ATTACHMENT

AEOD/E901

ENGINEERING EVALUATION REPORT
PROBLEMS WITH OILS, GREASES, SOLVENTS, AND OTHER CHEMICAL MATERIALS

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SUMMARY

Lapses in the control and handling of chemical materials are illustrated by examination of 26 incidents reported in NRC inspection reports or licensee event reports over the past three years. Most of the examples deal with deficiencies in operations or maintenance practices, although a few of the references involve design or consulting oversights. Many opportunities exist for different plant personnel to make mistakes in processing or using these substances, especially for routine activities such as maintaining oil levels or lubrication of safety equipment. Although the equipment manufacturers are the principle source of information regarding maintenance of their equipment, the process allows for alternative materials to be used if justified. Quite often alternatives are weakly supported or the licensee is poorly advised by a consultant. Programmatic controls exist, but ongoing vigilance must be maintained to minimize the potential for misuse of these materials which present a threat of common cause failure of redundant or similar equipment that may not be detected immediately. This is especially a concern for equipment that have small clearances that may be easily clogged or bound up.

1.0 INTRODUCTION

Problems with oils, greases, solvents, and other chemical materials arising out of maintenance activities create significant safety concerns because of the potential for common cause failure of redundant or similar equipment. In this report, the term chemical material includes all these materials even though some of the problems with oils and greases may involve physical attributes rather than chemical properties. The NRC has addressed this issue many times in information notices and in enforcement of quality assurance rules for components important to safety. The utilities generally have administrative procedures covering the purchase and use of various chemical materials in their maintenance activities. In spite of these efforts, misapplication of these substances continues to be reported as a cause of equipment failure at different installations.

This report examines several recent events that involved misuse of chemical materials. By compiling these data, the general problem of control of chemical materials can be examined and the administrative problems illuminated. In many instances, the examples reflect conscientious people performing good faith actions that fall short. Some of the cases involve design flaws or deficiencies in services provided by outside organizations.

2.0 DESCRIPTION OF EVENTS

Summaries of 25 events directly related to problems with chemical materials are presented in the Appendix. Most of the references are inspection reports from the past two years. Although not a complete collection of events, the appendix provides a broad spectrum of events involving a significant number of plants. These types of issues generally do not show up in the LERs as frequently as they are flagged in plant inspection reports. Four separate events described below provide an overview of the types of situations encountered.

Rancho Seco

During scheduled testing of safety system actuation circuitry, technicians discovered incorrect voltage readings and spurious module trips (Ref. 1). Subsequent trouble shooting attributed the problem to improper electrical contact between male and female connectors. Cleaning the connectors with available material did not improve the situation. Continued investigation disclosed a coating of solder flux, organic material, and plasticizers on the connectors that caused intermittent contact. About a year earlier, the licensee had initiated a preventive maintenance cleaning program for connectors in several safety related circuits. This cleaning program used a commercial grade of Freon TF which contains a plasticizer and organic impurities. The cleaning process also dissolved and dispersed solder flux to the connector surfaces. A laboratory analysis showed that these impurities migrate to areas of increased electrical potential at the point of contact and grow non-conducting organic crystals. As a result of this discovery, the licensee cleaned all the affected connectors with a refined Freon based compound.

Sequoyah

Following the inadvertent actuation of emergency power, one of the diesel generators tripped on overspeed caused by a faulty hydraulic actuator. About two years earlier, the diesels experienced loading problems which were attributed to poor electrical connections. RTV (silicone rubber) was applied inside the actuator to seal an electrical connector about two years before the current event occurred. In the present event, it was determined that RTV had blocked part of the oil passageways and thereby starved portions of the hydraulic actuator of oil (Ref. 2). Although all the actuators on all the diesels were treated in this way, only one unit failed.

Tests were performed to determine the effect of mineral oil No. 3 on General Electric RTV-106. Results of the tests showed that RTV immersed in oil immediately did not cure during the immersion. However, the samples did cure after removal from oil, draining, and standing in air at room temperature for 24 hours. Samples immersed in oil after curing were visually unaffected by exposure to oil for 24 hours. To prevent recurrence of the problem, the licensee will not use RTV in the actuators in the future.

North Anna

The licensee experienced piston pin bushing extrusion in the emergency diesels over a period of several years until it was discovered that a change in lubricating oil corrected the situation (Ref. 3). The original lube oil was not specified by the diesel manufacturer; however, it was subsequently learned that the manufacturer would not have approved the original oil, if asked, because it was not anti-foaming. An extensive investigation was initiated when the bushing extrusion was first noted. The piston wrist pin floating bushing elongated in its axial direction which is radial with respect to the piston. The floating bushing then forced the insert bushing outward against the piston skirt which in turn contacted the cylinder liner. This degradation was attributed to inadequate lubrication. To ensure correct lubrication in the future, the inappropriate oil is no longer stored on site.

Farley

Mixing of greases in the main gear boxes of motor operated valves (MOV) was cited by a special NRC inspection team as an unresolved issue at Farley (Ref. 4). Originally the MOVs were supplied with a calcium based grease in the gear boxes. Over a period of several years, the licensee performed periodic lubrication with a lithium based grease. The licensee had no requirement to change the grease completely before using a different type. However, Limitorque manuals specifically stated that greases of different types should not be mixed. In addition, this same finding was highlighted in an industry notification.

3.0 DISCUSSION

Within the limits of the collected references in the appendix, problems occur in old plants about as frequently as they occur in recently licensed plants and the number of events per year is not diminishing. Thus, problems with oils, greases, solvents, and other chemical materials are current and generic in scope. Several steps are involved in handling chemical materials at a plant. They include identification and purchase of the appropriate material, receipt inspection, storage control, specific identification in work orders or maintenance procedures, correct use of the substances, and inspection of the completed maintenance activity. The first four items reflect front end control and examples of mistakes in this area are the Rancho Seco, North Anna, and Farley citations in Section 2.0. The Sequoyah event illustrates a problem in the back end of the process. About two-thirds of the relevant citations in the appendix are front end related. Not all the examples in the appendix involve handling chemical materials directly. Other references illustrate design or operational problems such as chemical attack of electric cabling in conduits and general maintenance activities that highlight practices inimical to proper control and use of chemical materials.

The problems associated with handling chemical materials are largely people problems. Administrative procedures generally exist for controlling these materials and these procedures allow varying degrees of latitude in performing normal plant activities with these substances. In addition, many different plant personnel have opportunities to make mistakes in this area. Section 3.1 examines mishaps in the direct use of these materials, while Section 3.2 looks at some passive problems such as design oversights and spillages.

3.1 Mishandling Chemical Materials

Front End Problems

Identifying and purchasing the correct material for a particular task such as lubrication or cleaning is the first step in the control process. Generally, the equipment manufacturer specifies chemical materials for operation and maintenance of his equipment; however, the utility may use an outside consultant such as an oil company or their own chemistry and engineering departments to define alternate materials. In the Rancho Seco event (Ref. 1), the supplier suggested an alternate solvent for the cleaning program. The fact that this material had been used successfully by the licensee in less critical circumstances probably influenced the decision to use the commercial grade material.

The decision process appears to have been informal and the choice inappropriate in hindsight. Ref. 5 cited a related situation at another utility where commercial grade material was purchased for a safety related task. The proper material was ordered, but there was no supporting engineering justification for the lesser grade material nor was there any receipt inspection of critical parameters. Many utilities have provisions for using alternate materials, but if the supporting justification is weak, the result could be deleterious as it was in the Rancho Seco event.

Receipt inspection is generally minimal with respect to chemical materials of interest. Checking the brand name and part number appears to be the norm. One utility checks for water content in barrels of lubricating oil. In Ref. 6, a high particulate content in unused lube oil was noted after discovering abnormal oil discoloration in several safety grade pumps. As discussed above, Ref. 5 flagged the lack of receipt inspection at one plant. Discussions with one utility indicated that used oil had inadvertently been shipped back to the plant and was discovered accidentally by maintenance personnel who sensed something wrong with the material when they were using it. Although the alertness of the maintenance people is to be commended, it should not be relied upon to catch mistakes in such an informal fashion.

Storage control poses another opportunity for mixing up materials. Some utilities have very tight control of all materials using a central storage operation to dole out limited amounts of chemical materials and making sure the chemical use permit on the container corresponds to the material specified in the work order. Other utilities have a separate open storage area for frequently used materials, such as lubricants, as convenience for the auxiliary operators. There is generally no monitoring of these convenience areas. Ref. 7 and 8 are examples of lack of storage control. Rancho Seco instituted a very elaborate control process after the solvent problem (Ref. 1). However a subsequent inspection report (Ref. 9) at Rancho Seco indicated that a work order was not completely filled out with an approved cleaning agent specified.

Reliance on the operations or maintenance personnel to use the specified material for a particular job appears reasonable, but provides no assurance that unintentional mix-ups will not occur. Workorders may lack adequate specification; individuals may be walking around with their own supply of often used materials; and people may make mistakes. The absence of an independent check at this point in the process is a weakness. In a related example, a failed safety component was attributed to a piece of teflon tape that blocked a pressure switch (Ref. 10). This occurred in spite of a plant prohibition on the use of teflon tape imposed three years earlier. This may have been prevented by an reasonable storage control program and a ban on personal inventories of consumable materials.

Specification of the correct material and a description of any special requirements for its application in a work order or standing procedure is critical to the success of the activity. Ref. 4 illustrates the problem of inadequate information being given to the proper personnel. The licensee routinely added a different grease to MOV actuators although this had been cautioned against by the valve manufacturer and a generic report issued by an industry group. If relevant information is not processed effectively by the organization, acceptable control of these substances is lost. A similar problem with MOVs is noted in Ref. 35. Ref. 11 is another example of inadequate lubrication description. In the absence of any information (either vendor or plant procedures), a maintenance person added the wrong lubricating oil to a valve based on requirement for a valve from a different manufacturer. If gone unnoticed, it would have dissolved the seals in the valve. Ref. 12 discusses the use of a lubricant different from the vendor's original recommendation and different from that specified in the licensee's own equipment qualification program. The choice was based on an intervening document that approved the change without adequate test data. Weak justification for using an alternate material is a troublesome issue because of technical judgement involved. Ref. 17 is a similar incident where a component wasn't available and a weak justification was developed for using a substitute. QC personnel caught this one.

Susquehanna originally had solenoid valves lubricated with Parker Super-O-Lube that subsequently failed an EQ test in 1985 (Ref. 32). The lubricant was changed to Haughton 620 on all the solenoids in 1985. In 1986, one of the solenoids failed. According to the inspection report, the lubricant dried to a sticky substance; however, the valve manufacturer indicated that the lubricant attacked the aluminum in the valve (Ref. 33). The valve manufacturer refused to rework the valves with the Haughton lubricant and used the Parker lubricant instead. Parker is the valve manufacturer's recommended brand. The licensee subsequently determined in 1986 that Parker Super-O-Lube would satisfy the EQ requirements.

The North Anna event (Ref. 3) poses a different sort of problem. In this instance the equipment vendor did not fully specify an acceptable lubricant. After an exhaustive investigation, the utility finally determined that the oil type was responsible for chronic degradation of the equipment. When the vendor was asked about this information, he indicated that he would not have recommended the original lubricant, if asked. This lack of or abbreviated communication with the vendor is unfortunate because the vendors are a source of operational knowledge about his equipment/product that is supposed to be fed back to the utilities. Poor information transfer significantly reduces the effectiveness of the process. A slightly different situation occurred at WPPSS (Ref. 30) where an additive, suggested by an oil supplier to combat corrosion, adversely affected equipment operability during extended layup. The equipment could not be rotated because of the high viscosity of the material. This additive is apparently being used successfully for routine operation at another plant.

The examples cited above highlight the many opportunities for introducing the wrong material in routine and non-routine maintenance activities. The broad spectrum of documents for controlling the selection and use of these materials at the front end of the chemical material control process does not appear to be foolproof.

BACK END PROBLEMS

Using materials that are strongly dependent on the skill of the craftsperson introduces a different set of problems. The Sequoyah event (Ref. 2) is a good example of using an unforgiving material. In this instance the sealing compound had to be cured in air, but in the process of completing a maintenance activity, the system was probably buttoned up and refilled before the sealant had sufficient time to cure. Similar situations were discussed in Information Notices (Ref. 14 and 15) except in those instances, the sealant had to be cured in an air free atmosphere. Failure of components with very small clearances occurred in all three cases. Using a vendor representative to perform a component overhaul does not necessarily ensure success. Prior to the Salem ATWS event, a field representative lubricated the trip breakers with a material not specified in the vendor's manuals (Ref. 16). At ANO-2, maintenance people cleaned an air blower on a diesel generator using an approved solvent. Subsequently the blower could not be rotated by hand (Ref. 17). This failure was attributed to excessive use of the solvent which resulted in local puddling and attack of vulnerable materials in the vicinity. A study of excess grease (Ref. 36) searched the Sequence Coding and Search System and the Nuclear Data Reliability Data System and the Construction Deficiencies data base to identify situations where equipment failure occurred. Almost 30 instances of overgreasing equipment were found going back to the mid 1970s. An information notice was published on this issue in 1988 (Ref. 37). At Braidwood, several MOVs were found with mixtures of lithium and calcium based greases in the actuator (Ref. 18). Unlike the Farley case discussed above, the MOVs were supposedly cleaned before the new type of grease was added. Obviously, the personnel responsible didn't do an adequate job.

Mistakes are also a source of problems in the back end area. Refs. 19 and 20 involved using incorrect lubricants when the proper materials were spelled out in the relevant procedures. This type of error cannot be eliminated if it is truly an oversight. Ref. 21 identifies a situation where the personnel actions were known to be different than those indicated in the relevant stores and QA records. Deliberate disregard for the procedures should be a concern. In a related situation at Wolf Creek, a maintenance supervisor gave instructions to use teflon tape contrary to stated company policy. This individual was subsequently dismissed (Ref. 22). Discussions with plant personnel indicate that quality control checks are usually not used in routine maintenance activities such as lubrication and maintaining oil levels in various equipment. Although these activities are straight forward, they do represent opportunities for mistakes that would go undetected until some new situation prompted an examination of the earlier activities.

3.2 APPLICATION PROBLEMS

There are circumstances involving oils, greases, solvents, or other chemical materials that unknowingly result in undesirable reactions or degraded conditions. Some of these represent design flaws while others represent oversights or lack of knowledge by the personnel involved. At Monticello, the power cable for the main feedwater pumps deteriorated because of chemical attack inside the conduit (Ref. 23). AT D.C. Cook power cable to a charging pump was damaged by immersion in diesel fuel oil (Ref. 24). Both of these events were caused by inadequate definition of the environment that the cabling might be exposed to. Since the cabling is hidden from casual observation, there is little likelihood that this type of degradation would be caught before actual failure occurred. A different oversight resulted in an explosion at Robinson. In this incident, sodium hydroxide was transferred to an empty drum that previously contained hydrazine (Ref. 26). The drum was not adequately cleaned.

Equipment that have small passageways are especially vulnerable to particulates in fluids. At Waterford, the feedwater pump controller exhibited erratic performance because of impurities in the control oil (Ref. 25). The original design of the pump used a common reservoir for the lubricating oil and the controller oil. Consequently, the wear products occurring in the bearings were carried over into the control system. The situation was corrected by initially installing a centrifuge in the oil system and finally by substituting an electric controller for the hydraulic controller. The Sequoyah event (Ref. 2) also involved a hydraulic controller. Although the ultimate failure of the equipment was caused by poor implementation of the sealing material, discussions between the utility and the equipment vendor did not anticipate these difficulties in the repair work. There have been numerous problems with material incompatibilities in solenoids that reflect poor application decisions (Ref. 29). These deficiencies include lubricants and other materials that may react with impurities in their environment.

The above examples show the many opportunities for significant problems to occur even in the absence of human participation. These 'passive' situations require special care by the operating personnel to minimize their occurrences.

3.3 PRIOR ACTIONS

The importance of vendor feedback and up-to-date maintenance manuals was emphasized by the Salem ATWS event which resulted in a generic letter to all licensees (Ref. 27) requiring, among other actions, procedures for obtaining and processing up-to-date manuals from the equipment vendors. However, as previous discussion showed, the licensee may rely on other sources for lubrication advice and ignore the vendor's recommendations or the communication between them may be incomplete or not factored into the procedures.

Electric Power Research Institute (EPRI) has an ongoing program concerning lubricants. This effort includes lubrication guides that are posted in plant maintenance areas, training films, and consultation with individual utilities. A future effort is to search for a single lubricant that could be used for all components.

The following information notices have been issued regarding problems with different chemical materials:

IEC 77-06	Effects of Hydraulic Fluid on Electrical Cables
IEC 78-02	Proper Lubricating Oil for Terry Turbines
IN 84-53	Information Concerning Loctite 242 and Other Anaerobic Adhesive/sealants
IN 87-48	Information Concerning the Use of Anaerobic Adhesive/sealants
IN 87-51	Failure of Low Pressure Safety Injection Pump Due to Seal Problems
IN 88-12	Overgreasing of Electric Motor Bearings
Industry Rpt.	Mixing of Greases in Limitorque Motor Operators May Cause Operator Failure

Two of the notices dealt with inadequate curing of sealants which was the problem that occurred at Sequoyah (Ref. 2). One of the corrective actions at Sequoyah was to put stickers on the vulnerable component warning against the use of the sealant inside of the actuator. Problems with a solvent at Palo Verde resulted in modification of the plant maintenance procedures to allow only the use of demineralized water (Ref. 28). North Anna instituted a similar corrective action by removing the inappropriate oil from the site.

Rancho Seco instituted a very stringent chemical control process after the problem with a commercial grade solvent. Each material has a chemical use permit tag which identifies the specific applications for that material. The use permit must be approved by the chemistry department as well as the engineering department. All materials are controlled by stores and only a limited amount is doled out for each work order which also must specify the material. However, a subsequent inspection report (Ref. 9) indicated that even this rigorous system is not always people proof.

Control of chemical materials was also discussed with Shearon Harris (Ref. 38) who have a very comprehensive program. No materials can enter the site without prior approval. This includes materials used by outside contractors and vendor reps who perform maintenance on their equipment.

Examination of the NRC inspection reports, cited in the appendix, indicates that problems in this area are uncovered about equally by routine and special inspections. It appears that the problems are found as part of a general blanket procedures, routine inspections focused on this area may be more effective in stemming some of the ad hoc problems.

As part of a special maintenance inspection program conducted by the Office of Nuclear Reactor Regulation, a maintenance inspection tree was developed to facilitate and standardize the plant visits. Several of the elements on the tree relate to problems with chemical materials. These include material qualification, procurement, identification of consumables, material receipt inspection, storage control, and procedure control. The only two minor administrative problems related to routine lubrication were noted in the several plant inspections performed.

3.4 SAFETY CONCERN

Misapplication of chemical materials (including oils and greases in this general category) detracts from the reasonable assurance that safety equipment will operate if called upon because of potential common cause failures. This problem is exacerbated by its delayed appearance in some instances - it may not be immediately detected by a post maintenance test as shown by the Sequoyah problem with sealant in the oil passages of the control unit or the intermittent behavior of electrical connectors observed at Rancho Seco. This latent aspect may result in inopportune equipment failure for those components in standby status or those components needed during long term recovery from an accident or event. About 40 percent of the events cited resulted in equipment failure, the remaining events reflected breakdowns in process control. In a number of instances the utility was able to show after the fact that the misapplication was acceptable; however, this should not be a basis for not correcting deviations from the material control process. The problems appear to be particularly important for equipment that have small clearances and therefore are prone to plugging or sticking.

No probabilistic assessment has been performed to estimate the importance of this specific issue. To some extent the individual component failures caused by misapplication of these substances may be included in the existing data base; however, the common cause failure rates used in the analyses are catchalls reflecting a variety of potential effects. More importantly, the PRAs are based on the assumption that the equipment will function as designed. Although none of the references resulted in system losses, the issue still represents a significant potential for degrading multiple pieces of equipment so that they may not function as design.

4.0 CONCLUSIONS

1. At some plants, storage and control of some chemical materials is loosely structured to facilitate routine maintenance operations. In these situations, there is generally no independent check of activities which could result in inadvertent mix-ups or misuse of the materials.

2. Justification for using materials other than those recommenced by the equipment manufacturer is sometimes inadequately supported and results in degraded performance of the equipment. Conflicting requirements not adequately understood or resolved prior to implementation of an alternate approach can cause widespread problems.

3. Inadequate caution and supervision can result in unexpected reactions when handling chemicals that have unique requirements such as curing or mixing any fluids that have a potential for chemical reaction.

4. Unconfined liquids that come in contact with essential components may result in chemical attack that was not considered in the component design. Hidden or inaccessible equipment may be particularly vulnerable in these situations because of lack of casual observation.

5. Problems with chemical materials are more likely to be captured by NRC inspections than by LERs because the deficiencies generally do not result in total system failures or untoward transients.

6. Components with small clearances are particularly susceptible to plugging or sticking because of insufficient control of lubricants or other materials used inside the devices.

7. There does not appear to be comprehensive testing of new materials before they are widely used throughout the plant. Consequently, the nuances associated with introducing a new material into a specific application may not be well understood. This is especially important considering weak justifications or reviews approving such materials.

8. The licensees have taken drastic action to preclude recurrence of problems with chemical materials. These included banning the material from the site and dismissing employees for violating administrative injunctions against the use of certain materials.

5.0 REFERENCES

1. Sacramento Municipal Utility District, Licensee Event Report 50-312/87-042, Rancho Seco, Oct. 9, 1987.

2. Tennessee Valley Authority, Licensee Event Report 50-327/87-060 rev 2, Sequoyah Unit 1, November 25, 1987.

3. U.S. Nuclear Regulatory Commission, Inspection Report 50-338/87-34, North Anna Unit 1, Nov. 18, 1987.

4. U.S. Nuclear Regulatory Commission, Inspection Report 50-348/87-25, Farley Unit 1, Oct. 19, 1987.

5. U.S. Nuclear Regulatory Commission, Inspection Report 50-324/88-15, Brunswick Unit 2, May 23, 1988.

6. Public Service Electric & Gas Co., Licensee Event Report 50-272/87-001, Salem Unit 1, April 7, 1987.

7. U.S. Nuclear Regulatory Commission, Inspection Report 50-275/87-37, Diablo Canyon Unit 1, Nov. 9, 1987.

8. U.S. Nuclear Regulatory Commission, Inspection Report 50-373/88-06, La Salle Unit 1, April 8, 1988.

9. U.S. Nuclear Regulatory Commission, Inspection Report 50-312/88-10, Rancho Seco, June 15, 1988.

10. U.S. Nuclear Regulatory Commission, Inspection Report 50-331/88-09, Duane Arnold, July 6, 1988.

11. U.S. Nuclear Regulatory Commission, Inspection Report 50-382/87-21, Waterford Unit 3, Nov. 30, 1987.

12. U.S. Nuclear Regulatory Commission, Inspection Report 50-382/88-10, Waterford Unit 3, June 17, 1988.

13. U.S. Nuclear Regulatory Commission, Region I Daily Report, Arkansas Unit 2, April 15, 1988.

14. U.S. Nuclear Regulatory Commission, Office of Inspection and Enforcement, Information Notice No. 84-53, Information Concerning the Use of Loctite 242 and Other Anaerobic Adhesive/sealants, July 5, 1984.

15. U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Information Notice No. 87-48. Information Concerning the Use of Anaerobic Adhesive/sealants, Oct. 9, 1987.

16. U.S. Nuclear Regulatory Commission, Generic Implications of ATWS Events at the Salem Nuclear Power Plant, NUREG-1000 vol 1, April 1983

17. U.S. Nuclear Regulatory Commission, Region 1 Daily Report, Calvert Cliffs, April 15, 1988.

18. U.S. Nuclear Regulatory Commission, Inspection Report, 50-456/88-06, Braidwood Unit 1, May 27, 1988.

19. U.S. Nuclear Regulatory Commission, Inspection Report, 50-277/88-13, Peach Bottom Unit 2, June 13, 1988.

20. U.S. Nuclear Regulatory Commission, Inspection Report, 50-275/88-11, Diablo Canyon Unit 1, June 17, 1988.

21. U.S. Nuclear Regulatory Commission, Inspection Report, 50-440/87-25, Perry, Mar. 31, 1988.

22. U.S. Nuclear Regulatory Commission, Inspection Report, 50-482/88-01, Wolf Creek, Mar. 18, 1988.

23. U.S. Nuclear Regulatory Commission, Inspection Report, 50-263/87-21, Monticello, Feb. 11, 1988.

24. U.S. Nuclear Regulatory Commission, Inspection Report, 50-315/87-24, D.C. Cook Unit 1, Oct. 9, 1987.

25. Louisiana Power & Light, Licensee Event Report, 50-382/88-023, Waterford Unit 3, Aug. 5, 1985.

26. U.S. Nuclear Regulatory Commission, Inspection Report, 50-261/88-16, Robinson, Jul. 26, 1988.

27. U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Generic Letter 83-28, Required Actions Based on Generic Implications of Salem ATWS Events, July 8, 1983.

28. U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Information Notice No. 87-51, Failure of Low Pressure. Safety Injection Pump due to Seal Problems, Oct. 13, 1987.

29. Ornstein, H., Problems with Solenoid Valves to be published.

30. U.S. Nuclear Regulatory Commission, Inspection Report, 50-460/87-01, WPPSS Unit 1, Oct. 26, 1987.

31. U.S. Nuclear Regulatory Commission, Inspection Report, 50-368/88-05, Arkansas Nuclear One Unit 2, July 27, 1988.

32. U.S. Nuclear Regulatory Commission, Inspection Report, 50-387/86-27, Susquehanna Unit 1, Feb. 19, 1987.

33. Letter from T. Hutchins (Automatic Valve Corp.) to J. Keppler (NRC), Wrong lubricant in valves, dated Dec 19, 1986.

34. U.S. Nuclear Regulatory Commission, Region IV Daily Report, River Bend, Oct. 31, 1988.

35. U.S. Nuclear Regulatory Commission. Inspection Report 50-285/87-05, Farley Unit 1, May 8, 1987.

36. U.S. Nuclear Regulatory Commission, Memorandum, Problems Cause by Excess Grease, M. Harper to R. Denning, February 2, 1988.

37. U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Information Notice No. 88-12, Overgreasing of Electric Motor Bearings, April 12, 1988.

38. U.S. Nuclear Regulatory Commission, Memorandum, Trip to Shearon Harris, S. Israel to J. Rosenthal, to be published.

APPENDIX

Selected Operating Events Involving
Problems with Chemicals

Salem	Ref. 6	Oil in numerous safety related pumps was discovered to be dark and was changed; however, the oil discolored after only a short time in use. Tests revealed a high particulate count in unused oil. Oil quality control program was revamped because of this incident.
Waterford	Ref. 25	Feedwater pump controller exhibited faulty performance because of impurities in the control oil.
Brunswick	Ref. 29	Investigation revealed that solenoids failed because of degraded ethylene propylene discs which swell in the presence of hydrocarbons.
Sequoyah	Ref. 2	A diesel tripped off on overspeed during a routine surveillance test. Subsequent investigation indicated that RTV used as a sealant was blocking the oil passages in the hydraulic control unit. Informal discussions with the controller manufacturer did not elicit any concern about using the RTV inside the unit. Curing tests performed after the event showed the material to be very sensitive to the curing environment which was not fully appreciated when the RTV was used two years previously.
Rancho Seco	Ref. 1	Electrical contact problems with connector that had been cleaned with a commercial grade cleaner. Subsequent investigation revealed that the cleaner contained impurities that degraded the electrical connection. Use of this particular cleaner was based on informal internal discussions prior to initiating cleaning program.
D.C. Cook	Ref. 24	Investigation revealed that power cable to a charging pump was damaged by immersion in diesel fuel oil. The cable insulation deteriorated in a section running through an embedded conduit near a diesel generator sump pit.

Farley	Ref. 4	MOVs supplied with a calcium based grease, but routine lubrication checks used a lithium based grease to replenish the supply as necessary. Original valve manufacturer specifically stated that mixed greases should not used in the valve actuators.
WPPSS 1	Ref. 30	During an extended construction delay, the permittee imposed a moratorium on all pump shaft rotations because of poor performance of the oils in the gear boxes and bearing reservoir. All oils were to be replaced with oil that did not contain additives which apparently affect the oil properties at room temperature.
Diablo Canyon	Ref. 7	Inspection revealed unlabeled oil containers and grease guns and log books were not being maintained in bulk storage and dispensing areas.
North Anna	Ref. 3	The licensee was experiencing chronic problems with extrusion of piston pin bushings in the diesel generators. After exhaustive and lengthy investigation, it was determined that the lube oil used in the diesel generators was inappropriate and was changed to a non-foaming type. The original manufacturer's manual did not specify oil type. but post incident indicated that they would not have approved the original foaming type oil used in the diesel.
Waterford	Ref. 11	Addition of incorrect hydraulic fluid to safety related isolation valve was corrected by incorporating the proper fluid in the controlled plant lubrication manual.
Monticello	Ref. 23	Inspection revealed that power cable for main feedwater pumps deteriorated because of chemical attack inside a conduit.
Wolf Creek	Ref. 22	Contrary to licensee policy, a maintenance supervisor gave instructions to use teflon tape on a drain line to one of the condensate pumps. The supervisor was subsequently fired.

ANO2	Ref. 13	After cleaning the scavenging air blower on a diesel generator, the engine could not be rotated by hand. The licensee believes that a chemical reaction occurred between the solvent, the polymer coating inside the casing, and grease.
Perry	Ref. 21	Inspection of MOVs revealed that the stem lubrication was not performed with the brand indicated in the preventive maintenance instruction and a different brand was specified in a separate GE instruction. Review of QA records and stores records were at odds with discussions with the personnel directly involved with the lubrication.
LaSalle	Ref. 8	Inspection revealed that the operations department was maintaining a separate storage area for lubricants that was not controlled.
Calvert Cliffs	Ref. 17	Licensee discovered that air regulators contain BUNA-N material which can degrade under high temperature conditions.
Brunswick	Ref. 5	The licensee purchased the proper lubricant (part number) for the HPCI pumps as an off the shelf item without any special receipt inspection to verify the critical characteristics. No engineering evaluation was presented justifying the use of this commercial product.
Braidwood	Ref. 18	The licensee mixed lithium and calcium based greases in the actuators of motor operated valves. Percentage of lithium based grease varied up to 50%. No documentation justifying the adequacy of mixed greases was available.
Peach Bottom	Ref. 19	Inspection of an RHR pump revealed that the motor bearing oil had a higher viscosity than the specifications required (about double). Other pumps had the correct oil. Various uncontrolled lists indicated the correct oil type number for the particular pump.

Rancho Seco	Ref. 9	A review of maintenance control packages revealed an instance where a cleaning agent was required, but a chemical use permit had not been approved for a particular cleaner.
Diablo Canyon	Ref. 20	Observation of a maintenance activity indicated that the mechanics were not using the lubricant specified by the maintenance procedure for the lubrication of bolts.
Waterford	Ref. 12	Inspection revealed that lubrication of containment cooling fans did not use the lubricant specified in the manufacturer's manual and in the licensee's EQ document. An intervening internal request for changing lubricants was approved without supporting test data.
Duane Arnold	Ref. 10	A failed HPCI auxiliary oil pump was attributed to a small piece of teflon tape blocking a pressure switch. The plant had restricted the use of teflon tape three years earlier and began using Loctite brand sealant as a replacement.
Robinson	Ref. 26	An empty hydrazine drum exploded during the transfer of 50% sodium hydroxide from a storage tank. The explosion was determined to be a reaction between the residual hydrazine in the drum, which had not been properly cleaned prior to use, and the sodium hydroxide.
ANO2	Ref. 31	Licensee purchased prelubricated replacement bearings with unknown pedigree. The changeout lubrication, performed at the plant, used incomplete procedures that resulted in reduced assurance that the bearings were properly lubricated.
River Bend	Ref. 34	Maintenance personnel staged lubricating oil for DG "A" in front of DG "B" which was a different brand. Other personnel came along and added the "A" oil to the "B" DG whose lubrication requirements were different. The "A" oil was deleterious to the "B" DG.

Fort Calhoun	Ref. 35	The licensee had operated the plant with a mixture of greases in several MOVs. This practice was contradictory to the vendor's specifications.