Replacement of Emergi-Lite Units

After receipt of the Emergi-Lite units, it was evident that the quality of the workmanship of the units was less than desirable. Manufacturing problems, noticed at the time of receipt, required initial installation repair work to return the units to their as designed state. To avoid excessive maintenance during extended long term service, a plant design change was initiated to replace the Emergi-Lite units with a centralized inverter system.

## II.D.3.

### CORRECTIVE ACTION

The PVNGS Emergi-Lite units are being replaced with a centralized system for which inverters will be located in a mild environment in the Auxiliary Building, and which will have high temperature outdoor fluorescent fixtures located along the breezeway and within the MSSS. All replacements are expected to be completed by August 1990.



II.D.4.

CONCLUSION

APS reasonably determined that testing or listing by an independent laboratory for emergency lighting was not required by the National Electric Code, the UFSAR, or BTP 9.5-1. APS procured, tested and installed suitable emergency lights for the MSSS and Turbine Building Breezeway environmental conditions. To avoid significant maintenance expense, APS is replacing the Emergi-Lite units with a centralized inverter system, which will also meet the design requirements.

In the following discussion we assume, for purposes of argument that the apparent violations are valid and address only their reportability.

1. Apparent Violation 90-25-01:

The facts underlying the violation were developed during the inspection; moreover, the conclusion drawn from the data that the lights were "unreliable" has been the subject of continuing discussion and disagreement between APS and the NRC. Under the circumstances, APS cannot be charged with prior knowledge ("awareness") of either the operative facts which underlie the apparent violation or the ultimate conclusion which is the thrust of the violation (i.e. the lights were "unreliable").

2. Apparent Violation 90-25-02:

APS believed in good faith, if however wrong, that applicable QA requirements were being met. APS had not determined that a violation existed. It may be argued that APS should have been aware of the violation, but even if this were so, the violation is not one which meets the second prong of the test of reportability under the technical specifications (i.e. a condition that would adversely affect the ability to achieve or maintain safe shutdown). The potential availability of diesel-backed essential lighting and required availability of portable hand-held lights would have been sufficient for the limited number of operator actions necessary to achieve and maintain safe shutdown in the event of any postulated fire.

3. Apparent Violation 90-25-03: Even if one assumes that the deficiencies noted in the Inspection Report establish a violation of the requirement for annual review of the Pre-Fire Strategies Manual (PFSM), the violation entails only an administrative requirement. With respect to the specific deficiencies in the PFSM identified by APS, even in the period before they were corrected, these deficiencies would not have adversely affected safe shutdown because the PFSM is only used by operators as an aid. Required operator actions are sufficiently described in existing symptom based emergency operating procedures and abnormal operating procedures, which provide adequate operator guidance for the limited number of actions which may have been inadequately treated in the PFSM. Therefore, the ability to achieve and maintain safe shutdown would not have been adversely affected. Again, the second prong of the reportability test under Section 6.9.3 of the Technical Specifications is not met.





II.E.

REPORTABILITY REQUIREMENTS FOR FIRE PROTECTION EQUIPMENT

Summary of NRC finding:

Apparent Violation 90-25-05 identifies five items as reportable under Technical Specification 6.9.3; the items identified as Apparent Violations 90-25-01, 02 and 03 and two occasions in which inverter EQBN004 was out of service.

II.E.1.

APS RESPONSE

APS did not file reports on these items. APS has reported emergency lighting problems in the past (LERs 86-59 and 89-12) but did not, and does not believe the matters cited in this apparent violation are reportable or that it should be cited with a violation for failing to report them.

APS has reviewed the NRC policy and practice regarding the citing of a licensee simultaneously for violation of a technical requirement and for failure to report the same violation. Our review concludes that licensees are not normally cited for failure to report a violation unless the licensee had been aware of the underlying technical violation or clearly should have been aware of the violation.<sup>2</sup>

The importance of the state of the licensee's awareness as a factor in determining whether it is appropriate to issue a citation for both the underlying violation and the failure to report takes on special significance in the light of the language of Technical Specification 6.9.3. Awareness, in the context of Technical Specification 6.9.3 requires that the licensee knew or clearly should have known that: (1) the condition constituted a violation of the Fire Protection Program (i.e., the fire protection provisions of the UFSAR), and (2) the condition would adversely affect the ability to achieve and maintain safe shutdown in the event of a fire. Unless this two-pronged test is met the reportability requirements of Technical Specification 6.9.3 are not triggered. These principles, as applied to the Apparent Violations in the Inspection Report 90-25, make it clear that none are reportable.

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<sup>2</sup>This is the result one would expect in light of NRC enforcement policy as expressed in 10CFR Part 2, Appendix C:

"A licensee will not normally be cited for a failure to report a condition or event unless the licensee was actually aware of the condition or event which it failed to report." (emphasis added)

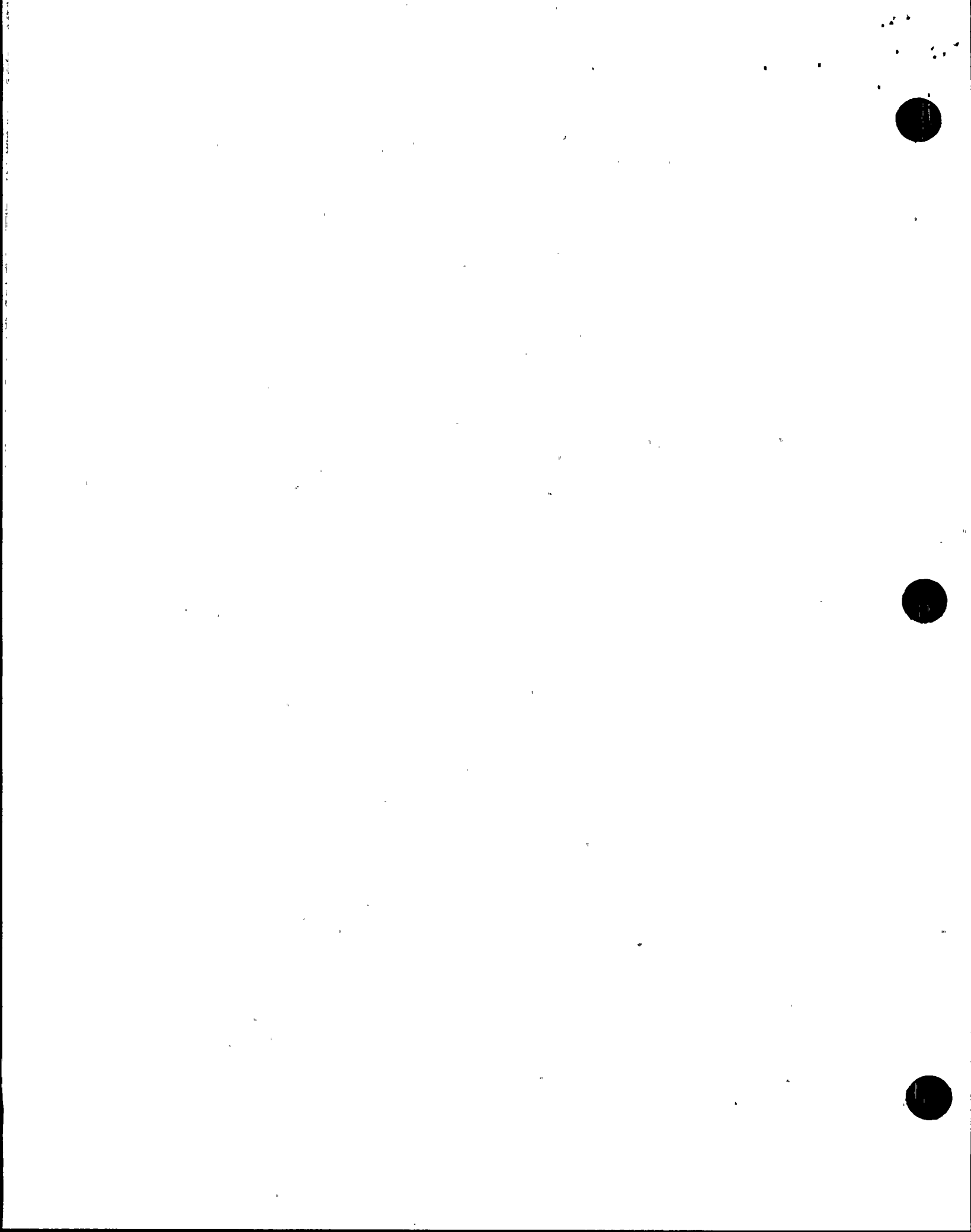


4. Other Reportability Items:

Finally, with respect to the two examples of inverter EQBN004 being out of service (EER 88-QB-003) and NOV 89-08-V01), the facts do not support the conclusion that the condition would have adversely affected the ability to achieve and maintain safe shutdown. Emergency lighting failures of the type involved in the failure of inverter EQBN004 would not be regarded as a condition that would "adversely affect the ability to achieve and maintain shutdown". Available portable lighting would have been adequate to perform the safe shutdown related activities in the affected area in the event of a fire. A further clarification of the facts associated with these items is included in Attachment B on pages 6 and 7.

ATTACHMENT A

CHRONOLOGY OF INSPECTION ACTIVITIES  
INSPECTION REPORTS 90-02 AND 90-25



CHRONOLOGY OF INSPECTION ACTIVITIES

INSPECTION REPORTS 90-02 and 90-25

01/08-4/12/90 Routine inspection activities conducted for Inspection Report Nos. 50-528/90-02, 50-529/90-02 and 50-530/90-02.

01/26/90 NRC/APS Exit Meeting - PVNGS (Inspection 90-02).

02/09/90 NRC/APS Exit Meeting - PVNGS (Inspection 90-02).

02/23/90 NRC/APS Teleconference.

03/23/90 NRC/APS Exit Meeting - PVNGS (Inspection 90-02).

03/30/90 NRC/APS Meeting - Region V (Inspection 90-02).

04/16/90 NRC/APS Teleconference.

04/24/90 Inspection Report Nos. 50-528/90-02, 50-529/90-02 and 50-530/90-02 issuance.

05/16/90 NRC/APS Meeting - Phoenix (Inspection 90-25).

05/17/90 NRC/APS Exit Meeting - Phoenix (Inspection 90-25).

06/14/90 NRC/APS Meeting - PVNGS (Inspection 90-25).

06/15/90 NRC/APS Exit Meeting - Phoenix (Inspection 90-25).

06/19/90 APS submittal to NRC; Emergency Lighting (161-03288).

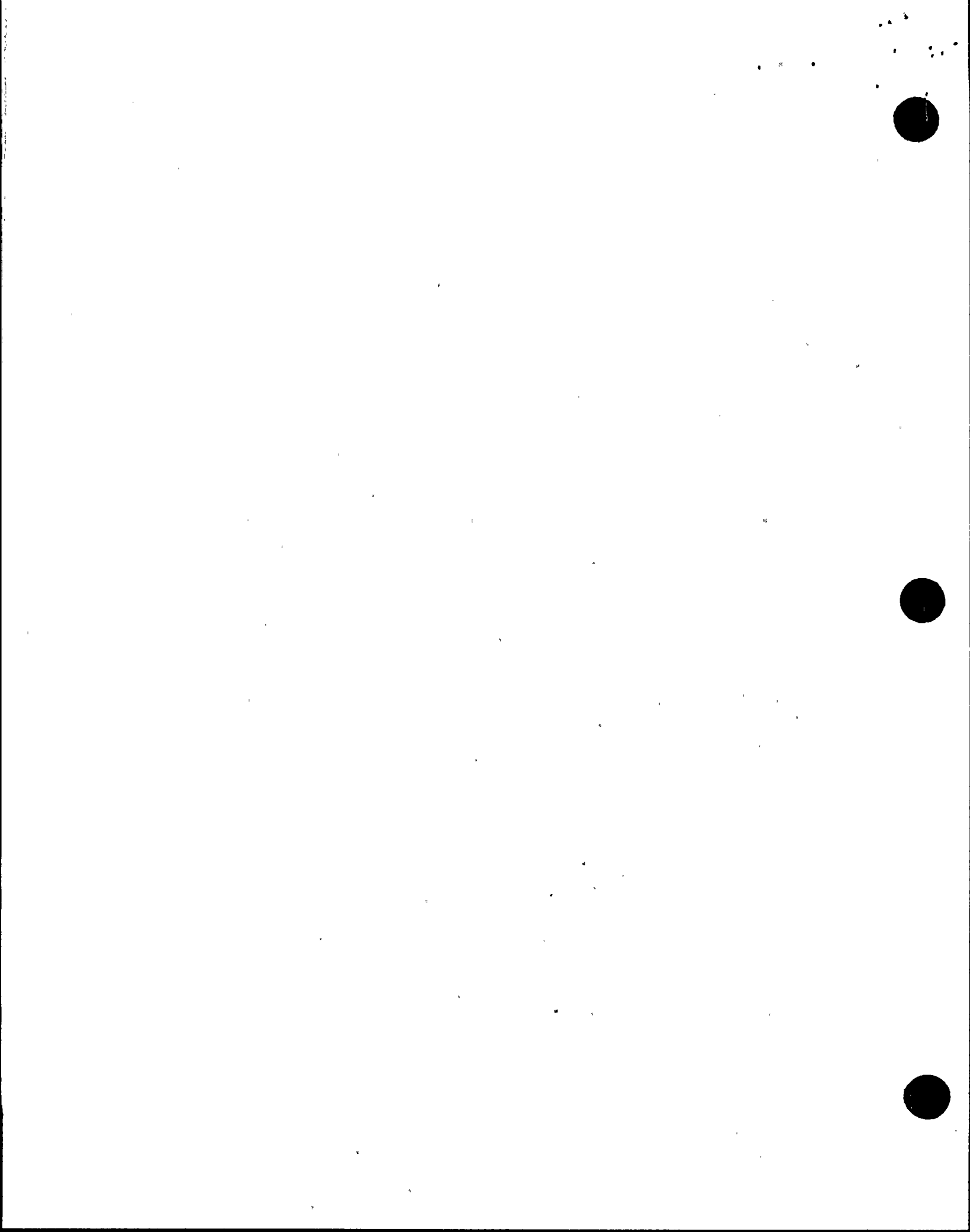
06/23/90 APS submittal to NRC; Emergency Lighting - Exide Power Supplies (161-03294).

06/24/90 APS submittal to NRC; Emergency Lighting - Exide Power Supplies (161-03295).

06/29/90 APS submittal to NRC; Emergency Lighting - Failure Data Update (161-03305).

07/05/90 Inspection Report Nos. 50-528/90-25, 50-529/90-25 and 50-530/90-25 issuance.

07/10/90 NRC/APS Enforcement Conference - Region V.

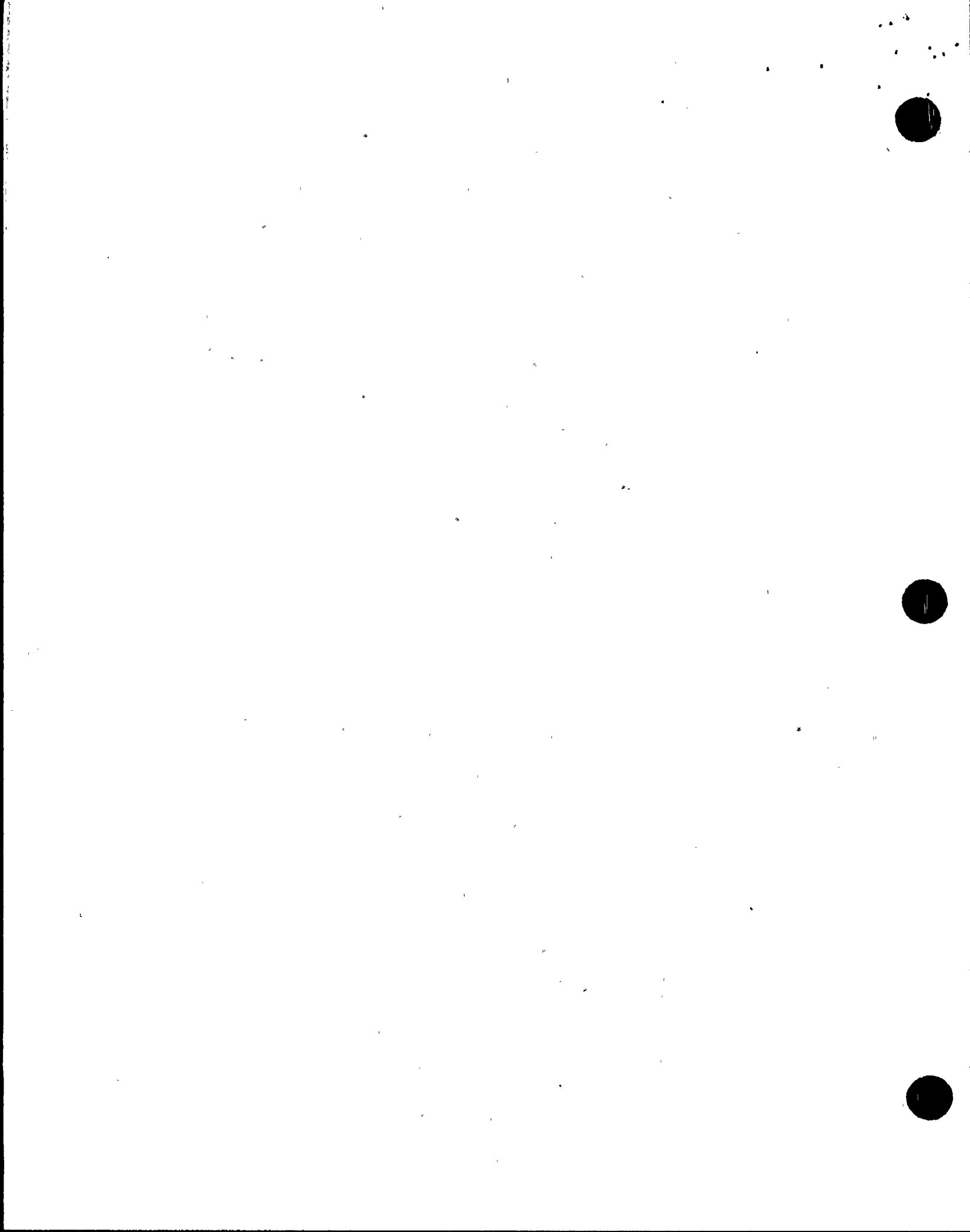




ATTACHMENT B

ADDITIONAL COMMENTS/CORRECTIONS

ON INSPECTION REPORT 90-25



## ADDITIONAL COMMENTS/CORRECTIONS

### ON INSPECTION REPORT 90-25

In addition to the comments and corrections in the body of the report, the following additional matters may require revision of the Inspection Report.

#### Paragraph 3.B.1.a (page 7)

This paragraph states that APS did not appropriately evaluate the numerous, documented emergency lighting system failures and did not implement appropriate corrective action to preclude recurrence of those failures. Examples of Emergency Lighting System failures that have been evaluated, and where corrective actions have been taken include:

- (1) Replacement of Exide battery banks in Unit 1 (1988) and one battery bank in Unit 3 (1987).
- (2) Replacement of the Dual-Lite 4 X 7 fixtures due to their high failure rate. Every failure in the turbine building of a Dual-Lite fixture referenced in the June 29, 1990, letter occurred on this type of light (1989).
- (3) Modification of the relamping PM tasks to ensure that correct lamps are installed. (January 1989)
- (4) Acceleration of the plan to replace the Emergi-Lites after testing in March 1990.
- (5) Lowering the Low Voltage Disconnect setpoint in Exide UPSs to prevent early disconnect of the batteries. The design is complete. Implementation is scheduled for August 1990.
- (6) Increase the capacity of the Holophane modular power station units in response to concerns regarding temperature capacity.

These actions were a combination of self-initiated corrective actions, and corrective actions resulting from NRC questions and activities.

#### Section 3.B.1.C (page F)

#### Paragraph 2 (page 8)

#### NRC Statement

At the time of the inspection, APS preventive maintenance schedules were based on an operating temperature of 77 degrees F instead of actual field conditions.



Comment

Although the existing PM frequency was based on 77 degrees F., at the time of the inspection, the FDT program did not indicate a need to increase the PM frequency. It is true that higher ambient temperatures will increase water consumption due to higher evaporation and charging rates, but evidence of a detrimental rate of electrolyte loss (i.e., faster than the quarterly PM could replace it) would have manifested itself by high failure rates in lights located in the warmest locations of PVNGS. There was no such manifestation.

Paragraph 3 (page 8)

NRC Statement

The discussion in the paragraph is centered on the availability of empirical data from battery vendors to determine the adequacy of batteries in high temperature environments. The inspector determined that, lacking this information, there was not an adequate basis to determine a preventive maintenance (PM) frequency to ensure reliability. The inspector concluded that APS failed to recognize the need to increase PM frequency since field conditions were different than vendor assumptions.

Comment

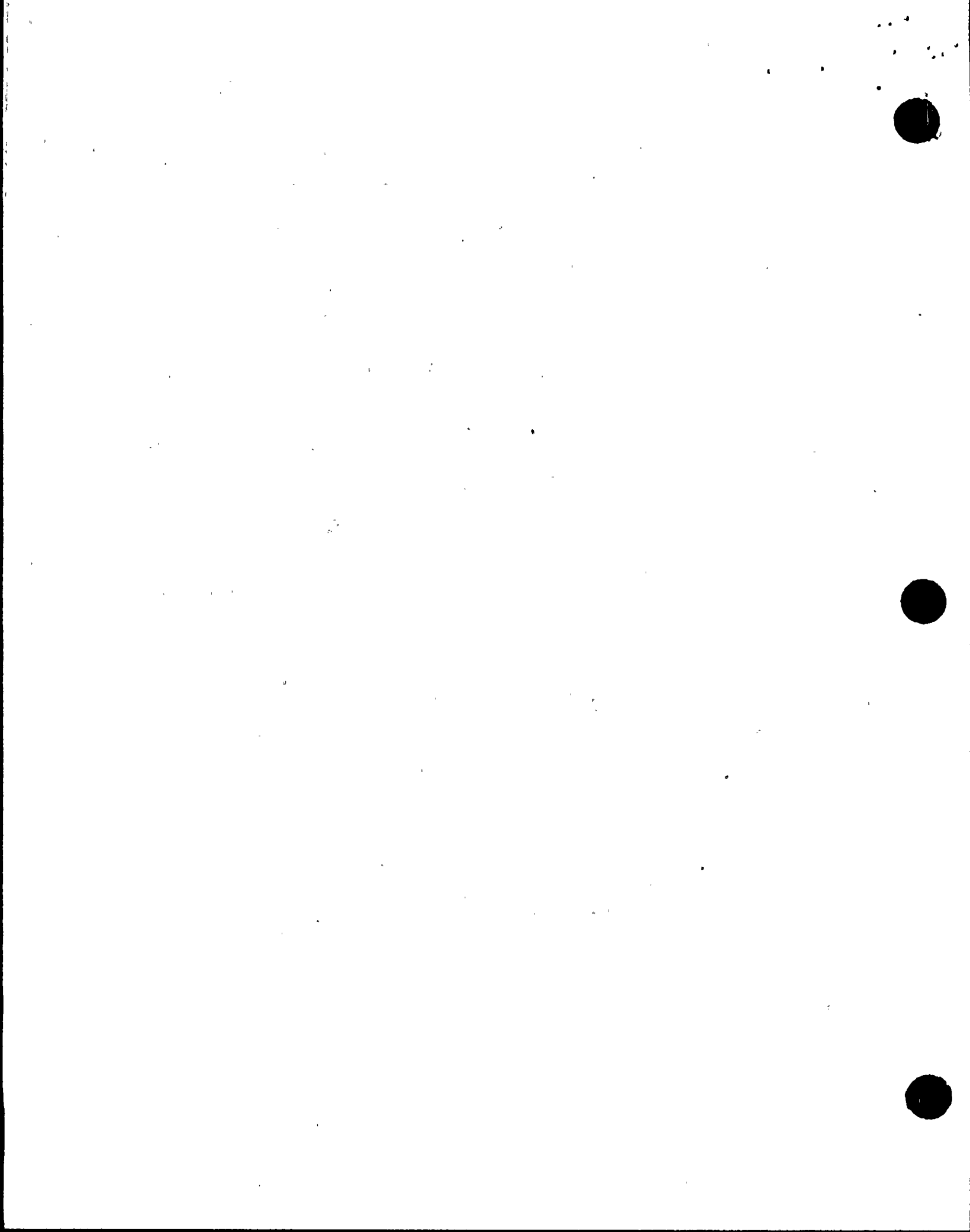
The vendor published battery curves are based on a combination of empirical data and theory. Although no empirical data could be obtained from the vendors to support the curves, APS has a high degree of confidence in these curves based on that fact that:

- . The curves are consistent for the same type of battery among different vendors.
- . The industry generally uses vendor curves for sizing class 1E batteries.
- . The curves follow the basic theory for batteries.

Based on the combination of vendor provided curves and data from the FDT program, the PM frequency has been set and determined to be adequate in all cases except for the Emergi-Lites.

Section 3.B.2 (page 8)

This Section of the Inspection Report relates NRC concerns based on inspector observations. While many of the observations are factual, the significance of those observations is subject to question. APS comments on these matters follow:



Paragraph 1 (page 8)

NRC Statement

This paragraph refers to a problem found in the lighting fixtures inside containment, i.e., electrolyte evaporation. The report states that APS missed an opportunity to apply this information to the safe shutdown lights in areas outside of containment.

Comment

Although the lights inside containment are the same as those outside the containment, the accessibility for Preventive Maintenance (PM) is much different due to ALARA concerns. APS is able to perform routine PMs on the lights outside of containment. Therefore, the NRC premise that electrolyte level from lights inside the plant would be useful input for evaluating problems in lights outside of containment is incorrect.

Paragraph 2 (page 9)

NRC Statement

The inspection report discussed two canceled Plant Change Requests that were written to replace fixtures in Containment and the MSSS. The quoted justification for cancelation of the PCRs provided in the inspection report only applied to the containment fixtures, not the MSSS fixtures.

Comment

PCR 87-13-QD-004 was written to replace the existing Dual-Lite units in the MSSS with a different type of Dual-Lite designed for outdoor use. This PCR was later canceled based on: (1) lenses on existing units were replaced with high temperature lenses, (2) circuit board failures could not be attributed to MSSS environment, and (3) the recent burn test had passed.

PCR 87-13-QD-007 was written to replace the containment (non-Appendix R) lights with an inverter based system. This PCR was canceled due to the following: (1) high cost, (2) all recent (October 1987) burn tests had passed, (3) no ALARA concerns, checks of dosage data showed very low dosages for electricians performing PMs, (4) few man-hours to perform PMs, and (5) EER 87-QD-004 disposition (i.e., adjusting float voltage and adding mineral oil) should mitigate any further electrolyte loss.

EER 86-QD-007 was found to be unrelated to this issue.

Paragraph 3 (page 9)

NRC Statement

The Inspection Report also discussed EERs written to adjust float voltages on Dual-Lite fixtures and questioned the advisability of performing the adjustment.

Comment

These EERs were written to drill a hole on the side of the Dual-Lite cabinets to allow easy access to the float voltage adjustment potentiometer. This modification was made for ALARA purposes to avoid dismantling the cabinet in high radiation areas.

Paragraph 4(a) (page 9)

NRC Statement

The NRC expressed a concern, based on a vendor's letter, which stated that the warranty on the battery would be void if APS adjusted battery float voltages.

Correction

The Dual-Lite technical manual provides the acceptable float voltages, and these values are used for adjustment of the float voltages. The notification from the vendor was a commercial issue and not the basis for the decision on adjustment of the float voltages.

Paragraph 4(b) (page 9)

NRC Statement

The NRC expressed a concern about adding mineral oil to battery electrolyte.

Comment

APS contacted Dual-Lite in 1987 and used the vendor's recommendation to support adding mineral oil. On October 24, 1989, a Dual-Lite letter provided a recommendation concerning the questionable use of mineral oil. However, further discussions with Dual-Lite on April 30, 1990, indicated that mineral oil was only a problem with lead-acid batteries.

To clear this issue, APS contacted the battery vendors directly. They supported APS' original position that mineral oil did not cause a problem when used to top off the electrolyte.

In addition, APS inspected all the Dual-Lite eight (8) hour batteries and found no evidence of mineral oil addition.





Section 3.C (page 10)

This section of the Inspection Report concerns the apparent failure to perform an annual review of the Pre-Fire Strategies Manual.

Paragraph 4, Concern 1 (page 11)

NRC Statement

The NRC states that, at the time of the inspection, APS had not reviewed the Pre-Fire Strategies Manual in accordance with Technical Specification 6.8.2 and procedure 01AC-OAP2.

Comment

The correct procedure number is 01AC-OAPO2 and, as noted in the enclosure, APS has met those requirements.

Section 4.0

This section of the Inspection Report concerns the apparent failure to provide emergency lighting of approved design for outdoor use to support safe shutdown.

Paragraph 3 (page 12)

NRC Statement

The NRC states that EER-QD-007 concludes that the Emergi-Lite units were poorly constructed and were not tested and approved for outdoor use.

Comment

APS disagrees with the third sentence. EER 89-QD-007 did not state that the lights "were not ... approved for outdoor use." The EER documented an apparent paperwork problem with labeling and poor workmanship. The EER's disposition was that the units were suitable for outdoor use.

Paragraph 7 (page 12)

NRC Statement

The NRC states that because the Emergi-Lites are in NEMA 4X enclosures, APS considers them installed indoors.

Comment

APS disagrees with the words "in essence installed indoors" found in the third sentence. It is APS's position that the units are suitable for outdoor use.

Paragraph 8, Item 2 (page 12)

NRC Statement

NRC states that APS altered the design of the Emergi-Lite units.

Comment

APS did not alter the Emergi-Lite units. They were advertised by the vendor as suitable for outdoor use and APS purchased a complete unit.

Paragraph 8, Item 4 (page 13)

NRC Statement

The NRC states that APS did not sufficiently evaluate the potential for short circuits in the Emergi-Lite units installed in the MSSS breezeway.

Comment

APS disagrees with this item. The vendor manufactures and markets units which comply with the NEC to preclude short circuits. A review of work orders has not indicated any failures due to short circuits at PVNGS.

Section 5.0

This section of the Inspection Report concerns the apparent failure to report violations.

Paragraph 2 (page 13)

NRC Statement

The NRC indicates that inverter 3EQBNO04 was inoperable for a period of greater than 30 days in January 1990.

Comment

As stated APS' April 20, 1990, response to NRC violation 530/90-08, this inverter was believed to be operable from January 7 until trouble shooting work began on February 8, 1990. The inverter was inoperable only from February 8th until February 16th during the period trouble shooting and repair work was in progress.



Paragraph 3 (page 14)

NRC Statement

The NRC indicates that inverter 3EQBN004 was inoperable for more than 30 days during a period starting in August 1988.

Comment

The inspection report should be corrected to indicate that rather than being inoperable for more than thirty (30) days as stated, the auxiliary building lighting unit (3EQBN004) power supply failure occurred on August 29, 1988 (refer to EER 88-QB-003) and was repaired the same day on August 29, 1988 (refer to the failure evaluation summary provided by APS letter dated June 19, 1990 (#161-03288), Appendix A, page 4. Batteries were replaced on September 1, 1988.

APPENDIX A

Section 1, Paragraph 3 (page 15)

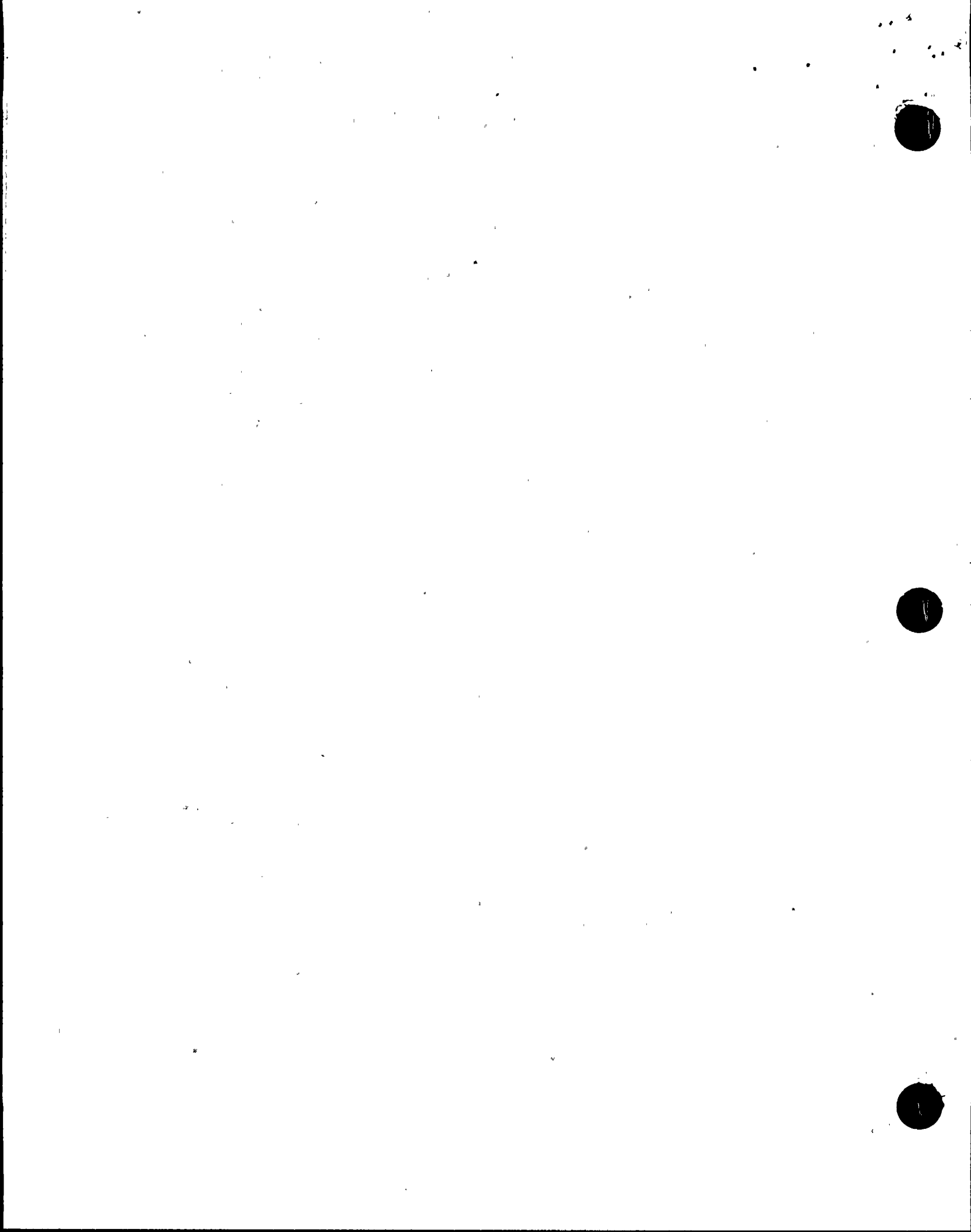
The PVNGS UFSAR does not contain table IV.J in Appendix 9B nor can it be located in other sections applicable to emergency lighting.

Section 1, Paragraph 4 (page 15)

Line 1 references UFSAR Appendix B, Safety Design Basis 18. Safety Design Basis 18 is listed in current FSAR Section 9.5.1.1. (There is no FSAR Appendix B.)

Section 4, Paragraph 5 (page 17)

As stated previously, Appendix 9B Table IV.J does not exist in the PVNGS UFSAR.



ATTACHMENT C

SUMMARY OF INDEPENDENT REVIEW  
OF EMERGENCY LIGHTING BY ABB IMPELL





## SUMMARY OF ABB IMPELL INDEPENDENT REVIEW OF EMERGENCY LIGHTING

In the interest of obtaining an independent evaluation of the status of the Palo Verde emergency lighting system, APS contracted with ABB Impell Corporation, whose expertise in nuclear plant fire protection was judged to be valuable for such a review. Under this contract ABB Impell was requested to:

- (a) determine which NRC requirements are applicable to the PVNGS emergency lighting system.
- (b) sample work done on the emergency lighting system to determine whether work done by APS meets these requirements.
- (c) survey other nuclear plants to determine what actions they are taking or have taken to meet requirements applicable to their emergency lighting systems.
- (d) evaluate the concerns raised by the NRC in Inspection Report 90-02 and other concerns raised by the NRC and others subsequent to January 1, 1990.
- (e) judge whether APS has been responsive to these concerns.

ABB Impell identified four issues as a result of the NRC requirements and the status of APS's implementation. These issues are:

- (a) Quality Classification of Emergency Lights.
- (b) Emergency Lighting Design.
- (c) Emergency Lighting Placement.
- (d) Emergency Lighting Aiming.

APS is currently completing its review of the Impell Study. During this review, APS will evaluate and disposition each recommendation and will ensure that appropriate actions are taken.

### Quality Classification of Emergency Lights

ABB Impell concluded that NRC regulations, APS regulatory commitments and license conditions require that the PVNGS emergency lighting system be treated as quality-augmented. ABB Impell also concluded that procedure 81AC-00006, "Quality Classification for Structures, Systems, Components, Spare Parts and Activities." is inconsistent, such that it can be

interpreted to limit the applicability of the BTP 9.5-1, Appendix A, QA criteria to only those items explicitly delineated in item 16 of the UFSAR. This is not consistent with sections 17.2, 9.5, 9B, the Operations Quality Assurance Criteria Manual-Criterion 2 and Appendix I, UFSAR Tables 9B.3-1 and 17.2-1.

ABB Impell made the following recommendations:

- (1) Procedure 81AC-OCC06 and related procedures should be revised to remove any source of confusion that structures, systems and components and activities described in UFSAR Section 9.5, which implement commitments made to BTP 9.5-1, Appendix A, are important-to-safety and should be classified QAG.
- (2) Classify the structures, systems and components and activities which implement commitments made to BTP 9.5-1, Appendix A, as QAG.
- (3) Implement the Operations Quality Assurance Criteria Manual for the items thus classified QAG.

#### Emergency Lighting Design

ABB Impell reviewed the emergency lighting system to determine if the overall design was adequate to fulfill its intended function. The battery supplies for emergency lights credited for meeting the requirements described above were evaluated in particular to determine if their sizing and capacity are adequate. Their review consisted of the following steps:

- (1) The different vendors that provide eight hour, battery backed emergency lighting to PVNGS were identified.
- (2) The installation locations of emergency lighting batteries credited for compliance with the requirements of 10CFR50, Appendix R, Section III.J were determined.
- (3) The sizing, capacity and suitability of the subject batteries (vendor and manufacturer's documentation) were reviewed with respect to the worst case temperature environments and outdoor applications.

The results of ABB Impell's review are summarized as follows:

Dual-Lite Emergency Lighting Units - The review demonstrated that there was sufficient battery capacity available at the design temperatures to provide eight hours of emergency lighting.

Holophane UPS Emergency Lighting Units - The review determined that the original Globe 6VHC96 96 amp hr. batteries are not capable of providing eight hours of emergency lighting at design temperatures of 50 degrees F. for emergency lighting loads greater than 800 watts. There was no readily available vendor information for the replacement Dynasty UPS 12-300 88 amp hr. and Dynasty GC12V100 73 amp hr. batteries. However, even without being compensated for design maximum/minimum temperatures, these batteries are incapable of providing eight hour emergency lighting to loads greater than 800 watts.

It should be noted here that a load analysis on the Holophane UPS emergency lighting was not performed. The above-mentioned loads are the maximum allowable emergency lighting loads without taking other tangibles into account.

Emergi-Lite - The review determined that the emergency light batteries manufactured by SAFT had enough capacity to provide over eight hours of operation and were appropriate for outdoor use.

Exide - Since these batteries are located in controlled temperature environments of 85 degrees F., their full capacity is expected to be available.

The life expectancy of the batteries discussed above is not considered a concern since the Preventative Maintenance activities should detect any propensity for failure and the batteries replaced prior to becoming inoperable.

ABB Impell provided the following recommendations:

- (1) QDR 90-0193 identifies the problems related to the replacement of Holophane emergency lighting batteries with batteries that do not have enough capacity to meet the requirements. The root cause for this specific problem has been identified.

Since the emergency lighting system is QAG, all replacement items for the system should fall under the QA requirements applicable to QAG classified systems. APS should determine whether additional verification or documentation is required as a result of the quality classification change.

- (2) APS MNCR 90-QB-0004 and MNCR 90-QB-0005 correctly identify the problems related to insufficient capacity of the Holophane batteries to provide eight hours of emergency lighting at 50 and 60 degrees F. However, the dispositions of the above MNCRs should state that the new replacement UPS units should be able to provide eight hours of emergency lighting for the design temperatures as specified in the UFSAR.

This can be achieved by greater inverter efficiency in the new units and/or greater battery capacity in the batteries supplied with the units.



- (3) All necessary vendor and manufacturers' documentation needed to verify the adequacy of any battery type installed for emergency lighting applications should be complete and maintained in a controlled manner for ease of availability (i.e. VARTA and Dynasty batteries).
- (4) Maintenance Procedures for batteries should be revised to provide an "Action" value for battery minimum voltage to assure that batteries are replaced before they are no longer capable of providing an eight hour discharge under adverse conditions.

#### Emergency Lighting Placement

In order to ascertain if the emergency lights were installed as required, ABB Impell conducted the following evaluation:

- (1) Was the action identified in the Spurious Actuation Study specific?
- (2) Was a light provided for each manual action?
- (3) Were lights provided for the access/egress paths to each manual action?
- (4) Was the action in the fire area/fire zone of concern?  
If the action was in the fire area/fire zone of concern
  - a) Would the equipment to be operated be "free of fire damage?"
  - b) Was there sufficient time to extinguish the fire and then complete the action?
- (5) Did the operator have to travel through the fire area/fire zone of concern to complete the action?  
If the access/egress path was through the fire area/fire zone of concern
  - a) Were the time frames for the action sufficient to ensure the fire was extinguished and the action completed?
  - b) Were there alternative actions outside the area/zone?

ABB Impell reviewed the Spurious Actuation Study 13-NS-110 and the Pre-Fire Strategies for all actions identified for fire areas I and XV. ABB Impell reviewed Procedure 42A0-2ZZ44 "Shutdown Outside the Control Room due to Fire and/or Smoke" to ascertain any additional information regarding the actions in fire areas I and XV. Emergency lighting drawings (13-E-ZPL-001 through -004) were reviewed to determine if lights had been provided for all actions and access/egress paths.

12



Ensure the Corrective Action QA criterion is implemented for Emergency Lights."

APS concurs with the recommendation to implement the Corrective Action QA criterion. This action is accomplished through the classification of this system as QAG.

APS is completing an equipment maintenance history review and will pursue corrective action to the equipment as a result of this review.

Concern No. 12:

EER No. 87-QD-004, dated January 28, 1987, identified and documented problems associated with batteries for the emergency lighting units as follows: "High temperatures inside Containment during operation cause loss of electrolyte in all fixtures; total loss in many, varying amounts in the rest. Salt accumulates on battery posts and vent caps and is discarded during PM cleaning. Continual repeated electrolyte loss with demin water replacement will cause premature battery failure". The same batteries (Dual-Lite Model EKE-30) used for Containment emergency lighting are used for safe shutdown emergency lighting in the Auxiliary Building, Control Building and Diesel Generator Building.

(E.2.a, p. 6-7)

Original Discussion:

EER 87-QD-004 identifies a concern with repeated replenishment of electrolyte by adding demineralized water to the batteries in Containment. Temperatures in containment and excessive float voltages are only some of the contributing factors of electrolyte loss. The major cause of electrolyte evaporation is the lack of quarterly PM's for the Containment emergency lighting. For emergency lights in Containment, PMs are currently performed only once per fuel cycle (during refueling outage). Access to Containment is restricted during plant operation for the performance of other than the cycle PM's. The time between the performance of the cycle PM's can vary from 1 year to 2 years. Varying amounts of electrolyte loss is expected with total loss of electrolyte expected if the last performance of the cycle PM's is over a year. Lights installed outside Containment are not subject to the same environment and have PM's performed on a quarterly basis. The performance of the PM's ensures that the light will perform its intended function. No battery plates have been uncovered for units outside of Containment if quarterly PM's were performed. The only exceptions were lights that were inadvertently left out of PM's (non-Appendix R lights).





The quarterly PM's for outside Containment emergency lights are adequate to ensure that the lights are maintained in accordance with Dual-Lite's recommended maintenance criteria. The lights in Containment are not required for safe shutdown and have their cycle PM's performed during the refueling outage.

Additional Discussion:

Impell recommended evaluating replacement of the emergency light batteries in containment (not Appendix R lighting) with a type that does not require maintenance between fuel cycle reloads.

APS concurs with the recommendation.

Concern No. 15:

Certain batteries have demonstrated a continuing failure history (Failure Data Trending). For example, 15 percent (70 failures of approximately 480 Appendix R emergency lights installed in all 3 units) failed over a 30 month period (May 1987 to October 1989). The NRC is concerned that Appendix R emergency lighting preventive maintenance tasks have not been designed to optimally assure a continued capability of Appendix R lighting units to operate for the required eight hours. Furthermore, apparently, timely preventive maintenance completion has not been aggressively pursued because, in about 84 instances, the required annual capacity test and quarterly electrolyte level checks were overdue in Unit 3 as of March 23, 1990.

(E.2.d, p. 7)

Original Discussion:

Refer to Concern 11 discussion for Failure Data Trending information.

PMs are developed based upon manufacturers' recommendations. Schedule dates are established based on the periodicity of the PM. PMs may be delayed past their due date without management approval under the following conditions:

Meets criteria for delaying specified in procedure 30AC-9MP02.

Does not exceed the grace period (25% of maintenance interval).

PMs can be delayed past their grace period with the written concurrence from the Maintenance Manager (or designee) on the Preventative Maintenance Task Disposition Report.

The grace period has been tabulated below for the different periodicity of PMs:

4W - + 7 days  
12W - + 21 days  
24W - + 42 days  
48W - + 84 days  
1Q - + 23 days  
1M - + 8 days  
1S - + 46 days  
1A - + 92 days  
1R - No firm due date, .  
must be completed during  
the refueling outage  
(Ref. 3.7.1.2 of 30AC-9MP02)

Majority of the PMs have been performed prior to the due date or during the grace period, as allowed by procedure 30AC-9MP02. All discharge PM tasks were performed prior to the overdue date (prior to end of grace period). Manpower restraint caused by having 3 units in an outage along with the Unit 3 Main Transformer event (January 1990) depleted the available manpower resources to perform emergency lighting PM tasks. Currently there are no PM tasks past their grace period (5/8/90).

Additional Discussion:

The Impell report recommended that APS address the issue of adjustments to the PM frequency to identify degraded performance prior to failure of the light.

APS has agreed to institute a program of capacity discharge testing and trending of result to preclude failure. APS has also agreed to shorten selected PM intervals and monitor electrolyte evaporation to determine appropriate maintenance intervals.

Concern No. 24:

Thirteen lighting level readings were taken at various locations outside the control room in Unit 3 with a photometer (Spectra Photometer Model FC-200, Serial number 476, NRC Equipment Number 000393, with the next calibration due date of 7/26/90). The locations were the stairwell outside the control room, the essential chiller surge tank level and valves, the chiller room stairwell exit, and the Emergency Diesel Generator rooms. The photometer readings ranged from 0.03 to 0.75 foot-candles with an exception of 1.3 foot-candles at the emergency diesel control panel.

(E.6.b, p. 11)

Original Discussion:

For Appendix R lighting, APS used the guidance of Generic Letter 86-10, which states that illumination, levels shall be sufficient to perform the shutdown function. Emergency lighting has been walked down to confirm this.

Additional Discussion:

The Impell report recommended clarifying the UFSAR on illumination criteria and consider recording baseline illumination levels for future use.

APS agrees with the recommendation.

Concern No. 25:

Orientation of the lamps on a lighting unit in the stairwell outside the control room were found to be not directed toward the access/egress pathway.

(E.6.b, p. 11)

Original Discussion:

Incorrect lamp orientation noted during recent NRC inspection was an isolated occurrence due to construction work on the adjacent Unit 3 Operation Support Building. Adequate lighting for access/egress existed even though the lamps were not directed toward the access/egress pathway. Inspection team members were able to access/egress the stairwell.

Lamp orientation is verified when performing quarterly preventive maintenance (PM). Quarterly PM's provide instructions to orientate the lamps.

Drawings are being developed to provide specific information to facilitate the orientation of lamps by the electrician during the performance of the PM.

Additional Discussion:

The previous response on this issue was not accurate. The modification of PM tasks to provide instructions to properly aim the lights has not been made. Drawing number 13-E-ZPL-004 was issued in June and identifies the equipment to be illuminated by each light. A review was made in June of all Dual-Lites in all three Units to verify proper orientation of the lights. This direction will be incorporated into PM tasks.

This action is consistent with Impell's recommendation of this topic.



ATTACHMENT D

DISCUSSION OF THE CONCERNS  
LISTED IN THE ENCLOSURE TO  
INSPECTION REPORT 90-25



DISCUSSION OF THE CONCERNS  
LISTED IN THE ENCLOSURE TO  
INSPECTION REPORT 90-25

COMMENTS TO INSPECTION REPORT 90-25, ATTACHMENT 1

APS reviewed the attachment to the Inspection Report, which was material provided to NRC staff in the May 17, 1990 meeting by APS personnel. The attachment listed 25 concerns and APS responses. As part of an independent review, Impell reviewed each response by APS. This attachment provides updated responses based on the review by Impell. Concerns where Impell provided "additional discussion" are also provided in this attachment.

Concern No. 2:

The various battery manufacturer's literature state that the manufacturer's warranty is invalidated if the batteries are operated in ambient temperatures above 110 degrees F., or if the batteries are not maintained in accordance with the National Electrical Code. FSAR Table 9.4.2 specified the maximum operating space temperatures for certain areas.

(E.1.a, p. 4)

Original Discussion:

There are four emergency lighting vendors which supply Appendix "R" required lighting in various applications throughout PVNGS. These applications, including the worst case temperature environment from UFSAR Table 9.4.2, are as follows:

<u>Vendor</u>	<u>Buildings</u>	<u>UFSAR Temperature</u>
Dual-Lite	All Areas	122 F (Turbine Bldg) 140 F (DG Bldg/DG running)
Holophane	Control Auxiliary	120 F (Aux Bldg)
Emergi-Lite	MSSS Breezeway	120 F (MSSS)
Exide	Control Room	85 F (Battery rooms)

### Dual-Lite

The Dual-Lite emergency lights are wall mounted, self-contained, battery powered emergency lighting units. These units are located in every building at PVNGS. They are used in both 8-hour and 1-1/2 hour applications.

Each emergency lighting unit has a long-life Nickel-Cadmium battery.

### Emergi-Lite

Emergi-Lite wall mounted units are used in the MSSS at the 140' elevation for the ADV's and in the Turbine Building Breezeway (the access/egress path for the MSSS).

Each Emergi-Lite unit is supplied with a sealed Polytemp Nickel-Cadmium battery manufactured by SAFT. These batteries are designed specifically to give long life under high temperature environments.

SAFT has recently provided to APS a curve showing that at a continuous temperature of 120 F, the cell life of the battery would be four to five years. This capacity, per SAFT, would be capable of delivering 8-1/2 hours total run time at 120 F.

In addition, the Emergi-Lite chargers are temperature compensated to automatically adjust float voltages for high temperatures. This will avoid over-charging of the batteries and hence extend the life.

### Holophane

In the Control Building and Auxiliary Building where a broader source of light was needed to illuminate switchgear and relay panels, a modular AC power station was used. These power stations supply numerous fluorescent fixtures from each power station. The units each contain their own lead-calcium battery enclosed in a separate compartment of the power station.

In the Auxiliary Building, these units are exposed to a worst case temperature of 120 F. Recent correspondence from the vendor has shown that at that higher temperature, continuously, with an uncompensated charger, as used at Palo Verde, the expected life of the battery is 9 months.

This is the absolute worst case, since we know in actual application the temperatures are not near this value continuously year round.

It should be noted that the capacity of these batteries would increase by 10% at this higher temperature.





Exide

The Exide units have their batteries located in the Class 1E battery rooms. Since this is a very controlled environment with an absolute maximum temperature of 85 F. The temperature concern is not a factor.

Additional Discussion:

The Impell evaluation of the APS response recommended that the temperature derating effect on battery capacity be included in the design criteria for the replacement Holophane lighting units.

APS concurs with the recommendation.

Concern No. 10:

There does not appear to be sufficient margin in the GC 12-100 battery capacity to supply power to the lighting fixtures for 8 hours. Further, it appears that two of the batteries installed in Unit 2 with the lower load profiles have never been tested, and one other failed the 8 hour discharge test on March 6, 1990.

(E.1.a, p. 6)

Original Discussion:

The statement "... two of the batteries installed in Unit 2 with the lower load profiles have never been tested..." is a misinterpretation of the APS self-imposed testing report. The two UPS' in question, 2EQBN002 and 2EQBN003, were unavailable for testing for not passing the monthly acceptance criteria for open circuit voltage of a battery. The defective batteries were replaced and 8-hour discharge tests were performed and all acceptance criteria met. UPS 2EQBN001 did fail its 8-hour discharge test, the batteries were replaced and the 8-hour discharge test re-performed and all acceptance criteria were met.

Additional Discussion:

ABB Impell recommended evaluation of the Unit 2 Holophane replacement batteries for adequate capacity at lower temperature.

APS has evaluated the capacity of the batteries that were installed prior to restart from the last refueling outage and have found them to be acceptable. The batteries were installed in all four Holophane lighting units in Unit 2.



Concern No. 11:

At the time of the inspection, it appeared that appropriate corrective actions had not implemented to preclude emergency lighting battery failures and recurrences as evidenced by emergency lighting battery failure data shown in a February 20, 1990 Failure Data Trending computer printout for the period 1988 through 1989, and a high volume of new battery usage as shown in a March 20, 1990 Procurement Materials Management Information System computer printout for the period 1986 through 1990. During the period of May 1987 to October 1989, 70 of approximately 480 emergency lighting unit batteries had failed. Approximately fifty of the failed batteries were required to support safe shutdown. However, appropriate evaluation of the failures to determine cause and prevent recurrence apparently had not been initiated or documented.

(E.2, p. 6)

Original Discussion:

There were 79 incidences involving some type of corrective action per the Failure Data Trending (FDT) database since 1987. There were only 13 battery failures for Appendix R emergency lights and 12 battery for Non-Appendix R emergency lights.. To compensate for component replacements under the PM program, the MMIS Material Activities Report dated March 20, 1990 was used to extract battery failures not identified in the FDT database for Dual-Lite supplied batteries. There were an additional 24 Appendix R battery failures and 12 Non-Appendix R battery failures. Of the 24 Appendix R battery failures, 15 were batteries used in the NEMA 4X Dual-Lite fixture which precipitated the issuance of DCP 1,2,3FE-QD-022 (Emergi-Lite units). The remaining 9 Appendix R failures per MMIS and the 13 battery failures in FDT represents only a 5% failure rate for 440 Appendix R emergency lighting units for a 30 month time period.

RCF EER are generated whenever the System Engineer identifies sufficient increase in failures. RCF EER 90-QD-002 was generated based on the fourth quarter FDT report due to the increase in failures of charging cards.

Additional Discussion:

The above discussion is superseded by Section II.A of this letter.

In addition, the ABB Impell Report recommended that:

"Corrective Action documentation should be dispositioned and completed for the following failure modes:

- 1) Battery failures
- 2) Charging Card failures

ABB Impell also conducted a walkdown of fire area XV to determine 1) the accuracy of the emergency lighting drawings, 2) the feasibility of the actions and 3) the orientation of the lights.

The results of ABB Impell's review indicated that:

- (1) The operator actions identified in the review can be shown to be acceptable based on 1) alternate actions available, 2) actions required after eight hours or 3) mechanical components shown to be free of fire damage. However, the current analysis, the existing QDR 90-054 and the Essential/Emergency Lighting Analysis do not contain this evaluation for all fire areas.
- (2) Based upon conversation with APS personnel, the action to "ensure the condensate transfer pump is not running" would take place in a fire zone which has emergency lighting and therefore is acceptable.
- (3) Based on conversations with APS personnel, the Train A diesel may be tripped by removing DC power from the breakers which feed the 4160V A bus from the A diesel. (Emergency lights are provided in this zone.) Furthermore, if the train A diesel is already running when the operators arrive to remove the DC power, they will trip the 4160V breaker first.

Therefore, emergency lighting is not required at the Train A Diesel. According to QDR-90-054, an enhancement light will be added to this area.

Based on conversations with APS personnel, the action to trip the turbine at the turbine stand is for equipment protection only because the trip of the MSIVs (at a location where emergency lighting is provided) will accomplish the same results. Therefore, emergency lighting is not required for the action at the turbine stand. According to QDR-90-054, an enhancement light will be added to the turbine stand area.

As a result of their review of emergency lighting placement, ABB Impell made the following recommendations:

- (1) The spurious actuation studies should be reviewed in detail to ensure that all manual actions are feasible. The draft action plan for closure of CAR 90-014 was reviewed and the plan appears to address the manual action issue for a fire in any fire area/zone.
- (2) The spurious actuation studies should be revised to clarify the specific operator actions for such vague action statements as "ensure" or "stop."



- (3) For alternate actions (e.g., enhancement lights) for a fire in the control room, moving the "nice to have" actions to attachments in procedure or identifying them in the procedure as optional actions would add clarity to the procedure and inform operators of those actions required for safe shutdown.
- (4) For those alternate actions resulting from a fire in any other fire area, APS should also consider identifying the actions in the pre-fire strategies as other actions which may be taken if time permits. This is consistent with what is done at other utilities.
- (5) The Diesel Generator A Actions should be clarified in the spurious actuation study and in the pre-fire strategies.

#### Emergency Lighting Orientation

Orientation of emergency lights has been identified as a concern by APS several times (for example, Monitoring Report MR90-0741 and EER 88-QD-007).

During the walkdown of fire area XV, Emergency Light SAL-72C-03-100-01 in fire zone 42B appeared to be misdirected. Without a blackout test, however, it was difficult to tell whether the lighting would have been adequate.

Also, the emergency lighting drawings 13-E-ZJL-001 through -003 do not adequately describe the orientation of the lamps.

ABB Impell concluded that emergency lighting units are susceptible to repositioning. To ensure that the lights are positioned properly, orientation verification should be included as preventive maintenance or in an operator round-sheet.

Also, during discussions with APS personnel, it was determined that drawing 13-E-ZPL-004 had been issued. This drawing identifies the equipment which will be operated and the lights which will provide illumination. Also, ABB Impell was informed that the orientation verification will be added to affected preventive maintenance tasks.

Based on this review, ABB Impell concluded that APS should complete the action to revise preventive maintenance tasks to include emergency lighting orientation verification.

#### ABB Impell Review of Identified Concerns

In Inspection Report 90-02, the NRC identified a number of emergency lighting concerns. Subsequent to that, the NRC and APS identified additional concerns. ABB Impell evaluated these concerns to determine whether the APS discussion was responsive to those concerns. APS has evaluated ABB Impell's review of these concerns and has documented significant items following this summary.





## Utility Survey

ABB Impell conducted, at APS's request, a survey of nuclear utilities to determine their approach and status of implementation regarding a number of the issues raised relative to emergency lighting.

The results of the utility survey are summarized for the following issues:

- . Battery Sizing
- . Preventive Maintenance
- . Quality Assurance Requirements
- . Operability/Compensatory Measures
- . Orientation of Emergency Lights
- . Illumination Levels
- . Training

### Battery Sizing

Of the seven utilities asked questions relating to battery sizing, two utilities stated that temperatures were taken into account in sizing the batteries. The remaining utilities indicated that they understood that temperature had an effect on battery capacity and life expectancy. However, they anticipated any degradation to be identified during regularly scheduled maintenance activities.

### Preventive Maintenance

Of the seven utilities asked the maintenance questions, all had some sort of testing program in place. The majority of the utilities have an annual discharge test in addition to a more frequent visual examination. None of the seven contacted did any pre-conditioning of the batteries prior to testing.

### Quality Assurance Requirements

Of the seven utilities contacted, two did not consider emergency lighting included in the fire protection augmented quality assurance program.

### Operability/Compensatory Measures

Eight utilities were contacted regarding this issue. Two of the eight hold GL 86-10 license conditions similar to PVNGS. One utility has defined operability requirements for not only emergency lighting systems but also

for safe shutdown equipment which is not currently in the technical specifications. The other utility does not have any special reportability/compensatory measures in place for emergency lighting, although this utility does take credit for hand-held portable units.

### Orientation of Emergency Lights

One utility has operators verify orientation as part of their weekly round sheets. All the remaining seven utilities contacted verify orientation as part of their monthly, quarterly or semiannual visual examinations.

### Illumination Levels

All utilities responded that the emergency lighting provided was done so in accordance with the guidelines of GL 86-10. Some utilities did, however, have quantitative illumination criteria for specific areas (for example, the control room, the remote shutdown panels and some committed to NFPA 101 for egress routes.)

### Training

Five of the eight utilities contacted maintain separate procedures for fires outside the control room. Each of these utilities provides some type of refresher training for these procedures. The other three utilities believe their shutdown for a fire outside the control room is encompassed by existing Emergency Operating Procedures.

ATTACHMENT E

UPDATED LIGHTING FAILURE SUMMARY  
AND  
AVAILABILITY EVALUATION



UPDATED LIGHTING FAILURE SUMMARY  
AND  
AVAILABILITY EVALUATION

This attachment presents updates to the information provided to the NRC in the letter dated June 29, 1990; and examples of the methodology used to calculate the equipment availability. Included in this attachment, as Table 1, is an evaluation of the Holophane component failure data promised in the July 10th meeting. Holophane Work Orders identifying a component or equipment deficiency from 1987 to June 1990 are discussed in this table.

Tables 2 - 4 are revisions to the June 29, 1990, data based on the completed review of the Exide, Holophane, and Emergi-Lite work orders for the period June 29, 1989, to June 30, 1990. This work order review was completed since the July 10 meeting. Any differences from previous information arise as a result of the June 29, 1990, letter data coming from various computerized (and therefore summarized) sources, while the current data comes from a detailed review of hard copy work orders.

Figures 1 - 6 illustrate the methodology used to arrive at the availability figures presented in Section II.A.4.C. These figures are presented for selected pieces of equipment and show the maintenance history, periods of availability and periods of unavailability. The figures for the balance of the equipment is available in APS offices.

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TABLE 1

HOLOPHANE FAILURE EVALUATION

The following deficiencies found during the review of 1987 through present Work Order hard copies are identified by date. The date represents the earliest known time the deficiency existed, as found by the review. The dates shown in parentheses are the dates the deficiency was referred to in the June 29, 1990, correspondence to the NRC. Deficiencies with an asterisk are deficiencies identified in the WO review which have not been noted in previous correspondence to the NRC.

UNIT 1

1-E-QBN-001

- 1-8-88\* Battery 1B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
- 1-28-88  
(4-13-88) Input breaker tripped due to 4 batteries being defective. This condition prevents the inverter from providing an 8 hour discharge.
- 12-17-89\* BBTV was found to be below the minimum criteria. With this condition this inverter is capable of providing an 8 hour discharge. The successful 8 hour discharge with an initial BBTV of 25.3 on WO 405060 demonstrates this inverters capability.
- 12-27-89\* BBTV was found to exceed the maximum criteria. This condition does not prevent the inverter from providing an 8 hour discharge.
- 12-27-89  
(12-27-89) 8 hour discharge was voluntarily terminated due to a faulty ballast. Evaluation indicates the inverter would have provide an 8 hour discharge if the test had not been terminated.
- 2-21-90  
(2-21-90) BBTV was found to be below the minimum criteria. With this condition this inverter is capable of providing an 8 hour discharge. The successful 8 hour discharge with an initial BBTV of 25.3 on WO 405060 demonstrates this inverter's capability.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.





TABLE 1

HOLOPHANE FAILURE EVALUATION

6-15-90*	Battery 5A did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge. (Note: This testing was a post modification retest)
1-E-QBN-002	
2-28-87 (1-7-88)	Battery 3B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
10-17-87*	One battery was found cracked and smoking. With this condition the inverter would not have been capable of providing an 8 hour discharge.
3-11-89*	Battery 3A was found with a cracked post. With electrical continuity being maintained, this inverter would have continued to provide an 8 hour discharge.
8-18-89 (3-26-90)	Battery 1A did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
12-27-89 (12-27-89)	This 8 hour discharge test was voluntary terminated because of a defective light ballast. Review of the work document has determined that the inverter would have successfully completed the 8 hour discharge if not terminated. This is supported by the successful 8 hour discharge of 3/26/90 (WO 405061)
5-8-90 (5-14-90)	Battery bank was replaced due to the batteries not meeting design configuration. This corrective maintenance does not constitute a failure since the batteries being replaced had passed a previous 8 hour discharge.
5-9-90*	It was determined the inverter was not capable of providing its intended function since the new batteries failed the post maintenance 8 hour discharge test.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

TABLE 1

HOLOPHANE FAILURE EVALUATION

1-E-QBN-003

- 2-25-88  
(3-1-88) BBTV did not meet minimum criteria. The inverter would not have been capable of providing an 8 hour discharge.
- 5-26-88  
(6-27-88) Battery 2A appeared to be leaking. This description was not a problem and no action taken. Discussion with the vendor on this issue is documented on WO 298166.
- 9-14-88\* LED indicator was not functioning properly. This condition does not impair the inverter from providing an 8 hour discharge.
- 2-6-89\* BBTV did not meet minimum criteria. The inverter would not have been capable of providing an 8 hour discharge.

1-E-QBN-004

- 1-9-87  
(1-15-88) Batteries 2A and 2B were isolated from inverter because of one battery being shorted. This inverter would have continued to support an 8 hour discharge based on the load and capacity study.
- 9-14-88\* LED indicator was not functioning properly. This condition does not impair the inverter from providing an 8 hour discharge.
- 11-8-88\* LED indicator was not functioning properly. This condition does not impair the inverter from providing an 8 hour discharge.
- 11-1-89  
(11-1-89)  
(3-2-90) Battery 2A did not meet the minimum IBV criteria. With this one deficiency along with the load and capacity study this inverter would continue to support an 8 hour discharge.

Note: Deficiency dated 11-1-89 was previously reported twice.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.



TABLE 1  
HOLOPHANE FAILURE EVALUATION

UNIT 2

2-E-QBN-001

- 10-25-88\* Graphic display board (LED) was replaced. This condition does not impair the inverter from providing an 8 hour discharge.
- 1-3-89  
(2-22-89) Battery 3B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
- 1-31-89\* Batteries 2B and 3B did not meet the minimum IBV criteria. With two batteries in this condition, evaluation has determined the inverter would not have provided an 8 hour discharge.
- 2-13-89\* Four batteries were replace, but not 2B. With only 2B in a low IBV condition the inverter would continued to provide an 8 hour discharge.
- 3-29-89\* After a successful 8 hour discharge, the IBVs on all batteries failed to meet minimum criteria within a reasonable period of time. During this deficiency the inverter would not have provided an 8 hour discharge.
- 6-24-89  
(8-15-89) Battery 4B was found with a cracked post. With electrical continuity still being maintained, the inverter would have continued to provide an 8 hour discharge.
- 3-5-90  
(3-16-90) Inverter failed an 8 hour discharge which indicates the inverter was not capable of providing an 8 hour discharge.

2-E-QBN-002

- 3-1-87  
(3-10-87) Inverter was providing inadequate charger output as a result of a loose connection. The capability and reliability of the inverter to provide an 8 hour discharge is indeterminate and dependent on the connection status.
- 9-9-87\* 8 hour discharge failure due to a defective transfer relay. The inverter was not capable of providing an 8 hour discharge.
- 5-5-88  
(5-12-88) 8 hour discharge failure. The inverter was not capable of providing an 8 hour discharge.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

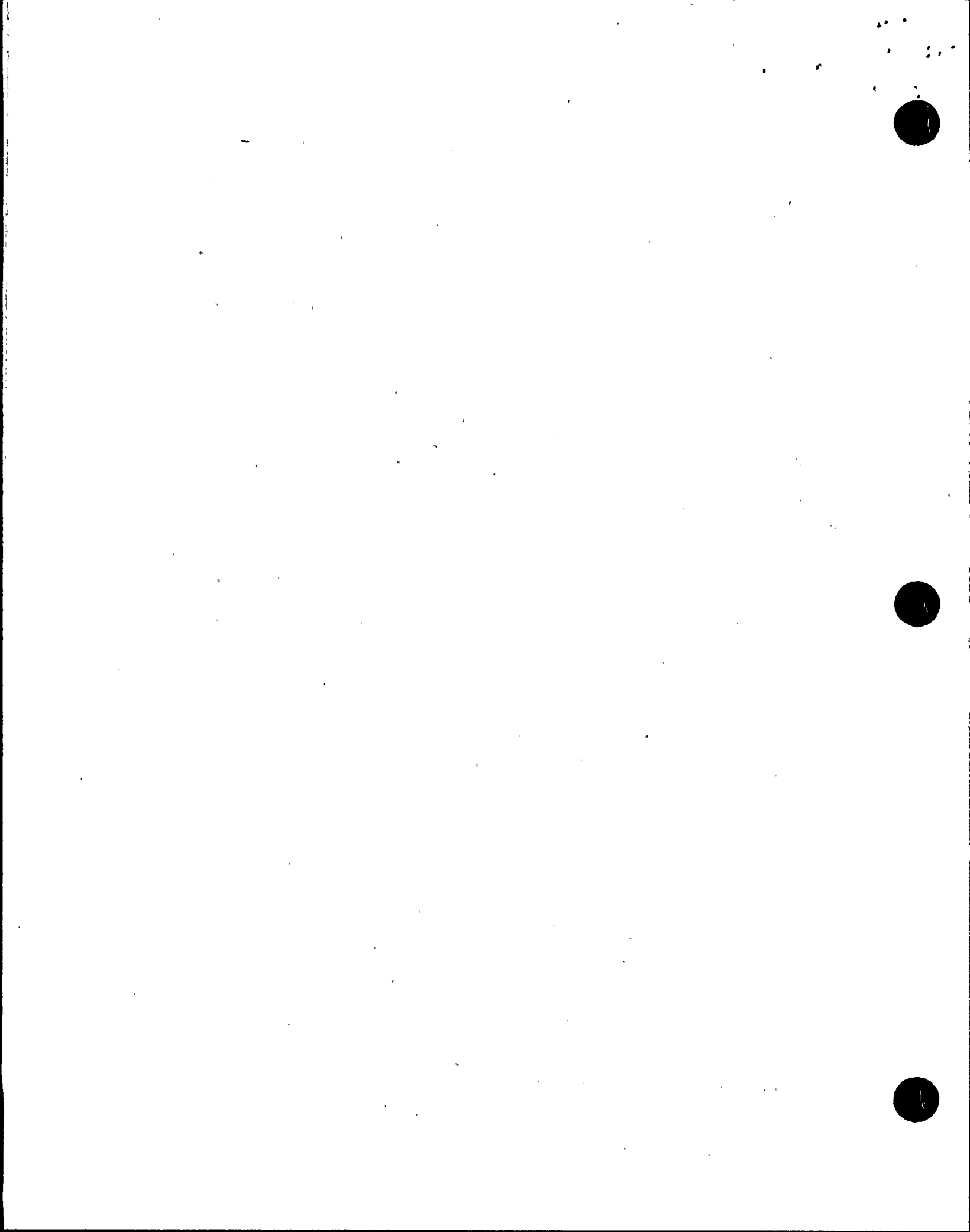


TABLE 1

## HOLOPHANE FAILURE EVALUATION

10-25-88*	LED was providing faulty indication. This condition does not impair the inverter from providing an 8 hour discharge.
1-6-89 (2-15-89)	Battery 4B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
1-23-90 (4-18-90)	Battery 2B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
3-14-90*	LED was providing faulty indication. This condition does not impair the inverter from providing an 8 hour discharge. (Defective termination block)
6-29-90*	LED was providing faulty indication. This condition does not impair the inverter from providing an 8 hour discharge. (Loose connection)
2-E-QBN-003	
7-6-87 (7-8-87)	Batteries were replace because the installed batteries would not come up. The inverter would not have provided an 8 hour discharge.
9-1-87 (10-1-87)	LED graph was providing faulty indication. This condition does not impair the inverter from providing an 8 hour discharge.
12-7-88*	LED needs recalibration. This condition does not impair the inverter from providing an 8 hour discharge.
2-15-89 (4-18-89)	Battery termination on battery 4B indicated the bolt was pulling through the terminal. With electrical continuity still being maintained, the inverter would have continued to provide an 8 hour discharge.
6-6-89*	BBTV was found to be to be low at the time the PM was worked. This condition should not be considered a failure since it is expected to see a low BBTV the day following an 8 hour discharge.
8-16-89 (8-25-89)	LED was providing faulty indications. This condition does not impair the inverter from providing an 8 hour discharge. (Termination problem)

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

TABLE 1

## HOLOPHANE FAILURE EVALUATION

12-29-89 (3-13-90)	Battery 2B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
3-16-90 (3-17-90)	New batteries provided an 8 hour discharge but battery 3B did not meet the minimum IBV criteria coming out of the 24 hour charge. With this one deficiency the inverter is capable of providing an 8 hour discharge.
5-11-90*	BBFV was found not to meet the minimum criteria. The inverter would not have been capable of providing an 8 hour discharge. Correction was made by adjusting the float voltage during performance of the PM and prior to PM closure.
2-E-QBN-004	
9-7-87 (10-1-87)	Battery 4A did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
8-31-88 (9-12-88)	LED display was not providing proper indication. This condition has no effect on the inverter to provide an 8 hour discharge. (Loose contacts)
10-25-88*	LED display was not providing proper indication. This condition has no effect on the inverter to provide an 8 hour discharge. (Replaced PC board)
6-4-89 (6-4-89)	Battery 2A did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
8-16-89 (8-25-89)	LED display was not providing proper indication. This condition has no effect on the inverter to provide an 8 hour discharge. (Loose contacts)
9-5-89 (9-5-89)	Battery 3A did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
12-29-89*	BBTV did not meet minimum criteria. This condition prevents the inverter from providing an 8 hour discharge.
1-24-90*	BBTV exceeded the maximum criteria. This condition will not prevent the inverter from providing an 8 hour discharge.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.





TABLE 1

HOLOPHANE FAILURE EVALUATION

- |          |  |
|----------|--|
| 4-3-90*  | LED display was not providing proper indication. This condition has no effect on the inverter to provide an 8 hour discharge. (Loose contacts) |
| 5-11-90* | BBTV did not meet minimum criteria. This condition prevents the inverter from providing an 8 hour discharge.                                   |

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

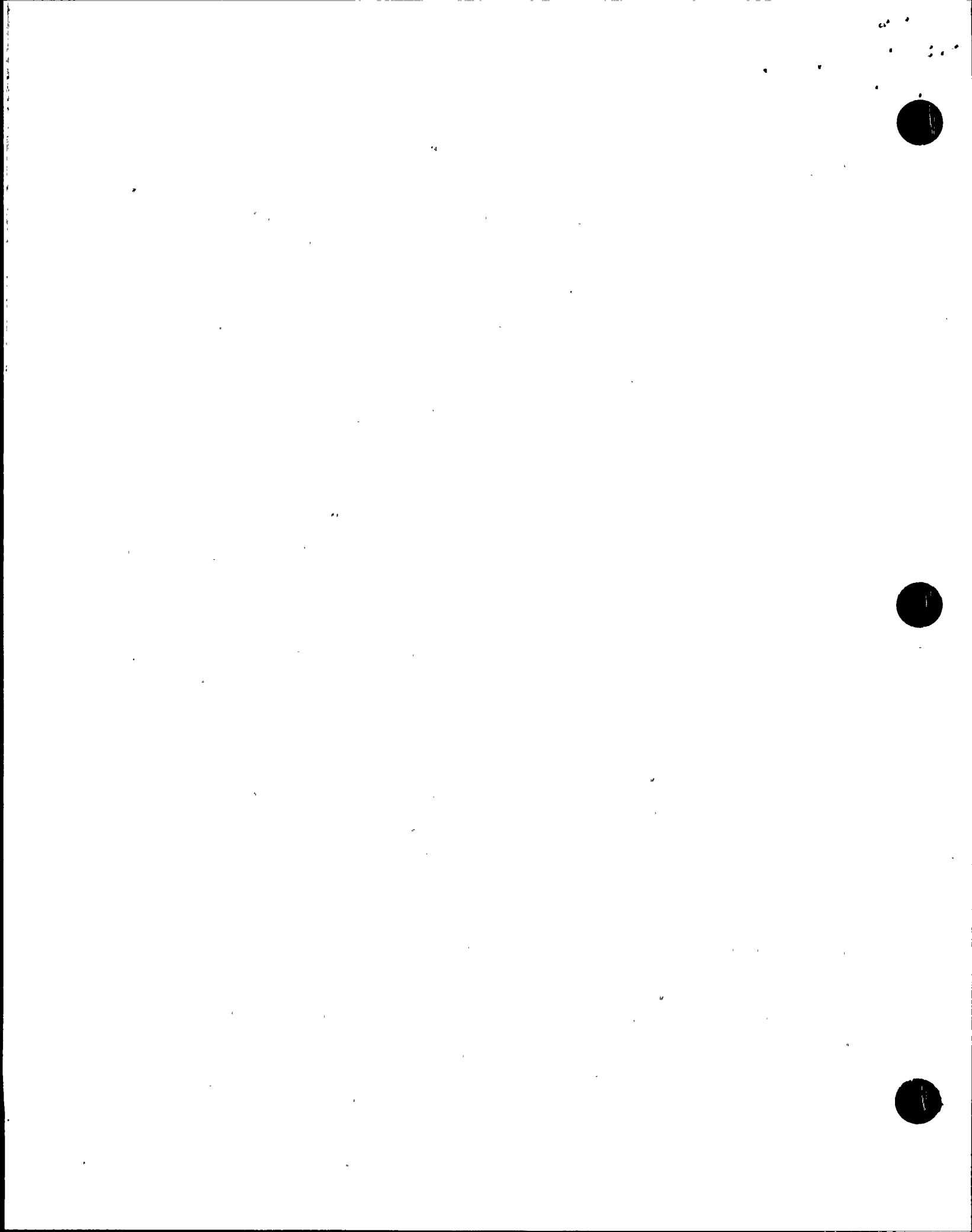


TABLE 1  
HOLOPHANE FAILURE EVALUATION

UNIT 3

3-E-QBN-001

- 7-8-87  
(1-17-88) BBTV did not meet minimum criteria. This condition prevents the inverter from providing an 8 hour discharge.
- 12-9-88\* LED display need recalibration. This condition has no effect on the inverter to provide an 8 hour discharge.
- 2-2-89  
(3-22-89) Battery 1A did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
- 6-8-89  
(6-8-89) Battery 3A was found to be drawing excessive current. As a result batteries 3A and 3B were isolated from the inverter until the deficiency was corrected. The inverter was not capable of providing an 8 hour discharge.
- 3-11-90\* BBTV was low after coming out of an 8 discharge. The inverter was not capable of providing a full 8 hour discharge for 2 shifts, which is expected after a discharge.
- 6-16-90\* After the installation of new batteries, battery 2A did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.  
(Note: This testing was a post modification retest)

3-E-QBN-002

- 9-12-87\* Battery 3A did not meet the minimum IBV criteria. With this one deficiency this inverter is capable of providing an 8 hour discharge.
- 2-5-88\* All batteries failed to meet the minimum IBV criteria. The inverter would not have been capable of supporting an 8 hour discharge.
- 4-15-88\* Input breaker would not open. This condition would not have impaired the inverter from providing an 8 hour discharge as proven by WO 247190.
- 8-30-88  
(9-29-88) LED display was not providing proper indication. This condition has no effect on the inverter to provide an 8 hour discharge.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.



TABLE 1

HOLOPHANE FAILURE EVALUATION

12-2-88*	Battery 2B did not meet the minimum IBV criteria. With this one deficiency this inverter is capable of providing an 8 hour discharge.
11-17-89*	LED display was not providing proper indication. This condition has no effect on the inverter to provide an 8 hour discharge.
3-E-QBN-003	
8-16-87 (4-14-88)	Batteries were missing from cabinet. With any batteries missing from the inverter, the inverter is not capable of providing an 8 hour discharge.
5-8-89 (5-11-89)	BBTV was high because of a defective charging card. This condition does not impair the inverter from providing an 8 hour discharge.
4-3-90*	Battery 4B was found with a split in the post. With electrical continuity still being maintained, the inverter would continue to provide an 8 hour discharge.
5-3-90*	Failed an 8 hour discharge indicating the inverter cannot support an 8 hour discharge.
3-E-QBN-004	
10-28-87 (11-21-89)	New transfer circuit was installed. With a deficiency of the transfer circuit the inverter would not support an 8 hour discharge.
10-29-87*	LED display was not providing proper indication. This condition has no effect on the inverter to provide an 8 hour discharge.
8-29-88 (11-21-89)	Batteries were found in a low and uneven condition. This deficiency would have prevented the inverter from providing an 8 hour discharge.
3-17-89 (5-24-89)	Battery 3B was found with a cracked post. With electrical continuity still being maintained, the inverter would continue to provide an 8 hour discharge.
2-7-90 (2-16-90)	Inverter was providing a high output voltage as a result of a defective power supply. This would have prevented the inverter from providing an 8 hour discharge.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

TABLE 1

HOLOPHANE FAILURE EVALUATION

4-3-90 (3-30-90)	LED display was fluctuating. This condition has no effect on the inverter to provide an 8 hour discharge. (Loose contacts)
5-4-90 (5-4-90)	Led display was not functioning properly. This condition has no effect on the inverter to provide an 8 hour discharge. (Bad electrical connection)

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.



TABLE 2

EXIDE DATA UPDATES

UNIT 1

1-E-QDN-F01 & 1-E-QDN-N01 .

02/28/90\*

Low electrolyte specific gravity was found after an 8 hour discharge was performed, and several attempts were required to restore the battery. This condition would have prevented the light from burning for 8 hours. In addition a float/equalize switch required replacement prior to performing the equalize charge. Batteries were placed on equalize charge until electrolyte specific gravities were acceptable.

1-E-QDN-F02 & 1-E-QDN-N02

02/28/90\*

Low electrolyte specific gravity was found after an 8 hour discharge was performed, and several attempts were required to restore the battery. This condition would have prevented the light from burning for 8 hours. Batteries were placed on equalize charge until electrolyte specific gravities were acceptable.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.





TABLE 2

EXIDE DATA UPDATES

UNIT 2

2-E-QDN-F01 & 2-E-QDN-N01

- 01/03/90\* The inverter input breaker tripped after taking battery bank terminal voltage readings at 7 1/2 hours, of an 8 hour discharge test. Voltage readings were acceptable at that time. After 7 1/2 hours of discharge the batteries had low electrolyte specific gravity. Batteries were placed on equalize charge until electrolyte specific gravities were acceptable. This condition would have prevented the UPS from burning for 8 hours.
- 04/05/90\* Low electrolyte specific gravity was found after an 8 hour discharge was performed, and several attempts were required to restore the battery. This condition would have prevented the light from burn for 8 hours. Batteries were placed on equalize charge and electrolyte specific gravities were subsequently found acceptable.
- 06/03/90\* A fuse (F1) blew when reset button was depressed and the inverter shut down. This condition would have prevented the UPS from burning for 8 hours. Fuse was replaced and the unit was restored. (Occurred after the cutoff date for the 6/29/90 letter.)

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.



TABLE 2

EXIDE DATA UPDATES

2-E-QDN-F02 & 2-E-QDN-N02

12/04/89*	Low electrolyte specific gravity was found. This condition would have prevented the light from burning for 8 hours. Batteries were placed on equalize charge.
01/04/90*	Low electrolyte specific gravity was found after an 8 hour discharge and several attempts were required to restore the battery. Batteries were placed on equalize charge until electrolyte specific gravities were acceptable. This condition would have prevented the light from burning for 8 hours.
03/21/90*	Low electrolyte specific gravity and individual cell voltage were found after an 8 hour discharge test and an excessive amount of recharging was required to restore the battery. Batteries were placed on equalize charge until electrolyte specific gravities and individual cell voltage's were acceptable. This condition would have prevented the light from burning for 8 hours.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

TABLE 2

EXIDE DATA UPDATES

UNIT 3

3-E-QDN-F01 & 3-E-QDN-N01

NO CHANGES

3-E-QDN-F02 & 3-E-QDN-N02

08/03/89\*

Electrolyte specific gravity was low after an 8 hour discharge was performed and several attempts were required to restore the battery. This condition would have prevented the light from burning for 8 hours. Batteries were placed on equalize charge until electrolyte specific gravities were acceptable.

03/31/90\*

Low electrolyte specific gravity and low individual cell voltage were found and an excessive amount of recharging was required to restore the battery. This condition would have prevented the light from burning for 8 hours. Batteries were placed on equalize charge until electrolyte specific gravities and individual cell voltages were acceptable.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.



TABLE 3

HOLOPHANE DATA UPDATE

UNIT 1

1-E-QBN-001

12-27-89  
(12-27-89) 8 hour discharge was voluntarily terminated due to a faulty ballast. Evaluation indicates the inverter would have provide an 8 hour discharge if the test had not been terminated.

2-21-90  
(2-21-90) BBTV was found to be below the minimum criteria. With this condition this inverter is capable of providing an 8 hour discharge. The successful 8 hour discharge with an initial BBTV of 25.3 on WO 405060 demonstrates this inverter's capability.

1-E-QBN-002

2-28-87  
(1-7-88) Battery 3B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.

10-17-87\* One battery was found cracked and smoking. With this condition the inverter would not have been capable of providing an 8 hour discharge.

5-9-90\* It was determined the inverter was not capable of providing its intended function since the new batteries failed the post maintenance 8 hour discharge test.

1-E-QBN-003

5-26-88\*  
(6-27-88) Battery 2A appeared to be leaking. This description was not a problem and no action taken. Discussion with the vendor on this issue is documented on WO 298166.

2-6-89\* BBTV did not meet minimum criteria. The inverter would not have been capable of providing an 8 hour discharge.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

200  
100





TABLE 3

HOLOPHANE DATA UPDATE

1-E-QBN-004

1-9-87  
(1-15-88)

Batteries 2A and 2B were isolated from inverter because of one battery being shorted. This inverter would have continued to support an 8 hour discharge based on the load and capacity study.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

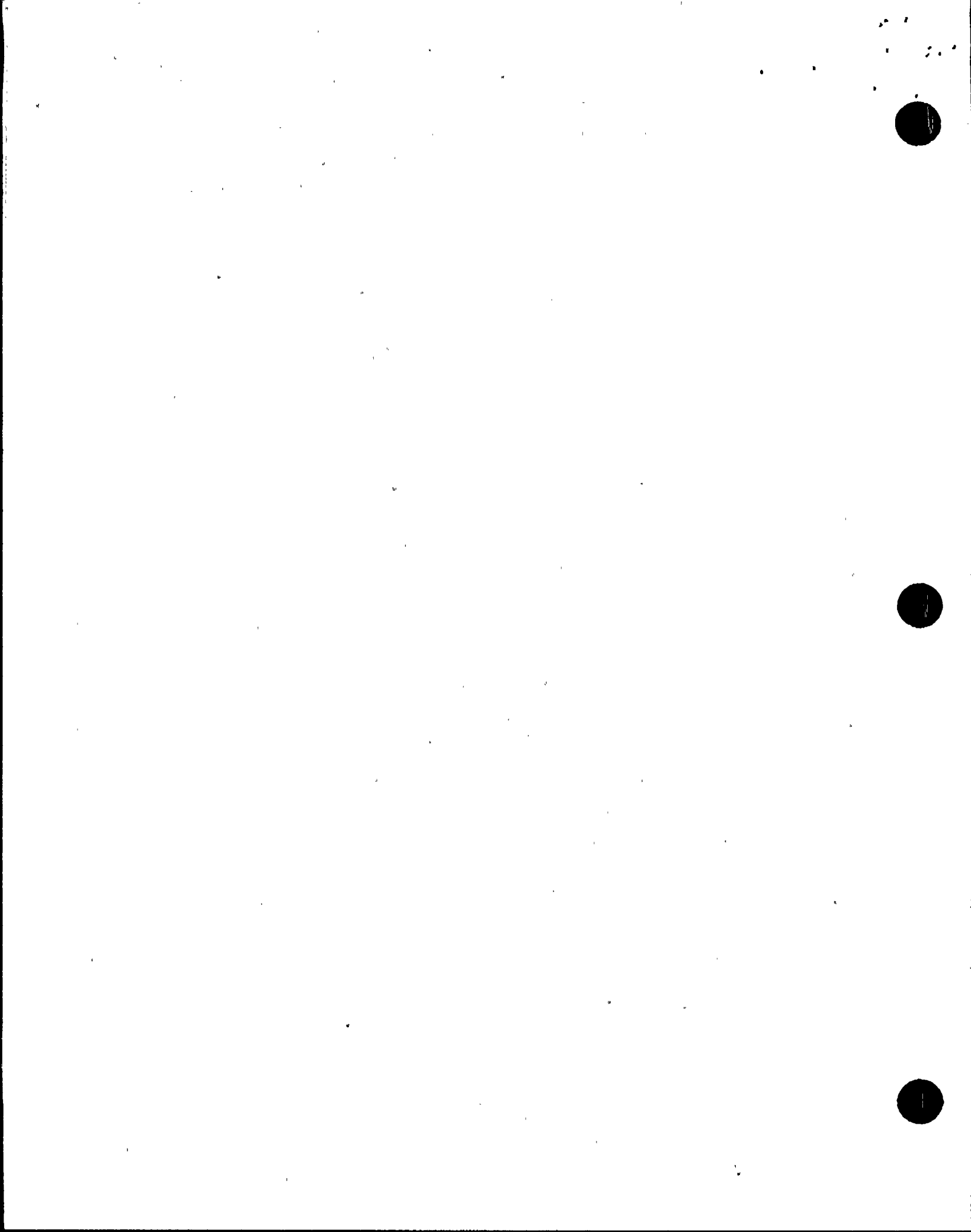


TABLE 3

HOLOPHANE DATA UPDATE

UNIT 2

2-E-QBN-001

- 1-3-89  
(2-22-89) Battery 3B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
- 1-31-89\* Batteries 2B and 3B did not meet the minimum IBV criteria. With two batteries in this condition, evaluation has determined the inverter would not have provided an 8 hour discharge.
- 3-29-89\* After a successful 8 hour discharge, the IBVs on all batteries failed to meet minimum criteria within a reasonable period of time. During this deficiency the inverter would not have provided an 8 hour discharge.
- 6-24-89  
(8-15-89) Battery 4B was found with a cracked post. With electrical continuity still being maintained, the inverter would have continued to provide an 8 hour discharge.

2-E-QBN-002

- 9-9-87\* 8 hour discharge failure due to a defective transfer relay. The inverter was not capable of providing an 8 hour discharge.
- 1-6-89  
(2-15-89) Battery 4B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.
- 1-23-90  
(4-18-90) Battery 2B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.

2-E-QBN-003

- 2-15-89  
(4-18-89) Battery termination on battery 4B indicated the bolt was pulling through the terminal. With electrical continuity still being maintained, the inverter would have continued to provide an 8 hour discharge.
- 12-29-89  
(3-13-90) Battery 2B did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

TABLE 3

HOLOPHANE DATA UPDATE

hour discharge.

3-16-90. New batteries provided an 8 hour discharge but battery 3B  
(3-17-90) did not meet the minimum IBV criteria coming out of the 24  
hour charge. With this one deficiency the inverter is  
capable of providing an 8 hour discharge.

2-E-QBN-004

9-7-87 Battery 4A did not meet the minimum IBV criteria. With this  
(10-1-87) one deficiency the inverter is capable of providing an 8  
hour discharge.

6-4-89 Battery 2A did not meet the minimum IBV criteria. With this  
(6-4-89) one deficiency the inverter is capable of providing an 8  
hour discharge.

9-5-89 Battery 3A did not meet the minimum IBV criteria. With this  
(9-5-89) one deficiency the inverter is capable of providing an 8  
hour discharge.

12-29-89\* BBTV did not meet minimum criteria. This condition prevents  
the inverter from providing an 8 hour discharge.

5-11-90\* BBTV did not meet minimum criteria. This condition prevents  
the inverter from providing an 8 hour discharge.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

TABLE 3  
HOLOPHANE DATA UPDATE

UNIT 3

3-E-QBN-001

2-2-89  
(3-22-89)

Battery 1A did not meet the minimum IBV criteria. With this one deficiency the inverter is capable of providing an 8 hour discharge.

3-E-QBN-002

2-5-88\*

All batteries failed to meet the minimum IBV criteria. The inverter would not have been capable of supporting an 8 hour discharge.

3-E-QBN-003

5-8-89  
(5-11-89)

BBTV was high because of a defective charging card. This condition does not impair the inverter from providing an 8 hour discharge.

5-3-90\*

Failed an 8 hour discharge indicating the inverter cannot support an 8 hour discharge.

3-E-QBN-004

10-28-87  
(11-21-89)

New transfer circuit was installed. With a deficiency of the transfer circuit the inverter would not support an 8 hour discharge.

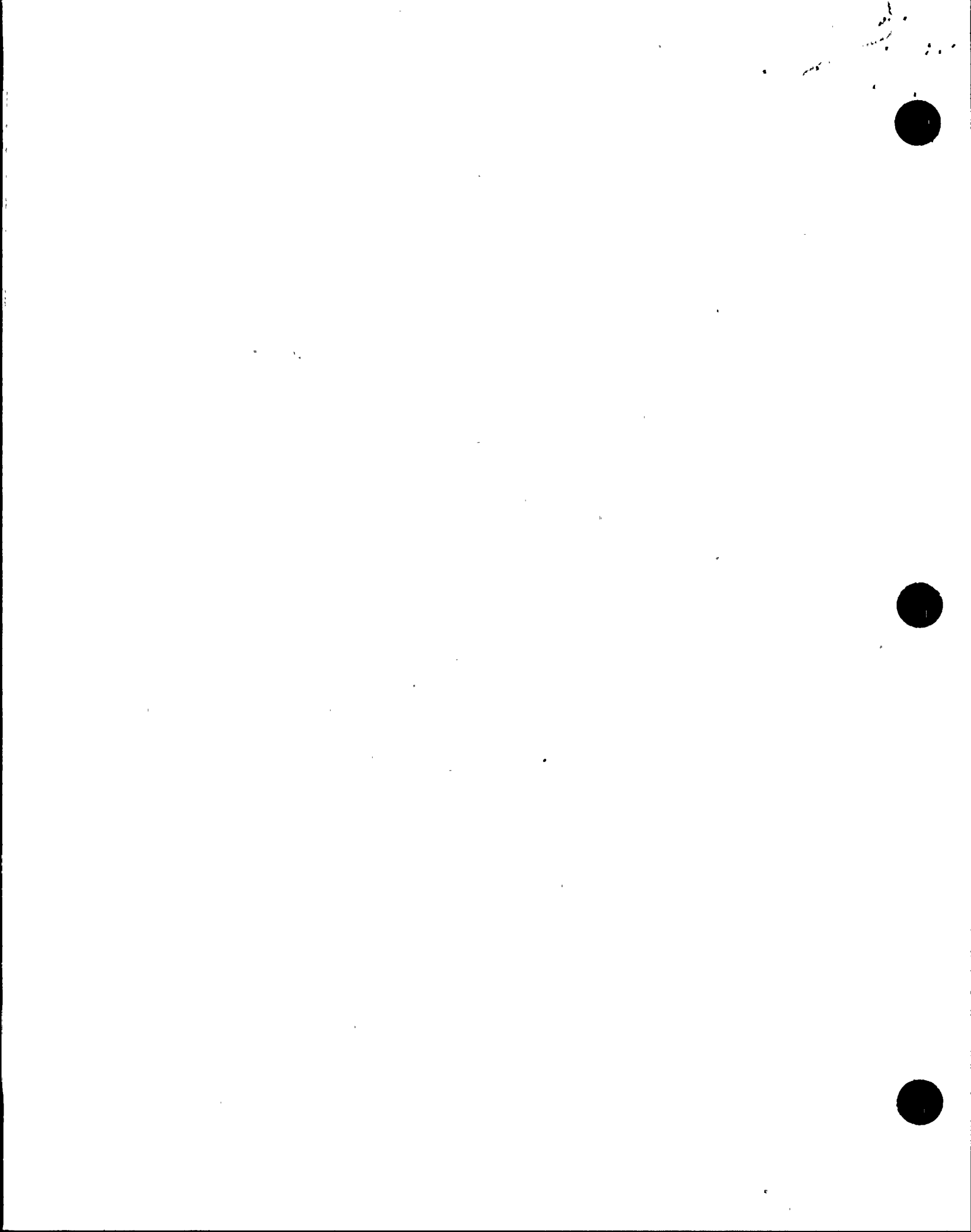
NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.

TABLE 4

## EMERGI-LITE DATA UPDATES

TAG NUMBER	DATE	EVALUATION
1ESTL74C09 090 06	2/28/90	Although a work order was written against this component, the 8-hour discharge test was successful. The work order was not applicable to this component. This would not have prevented the unit from burning for 8 hours. This was reported as a failure in the 06/29/90 letter.
1ESCL72A14 140 20	4/9/90*	Light bulb was broken. This would have prevented the unit from burning for 8 hours.
2ESTL74C09 110 07	3/8/90*	Lights stayed on after test switch was released. It was determined that the circuit would not provide illumination and maintain battery BBTV. Lights would not have burned for 8 hours.
2ESTL74C09 140 09	9/7/89	The charging card was replaced due to the blinking of the lights following the completion of a PM. Pushing the test button stopped the blinking. The card was replaced as a preventive measure when trouble shooting could not duplicate the condition. This condition would not have prevented the lights from burning for eight hours. This event was reported as a failure in the 06/29/90 letter.

NOTE: '\*' indicates the deficiency was not reported in the June 29, 1990 letter.







FIGURES 1 - 6

2 2  
2 1 2



FIG 1

EMERGENCY LIGHTING COMPONENT AVAILABILITY  
TYPE: EXIDE  
EQUID: 1EQDNNF02 & 1EQDNN02

REQUIRED AVAILABLE DAYS: 366  
KNOWN UNAVAILABLE DAYS: 24  
ESTIMATED UNAVAILABLE DAYS: 0

- Available
- Known unavailable
- Estimated unavailable

DATA START DATE - 6/29/89 (UNIT 2 RESTART)

# 00359660 (7/6/89 - 7/10/89) MONTHLY UPS MAINTENANCE

# 00360585 (7/21/89) - MONTHLY BATTERY MAINTENANCE  
# 00360538 (7/22/89) - MONTHLY UPS MAINTENANCE

# 00375708 (8/17/89 - 8/18/89) ANNUAL BATTERY MAINTENANCE  
# 00371960 (8/17/89 - 8/24/89) EQUALIZING CHARGE

# 00360588 (8/17/89 - 8/18/89) QUARTERLY BATTERY MAINTENANCE  
# 00371385 (8/23/89) - MONTHLY BATTERY MAINTENANCE  
# 00371357 (8/25/89 - 8/26/89) MONTHLY UPS MAINTENANCE

# 00375487 (9/25/89) - MONTHLY BATTERY MAINTENANCE  
# 00375444 (9/26/89) - MONTHLY UPS MAINTENANCE  
# 00380441 (9/29/89) - ANNUAL UPS MAINTENANCE

# 00380080 (10/17/89) - MONTHLY UPS MAINTENANCE  
# 00380424 (10/17/89) - MONTHLY BATTERY MAINTENANCE

# 00384096 (10/31/89) - QUARTERLY BATTERY MAINTENANCE

# 00385924 (11/13/89 - 12/19/89) MONTHLY BATTERY MAINTENANCE  
# 00385881 (11/13/89) - MONTHLY UPS MAINTENANCE

# 00392768 (12/21/89) - MONTHLY UPS MAINTENANCE  
# 00392798 (12/21/89) - MONTHLY BATTERY MAINTENANCE

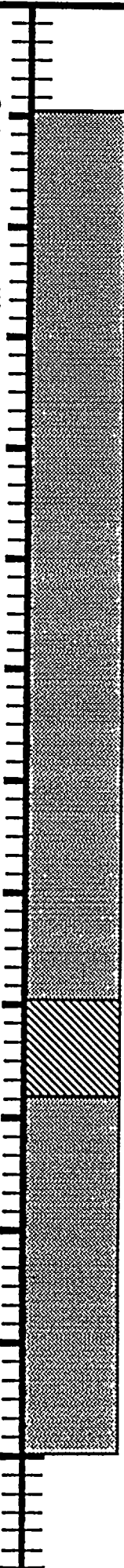
# 00409016 (2/27/90 - 2/28/90) TEST DISCHARGE

# 00412476 (2/28/90 - 3/13/90) EQUALIZING CHARGE (FAILED 2/28/90 - REF. 414513)  
# 00399746 (3/6/90) - MONTHLY BATTERY MAINTENANCE - FAILED REF. 412476  
# 00399748 (3/6/90) - QUARTERLY BATTERY MAINTENANCE - FAILED REF. 412476  
# 00398393 (3/6/90 - 3/7/90) MONTHLY BATTERY MAINTENANCE - FAILED REF. WO # 412476  
# 00398372 (3/6/90 - 3/7/90) MONTHLY UPS MAINTENANCE  
# 00399717 (3/6/90 - 3/7/90) MONTHLY UPS MAINTENANCE  
# 00414513 (3/9/90 - 3/29/90) EQUALIZING CHARGE FAILED (RESTORED 3/24/90 WO # 412476  
# 00340568 (3/15/90 - 3/20/90) MONTHLY UPS MAINTENANCE  
# 00404337 (3/26/90) - MONTHLY UPS MAINTENANCE  
# 00404486 (3/29/90) - MONTHLY BATTERY MAINTENANCE

# 00404499 (5/1/90) - QUARTERLY BATTERY MAINTENANCE  
# 00404488 (5/9/90) - MONTHLY BATTERY MAINTENANCE  
# 00404339 (5/9/90) - MONTHLY UPS MAINTENANCE  
# 00359659 (5/23/90) - MONTHLY UPS MAINTENANCE

# 00404340 (6/7/90) - MONTHLY UPS MAINTENANCE  
# 00404489 (6/7/90) - MONTHLY BATTERY MAINTENANCE

# 00404341 (7/7/90) - MONTHLY UPS MAINTENANCE  
# 00404490 (7/8/90 - 7/10/90) MONTHLY BATTERY MAINTENANCE



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FIG 2

EMERGENCY LIGHTING COMPONENT AVAILABILITY  
EQUID: 3EQDNF02 & 3EQDNN02 TYPE: EXIDE

REQUIRED AVAILABLE DAYS: 366  
KNOWN UNAVAILABLE DAYS: 24  
ESTIMATED UNAVAILABLE DAYS: 2.5

- ▣ Available
- ▤ Known unavailable
- ▥ Estimated unavailable

DATA START DATE - 6/29/89 (UNIT 2 RESTART)

# 00366434 (7/19/89) MONTHLY UPS MAINTENANCE  
#00367789 (7/19/89) MONTHLY BATTERY MAINTENANCE

#00356239 (8/1/89 - 8/3/89) DISCHARGE TEST  
#00373800 (8/3/89 - 8/8/89) EQUALIZE CHARGE (FAILED) Ref. WO # 00372636

#00372636 (8/18/89 - 8/23/89) MONTHLY BATTERY MAINTENANCE Ref. WO # 00373800  
#00372635 (8/18/89 - 8/23/89) MONTHLY UPS MAINTENANCE  
#00372637 (8/28/89 - 9/4/89) QUARTERLY BATTERY MAINTENANCE

#00378204 (9/14/89) MONTHLY BATTERY MAINTENANCE  
#00378203 (9/20/89) MONTHLY UPS MAINTENANCE

#00382334 (10/13/89) MONTHLY BATTERY MAINTENANCE  
#00382333 (10/14/89) MONTHLY UPS MAINTENANCE

#389238 (11/13/89 - 11/14/89) MONTHLY UPS MAINTENANCE  
#00391584 (11/19/89) - QUARTERLY BATTERY MAINTENANCE

#00392541 (12/23/89 - 12/24/89) MONTHLY UPS MAINTENANCE  
#00392542 (12/23/89 - 12/24/89) MONTHLY BATTERY MAINTENANCE

#00400694 (1/28/90 - 2/5/90) MONTHLY BATTERY MAINTENANCE  
#00400693 (1/29/90 - 1/30/90) MONTHLY UPS MAINTENANCE

#00403891 (2/28/90) MONTHLY BATTERY MAINTENANCE  
#00403887 (3/4/90 - 3/5/90) MONTHLY UPS MAINTENANCE

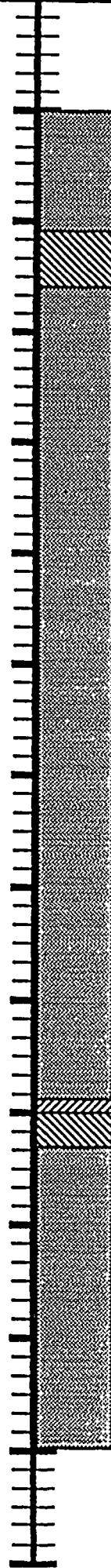
#00403888 3/26/90 - 3/27/90 MONTHLY UPS MAINTENANCE  
#00403892 3/26/90 - 3/27/90 MONTHLY BATTERY MAINTENANCE  
#00412655 3/31/90 - 4/13/90 EQUALIZING CHARGE (FAILED - 3/31/90 - 4/9/90)  
#00417958 4/1/90 CORRECTED INDICATING LIGHTS

#00410487 4/12/90 - 4/13/90 MONTHLY UPS MAINTENANCE

#00410488 5/8/90 - 5/9/90 MONTHLY UPS MAINTENANCE  
#00410491 5/8/90 - 5/9/90 MONTHLY BATTERY MAINTENANCE  
#00413674 5/19/90 - 5/21/90 QUARTERLY BATTERY MAINTENANCE

#00416061 6/8/90 - 6/11/90 MONTHLY UPS MAINTENANCE

#00432676 6/28/90 - 7/9/90 EQUALIZING CHARGE  
#00422803 7/4/90 - 7/5/90 MONTHLY BATTERY MAINTENANCE  
#00422805 7/5/90 QUARTERLY BATTERY MAINTENANCE  
#00422800 7/7/90 - 7/9/90 MONTHLY UPS MAINTENANCE  
#00431001 7/7/90 ANNUAL UPS MAINTENANCE



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2.3  
2.12



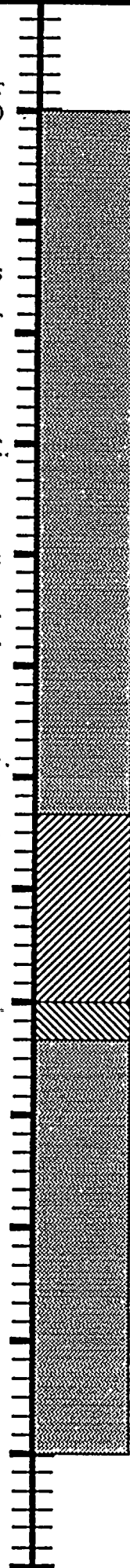
FIG 3

EMERGENCY LIGHTING COMPONENT AVAILABILITY  
EQUID:2EQBN001 TYPE: HOLOPHANE - UPS

REQUIRED AVAILABLE DAYS: 366  
KNOWN UNAVAILABLE DAYS: 10  
ESTIMATED UNAVAILABLE DAYS: 52

- Available
- Known unavailable
- Estimated unavailable

- # 00356529 (6/24/89 - 6/26/89) MONTHLY TEST  
DATA START DATE - 6/29/89 (UNIT 2 RESTART)
- # 00364092 (8/2/89 - 8/2/89) MONTHLY TEST
- # 00371985 (8/14/89 - 8/15/89) REPLACED 4 BATTERIES
- # 00372897 (8/28/89 - 8/28/89) MONTHLY TEST
- # 00380771 (10/02/89 - 10/4/89) MONTHLY TEST  
# 00385138 (10/3/89 - 10/3/89) MONTHLY TEST
- # 00389416 (11/1/89 - 11/1/89) REPLACED LIGHTS
- # 00381567 (11/20/89 - 11/22/89) 8 - HOUR DISCHARGE TEST  
# 00388910 (11/27/89 - 11/28/89) MONTHLY TEST
- # 00393424 (12/29/89 - 12/29/89) MONTHLY TEST
- # 00398846 (1/23/90 - 1/23/90) MONTHLY TEST
- # 00403611 (2/20/90 - 20/20/90) MONTHLY TEST
- # 00412340 (3/5/90 - 3/6/90) 8-HOUR DISCHARGE \* FAILED (6 HOUR) \*  
# 00414355 (3/12/90 - 3/16/90) REPLACED ENTIRE BATTERY BANK  
# 00409088 (3/16/90) - CANCELLED BY WO # 414355  
# 00414689 (3/22/90) - CANCELLED
- # 00419024 (4/16/90) - CANCELLED WO # 470403 / 470443  
# 00420443 (4/18/90 - 4/18/90) MONTHLY TEST
- # 00424858 (5/9/90 - 5/9/90) OUTPUT VOLTAGE TAKEN  
# 00420403 (5/11/90 - 5/11/90) MONTHLY TEST
- # 00424291 (6/11/90 - 6/12/90) MONTHLY TEST
- # 00430543 (6/16/90 - 6/27/90) INSPECTED LIGHTS (WATT)  
# 00425953 (6/18/90 - 7/2/90) BATTERY REPLACEMENT



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**EMERGENCY LIGHTING COMPONENT AVAILABILITY**  
**EQUID:2EQBN004**  
**TYPE: HOLOPHANE - UPS**

**REQUIRED AVAILABLE DAYS: 366**

**KNOWN UNAVAILABLE DAYS: 4**

**ESTIMATED UNAVAILABLE DAYS: 27.5**

- Available
- Known unavailable
- Estimated unavailable

DATA START DATE - 6/29/89 (UNIT 2 RESTART)  
 # 0035749 (7/9/89) MONTHLY INSPECTION OF UPS

# 00365137(8/5/89) MONTHLY INSPECTION OF UPS EMERGENCY LIGHTING

# 00373829 (8/16/89 - 8/25/89) FAILED BAR GRAPH DISPLAY BOARD

# 00374623 (9/5/89) MONTHLY INSPECTION OF UPS EMERGENCY LIGHTS. BATTERY # 3A FAILED ACCEPTANCE CRITERIA

# 00381416 (10/15/89) REPLACEMENT OF DEFECTIVE BATTERY # 3A (NOTE 4 BATTERIES REPLACED)

# 00385141(10/31/89 - 11/1/89) MONTHLY INSPECTION OF UPS

# 00381568 (11/16/89) 8 HOUR DISCHARGE TEST

# 00388913 (11/28/89) MONTHLY INSPECTION OF UPS

# 00393427 (12/29/89 - 1/1/90) MONTHLY INSPECTION OF UPS. BBTV FAILED LOW BBTV ADJUSTMENT WAS MADE

# 00398849 (1/24/90 - 1/24/90) MONTHLY INSPECTION BBTV FAILED HIGH

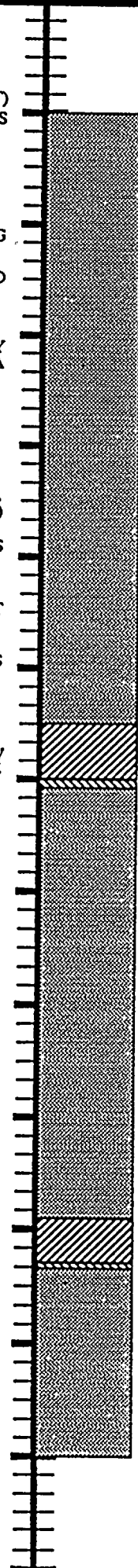
# 00403614 (2/19/90) MONTHLY INSPECTION OF UPS

# 00409091 (3/23/90) MONTHLY INSPECTION  
 # 00405149(3/23/90) REPLACE CHARGING CARD

# 00420446 (4/17/90) MONTHLY INSPECTION

# 00420405 (5/11/90 - 5/12/90) MONTHLY INSPECTION BBTV FAILED LOW  
 # 00424805 (5/13/90) CYCLE EMERGENCY LIGHTING

# 00424294 (6/12/90) MONTHLY INSPECTION



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FM 5

**EMERGENCY LIGHTING COMPONENT AVAILABILITY**  
**EQUID: 1ESTL74C0913008 TYPE: EMERGI-LIGHT**

**REQUIRED AVAILABLE DAYS: 184**  
**KNOWN UNAVAILABLE DAYS: 3**  
**ESTIMATED UNAVAILABLE DAYS: 31**

- Available
- Known unavailable
- Estimated unavailable

IFE - QD - 022 IN SERVICE DATE: 12/28/89

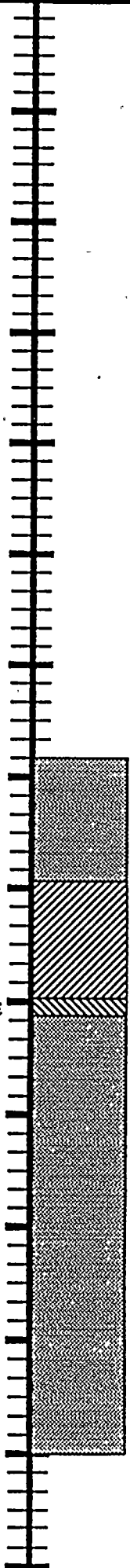
# 00411962 (PM) 2/27/90 - 2/28/90 8-HOUR DISCHARGE TEST\*FAILED (5.5 HOURS)\*  
# 00412682 (CM) 3/1/90 - 3/7/90 REPLACED DEFECTIVE BATTERY, 8-HOUR DISCHARGE  
RETEST, SAT. ON 3/3/90

# 00412887 (PM) 4/3/90 - 4/3/90 TEST/TEST PERFORMANCE

# 00414086 (PM) 5/6/90 - 5/6/90 TEST/TEST PERFORMANCE

# 00421971 (PM) 5/28/90 - 5/28/90 TEST/TEST PERFORMANCE  
# 00428189 (CM) 6/7/90 - 6/8/90 WATER TIGHT INSPECTION

# 00429226 (PM) 6/30/90 - 6/30/90 TEST/TEST PERFORMANCE



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