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CONWAY,W.F. Arizona Public Service Co. (formerly Arizona Nuclear Power
RECIP.NAME RECIPIENT AFFILIATION
MARTIN,J.B. Region 5, Ofc of the Director 89-29

SUBJECT: Advises that corrective action plan re atmospheric dump valve failures & compressed gas sys expected by 890929.

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WILLIAM F. CONWAY
EXECUTIVE VICE PRESIDENT
NUCLEAR

102-01418-WFC/TDS/TRB
September 20, 1989

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

Reference: (a) Letter from J. B. Martin, Regional Administrator, NRC to W. F. Conway, Executive Vice President Nuclear, APS dated July 7, 1989

(b) Telephone call between R. P. Zimmerman, Acting Director, Division of Reactor Safety and Projects and J. N. Bailey, Vice President Nuclear Safety and Licensing, APS on September 5, 1989

Dear Sir:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, and 3
Docket No. STN 50-528 (License No. NPF-41)
STN 50-529 (License No. NPF-51)
STN-50-530 (License No. NPF-74)
Reply to Inspection Report 50-528/89-29
File: 89-019-026

During the NRC/APS Management Meeting held on June 5, 1989, APS committed to review the adequacy of the root cause evaluation conducted in response to the Atmospheric Dump Valve (ADV) failures and the problems encountered with the Compressed Gas System (CGS). Reference (a) requested that the evaluation be submitted to the NRC by September 5, 1989. APS requested and received permission to submit the evaluation by September 19, 1989, during reference (b). The evaluation has been completed and is attached for your review.

APS is currently developing corrective actions in response to the findings of the evaluation. The corrective action plan is scheduled to be completed by September 29, 1989, and will be transmitted to you upon completion. If you have any questions or additional comments, please contact me.

Very truly yours,

WFC/TDS/TRB/kj

IE-01

Nuclear Safety Department
Independent Case Study of
Compressed Gas and ADV Events

The Nuclear Safety Department (NSD) has performed a review of the history surrounding the Atmospheric Dump Valve (ADV) and Compressed Gas System (CGS) (instrument air and nitrogen backup interface) problems identified subsequent to the Unit 3 Trip in March, 1989. The purpose of this review was to identify why the various technical problems were not adequately addressed prior to that event. This report is not intended to detail the chronology of the events, which was accomplished by previous engineering analysis reports.

The major factors which caused the ADV and CGS problems to remain uncorrected until March, 1989 are:

A poor quality engineering calculation and technical review for the compressed gas system design. This has been aggravated by a failure to update those calculations during plant changes or to periodically compare the calculations to actual plant performance, particularly when performance problems have been noted. Also, performance problems have not been communicated to Nuclear Engineering to prompt the need to review design basis. Root cause evaluations and retests have been made on the criteria of "did it work?" instead of "did it perform up to the standards of the design basis?"

Reluctance to perform comprehensive integrated tests to fully demonstrate system performance up to the standards of the design basis. This failure to perform adequate testing has resulted in the failure to identify that corrective action was ineffective and original root cause evaluations were incorrect. This is further aggravated by the failure of management and oversight organizations to monitor corrective action effectiveness, instead of simply concurring with the proposed corrective action.

Poor communication evidenced by these events among the Operations Engineering (now Engineering Evaluations Department), Nuclear Engineering, Startup Testing and upper management was indicated by a lack of requests for assistance or the notification to Nuclear Engineering that design basis was in question and by the failure of management to understand the need for modifications to the ADV's.

Improper evaluation of three vendor's design change recommendations presented in 1985. These recommendations would have significantly resolved both the ADV and the CGS events. After the March 3, 1989 event, these vendor recommendations were implemented.

An additional factor is the failure of APS to fully embrace the importance of the Operating Experience Review Program.

A lack of supervisory participation in the decisions made by the system engineers. This was particularly evident during the late start-up phase when a design freeze was in effect. Two plant changes directed toward correcting compressed gas and ADV problems were rejected by the system engineers without any evidence that their supervision, and therefore higher levels of management as well, were aware of the termination of corrective actions. These rejections were based on the system engineer's recognition of management expectations that changes were only to be performed for cases of safety, operability or regulatory commitment. These rejections were complicated by the fact that no tracking system was used to ensure that these corrective actions would be re-initiated as conditions or priorities permitted.

A failure of the investigation process in effect at that time to revise corrective action to update procedures and training when root cause was determined to be lack of understanding of normal ADV operation instead of an ADV mechanical failure.

A more detailed discussion including the basis for these conclusions is attached.

Attachments: 1: Compressed Gas System Case Study
2: Atmospheric Dump Valve Case Study

ATTACHMENT 1

COMPRESSED GAS SYSTEM CASE STUDY

The origin of the inability of the nitrogen backup system to deliver design pressure and flow to the instrument air system was the presence of incorrect assumptions by the Architect-Engineer of the performance of certain components in the design calculations. The quality of such engineering calculations is important, as demonstrated by the impact that this error has had upon Palo Verde. The independent technical review by the Architect-Engineer also failed to detect or correct the errors. During the design of Palo Verde, the Nuclear Engineering Department did not review and approve design, but was primarily involved in design changes and their cost effectiveness. The responsibility to review calculations performed by contractors was not taken on by Palo Verde until the Unit 1 Operating License was issued. This is typical of the transition from a construction to an operating organization in the nuclear industry.

The next opportunity to detect and correct the deficiency was during the pre-operational testing phase. The FSAR description of the instrument air system test includes verification of the capability of the nitrogen backup. Only an integrated flow test would have disclosed the condition and the problem was not detected.

The first time that the problem was observed was the Unit 1 trip of 10/3/85, when a low system pressure of 62 psig was observed, followed by another trip on 10/7/85 which resulted in an instrument air pressure drop to 72 psig. It was erroneously assumed, without analysis, that the reason was excessive instrument air system out-leakage (excessive air use).

Rather than review of the design basis, calculations, or related assumptions, efforts were directed to locating the source of excessive out-leakage.

In the Post Trip Review Report closeout, only the completion of actions associated with minimizing leakage was reported, without indicating that the problem had not been corrected. Thus, management was led to believe that the problem had been corrected. The preparation and final issue of Post Trip Reviews (now Incident Investigations) are heavily monitored by all levels of management and also the oversight organizations. The results, however, are not. As a result, it was thought that the corrective actions were adequate, but the failure to follow-up left personnel with the incorrect assumption that the problems would be fixed.

Actions specified as corrective action were recorded as completed without evaluation of the results. For example, a walkdown of the instrument air system was performed for excess leakage, but apparently none was found. This was contrary to the previously

determined root cause and should have triggered further investigation. Similarly, the compressor run-time program apparently did not show excessive leakage and should have caused the incorrect root cause to be suspect.

Engineering Evaluation Request (EER) 85-GA-013 was dispositioned by a contract system engineer. The disposition identified that the spring for check valve IAN-V056 was incorrectly sized (the pressure drop across the valve was 18.4 psid, when it should have been 1 psid). The engineer came to this conclusion based on consultation with the valve vendor. No Plant Change Request was written due to an assumed lack of funding for a non-safety item of this nature. This decision was based on the system engineer's recognition of management expectations that funding was only available for cases of safety, operability or regulatory commitment. There is no evidence that the engineer's supervision or management was informed of the high pressure drop across IAN-V056. The EER was closed "for information only" without any supervisory signature. Because no repair was made to the check valve, the remaining system deficiencies were not detected. Had the spring been replaced, a retest of the nitrogen backup (if performed) could have then detected the presence of additional problems.

The Post Trip Report was closed out on the basis of the EER sign-off. Management was not informed or aware that the EER did not resolve the original Post Trip concern.

The Nuclear Safety Department (NSD) receives Post Trip reports and evaluates the proposed corrective action, but does not review closeout documents. Additionally, the Nuclear Safety Department does not review EERs that are dispositioned "for information only" because this kind of disposition is not used to report safety significant issues.

Since no non-conforming condition was identified by the system engineer, neither Quality Assurance nor the Independent Safety Engineering Department were informed. The closeout documents of the Post Trip Report were not reviewed or questioned by Quality Assurance, the Nuclear Safety Department or the Independent Safety Engineering Department.

Should the design basis be suspect, or found to have been exceeded, it is generally good practice to review the supporting design basis calculations. The system engineer did not inform the Nuclear Engineering Department of this concern. If they had been informed and reviewed the calcs for the check valve problem, then the additional problems might have also been discovered. A review of the calculations would have highlighted that the 17.4 psid error in the check valve design could not fully account for the 62 psig pressure that was observed. This "proactive curiosity" did not exist at the time of the trips in 1985.

In summary, the total reliance on the system engineer to communicate problems as well as recognize and initiate corrective action failed. In addition, the engineer's willingness to accept substandard system performance because the system "worked good enough" was evident.

The fact that this is a non safety-related system may have contributed to the lack of follow-up by the system engineer to do a safety evaluation and by Quality Assurance, Nuclear Safety Department or the Independent Safety Engineering Department to review and concur with the associated Post Trip Review Report closeout. This Compressed Gas System deficiency was, therefore, not corrected during that time period.

Although the system engineer was alert to recognize the problem with the check valve, it was determined that no change was to be made at the time. Because the EER was closed, with no other tracking mechanism in place, there was never any effort to make the change at a later date. Thus problems identified during the design freeze period at the end of the Palo Verde start-up phase were prone to being overlooked.

The second opportunity to correct this Compressed Gas System deficiency was provided to PVNGS through the program for integrating industry experience as highlighted by the NRC Information Notice IEN 87-28 (issued on 9/17/87), Generic Letter 88-14 (issued on 8/8/88), and INPO significant Operating Experience Report SOER 88-01 (issued on 5/18/88). PVNGS integrated the entire response into GL 88-14. This response did not include comprehensive Compressed Gas System testing that would have rediscovered the existing deficiency and presented it to line management and to oversight groups.

The backlog of the Operating Experience Review Program may have contributed to the lack of timely correction. The earlier reports (IEN 87-28 and SOER 88-01) not yet been closed upon receipt of Generic Letter 88-14. The closeout for those were rolled over to the Generic Letter. Further, a review of the response by Palo Verde to Generic Letter 88-14 testing requirements identified that APS did not have actions as aggressive as most other utilities, both in terms of depth of review or timeliness.

The purpose of these experience reports was to elevate the importance of the instrument air system. It is not clear that the desired "attitude change" occurred until after the Unit 3 trip in March, 1989.

During the October 1985 Unit 1 trips and the August 1988 NRC correspondence in GL 88-14, the potential problems and importance to safety of Instrument Air and nitrogen backup were surfaced. Engineering support at PVNGS did not review Architect-Engineer calculations and related assumptions to ensure that design basis is met under normal and transient conditions This review was not done, therefore the Compressed Gas System deficiency in flowrate requirement under transient conditions was not discovered. Oversight groups did not alert engineering groups (Nuclear Engineering, Evaluations Engineering) of the necessity to review the Architect-Engineer's calculations.

The evaluation that followed the Unit 3 trip in March, 1989 identified additional pre-existent problems. Numerous preventive maintenance activities recommended by the vendors were deferred at PVNGS without obtaining advice of the vendor. These PMs, although not specifically related to the detection of the low pressure condition, might have increased the overall reliability of the system. Furthermore, the Instrument Air system was modified during the past four years by adding numerous small loads (via 43 FCRs) which amounted to a total of about 3.5% increase in demand. The design basis calculations were, again, not reviewed or revised to ensure compliance with design basis. Since these changes were introduced one by one as minor changes, neither engineering nor any of the oversight groups did a review of their combined effect on the air/nitrogen backup flowrate. The calculations are currently being revised to include the effect of these changes.

COMPRESSED GAS SYSTEM

DESIGN

- Quality of Architect-Engineer calculation was inadequate.
- Architect-Engineer Technical Review failed.
- Prior to the Operating License issue, NED did not participate heavily in design, participation was primarily in design changes and their cost effectiveness.

PRE-OPERATIONAL TESTING

- Missed opportunity to detect/correct deficiencies.
- Pre-op test was not an integrated flow test.
- Failed to effectively test capability of N_2 backup.

COMPRESSED GAS SYSTEM

1985 UNIT 1 TRIPS

- Missed opportunity to correct deficiencies.
- Root cause in Post Trip Review Reports (PTRR) not justified by analysis.
- EER disposition and close-out sole authority of system engineer.
- Management and oversight review of PTRR limited to recommended corrective action, not performed corrective action or retest.
- Negative findings of instrument air walkdown and compressor run time did not trigger re-evaluation of root cause.
- PTRR closeout recorded actions without evaluation.
- Lack of communication to management, oversight or NED of the failure to meet design basis.
- Willingness to accept substandard performance because system "worked good enough."
- Proposed changes, intended to be performed at a later date, were rejected.

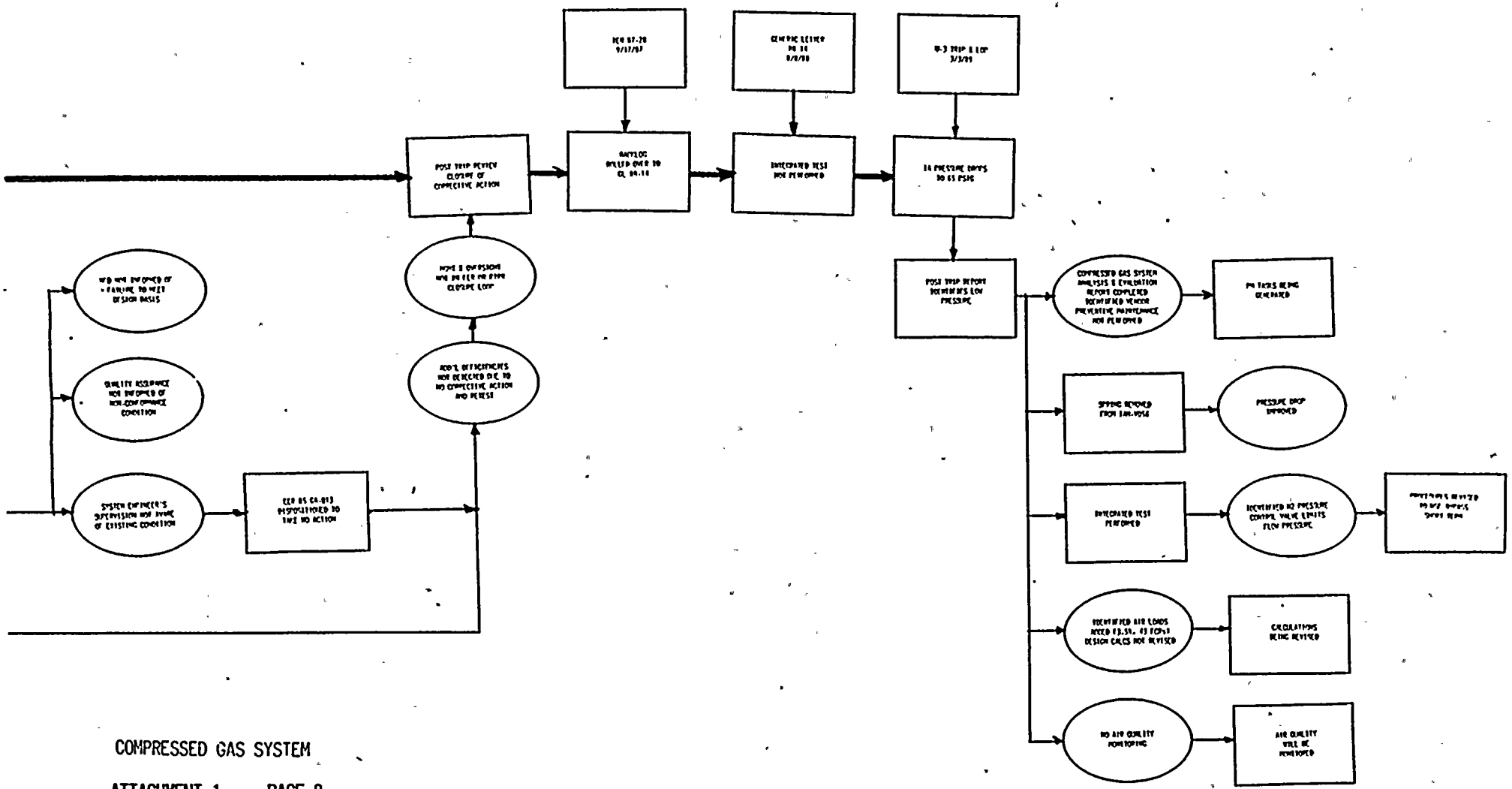
COMPRESSED GAS SYSTEM

OPERATING EXPERIENCE

- Attitude of PVNGS (and industry as a whole) that instrument air is a less significant, non-safety system.
- Backlog of OER Program prevented timely correction.
- SOER 88-01 did not specify any corrective action that would have detected the problem, but should have elevated attention to importance of instrument air system.
- PVNGS took exception to performing the integrated test of IEN 87-28 and GL 88-14.
- Operating Experience Information surfaced the potential problems and importance to safety of the instrument air system. Engineering support should have then reviewed Architect-Engineer calculations and related assumptions to ensure that design basis is met under normal and transient conditions.

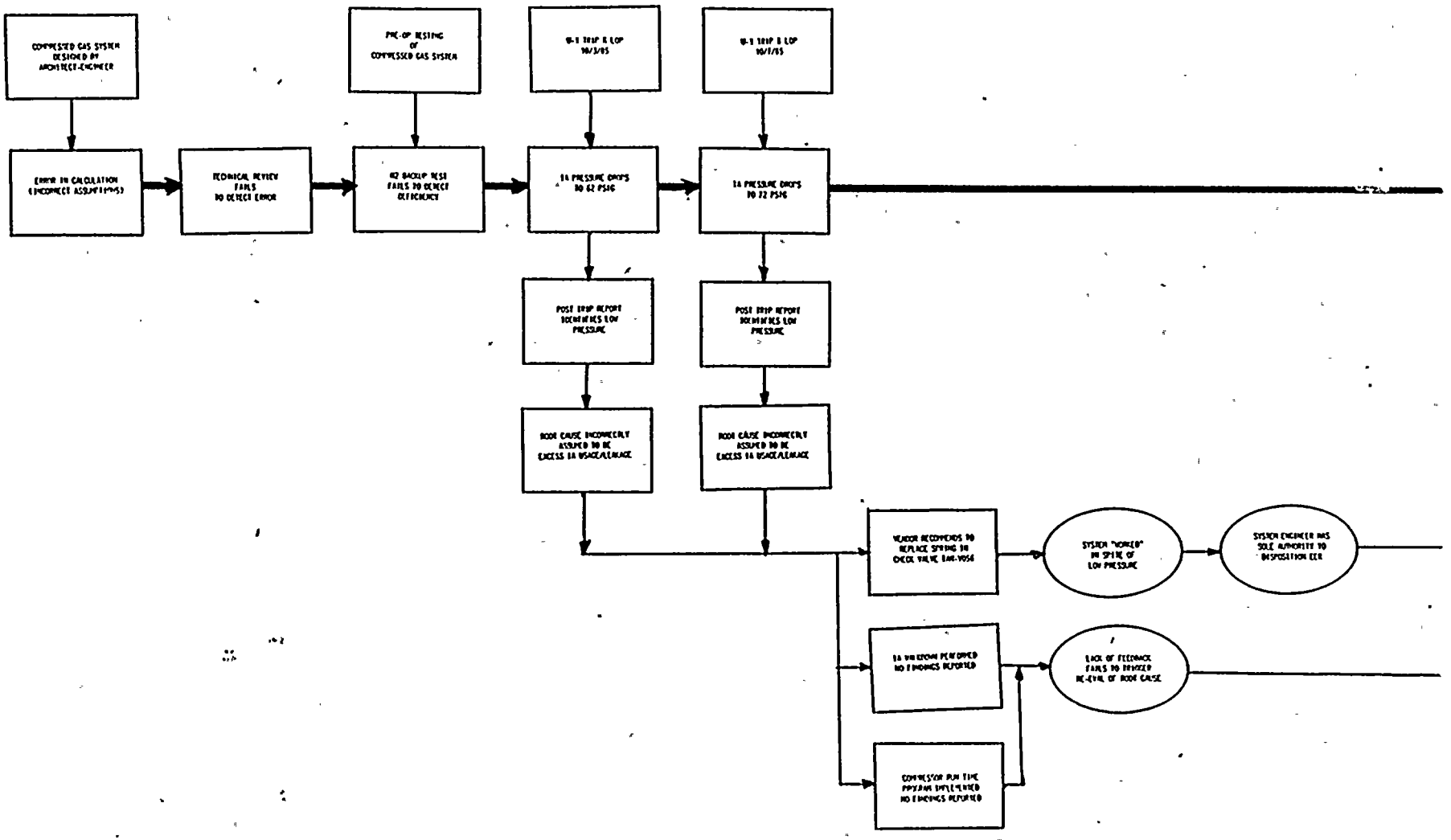
UNIT-3 TRIP, 3/3/89

- Integrated flow/capacity test performed.
- Check valve spring identified in 1985 was investigated and found to only partially contribute to root cause.
- Additional investigation identified design errors in sizing of N_2 pressure regulating valves.
- Design changes added air loads (3.5%, 43 FCRs) without identifying to NED the need to re-evaluate the design calcs.



COMPRESSED GAS SYSTEM

ATTACHMENT 1 - PAGE 8


COMPRESSED GAS SYSTEM DESIGNED BY ARCHITECT-ENGINEER
ERROR IN CALCULATION (INCORRECT ASSUMPTIONS)
TECHNICAL REVIEW FAILS TO DETECT ERROR
PRE-OP TESTING OF COMPRESSED GAS SYSTEM
#2 BACKUP TEST FAILS TO DETECT DEFICIENCY
U-1 TRIP 8 LOP 10/3/85
1A PRESSURE DROPS TO 62 PSIG
U-1 TRIP 8 LOP 10/7/85
1A PRESSURE DROPS TO 72 PSIG
POST TRIP REPORT IDENTIFIES LOW PRESSURE
POST TRIP REPORT IDENTIFIES LOW PRESSURE
ROOT CAUSE INCORRECTLY ASSUMED TO BE EXCESS 1A USAGE/LEAKAGE
ROOT CAUSE INCORRECTLY ASSUMED TO BE EXCESS 1A USAGE/LEAKAGE
VENDOR RECOMMENDS TO REPLACE SPRING IN CHECK VALVE 1AR-V056
SYSTEM "NORMAL" IN SPITE OF LOW PRESSURE
SYSTEM ENGINEER HAS SOLE AUTHORITY TO DISPOSITION ECR
1A VALVE(S) PERFORMED NO FINDINGS REPORTED
LACK OF FEEDBACK FAILS TO PROMPT RE-EVAL OF ROOT CAUSE
COMPRESSOR RUN TIME PROGRAM IMPLEMENTED NO FINDINGS REPORTED

ATTACHMENT 2

ATMOSPHERIC DUMP VALVE CASE STUDY

ATMOSPHERIC DUMP VALVE PROBLEM AT PVNGS

During the first half of 1985, all ADVs at PVNGS exhibited slow, erratic, and oscillating performance. Bechtel Power Corporation (BPC), APS, and Control Component International (CCI) devoted significant efforts to correct the ADV problems. The Nuclear Safety Department was cognizant of the ADV corrective actions efforts. The ADV delayed response and elevated signal requirement were believed to have been corrected by incorporating industry experience gained at San Onofre Nuclear Generating Station (SONGS). Subsequent ADV testing showed that the valves' slow and erratic performance was not corrected. Additional industry experience and CCI's and BPC's recommendations proved that periodic valve stroking is necessary to reliable ADV performance. As recommended by a consultant to BPC, an electric motor was temporarily installed on ADV184 and the valve stroked satisfactorily, but the electric motor was removed with the expectation that the pneumatic valve operator provides higher valve reliability.

Having recognized that periodic valve stroking is necessary to valve reliability, engineering initiated PCP 85-01-SG-056 (DCP 1 OP-SG-136) to install a block valve upstream of each ADV and a blind flange downstream, so that each ADV can be isolated for valve testing and maintenance. This proposed design change was also thought to be useful to alleviate the consequences of a stuck open valve by closing the normally locked open block valve.

This plant design change would have impacted the Unit-1 start-up schedule. Therefore, needed to be approved by the Executive Vice President, PVNGS, since there was a design change freeze at that time. This design change was supported by Nuclear Engineering, Engineering Evaluation Department (formerly known as Operations Engineering), and by the Nuclear Safety Department. The PCP received management approval up to the Director level, but was later placed on hold by upper-management. The reasons for this missed opportunity to install block valves to isolate each ADV (one at a time) for stroke testing was not documented. However, the Nuclear Safety Department interviews of involved personnel indicated that engineering presented the proposed plant change to upper management primarily as a safety improvement issue, since the block valve may alleviate the consequences of a stuck open ADV. This engineering request to install the block valves was rejected by upper-management because the existing alternative of operator's intervention to close a stuck open ADV was deemed acceptable and thus the request did not warrant a start-up schedule delay for Unit-1.

In fact, engineering personnel stated that they were criticized for initiating this plant change installation at Unit-3, which was not affected by schedules and did not require approval from upper-management. This missed opportunity to install block valves and blind flanges for ADV isolation for testing and maintenance is attributed to: a) inadequate communications between engineering groups and upper-management, such that upper management did not appreciate the importance of exercising ADVs to their reliability, and therefore plant safety, resulting in the design change being placed on hold; and, b) management instituted a plant design change freeze so that Unit 1 startup would not be delayed with overly restrictive exceptions; this ADV-related plant design change was supported by NED, EED, and oversight groups up to director level and, yet, it was overcome by the design freeze.

After June, 1985, when PCP 85-01-SG-056 was placed on hold, Nuclear Engineering, Operations Engineering, and oversight groups missed the opportunity to alleviate potential ADV malfunctions by not instituting operator training, updating related procedures, and updating plant simulator. These actions would have alleviated the ADV problems exhibited during the March 3, 1989 event. During that event, the operators did not know that the ADVs require a relatively large duration signal of higher than specified magnitude for proper ADV positioning. The written procedures did not provide the operators with the necessary details. The simulator was then presenting the ADVs as having immediate and accurate responses.

The proposed plant design change of June, 1985 was not cancelled. It was only placed on hold during the time period of U-1 start-up. NED and EED failed to reactivate the issue at a later date when extended plant outages were encountered. QA and other oversight groups did not follow-up on this ADV problem.

Between June 1985 and March 1989, there were several ADV uses in which slow and erratic performances were noted; yet, no corrective actions were initiated by any PVNGS department. The valves have been consistently evaluated to design basis criteria (safety analysis), but these evaluations were not incorporated into operator's training and procedures.

BPC's recommendation to weld together the valve disk stack in order to improve the valve's erratic operation was initiated as a Plant Change Request (PCR). This PCR was rejected by the system engineer without supervisory concurrence due to the implementation of the design freeze at that time. The system engineer based his decision on management expections that changes were only to be performed for cases of safety, operability or regulatory commitment during the design freeze. When the design freeze ended, the change was not reconsidered because there was no tracking system in effect at the time of rejection.

ATMOSPHERIC DUMP VALVES

- ADV's erratic performance was believed to have been fixed by implementing fixes made at San Onofre Nuclear Generating Station (SONGS). Later testing showed that ADVs continue to be erratic.

- Plant modifications to isolate each Atmospheric Dump Valve (ADV) for stroke testing, which could have improved the reliability of the ADVs, were rejected during the design freeze, but not reconsidered when the freeze was over.

- Upper-management instituted plant design change freeze to accomplish the start-up schedule dates. Exceptions from this freeze on design changes were overly restrictive.

- The importance of the block valves modification was poorly communicated to executive management.

- The system engineer had sole authority to reject plant modifications without supervisory concurrence.

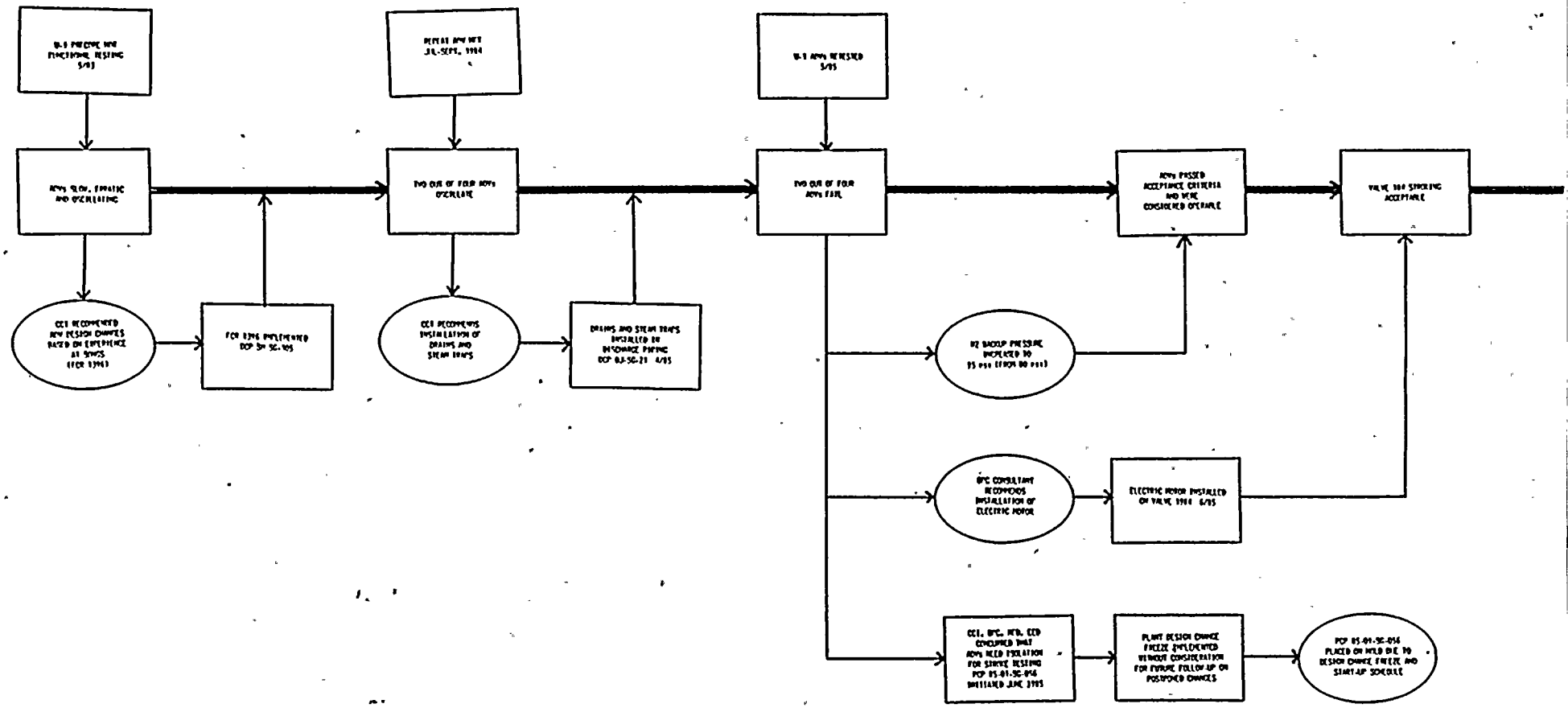
- The need to periodically exercise the ADVs was recognized, but not implemented.

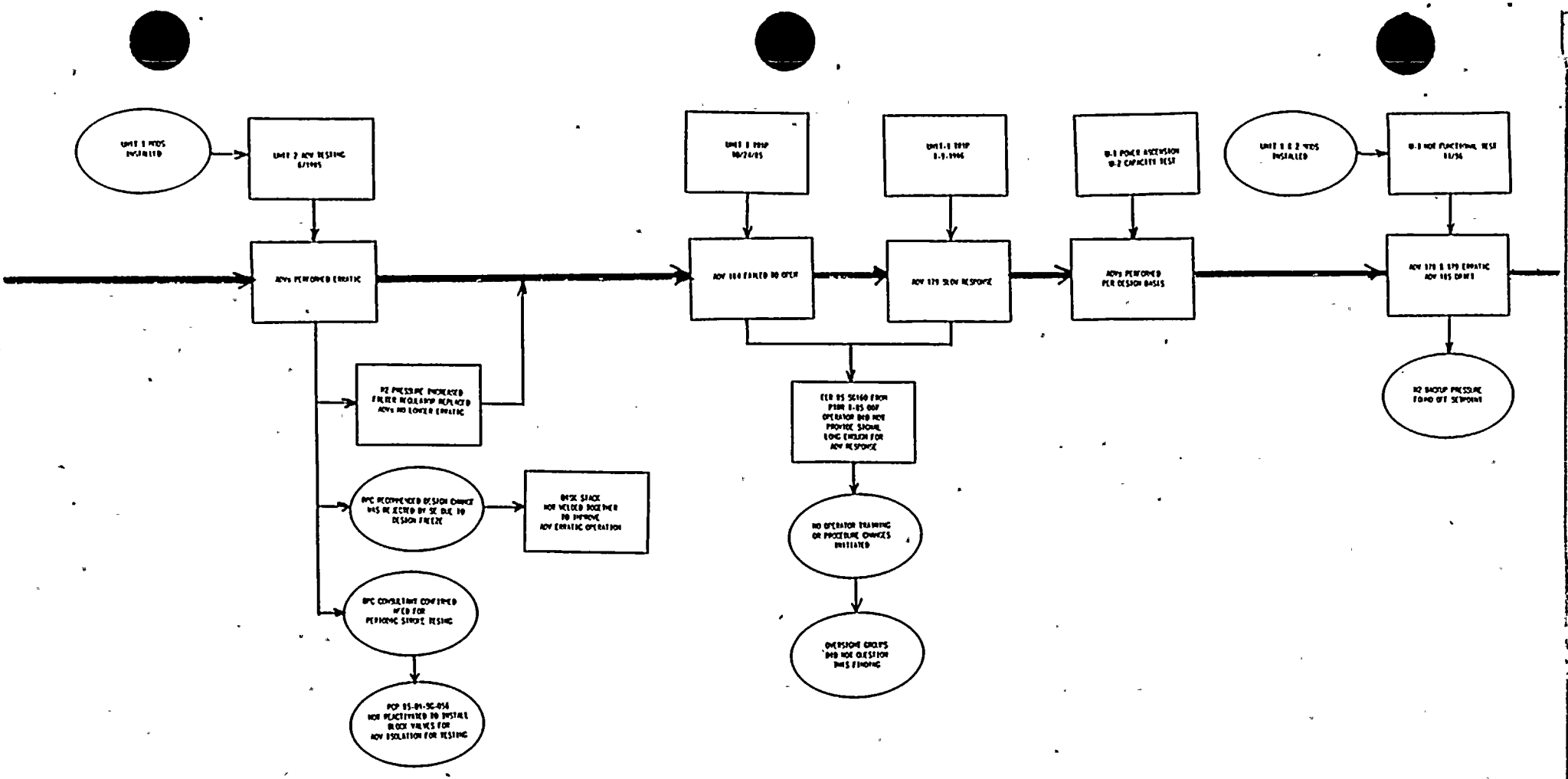
- Numerous reports of inadequate ADV response were evaluated as a lack of understanding of normal operating characteristics. Yet, this did not trigger either procedure revisions or additional training.

- The simulator was not updated to reflect actual valve response.

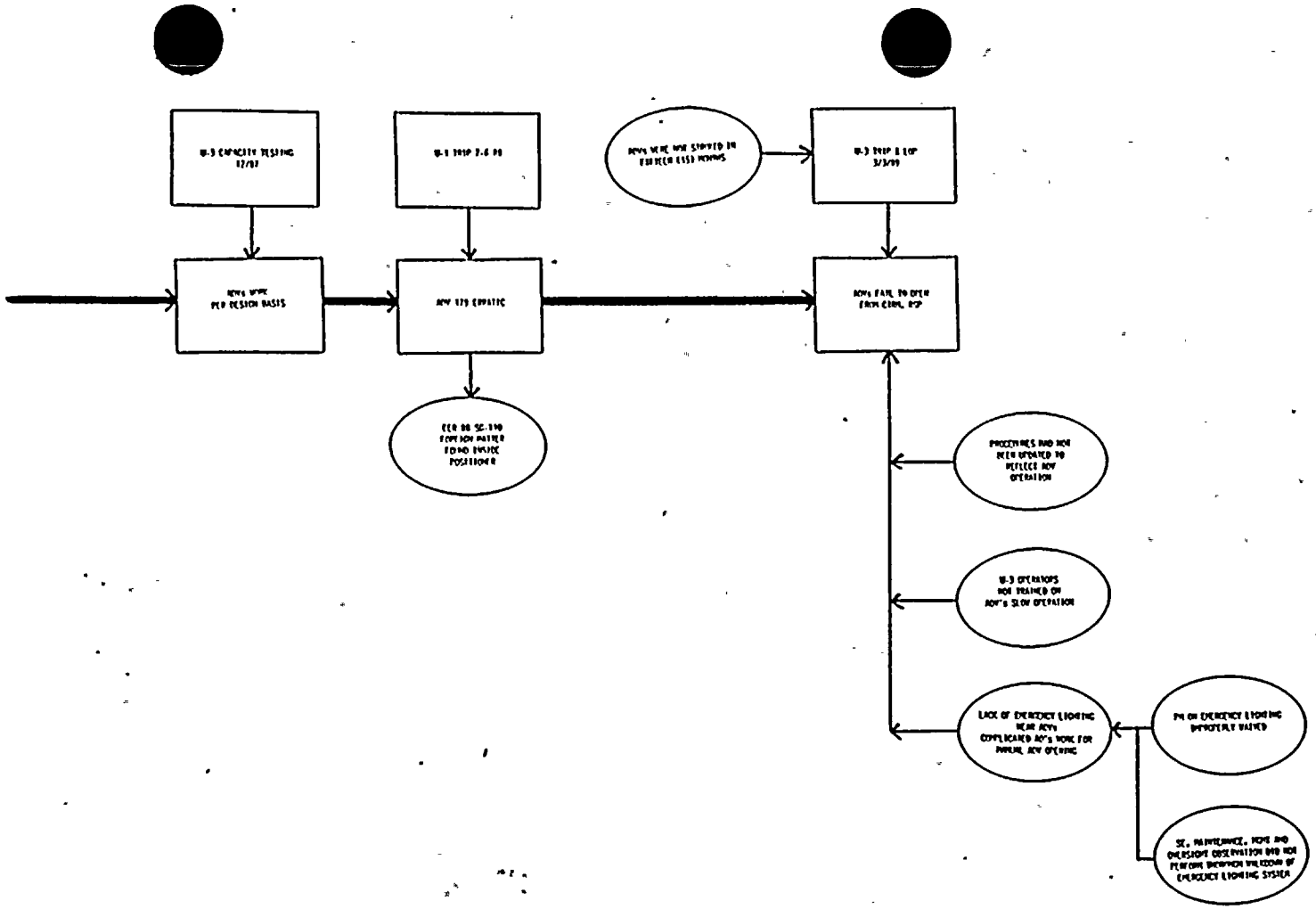
- The valves have been consistently evaluated to design basis (safety analysis) criteria, but not to the operator's concerns.

- Verification and validation process had not been applied to procedures for locally operating the ADVs.





ATMOSPHERIC DUMP VALVES


U-3 CAPACITY TESTING 12/97
U-3 TRIP 7.6 PP
AOVs WERE NOT STROKED IN FAVORED ESS POSNS
U-3 TRIP & EOP 3/3/99
AOVs WERE PER DESIGN BASIS
AOV 179 ERRATIC
AOVs FAIL TO OPEN FROM CBOL PCP
PER GE SC-190 FOREIGN MATTER FOUND INSIDE POSITIONER
PROCEDURES DID NOT BEEN UPDATED TO REFLECT AOV OPERATION
U-3 OPERATORS NOT TRAINED ON AOV's SLOW OPERATION
LACK OF EMERGENCY LIGHTING NEAR AOVs COMPLICATED AO's WORK FOR MANUAL AOV OPENING
PM ON EMERGENCY LIGHTING IMPROPERLY WAIVED
SE, MAINTENANCE, MCNE AND OPERATIONS OBSERVATION DID NOT PERFORM SHUTDOWN WALKDOWN OF EMERGENCY LIGHTING SYSTEM