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ENHANCEMENT OF ON-SITE EMERGENCY DIESEL GENERATOR RELIABILITY

Final Report

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Research Institute

Prepared for
U. S. Nuclear Regulatory Commission

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TABLE OF CONTENTS

PREFACE

This document is the final report on a five-task program conducted under Contract Number NRC-03-77-192 for the U.S. Nuclear Regulatory Commission. This report consists basically of the individual task reports covering the five following tasks:

Task I-Review of Operating Experience
Task II-Diesel Problem Areas
Task III-Diesel Engine Manufacturers Recommendations
Task IV-Comparative Study
Task V-Recommendations

The appropriate supporting appendices are also included.

All documentation previously generated under this program is superceded by this final report.

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ENHANCEMENT OF ON-SITE EMERGENCY
DIESEL GENERATOR RELIABILITY
CONTRACT NO. NRC-03-77-192

TASK I - REVIEW OF OPERATING EXPERIENCE

A comprehensive overview of diesel generator (DG) operation was a necessary prerequisite to accomplishment of the overall goals of the program. This was achieved by conducting:

A. a review of relevant licensee event reports;
B. a review of the available data from the nuclear plant reliability data system (NPRDS);
C. a review of literature pertinent to the operation and maintenance of diesel generator systems;
D. a survey of operating reactor licensees with respect to the operation and maintenance of the DG systems;
E. a survey of other large-scale users of DG systems for emergency or standby power applications.

The details of the above reviews and surveys are discussed in the sections that follow.

SECTION 1
REVIEW OF LICENSEE EVENT REPORTS (LER's)

First and foremost in the conduct of Task I was the review of the LER's provided by the NRC. The 592 LER's so provided, covered the time period from 1969 to September 28, 1977 identifying a total of 610 failures and/or troubles. These reports referred mainly to DG operation and maintenance; however, a few mentioned more than one item which was not necessarily related to DG operation and very few were obviously out of place and should have been reported elsewhere.

In addition to a general study of the LER's, each failure or trouble was classified in an expanded list of categories following the general plan previously used in the report by the U.S. Atomic Energy Commission Office of Operations Evaluation, June 1974, OOE-ES-002. This approach provides for the opportunity to correlate this current classification with that of the previous classification reported in 1974. This also provides a better category breakdown, particularly in the classification areas of electrical and general. This expanded classification also provided better guidance in the development and evolution of the questionnaire and, more importantly, those areas of particular interest during plant visits.

The classification of the LER's by operating plant is tabulated in Appendix A. The grand total in each category is given in Table 1.1 below.

TABLE 1.1

	Engine and Related						Electrical				General		
Category	Starting	Fuel System	Lube Oil System	Cooling	Governor	Misc.	Relays/ Breakers	Conn. & Term.	Excitor/ Volt. Reg.	Misc.	Design Logic	Procedure	Personnel
No.	122	32	25	41	43	76	80	22	15	45	13	37	59
%	20.0	5.3	4.1	6.7	7.1	12.5	13.1	3.6	2.5	7.9	2.1	6.1	9.7

Grand Total all LER = 610 (October 1977)

Sub Divisions	Engine & Related	Electrical	General
Total LER	339	162	109
% Total LER	55.7	26.6	17.9

Examinations of these grand totals indicate that starting failures and related problems continue to be the most prevalent failure, though now at 20.0 percent rather than 34 percent as reported in 1974. Engine and engine related problems dominate over half the total at 55.7 percent. Problems which are entirely electrical contribute 26.6 percent, while "general" items are 17.9 percent. Actually many of the engine related problems are really electrical in origin since almost all of the monitoring and safety functions are performed electrically and power for several necessary engine services such as fuel pump, etc., is also electrical. Purely mechanical problems are relatively few. The items classified under "general" are basically "people oriented" in that people are necessarily involved in the origin of the items so classified since they are generally procedural or employee related.

The individual plant tabulations (Appendix A) were up-dated to include additional LER's covering the remainder of 1977 and January 1978. However, there were relatively few of these additional LER's and, therefore, no further analysis was made of these classifications; they are not included in Table 1.1. At that point in the program, NRC personnel suggested an approach of identification of "root cause" associated with the various reported events. This approach was used for a new classification for a few of the operating plants visited which aided in the discussion and inquiries during the visit. This, of course, involved multiple entries which would have to be considered differently for any statistical purposes. The true "root cause" cannot always be reliably identified since it is a matter of judgement depending on knowledge and degree of investigation. The "root cause" concept is very fundamental to the trouble-shooting process in correcting any equipment malfunction or failure.

During the review of the LER's, it was observed that there were operating plants which had been in service for a relatively long period of time with few LER's. On the other hand, there were plants which had been in service a relatively short period of time with several LER's. The reason for this was questioned

from the beginning. Early in the plant visitation cycle of the program, it became obvious that the interpretation of the regulatory guides and technical specifications by the respective licensees varied considerably. The variation in interpretation raises questions as to what is a reportable event makes it difficult to compare reliability of one plant to another. However, the LER system is the best and most complete source of reporting DG operational problems available and, therefore, was a vital source of information for this program.

The LER system covers the reporting of failures or problems which prevent an emergency standby diesel generator from being available and operating when called upon under certain conditions. Reports are made according to the following format.

Facility/System
Component/Component Subcode/
Cause/Cause Subcode/
Component Manufacturer
Docket No./Event Date/
Ler No./ Report Date/
Control No. Report Type
Event Description/
Cause Description

As a new user of the LER system, the following observations and/or opinions are offered.

LER System Values and Advantages

1. Documentary evidence is given of the existence of Problems or Failures, giving a description of the event.

2. The Licensee Event Report (LER) is definitely related to the facility and/or system, the pertinent dates, and identified by numbers in the system.

3. The cause given is usually helpful in correction of the problem.

4. The name of the manufacturer possibly involved is valuable if additional help is needed.

Limitations and Deficiencies

1. Causes given are often incomplete.

2. Causes given are occasionally incorrect and misleading.

3. Causes given are often no more than a personal conclusion or judgement though related as positive and factual.

4. Cause given is usually limited to specific component damage and/or condition and not the basic or "root cause".

5. Interpretation of what constitutes a Reportable Event varies widely among the licensee power plants. Thus an unusually large or small number of LERs may be very misleading when judging reliability.

6. Three of the fifteen (15) power plants visited had encountered very serious expensive failures with long time outage up to 40 days which were not related in the LERs. Reasons for lack of reporting are obscure.

7. Simply asking for a cause or "root cause" to be given does not insure that it will be forthcoming. The result is a judgement depending on the knowledge and degree of investigation especially in complicated serious common mode situations. A number of these situations have actually occurred.

LER System Evaluation Summary

The LER system is the most valuable single source of operative reliability since the most important first step in improving reliability is recognition and reporting of failures or problems and this in general is being done reliably.

While the LER system is officially only a reporting system, it nevertheless does exert considerable indirect influence. It discloses much about the effectiveness of the Regulation Guides and also the Regulations with respect to power plant reliability. Study of the LER system records and visits to the power plants indicate that failures and problems are truly being reported. The same confidence cannot be placed in the causes given or the corrective action taken since these reports are frequently made with incomplete investigation and no follow up reports. Obvious improvement is subject to the authority which can be exercised by the regulating agency.

Recommendations to be made in Task V for revisions to the applicable Regulation Guides would be conductive to causing the LER system to be more responsive to information needs and consequently more effective in improvement of reliability.

During the plant visits the personnel at some of the utilities were especially helpful in explaining the procedural sequence of the LER system. It was understood that delayed corrective action is required to be reported later and a revision or addition made to the initial LER.

The series of failures in one particular power plant is discussed below as an example of how misleading the current system of information can be. Admittedly the case chosen is extreme, but many others vary only in degree, not in principle.

A buckled connecting rod, four (4) cracked cylinder heads, and a split cylinder liner were discovered one at a time as described in LER's over a period of more than three months. The so-called reasons or causes given in the LER's were merely a rewording of the failure descrption. The basic or "root cause" was not given or hinted in the LER's. It was disclosed on page 20 of the response to the questionnaire that #1 diesel had been overheated. Recirculation of both the engine exhaust and the cooling air contributed to the problem. The construction of the power plant itself with respect to engine exhaust and cooling air made this recirculation inevitable.

Only during the visit to the plant was it learned that a water temperature control switch mounted on the engine skid assembly failed allowing the radiator shutters to fall closed, resulting in overheating of the engine. It was also said that the radiator shutters had not always opened when starting the engine. In the LER's the cause was given as "personnel error" for the cause of the cracked cylinder heads. Again only through the plant visits was it understood that the personnel error was presumed to be failure to blow water out the compression pressure release valves before starting the engine.

The actual failure sequence was:

Thermostatic switch failed from vibration	1st basic cause
Shutters fell closed	2nd basic cause
Engine overheated	Consequential basic cause
Many parts failed	Detected singly over a three month period
LER's incomplete and misleading	Complete story from a plant visit
Failures on engine of good commercial reputation	Explained from plant visit, not LER's

Plans were made to change the shutter system so the shutters would fall open if the control switch failed. The control switch itself was still being subjected to the damaging engine vibration though now the engine might simply overcool instead of overheat.

SECTION 2

REVIEW OF REPORTS FROM THE NUCLEAR PLANT RELIABILITY DATA SYSTEM

A newer computer printout system from the Nuclear Plant Reliability Data System (NPRDS) for the quarter ending 1 June 1977 was received from the NRC. (The NPRDS is a newer reporting system in the process of being developed.) The formatted information was reviewed along with the NPRDS reporting procedures manual. The information was presented in a more complex format and contained very little additional information beyond that contained in the LER's or the completed questionnaires.

The LER's and the questionnaire were documents requiring submittal by and to the NRC by the licensees. Consequently, it was felt that the information received through these two sources was more comprehensive and complete. Also, the NPRDS reporting system is based upon licensees submitting information voluntarily which leaves the completeness of the information open to question. Therefore, the NPRDS is considered to be of very limited value to the current overall program objectives and with the consent of the contracting officer's authorized representative, was reviewed no further.

SECTION 3
REVIEW OF LITERATURE

A literature search was conducted by the Information Systems Division of the Research Institute to obtain additional information relevant to the operation and maintenance of diesel engines particularly of the class of engines used for the emergency standby service in nuclear power plants. The search was performed by conducting on-line computer-based literature searches of commercially available data bases covering Government research and development reports, technical journal literature, conference proceedings, etc. It was based upon a list of keywords relevant to this program which is provided below.

Single Word	Two Word
Diesel	Diesel Engines
Engine	Diesel Electric
Electricity	Acceptance Test
Generator	Combustion Air
Reliability	Air Filter
Maintenance	Fuel Filter
Combustion	Light-Load Operation
Testing	Preoperational Testing
Standby	Fatigue Failure

Single Word Continued	Two Word Continued
Power	Reliability Analysis
Failure	Cooling System
Analysis	Starting System
Oil	Exciter/Voltage Regulator
Operation	
Operator	
Filtration	
Storage	
Governor	
Injection	

Of the one-line data bases searched, documents relevant to the program were identified in two of these bases. One data base is the National Technical Information Service (NTIS), a data base of unclassified, unlimited Government research and development reports covering all subject areas. The other data base is the Comprehensive Engineering Index (COMPENDEX), a data base of journal literature, reports, and conference proceedings in all fields of engineering. A total of 357 documents were identified, the abstracts of which were received for review for relevancy to the program. Of this total, 70 documents were selected and purchased for further review as they relate to the goals of program, particularly Tasks IV and V. Seven documents were acquired from other resources. Listings of these documents by data base are contained in Appendix B.

SECTION 4
SURVEY OF REACTOR LICENSEES

Another vital source of information with respect to the operating experience of the operating plants was through direct contact (mail and personal) with the licensees, particularly the personnel immediately responsible for the daily operation of

the plants. This was accomplished by two approaches: the mailing of a comprehensive questionnaire to the licensees of all operating plants and a personal visit to selected operating plants. The specifics of these two approaches are discussed in the paragraphs that follow.

4.1 QUESTIONNAIRE

One of the most difficult problems of the program was one of securing specific information relevant to the various operational attributes of all the operating plants. Short of visiting each plant, the best compromise was the development of a comprehensive questionnaire. This document was designed to secure information concerning various elements of system and subsystem operation such as operating conditions, configuration, and maintenance.

While admittedly searching in scope, the questionnaire required a great deal of joint effort between the University investigators and the NRC. The initial 13 page document drafted by UD investigators was reviewed with NRC. After editing, revisions and additions, a 22 page document was mailed by the NRC to all licensees of operating plants in mid-December with a 30 day response period requested. The questions addressed such elements as listed below.

- Starting systems and conditions
- Fuel oil systems
- Lube oil systems
- Cooling systems
- Governors and governing
- Generator and related controls
- Safety shutdowns and emergency control
- Combustion air filtration
- Operator qualifications
- Time-load operation
- Maintenance specifics
- Operation specifics

Since it was impossible to anticipate all possible plant configurations and operating conditions, the licensees were given the opportunity to respond "NA" to those questions not applicable to their particular installation or operating condition. Also, the opportunity was provided for them to respond "UN" to those questions where specific information was unknown or lacking with the understanding that it would be provided later, per the instruction of the NRC cover letter to the questionnaire.

4.2 RESPONSES TO THE QUESTIONNAIRE

The majority of the responses to the questionnaire were returned within the 30 day period as instructed and were coded for entry into a computer. The main computer print-out, which is strictly a frequency count of the responses to the individual questions, indicates a total of 43 operating plants as opposed to 65. The reasons for this are that some questionnaires had not been received at the time the final tabulation was made, and the reporting by some licensees on two or more very similar plants under essentially the same operational control; thus covering 59 individual plants. The printout from these entries is quite voluminous and therefore was condensed in order to be accommodated into this report. This was done by taking a questionnaire and applying the totals in the available space (see Appendix C). This applied particularly to those questions answerable by "yes", "no", "NA", or "UN". Some questions had almost as many different answers as licensees and therefore did not lend themselves to summarizing. These questions are marked with an asterisk (*). Those questions where the responses varied considerably but fell within a particular range (i.e., starting air pressure), the range has been given to indicate it accordingly.

To more effectively utilize the main computer printout, the cross-tabulations were run. These cross-tabulations basically relate certain subsystems or areas of concentrated interest to either engine manufacturer or the licensee power plant. The letters preceding the designated subsystem or areas of interest are as they are identified in the questionnaire. The cross-tabulations will enhance the utility of the printout particularly as they bear on the overall program in Tasks IV and V. The printouts of the cross-tabulations are also quite voluminous and, therefore, only the more important portions of them have been included in this report. The portions so included are identified by variable numbers (i.e., V62, V113, V239, etc.) in the listing below and form Appendix D.

The cross-tabulations with respect to engine manufacturer (V6) are:

B. Starting Systems - all questions (V26, V27, V62)

C. Fuel System - all questions (V75, V83, V86)

D. Lube Oil System - all questions (V90)

E. Cooling System - all questions (V112, V113, V115)

F. Governor - speed control (V148)

O. Starting Conditions - most troublesome problem (V239).

The cross-tabulations with respect to the licensee power plant (V4) are:

O. Starting Conditions - most troublesome problem (V239)

M. Emergency or Alert Conditions - all questions (V213, V214, V215, V216, V217)

R. Operator Qualifications - all questions (V267, V271)

S. Foreign Gases - question on storage only

T. Control System Automatic Bypass - all questions (V285)

U. Control System Automatic Override - (V287)

W. Testing by Outside Experts - all questions

X.4. Surveillance Testing

Also a cross-tabulation of the number of "NA's" and "UN's" versus plant was run. It, too, is quite voluminous and has not been included in this report.

4.3 LICENSEE PLANT VISITATIONS

Though limited in scope in terms of the number of plants visited, the plant visitations were a very significant part of the program. Twenty of a total of sixty-five operating plants were visited at 14 different site locations. In order to work within the financial and schedule constraints of the program, a number of factors influenced the ultimate choice of plants to be visited. Those factors were:

A. NRC suggestions
B. Plants size in MW power capacity
C. Number of LER's reported by the respective plant(s)
D. Geographic location
E. Diesel engine manufacturer
F. Possible reasons gleaned from the questionnaire
G. Additional judgement based on an evaluation of the degree of severity and consequences of troubles reported or attitude indicated.

A couple of the factors cited above need further explanation. The geographic location was important in that costs of time and travel were significant. More importantly, selection of sites which would provide a representative sampling of seacoast and inland plant locations was done. A concentrated effort was made to visit plants which would be representative of the engine installations consistent with approximately an equal percentage with respect to the total number of engines supplied by each manufacturer; in other words, equal treatment of each engine manufacturer was attempted. This was done successfully without compromising other factors to any great extent.

Using the factors cited above for the basis for plant selection, the plants listed in Table 1.3 were visited.

TABLE 1.3 POWER PLANT VISITATION PREFERENCE

Engine Mfr.	Power Plant Site	Start Date	No. LER's	Address
GM	Beaver Valley	1976	16	Shippingport, PA
	Dresden-2	1970	31	Morris, IL
	Dresden-3	1971	14	Morris, IL
	Ft. Calhoun	1973	19	Ft. Calhoun, NE
	Fitzpatrick	1974	19	Scriba, NY
	Surrey-1	1972	11	Surrey, VA
	Surrey-2	1973	2	Surrey, VA
	Nine Mile Pt.	1969	1	Scriba, NY
	Oyster, Creek-1	1969	16	Forked River, NJ
FM	Hatch, Edwin I	1974	15	Baxley, GA
	Millstone-2	1975	23	Waterford, CT
	Duane Arnold	1974	17	Palo, IA
	Calvert Cliffs	1974	24	Lusby, MD
	Millstone-1	1970	2	Waterford, CT
	Calvert Cliffs-2	1976	8	Lusby, MD
ALCO	Indian Pt.-2	1973	9	Indian Point, NY
	Indian Pt.-3	1976	9	Indian Point, NY
CB	Zion-1	1973	18	Zion, IL
	Zion-2	1973	15	Zion, IL
	Cooper-1	1974	12	Brownville, NE

The power plant visits were organized by locales so that a trip by the University investigators could travel to that locale and visit a number of plants. Planning such a trip to conform to the various desired or necessary plant schedules was difficult indeed. The preliminary steps involved in making the plant visitations are as follows:

A. Plant Choice - mutual selection and agreement between NRC and University personnel on the plants to be visited as previously discussed.

B. NRC approval for specific plant visits.

C. Contact the proper respective plant authority - contact by the NRC personnel followed by contact by the University for specific visitation arrangements.

The power plant visitations were conducted using the following guidelines:

A. Discuss specific power plant questionnaire and any other important or relevant information or experience cited in other questionnaire responses without revealing the source (general discussion).

B. Make cursory physical examination of the power plant with respect to conformance to accepted good practice.

C. During the discussions and examinations in (A) and (B) above, three classes of machinery were considered, namely,

1. Engine and/or engine related
2. Generator and/or generator related (switchboard)
3. Auxiliary machinery, piping, building, such as ventilation, heating, combustion air, exhaust gases, fuel storage, etc.

Each visitation itself involved an introductory conference, the plant inspection, and a post inspection conference. The introductory conference was conducted prior to the plant inspection. This provided an opportunity to meet the appropriate plant supervisory and operating personnel. Even though specific reference was made to a prepared check list, problems cited in the

LER's, and unclear responses on the questionnaire, a concerted effort was made to maintain a true open discussion while avoiding an interrogation type of exchange. These discussions centered around the procedures and practices as they relate to the operation and maintenance of the DG units. Also, an attempt was made to obtain opinions regarding adequacy of the equipment with respect to the requirements and performance demands. This segment of the visit required approximately two hours.

The plant inspection was limited to those areas related to the DG units and their operation. This included the DG room, surrounding area, auxiliary equipment room, battery room, and the control room. Particular effort was made to examine those components and subsystem configurations which were not clearly explained or understood from the LER's, questionnaire, or the introductory conference. The fuel storage and transfer subsystems, air starting subsystem, and DG protective subsystems were given special attention. The DG room ventilation and combustion air induction subsystems were examined with respect to dust and dirt as it affects the quality of combustion air and access to contactors, relays, and breakers. When possible, start-up and loading of the DG units was witnessed. The time to conduct the plant inspection required approximately one hour or longer if arrangements for DG start-up and loading have been successful.

The post inspection conference provided an opportunity to clear up any unanswered items from the introductory conference and to clarify and/or discuss in detail observations made during the plant inspection. This conference required 1 to 2 hours to complete.

Preparation for each plant visit required insuring the availability of information on that particular plant as contained in the LER's and LER classification, the questionnaire response, and a visit format, including a list of possible concerns. Experience immediately indicated that it was best

to discuss items of concern in that particular plant based on available information and not those items properly covered in the questionnaire. An effort was made to keep the discussion informal in order to develop new information not previously disclosed. This latter effort was quite productive as we were informed of both positive and negative situations of which we had no previous information. In one plant we were proudly shown new equipment in operation to effectively improve starting conditions while in another plant we were shown the remains of a severely damaged engine. In most plants the problems of incomplete or puzzling information were resolved.

After our first plant visit we reappraised our procedure for the remaining visits. Shorter visits made possible the presence of more responsible plant personnel in our interviews and conferences since most of these people could be detached from their usual duties for a short time. This resulted in meaningful pertinent information and general willingness to be helpful.

As can be inferred from the discussion above, the information secured on the plant visits basically supplemented the information secured through the LER's and the questionnaire. Consequently, the areas of concern may appear somewhat limited. However, it soon became evident early in the visitation schedule that these areas of concern are the most relevant as they bear on the reliable operation of the DG units. The areas include the major subsystems for the DG unit along with certain operation and maintenance practices. These areas of concern are:

A. Air start subsystem - moisture removal; compressor drive power source(s); receiver placement; pressure, size, and number; piping to engine; etc.

B. Fuel subsystem - day tank size and placement; air vent; bleed; fuel transfer pumps; pump power source(s); etc.

C. Cooling subsystem - expansion tank height and placement; air vent; thermostat configuration; primary cooling method (water-to-water heat exchanger or radiator); standby heating; etc.

D. Lubrication subsystem - cooling; standby heating; prelubing; etc.

E. Battery room and batteries - inspection; maintenance; cleanliness; etc.

F. DG room ventilation and combustion air - inside or outside combustion air; combustion filtration; room air filtration; DG control cabinet configuration and cleanliness; etc.

G. Turbocharger drive problems

H. Maintenance and inspection practices

I. Surveillance and light loading practices

J. Personnel training

K. Electrical components

L. Power plant related concerns.

A. <u>Air Start Subsystem</u> - moisture removal; compressor drive power source(s); receiver placement, pressure, size, and number; piping to engine; etc.

Moisture removal from the compressed starting air was accomplished by blowing water from the bottom of the air tanks and various lower parts of the air piping, including the entrance to the engine piping. The best prevailing practice appeared to be that of blowing air from all vents every eight hours or every work shift. The personnel at the various power plants apparently adapted their practices according to the severity of the problem. Expressed recognition of the need for a condensing water extraction system from the compressed air was noted in several plants, but only one plant had such a system in operation with an air "aftercooler" using cold water to cool the air.

The basic compressor drive power source was a.c. power. Standby compressor power was primarily a small diesel engine. A second a.c. motor driven compressor was also used in some instances.

The air receivers were generally on the engine room floor. One plant had a great deal of trouble from water, rust, pipe scale, etc. in the starting air, It had five small tanks located in the hottest part of the room near the ceiling which would tend to minimize condensation. This plant was also in a locality noted for both simultaneous high ambient air temperature and high humidity weather. The least trouble was in plants in the northern part of the country where both cooler weather and lower humidity tend to prevail. Two of these plants also used only one large air tank and the air was compressed to double the pressure used at the air motors. The higher air pressure tends to condense more water and the expansion through the pressure reducer tends to further reduce the humidity and water in the starting air passing through the air motors. There were contributing additive causes in the two instances given, but

the overall difference in operation was very marked. Different engines, etc. were also involved though most used air starting motors.

Most air starting problems were associated with engines which used air starting motors, and the least problems existed where air was admitted directly to the engine cylinders. One make of engine uses an air distributor system having close clearances in the distributor which encountered some trouble. Closely fitted parts such as used in air motors, or distributors, are obviously more prone to damage from water, rust, grit, pipe scale, etc.

Some appreciable air starting trouble is caused by and associated with the electrical components. This may be caused by either a malfunction of the part itself or dirt and grit getting between the electrical contacts. This has led to a practice of using a second start signal in case the engine does not start from the first actuation.

A second set of air motors is installed as standard for a second starting effort on one make of engine, in answer to the air motor problems. Both the second start signal and the duplicate set of air motors reduce the likelihood of complete starting failure.

B. Fuel Subsystem - day tank size and placement; air vent; bleed; fuel transfer pumps; pump power source(s); etc.

In all the power plants visited the fuel systems were good with respect to the day tanks, piping, air vents, and bleed lines. One make of engine does consistently have the day tank lower than the top of the engine fuel system, but this engine has a long time satisfactory service record with this particular arrangement. The fuel transfer or supply from the day tank pump to the engine varies from no pump with gravity feed only from a well elevated tank to an a.c. driven pump, to a 125 v. plant battery system driven pump. The back up or standby pump may

include a duplicate of one of the above or in a few cases a small hand operated pump for priming purposes. Automatic positioning of the fuel controls to the full position is commonly used to facilitate the engine start.

C. Cooling Subsystem - expansion tank height and placement; air vent; thermostat configuration; primary cooling method (water-to-water heat exchanger or radiator); standby heating; etc.

In all plants the cooling water expansion tank was properly piped with respect to piping to the engine system including the air vent bleed. The water expansion tank was above all parts of the engine system except for one engine make where the height was slightly lower following the successful practice of this particular manufacturer. Water temperature was controlled by "3-way" bypass type water thermostats in all plants except two. These two plants had diesel generator sets which were assembled on a steel foundation frame or "skid" in a separate fabrication plant and then transported and installed as a unit in the power plant. This assembly also contained the cooling system and controls, lubrication system, most of the fuel system, controls and safety equipment, etc. These latter units had skid mounted water temperature actuated electrical switches which positioned radiator shutters. (See also malfunctions discussed in detail in Section K following.)

Radiator cooling and heat exchangers to "raw water" were both used in various plants. The water-to-raw water systems did give a little trouble from trash or marine growth in some plants.

Standby water temperature heating systems functioned satisfactorily.

D. Lubrication Subsystem - cooling; standby heating; prelubing; etc.

The lubrication systems gave good performance and most practices appeared to be satisfactory. In one plant we were told by the power plant personnel that the standby oil temperature was temporarily too low during the winter and probably contributed to incipient

crankshaft bearing failure as detected during general engine inspection. The problem of lube oil fires on exhaust manifolds was discussed in some plants and shortened prelube periods were suggested in one power plant by the personnel. This subject is covered in detail in the report of the Fairbanks Morse visit.

E. Battery Room and Batteries - inspection; maintenance; cleanliness; etc.

In all the power plants visited, the battery room, batteries, and charging equipment was clean, neat, and in good working condition. The "station batteries" for the diesel generator emergency power plant control system were 125 v. (132 volt) in the standard fashion. Some of the diesel generator plants had a second 125-132 v.d.c. system for engine starting and there were some 12 or 24 v.d.c. battery systems not concerned directly with the diesel generator plant.

F. DG Room Ventilation and Combustion Air - inside or outside combustion air; combustion air filtration; room air filtration; DG control cabinet configuration and cleanliness; etc.

The DG rooms and combustion air intake followed two patterns. In one pattern, the DG unit was set in the middle of a seismic shock approved room and the combustion air was taken directly from the room. In the other pattern, the combustion air was brought from outside through seismic approved piping. In either case, the practice is to ventilate the room by air through a coarsely screened grill (to exclude birds, etc.) about 4 feet by 6 feet and vent through a similar grill. Steel shutters or louvres were used which open automatically along with the starting of powerful fans when the DG units start. In many plants, the room air is cooled by passing it through water cooled tube and fin type coolers.

A number of these installations use Cardox (CO_2) fire protection systems. Those installations using such fire protection along with the practice of drawing combustion air from the DG room raises a concern about the possible suffocation of an engine during an emergency.

The dirt, dust, grit, etc. in the DG rooms was determined by the large amount of air circulated or brought in from outside, the height of the air intake from the ground level, the terrain in general outside the DG room,and the lack of building air cleaners or filters for the air. By far the worst conditions were where a new power plant was being built, just outside or nearby the DG room, and where the air intake was at or next to the ground level. Several plants do actually have new bare ground construction sites with earth moving machines, trucks, etc. "next door." In one such plant, the dust, dirt, and grit in some of the electrical control cabinets had deposited a layer estimated to be about 1/32 inch thick.

Dust and dirt are known to be a major cause of contactor and relay malfunction. In most of the plants visited, the DG control and exciter voltage control cabinets did not have completely gasketed doors. Some plants had no gaskets at all, and only one plant had all electrical cabinets completely gasketed and reasonably dust tight.

Several power plants did have relays and contactors with plastic dust tight covers including that plant which had submitted the smallest number of LER's. It is not intended to infer that all malfunctioning of contactors and relays is caused by dust and dirt on contact surfaces. Some trouble may also be caused by a lack of sufficiently rugged construction and also simply by "early failure" or "infant mortality." Simple replacement of the "early failure" units and continued use of "enclosed" units did appear to contribute to a good operational record and reduce repetitive failures. In one plant which did have relays and contactors with plastic covers, a modification was made. Concern about seismic shock effects resulted in a bar being placed over the covers which, when tightened to the supporting base, distorted the cases and units so that malfunctions immediately developed. The improvement in seismic shock resistance did not appear to have been tested.

G. Turbocharger Drive Problems

Turbocharger mechanical drive problems have been encountered in a number of DG power plants. The reasons for the failures and suggestions for changes for improvements are covered in detail in the report of the visit to the Electromotive Division of General Motors plant.

H. Maintenance and Inspection Practices

Maintenance and inspection practices vary considerably from plant to plant, as influenced by: the original Architects and Engineers (A. & E.), occurrances or problems during the plant construction and start-up, the rules and regulations of the utilities, the influences of labor unions, and the recommendations of the manufacturers of the engines and/or the generator equipment. A great deal of the specific needs for changes, adjustments, etc. are learned during the surveillance testing and most of the remaining information during the yearly inspection.

Some plants have the engine generator responsibility divided principally between operation (operators) and maintenance. A further classification may be that of engineering and shop personnel. In some plants, the operators designate in their reports the work they want performed by the maintenance personnel and in others, the maintenance people make their own observations and notify the operators. Labor unions have a tendency to emphasize particular skills which result in labor force divisions of mechanics and electricians. The utilities tend to favor overall responsibility and duties. This multiplicity of differences in power plant organizations was not anticipated prior to our visits, consequently, the relative merits of any particular organization structure have not been considered in detail. The attention given various items regarding inspections, and observations of operation performance with respect to maintenance needed was strongly influenced by the

recommendations of the manufacturers, and rightfully so, because substantially different characteristics do exist among the various brands of equipment.

Maintenance appears to be principally based on actual malfunction and repair or replacement, and meeting of the original factory standards of the manufacturers. Surveillance tests are short so changes based on test logs are difficult to make as could be evidenced by long term trends or degradation of equipment performance. At present in most plants the evaluation of the need for maintenance action appears to be based on "start and run" for surveillance testing rather than specific trouble shooting tests to determine if marginal conditions exist.

I. Surveillance and Light Loading Practices

The scheduling and frequency of surveillance testing and loading is strongly influenced by the manufacturers' recommendations and ranges from weekly to the NRC minimum of monthly. This results in a range of weekly testing at full load to a monthly testing at 25 to 50 percent load for engines of another manufacturer. The length of the prelube period before each test run except that of a safety injection signal has been covered in detail in the report on the plant visit to one engine manufacturer.

Excessively long periods of no load and light load running tend to be practices in nearly all plants. An engine may be started and run up to full speed. Time passes as the lube oil pressure and temperature, cooling system functioning, water temperature, engine speed, and other factors are carefully checked. The operator is simply being very careful that everything is satisfactory before the next step is taken. When the engine is loaded by paralleling with the utility electrical system, more

time may pass before any appreciable load is applied while the operator is taking "extra care". Fifteen to 20 minutes may pass before the engine is loaded. The result is sometimes an appreciable collection of lube oil and unburned fuel in the engine cylinders and exhaust system which may also "load up" and possibly damage the turbocharger. Excessive no load and light load running is opposed by all the engine manufacturers and is considered bad practice in the industry. (This subject is covered in each of the reports of visits to the four engine manufacturers.)

J. Personnel

Personnel in the DG power plants for emergency service in the nuclear power plants vary from those with no previous nuclear power plant experience to a considerably number who have U.S. Navy nuclear submarine experience. The minimum education required is a high school diploma. Training varies from on-the-job training to special training in a school maintained by the utility. Some utility employees are also sent to schools provided by the engine manufacturers for further training.

The use and organization of personnel is separately covered above in Section H - "Maintenance and Inspection Practices." The person-to-person conversations in our conferences and plant inspections during the plant visits gave tangible acquaintance with the plant personnel from top supervisors to the plant operators and other personnel. The impression was of informed workers dedicated to making a success of the nuclear power plant operation.

These plant personnel may be unjustly blamed in many cases for certain problems. In their behalf, it should be said that their efforts are hampered in many ways. In instances brought to our attention verbally, one suggestion to effect a certain improvement in operation was rejected as too expensive by the

utility executives, while in another utility, the same suggestion was approved and put into service. In another case, the utility operating practices were continued despite recognition of the problems caused because the rules were not changed. The problem of getting desirable changes properly approved and implemented once the plant was approved and licensed by NRC was said to prevent certain changes from being suggested. This comment may be simply an excuse or alibi, but it was made at several plants and whether justified or not, frustrations were being expressed.

K. Electrical Components

Generator, Exciter-Voltage Regulator, and Generator Controls:

The generator and the usually combined static type exciter-voltage regulator, while not taken for granted, in general gave no trouble. About the only problem mentioned in our plant visits were a few cases of failure to build up voltage on start-up because the field flashing circuit relay did not always make contact. Little trouble was experienced with solid state components except that normally attributed to infant mortality.

Design Logic and Protective Control System:

The design logic errors had long since been corrected by the time the power plants were visited. Components of this part of the electrical system are chiefly comprised of contactors, relays, and sensors which have "make or break" contacts, and also annunciators which are lights, bells, or horns. This control part of the electrical system contributed many of the operating problems and the plant visits did much to show the reasons. General observations were made as classified below:

Environmental Exposure:

Engine generator room airborne dirt was obviously a major concern, and is explained in detail elsewhere.

Temperature was not a factor because of the large amount of ventilation air from outside.

Design Characteristics:

Industry durability reputation of various brands was not discussed.

In general, the components were either of open type or else dust tight (plastic covers) construction. In view of the very dirty conditions in most plants, this difference appeared significant.

Installation:

The control cabinets, etc., were either free-standing, mounted separately and directly on the floor, or else packaged and integral on the engine generator skid. The latter method of direct or skid mounting is notorious in the engine industry for producing multiple repetitive failures of the components. Engine vibration commonly causes pitting of contacts from arcing and also vibration induced fatigue failures of contact springs and wiring.

Maintenance and Failures:

In our discussions, there was no mention of common mode failure of the electrical equipment while the random mode failures were of components.

L. Power Plant Related Concerns

A number of plants had a DG room which was basically a box with the DG unit set down in the middle of the room. While this arrangement is obviously quick and simple it does inherently generate problems of vibration, dirt, and possibly high temperatures.

In two different plants, the apparent concern about rain water caused engine exhaust gases to be driven back into the power plant. In one of these plants, the engine exhaust, hot air from the engine cooling radiator, and the room ventilation air were all recirculated back into the DG room producing an obvious very bad condition.

The seaside plants had peculiar problems such as plugging of the sea water side of the marine type cooling system by mussels growing in the passages. In another plant, the salt water erosion-corrosion had damaged the salt water piping, and caused one DG unit to be withdrawn from service. This was said to not be a concern for the DG responsibility because the damage was in main steam power plant salt water piping. It does seem that anything which causes an emergency DG unit to be withdrawn from service should be more of a concern.

One power plant which had a fairly good record was visited principally because the LER's were vague and inconclusive. Inspection of the plant showed it to be clean, neat, and in good order. Discussion about the functioning of the diesel generator units with the supervisors did little to dispel our original apprehensions. Further discussions with some of the mechanics and electricians indicated that credit for the good operating record was because of their skills and knowledge.

SECTION 5
SURVEY OF OTHER USERS

As a significant adjunct to the overall program, visits were made to two large scale users of DG units comparable in size, who operate the units under similar conditions and experience similar problems. They were the Bell Telephone Laboratories in Whippany, N.J. and the Federal Aviation Administration (FAA), in Washington, D.C. As anticipated, these two organizations were extremely valuable resources in providing us the benefits of their operating experience and practices.

Initially, the personnel at the Ohio Bell Telephone Company in Dayton were contacted. However, it was soon learned that Bell Labs was the appropriate agency rather than any of the Bell operating companies with which to discuss DG matters primarily of interest to the NRC. The discussion with Bell Labs personnel and FAA were very worthwhile even though these activities were rather minimal in terms of the overall contractual effort. The specific DG requirements to meet the needs of each of these organizations are somewhat different from each other and different from those of the NRC and its licensees. These differences, to a certain extent, help to highlight the existence of some of the DG related problems at the nuclear power plants from both a systems and operations standpoint. On the other hand, there is sufficient commonality among the basic DG requirements that certain Bell Labs and FAA practices are worthy of close review for possible adoption of these practices or variations of them by the NRC and its licensees. These practices are discussed and summarized in each of the respective reports that follow.

VISIT TO BELL TELEPHONE LABORATORIES OF A. T. & T. SYSTEM at Whippany, New Jersey on May 9, 1978

PERSONNEL INVOLVED:

Supervisor A.C. Reserve Systems	Bob Kenny
Head A.C. Reserve Systems	Frank Flaherty
Supervisor Use and Applications A.C. Reserve Systems	Alan Morr
Supervisor Technical Staff	S. E. Scheverell
Fuels and Chemicals (Telephone call)	George Kitchen
Visitors:	G. L. Boner University of Dayton H. W. Hanners University of Dayton

The Bell Telephone Laboratories of A. T. & T. have the single responsibility of developing or approving all equipment used in the telephone exchanges and systems. This includes the standby emergency power systems for use when utility power outages occur. Immediate response of these auxilliary power systems while desirable is not necessary as individual exchanges can operate all essential services from battery power for at least four hours.

PURCHASE POLICY

A good quality power supply with respect to voltage and frequency regarding load changes is important. The Bell Systems are, however, extremely concerned about the absolute reliability of all electrical equipment with particular emphasis on contactors and relays. Extensive approval tests are made on all purchased equipment. Emergency electric generator systems have

been tested in the Bell Laboratories as long as one year. All purchased parts and equipment must have Bell Laboratory approval. Gas turbines are also used because of lower installation costs with smaller weight and size since immediate response is not mandatory.

OPERATING PROCEDURES - DIESEL GENERATORS (DG)

There is a continuing trend toward automatic operation of equipment although a few exchanges operate the emergency power supply systems in the "manual mode." Procedures do not require that equipment either work or run to destruction.

A true crisis test is run yearly in which all of the emergency power system is given a true complete test. Simulated or partial system tests have not been effective in proving operability in emergencies. Periodic operation in the meantime is considered helpful in maintenance but not in proving operability.

PROBLEMS AND CONCERNS

Component quality continues to be a major concern. Experience has shown that most problems or failures occur in the periphery rather than in the heart of the systems.

DIESEL FUEL SUPPLY

All diesel fuel tanks are kept slightly below the top of the diesel fuel injection system to guard against any possible hydraulic lock in engine cylinders caused by leakage.

The engine proper is supplied fuel by an electrically driven fuel pump and with a duplicate redundant alternate pump and motor plus a hand operated pump for possible emergency priming.

PROBLEMS AND CONCERNS

Contactors and Relays

Extreme care is taken to guard against dust, dirt, and grit getting into or on electrical contact surfaces. All contactors and relays are of the closed bifurcated type with individual component plastic dust tight covers. (Struthers-Dunn equipment is preferred.) This equipment is mounted in gasketed dust tight cabinets and housed in a room not directly open to the outdoors. The enormous contrast to some of the nuclear power plant DG rooms and control cabinets with respect to dust, dirt, grit, etc., is most impressive. This was especially true of those sites adjacent to the construction of another new power plant.

Diesel Fuel

In addition to the usual considerations for good fuel quality, the Bell Systems and Bell Laboratories are concerned with the long-time storage of fuel having a minimum deterioration within acceptable limits such as gum formations. Water-white #1 kerosene from specially selected refinery runs has been approved for dead storage for as long as 10 years. Current efforts include the testing and use of additives to more easily obtainable diesel fuels with encouraging results. The compounds used were not described and may be either confidential or proprietary.

Seismic Shock

Bell supports the seismic shock concern and recognizes four levels of concern on sensitivity and importance.

Principal Advice

Component functioning and durability is extremely important.

Quality proof is best established by exhaustive testing.

Operability is best proven by yearly full scale "crisis tests," while simulated or partial tests are not conclusive.

VISIT TO FEDERAL AVIATION AUTHORITY (FAA)
in Washington, D.C. on April 10, 1978

PERSONNEL INVOLVED:

Chief Program Mgr.	Ray McCormick
(Asst.) General Engineering	Ralph Stolhard
(Asst.) Engineering	Tony Froelich
Visitors:	G. L. Boner University of Dayton H. W. Hanners University of Dayton

The FAA (Federal Aviation Authority) is singly responsible for the purchase, ownership, operation and surveillance of the standby emergency diesel generator (DG) electric power plants in the various flight control stations covering the United States as a part of the National Air Space System.

As a Federal Government agency or bureau, it is also responsible to the U.S. Congress who must approve all purchases either directly or indirectly. Depending upon the circumstances, it may at times be directly concerned with human life in a most immediate fashion such as a major power outage at night under poor visibility conditions. This background influences the choice of equipment, also the procedures and regulations of operation. Immediate reporting of all troubles is required to the head office in Washington, D.C. not later than the next day.

PRIME MOVER CHOICE

The FAA has 3500 standby emergency DG units in service, about half have gasoline engines, and the remainder diesels. Units are purchased in groups to minimize the differences in equipment on open authorization limited to lots such as 100 or 150 identical units, and authorized by the U.S. Congress. Qualification on such an order is attained only after exhaustive tests which

may require as long as 18 months. Diesel engines with starting air direct to the cylinders are favored. Equipment is purchased from the lowest qualified bidder which sometimes results in poor quality components, but FAA has total control in purchase and inspection.

The starting air supply is from a motor driven compressor with a small engine driven standby compressor. Starting air is filtered.

OPERATING PROCEDURES

"Surveillance" or check testing at one time was done weekly, but now is done monthly. The loads usually consist of fan cooled resistor banks. The electric public utility systems, the country over, have consistently resisted paralleling for loading with their systems. However, since the recent system-wide power outages in the eastern part of the U.S., there has been some change in attitude such that Detroit Edison now allows the practice of test loading for FAA.

The starting requirement from "alarm" to "on the line" is 15 seconds and may be reduced to 12 seconds.

Three levels of coverage for radar are recognized for power restoration namely, 24 hours, 16 hours, and 8 hours. (The Bell Telephone System recognizes four levels in their operations.) This may include both time and equipment. Provisions exist for overtime and "call back" time for employees in order to get the generator units back into service when failures and troubles do occur.

REPORTING SYSTEM (ON FAILURES AND TROUBLES)

Great emphasis was given to the FAA reporting procedures with respect to immediate and speedy reporting. The use of the telephone is encouraged both to the head office and to other FAA installations both for cooperation and relaying of information

regarding failures or concerns. Every power plant has the right to go "right to the top" with any complaint and this is supported by top management. Every Regulation book has in the back of the book a special notice calling attention to this matter of direct reporting. Written reports must follow which may require as long as six weeks to reach the top.

PROBLEMS AND CONCERNS

Fuel for diesels has not been a problem because about 75 percent of the fuel in storage is expected to be burned every nine months. There has been some trouble with gasoline in storage.

Light load problems have occurred when the loads are decreased because of changes from vacuum tubes to solid state electronics. Unburned fuel in the exhaust runs out and drips on the floor.

Maintenance and immediate attention to problems is emphasized, but tinkering or changes without specific reason has caused problems and is discouraged. Approved modifications usually require as long as 1 to 1-1/2 years, but under emergency conditions, have been installed in three weeks time.

PERSONNEL

All operators of 300 kW units and larger must be certified and for smaller units it is not required. The FAA training center is in Oklahoma City, Oklahoma.

SUMMARY AND RECOMMENDATIONS

Keep the equipment and system as simple as possible.

Attempts to attain reliability above 98 to 99 percent is sure to be very expensive and surely show diminishing returns for expense and effort, and may even cause poorer reliability because of greater mortality in a complex system.

Short circuit all red tape by telephone with written reports to follow later and encourage interchange of reports between plants.

FAA does have an advantage in the complete control of the FAA system from specification, purchase, ownership, operation to the overall responsibility.

The Department of Defense (DOD) was suggested as another government agency or bureau which has a large number of DG emergency power plants in radar sites, missile launching, etc. which would provide further information.

A copy of our final report was requested to be sent to the FAA head office in Washington, D.C.

TASK II - DIESEL GENERATOR PROBLEM AREAS

The items covered in Task II are principally those about which little or no trouble had specifically been reported. An outstanding exception was the air start problem. The problem areas covered in Task II of the proposal were based on the usual experience in a diesel generator power plant. The little total running time on the nuclear power plant standby units account for the change of emphasis in importance among the possible problem areas. The report on Task I does cover in detail most existing problems except that of the turbocharger gear drive failures covered in considerable detail in the report on the visit to the engine manufacturers, see Task III report.

COMBUSTION AIR QUALITY

The combustion air quality appeared to be assured for all engines by the use of air filter systems. The sizes and installations appeared to follow good commercial practice and servicing practices appeared adequate. These appraisals take into account the very small amount of running time accumulated per year because these are standby emergency units. Both dry paper and oil bath or wetted type elements were used on the various engines. The relative merits of these types of elements are tabulated below with respect to a number of significant factors.

	Air Filter Element Type			
Factor	Dry	Oil Bath	Wetted	Comments
Effectiveness	Best	-	-	Dry elements are best for small particle size
First Cost	Least	Most	Most	Dry elements are simpler
Servicing Cost	Most	Least	Least	Labor is the greatest cost
Restriction Change	High	Low	Low	Oil bath and wetted elements stay nearly constant

Basically, the dry type element is the most effective means of air filtration with the lesser first cost. However, the servicing cost is higher, and it suffers a greater change in restriction as it accumulates dirt. On the other hand, the wet type element provides the lesser servicing cost, the higher first cost, and the lesser effectiveness, but a lower change in restriction. The dry type with paper filter elements develop extremely high resistance or "blocking" if the paper becomes wet and should not be used in climates where the air may be heavily laden with mist and fog.

The size and capacity of air filter systems is influenced by a number of factors. These factors are dust removal effectiveness, restriction to air flow, surface area, flow velocities, flow capacity, first cost, and servicing cost. The environmental conditions (namely air temperature, humidity, and dust content) under which the air filter system operates must also be considered. A certain amount of uniqueness exists with every diesel generator installation, requiring each to be evaluated prior to installation. No optimum air filter system exists for all installations.

A question was posed during a quarterly review meeting regarding the dirt holding capacity of air filter systems. This question was passed along to the same diesel engine manufacturers visited as reported in Task I by means of a telephone canvass which also included two of the leading manufacturers of the larger filter systems used on large diesel engines. The same sort of qualified response was received from all six of these companies. It was pointed out that the characteristics of the dirt such as particulate size and percentage of each size were extremely important. The time rate of deposition of the dirt and the ambient atmospheric conditions such as humidity and temperature were also pertinent factors.

The initial sizing of the air filter systems is normally based on the air flow during an engine test run at the rated

horsepower load and a pressure drop of about seven inches water column. Normally about half of this value is across the air filter proper and the other half through the air flow ductwork or piping. Servicing of the filter system is recommended at an overall pressure drop of about 14 inches water column. One engine manufacturer would allow about 25 inches water column pressure drop. The top limit was chosen as that value beyond which either engine performance would deteriorate or damage result. Under normal conditions this would result in periods between servicing of several hundred hours up to several thousand hours depending on the accompanying condition of the combustion air. The surrounding terrain and weather conditions are also factors. The original questioner also projected the possibility of a tornado or hurricane as operating conditions causing a power outage demanding operation of the emergency diesels. This brought further qualified answers for obvious reasons from all parties.

One of the leading air filter system manufacturers did venture some probable dirt holding capacities based on normal operating conditions. These capacities are tabulated below according to generic type assuming a typical diesel engine of 4200 hp requiring approximately 2.75 cfm/hp under normal conditions with an air filter system of normal size for the engine horsepower. Also, the capacities are based on normal and usual commercial good practice with respect to the size of element versus rated horsepower and the dirt usually encountered in the air with respect to proportions of particulate size range, type of dirt, and time rate of deposition. The maximum loading condition is also when the typical maximum allowable pressure drop is reached across the filter. Clean filters are sized for the cfm air flow at rated horsepower engine load and 3 to 5 inches water column pressure drop.

AIR FILTER SYSTEMS - TYPICAL

	Generic Type	Grams Dirt Total Dirt Capacity	LBS Dirt 4200 HP Engine
1.	Dry ("paper")	2 gm/cfm x CFM	50.8 lbs
2.	Oil Wetted	1 gm/cfm x CFM	25.4 lbs
3.	Oil Bath	6 gm/cfm x CFM	152.0 lbs
4.	Traveling Screen or Curtain	2 gm/cfm x CFM	50.8 lbs

A centrifugal precleaner of the self cleaning type would add about 50 percent to the operating time between the necessar: air cleaner servicing periods as only about 2/3 of the dirt would remain for the main air filter system but would increase the air flow restriction by about five inches water column.

Other significant criteria relative to the application and servicing of air filter systems are as follows:

1. Application - Performance and "Sizing"

   a. Dirt removal - 90 percent removal of 20 micron or larger particulates is a common requirement using "Arizona Fine".*

   b. At 3 cfm per rated horsepower (2000 hr) with the air cleaner in clean condition the pressure drop is not to exceed 5 to 7 inches water column.

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* The "standard dirt" for air cleaner testing is "Arizona Fine" which actually does come from the Mojave Desert area of Arizona. It is comprised of dust and sand which has been blown and drifted about for ages. This is carefully graded according to proportion of particle size and is somewhat expensive. The Arizona desert has been used extensively for tests of automobiles, crawler tractors, and farm tractors. "Arizona Fine" has been a test dirt or dust standard test material for more than a quarter century.

2. Servicing

Element replacement, cleaning, or servicing to be done when air flow restriction reaches 14 to 25 inches water column depending on the manufacturer. Oil bath filter systems commonly require checking of the depth of dirt in the oil sump of the unit. An arbitrary time schedule may additionally be established for: servicing, examination, or element replacement. This schedule may be based on the calendar or on operating hours of the engine.

Standards for filter element selection, sizing, effectiveness, use and maintenance are well established but do not include dirt holding capacity as such, but instead on functioning with respect to possible effects on engine performance.

The opinion is expressed that engines equipped similar to those in the nuclear power plants would have sufficient air cleaner capacity for the duration of a hurricane or tornado. This opinion is strengthened by the fact that copious rainfall accompanies such storms thus wetting the dust and cleaning the air. An oil bath air filter system with an extra large oil sump up to five times normal plus a centrifugal precleaner could be used to cover the most severe conditions conceivable. Such extreme overdesign would not appear to be consistent with other components and subsystems of the diesel generator units.

Those units which take the combustion air from the engine generator room are vulnerable to a fire extinguisher system which floods or fills the engine room with CO_2. Taking combustion air from the engine room also increases to some degree the ingestion of atmospheric dirt into the engine room which can impair performance of electrical equipment. Taking engine combustion air from outside the engine room eliminates both these problems, but does introduce the problem of seismic shock resistance of the combustion air intake piping.

The impact of ingestion of solid particulates into a diesel engine is two-fold. One effect is the accumulation of the particulates in the air filter system. This results in an increase in pressure drop across the filter, with the consequent need for filter servicing. In the absence of a filter, or if the particulates pass through the filter, the effects become more detrimental. The principal problems are increased cylinder wear and the build-up of particulates on the combustion chamber, exhaust manifold, and turbocharger surfaces, inherently reducing the period of satisfactory performance and useful engine life. Some of the particulates could ultimately get into the lubricating oil, resulting in increased bearing wear.

The effects of ingestion of a foreign gas into a diesel engine are dependent upon: (a) the type of the gas (i.e., corrosive, combustible, or inert); and (b) the quantity of gas. Foreign gases have less effect on engines than to human life and health in the same concentrations. Corrosive foreign gases ingested by an engine is an unusual occurrence, but if continued over a long period of time could have noticeable corrosive effects on the internal surfaces of air intake system, combustion chamber, and exhaust system.

Combustible gases such as propane, if present to any appreciable degree, tend to produce detonation and possibly cause engine damage from high firing pressures.

The volume of any foreign gas, inert or other, in the combustion air results in the reduction of the specific volume of air available for combustion, and consequently affects the power output of the engine. Minor quantities of foreign gases would have minimal effect, since a diesel engine normally operates with a considerable excess of combustion air.

FUEL OIL QUALITY

The diesel fuel oil used in all plants is No. 2 which is practically ideal for this diesel engine service. As currently

produced and sold, the quality of this product is closely controlled and well within the desirable limits on the various characteristics. Burning of high sulfur fuels leads to formation of sulphurous and sulfuric acids in the crankcase oil causing selective chemical leaching of the lead from engine bearings with serious consequences. Of particular importance are control of sulfur content to a very low value, and also a sufficiently high cetane number to ensure quick ignition in a cold engine. Marginal fuels available on a basis of price are not being bought or used because so little fuel is used per year, and instant good performance is required.

Long time storage of fuel is important because of the possible formation of gum in long time storage. Buried fuel tanks give longer fuel life because of the lower storage temperature. Most plants are burning a quantity of fuel per year well over 50 percent of that in storage. Only when the fuel burned per year is no more than 10 to 20 percent of that in storage is there any likelihood of harmful gum formation.

Fuel oil characteristics of typical Sohio refinery runs are included for three different fuels from two different refineries. The appropriate ASTM test method is also identified with respect to the particular characteristics.

OTHER PROBLEM AREAS

Other problem areas covered in the RFP and in the proposal are: the starting air support system, design logic and the interrelationship of the isochronous speed governor with the voltage regulator-excitor. An additional definitely serious problem is caused by airborne dirt and grit which causes a great deal of trouble in all the electrical devices which have electrical contacts.

The starting air problem and the dirt caused malfunction of electrical contacts are so very serious that they have been previously covered at some length in more than one section of

the Task I report. Significant improvement in reliability can only be achieved by substantial changes in removal of water from the starting air system, and in exclusion of dirt from the engine generator rooms, electrical cabinets and electrical components with contacts.

On the other hand the design logic and also the govenor versus voltage regulator-excitor interrelationship have given very little trouble. Once corrections have been made there have been few if any repetitive malfunctions. This excellent record is true despite the complexity of these overall relationships. It is also notable that in general the more complicated components have good records and problems are concentrated in components chiefly from two simple basic causes, namely: water and dirt.

SOHIO

DIESEL SUPREME - TYPICAL INSPECTIONS

Quality	Typical Value Toledo Refinery	Typical Value Lima Refinery	Test Method
API Gravity	37.5	38.6	D 287
Distillation, °F			D 86
IBP	346	396	
10%	400	437	
50%	479	486	
90%	560	545	
EP	614	577	
B S & W, %	.013	0	D 1796
Pour, °F	-25	-12	D 97
Cloud, °F	-10	-11	D 2500
Flash, PM, °F	158	170	D 93
Viscosity @ 100°F, SSU	35.0	34.2	D 88
Color	Red	Red	D 1500
Total Sulfur, %	.16	.13	D 1552, STM 179
Mercaptan Sulfur, %	.0006	.0039	STM 7
Corrosion, 3 Hrs. @ 212°F	1A	1A	D 130
Carb. Residue 10% Btms., %	.14	.13	D 524
Cetane Index	49.8	51.8	D 975
Btu/gal. Gross	137,384	136,602	D 1405, STM 132
Ash, %	Nil	0	D 482

Revised
Sales Technical Division
W. R. Tuuri
10/14/77

SOHIO

NO. 2 DIESEL FUEL - TYPICAL INSPECTIONS

Quality	Typical Value: Toledo Refinery	Typical Value: Lima Refinery	Test Method
API Gravity	36.4	36.9	D 287
Distillation, °F			D 86
IBP	352	366	
10%	411	416	
50%	481	478	
90%	556	564	
EP	608	609	
B S & W, %	.05	0	D 1796
Pour, °F	-16	B-20	D 97
Cloud, °F	- 9	-5	D 2500
Flash, PM, °F	148	160	D 93
Viscosity @ 100°F, SSU	34.5	33.5	D 88
Color	0.7	< 1.0	D 1500
Total Sulfur, %	.20	.21	D 1552, STM 179
Mercaptan Sulfur, %	.0040	.0034	STM 7
Corrosion, 3 Hrs. @ 212°F	1A	1A	D 130
Carb. Residue 10% Btms., %	.15	.16	D 524
Cetane Index	47.2	47.3	D 975
Btu/gal. Gross	137,652	137,403	D 1405, STM 132
Ash, %	.0004	0	D 482

Revised
Sales Technical Division
W. R. Tuuri
10/14/77

SOHIO

KEROSENE (No. 1 Heat Oil) - TYPICAL INSPECTIONS

Quality	Typical Value Toledo Refinery	 Lima Refinery	Test Method
API Gravity	43.7	44.0	D 287
Distillation, °F			D 86
IBP	336	342	
10%	372	374	
50%	416	415	
90%	485	484	
EP	521	533	
B S & W, %	.013	0	D 1796
Pour, °F	-40	B-30	D 97
Cloud, °F	-35	-	D 2500
Flash, PM, °F	126	134	D 93
Viscosity @ 100°F, SSU	31.4	31.1	D 88
Color	+25	+25	D 1500
Total Sulfur, %	.06	.06	D 1552, STM 179
Mercaptan Sulfur, %	Nil	0.0002	STM 7
Corrosion, 3 Hrs. @ 212°F	1A	1A	D 130
Carb. Residue, 10% Btms., %	.04	.08	D 524
Cetane Index	49.0	50.5	D 975
Btu/gal. Gross	134,101	133,946	D 1405, STM 132
Ash, %	Nil	-	D 482

Revised
Sales Technical Division
W. R. Tuuri
10/14/77

TASK III - DIESEL ENGINE MANUFACTURERS RECOMMENDATIONS

Generally speaking, the manufacturers of various types of equipment are vitally concerned in the end application and use of their equipment. This is particularly true of the manufacturers of diesel engines of the class used in the nuclear power plants. These manufacturers are older, well established business concerns, the success of which rests strongly with the quality of their engines and the strength of their customer relations. They also possess a broad spectrum of experience in the application of their engines to various power applications.

The visits to the manufacturers were conducted with two thoughts in mind: (1) they would develop a better awareness of the operational problems experienced by the NRC licensees; (2) the licensees would benefit from approaches used by the manufacturers to solve similar operational problems experienced by other customers.

The manufacturers visits were not conducted until after the review of the LER's and after the visits to the plants using their respective engines. Therefore, the investigators were in a good position to better address the licensee diesel generator (DG) operational problems as they related to each manufacturers units; thus making the sequence of these activities very important. The two objective thoughts addressed in the previous paragraph were fulfilled to the extent possible along with some beneficial and interesting sidelights that are reported specifically in the individual manufacturer visit reports.

The visits to the manufacturers of electrical equipment was decided against after the review of the LER's and after a few plant visits. It was felt that the majority of the electrical problems were related to the subjective influences (i.e., dirt, preventative maintenance) on the components and not

related to the basic electrical equipment malfunctions. Details of these observations are discussed in detail in Tasks I and II. Details of the individual manufacturer visits are reported in the pages that follow. These reports are summarized individually rather than collectively due to differences in the engines and differences in the concerns of the respective manufacturers as they relate to the problems experienced by the licensees.

VISIT TO FAIRBANKS MORSE DIVISION, COLT INDUSTIRES
at Beloit, Wisconsin on May 23, 1978

PERSONNEL INVOLVED:

V.P. Customer Services	Ben Feldmiller
V.P. Engineering	R.H. Beadle
V.P. Marketing	Ed Fay
Utility Sales Engineer	J.M. Moriarty
Manager Gov't Sales	Tom Bullock
Visitor	H.W. Hanners University of Dayton

Arrangements for the visit were made through Ben Feldmiller, V.P. Customer Services. All the various responsibilities of the company were represented during the conference by the personnel listed above. The sales policy regarding the diesel generator (DG) units and the after-market service policy were discussed.

ENGINE DEVELOPMENT

The FM opposed piston (OP) diesel engine was initially patterned after the German Junkers gasoline aircraft engine used in the Zeppelins. The FM engine was originally an eight cylinder diesel developed specifically for the United States submarine service. The number of cylinders and horsepower rating was increased and this trend continued in the application as a railroad locomotive engine, then for electric generating service and currently for nuclear power plant standby service. Turbocharging was introduced for the latter services and retaining the roots type positive displacement blower in a series arrangement with the turbocharger in the combustion air supply. This provides air for starting and light load operation.

SALES & SERVICE POLICY

FM DG units are sold through general contractors such as the Bechtel Corporation to the public utilities. FM works with the subcontractors such as G.E. and Westinghouse to meet NRC requirements. The preference for working with the Architects and Engineers (A.&E.) was emphasized. After-market service is through general contractors which maybe the original installation organizations or the other similar companies or directly to the utilities.

PROBLEMS

A willingness to help solve all problems as they arise was expressed as well as dissatisfaction because the utilities did not always follow the advice given especially regarding operating procedures. Various specific problems were discussed with the major and repetitive items covered at some length.

EXHAUST MANIFOLD FIRES

Lube oil fires on the exhaust manifolds tend to be characteristic of the FM-OP engine. The specific reasons for this problem were detailed. (A similar discussion occurred in one nuclear power plant visit.) In the FM-OP engine the opposed-piston arrangement has vertical cylinders with the upper half of the pistons having the crown facing downward and the piston skirt upward forming a cup. During the pre-lube period before starting the engine, these upper pistons in the cup shaped position partially or almost fully fill with lube oil falling down from the crankshaft-connecting rod bearing and perhaps some oil from the upper main bearings of the crankshaft. Some of this oil will leak or run down the cylinder walls and out those exhaust ports which happen to be open and further leaking out of the joints to the exhaust manifold. During a start more of the oil may be blown out the exhaust ports during the first revolutions of the engine until the upper pistons have emptied. The FM personnel pointed out that the obvious remedy was to limit the

prelube period to a very short time such as two or three minutes instead of the 15 to 30 minute prelube period now practices before surveillance tests. It was said that such advice given to the utilities was not being followed in general in many of the utility plant procedures despite the repetitive problem.

LIGHT LOAD OPERATION

Light load operation was opposed in principle for any period longer than necessary for applying load to the engine during surveillance testing. Lube "oil pumping" with partially burned fuel oil and lube oil coat the pistons, rings, and cylinder walls during such operation and may contribute to the exhaust manifold fire problem.

STARTING AIR AND STARTING AIR PROBLEMS

The starting air supply system favored by FM includes a small diesel engine (Lister) to drive the standby air compressor for true standby independence, but not always supplied depending on the purchase specification. The FM-OP engine air starting system has an air starting distributor to control the individual cylinder air starting valves which may be affected by water or debris in the starting air. FM favors a dehumidifier and water separation accessory in the starting air supply system.

OTHER CONCERNS MENTIONED

More monitors and annuciators on important functions and components in the DG standby power plant would be helpful and are desired, though they weren't specific. It was understood that attention to this concern should result in a cooperative effort with the utilities and the NRC.

Seismic requirements on exhaust and engine combustion air piping appear to be excessive and add very considerably to the cost.

Updating on specifications are a major problem during installation and pre-acceptance operation particularly with respect to resolution of costs.

More attention should be followed in operating plants regarding types and frequency of inspection with an eye to preventative maintenance. Present practice tends to be perfunctory and not specifically pointed toward troublesome problems such as the exhaust manifold fires, or water in starting air, etc. The weekly surveillance tests recommended by FM could be more effective in preventative maintenance.

Attention and consideration is given to the climatic, environmental and ambient operating conditions in the FM choice of auxiliary equipment. The auxiliary equipment supplied by FM is usually specified by the utility as influenced by FM suggestions. FM does not have a standard set of auxiliary specifications and equipment as such for starting air or fuel supply, etc.

FUEL

Diesel fuel no. 2 is satisfactory except a few instances of copper fuel line corrosion. Elevated (above top of engine) fuel day tanks and water surge tanks are specified and used on FM engines. Long time storage fuel deterioration is not a problem because the utilities in general do follow the FM recommendations of full load running and weekly surveillance so a considerable amount of fuel is burned and the ratio of fuel burned to fuel in storage is favorable.

LUBE OIL

Practices in the power plants are in general satisfactory.

DIESEL SCHOOL

In keeping with other suppliers of locomotive and submarine engines, FM has and maintains an excellent DG school for operators

of equipment in the diesel power industry. Twenty (20) school sessions per year are tentatively offered. Attendance is invited and recommended.

SUMMARY, IMPORTANT ITEMS, AND RECOMMENDATIONS

Exhaust manifold fires can be eliminated by shortening prelube periods to not over three minutes.

Strong objections to extended light load running.

Starting air dehumidification and water removal favored.

DG schooling recommended.

VISIT TO ELECTROMOTIVE DIVISION (EMD) OF GENERAL MOTORS
at La Grange, Illinois on May 24, 1978

PERSONNEL INVOLVED:

General Service Manager	Bill Becker
Asst. Service Manager	Gene Young
Secretary	Alice Carter
Visitors	G.L. Boner University of Dayton H.W. Hanners University of Dayton

Bill Becker, General Service Manager, was extremely well informed about the EMD engines in the nuclear power plants. He covered in detail the history of the engine development starting with the locomotive engine up to and including the present day engine in nuclear power plants. Specific reasons and causes of the problems were covered in detail as well as design changes and some information on the costs. The history of the sales policy of the diesel generator (DG) units and the corporate policy with respect to aftermarket responsibility were explained with respect to dealers or packages of these units.

ENGINE DEVELOPMENT

The basic engine was a railroad locomotive engine until 1954. The first electric power units were rated at 1000 kW and later extended to 2850 kW as supplied to electric utilities in "peaking units" which are often installed near the end of a power line to carry the short time heavy loads. They were designated M for Mobile and P for Power, such as MH-8, M-16, MP-36, MU-32, and also as 999 of which 16 were made. The MP-36 and 999 were turbo-charged units on which 1100 starts were made.

SALES AND SERVICE POLICY

The high volume of production results in a lower cost and an attractive price for the DG units which are sold only to packagers or engineering firms who sell a complete power plant unit with additional equipment to satisfy the electric utility specifications and requirements. These packagers include firms such as: Western Engine, Rocky Mountain, Morris and Knudson, Schoonmaker, and others, some of which are no longer in business. EMD tries to work through the Architects and Engineers. These firms as well as the utilities were said to have been fully informed by EMD of the characteristics and limitations of the DG units. The electric utility personnel are steam power oriented, but some are now becoming better informed on diesels. In view of the manner in which the units are sold, EMD does not supply service directly, but is interested in being informed on problems through one of these intermediate organizations who have the responsibility to inform EMD. Considering everything the EMD units were said to be the best in the industry for this service.

PROBLEMS

Objections were raised regarding too much testing especially simulated emergency starting, pointing out that such starts are severe and that they can finally be damaging to bearings while constituting abnormal usage in any kind of service. In response to a direct question about possible gas turbine competition in the nuclear power plant service, Bill Becker replied that in no case has a gas turbine generator unit met the NRC requirements. He also referred to this own experience on gas turbines as a design engineer on the EMD free piston gas generator gas turbine development which was finally abandoned.

TURBOCHARGER DRIVE

Any two-cycle engine has a particularly small amount of energy in the exhaust gas at no load. The disproportionately large proportion of excess scavenging air in the exhaust at no load further degrades the energy level. It was, therefore, necessary to drive the turbocharger mechanically in order to supply enough combustion air to the engine at no load and light load conditions.

In a locomotive generator unit, the engine is normally at no load only when at the lowest engine speed of about 325 rpm or the lowest of the eight speed load steps or "notches" of the controller. In a locomotive the torque and horsepower load are increased from zero (0) at the lowest speed by generator loading control in conjunction with each throttle position or notch to meet load requirements as the controller is "notched up". The loading curve is therefore very similar to the "cube law" relationship of propellor loading on a Marine propulsion engine. The locomotive turbocharged diesel engine almost never runs at full speed except at full load. It was not designed to run at full speed with no load. Eighty percent torque load on the engine is required to develop enough turbine power to unload the turbocharge gear drive train.

The turbocharger mechanical drive failures were said to be simply a horsepower overload as 500 horsepower is required to drive the blower at full speed with no load on the engine. The time-load durability relationship indicating the extreme short life expectancy of the gear drive at full speed with light load conditions was given the utilities with very little effect on their operating practices.

This gear train failure problem was first encountered on drill rigs, and later in the (NRC) nuclear power plant units.

The 16:1 speed up drive ratio met the durability requirements of the drill rigs and the peaking power units, but not the

NRC load response time requirement as it was only 23 seconds, and starting in 16 to 18 seconds. The 16:1 change out is currently available.

The heavy duty 18-1 2:1 ratio is now said to meet the NRC response time requirements and will soon be available. Twenty-two of these 18-1/2:1 units are now being tested in locomotives. The opinion was expressed that the response time requests are not realistic.

TURBOCHARGER DRIVE "CHANGE OUT" POLICY (WORK TO BE DONE BY EMD ONLY)

In addition to all usual work, each turbocharger will also be magnafluxed, Xyglowed, and spin tested. Cost estimates depending on the turbocharger conditions following examination, as well as a new drive are about as follows:

Entire turbocharger unit must be overhauled as well as the drive in order to qualify for the 1 year EMD warranty.

Original 18-1/2:1 drive unit - $4000 to $5000

16:1 heavy duty drive unit - $5000 to $7000

18-1/2:1 heavy duty drive unit slightly higher

Typical Severe Failure - $13,000 to $14,000

Normally a unit exchange plan (UEP) is followed and there must be a complete change out for a heavy duty gear train.

On a Unit Exchange Plan (UEP), all parts must be on hand before work is started.

The latest heavy duty turbo drive unit will "do the job" if surveillance tests are monthly for 1 hour at full load.

LIGHT LOAD OPERATION

Strong objection was expressed against prolonged no load or light load running which causes general engine deterioration. Any turbocharged diesel engine will then have the exhaust system

load up with lube oil and unburned fuel. If full load is then applied there is some likelihood that exhaust fires and perhaps even turbocharger overspeed and destruction will occur because of the very large volume of exhaust gas and high temperature.

AIR STARTING MOTOR PROBLEMS

Early problems said to be the result of no lubricators in the starting air lines and water entrained in the air.

There was a general disclaimer of responsibility on the starting motor problems as the air supply systems were supplied by the packagers. The EMD locomotive engines start from batteries through starting motors or starting windings in the main generator.

FUEL

The fuel tank (integral tank) is mounted below the top of the engine to avoid any fuel leakage into the engine crank case.

An electric fuel supply pump, battery driven, to the engine is favored.

High sulfur fuel should be avoided as they damage cylinder walls and piston rings, and likewise avoid fuel with vanadium because the vanadium pentoxide slag formed will deposit on and damage exhaust valves. 0.7 percent sulfur or more is especially bad.

LUBE OIL

In addition to usual lube oil choices for diesel engines the following are favored:

High Total Base Number (HTBN) lube oils
(toward the alkali end or low end of the pH scale)

Contain Zinc dithio-phosphate
(an anti-scuff additive)

DIESEL SCHOOL

Gene Young explained their excellent personnel Training School and gave a tour of the school.

The school is general but particularly geared to the locomotive business.

School rooms and facilities are excellent. Attendance to the school is invited.

Utilities, railroads, and other final customers send their personnel for training.

Service personnel sent to the utilities are usually supplied by the packagers.

SUMMARY - IMPORTANT ITEMS

Turbocharger Gear Drive

18-1/2:1 ratio now available.
Meets NRC specs.
Price to be available.

Air Starting Problems

Prime responsibility placed on packagers.
Recommendations for a starting air supply system will soon be released.

Excellent school for DG personnel training.

VISIT TO ALCO POWER PRODUCTS (div)
at Auburn, New York on June 19, 1978

PERSONNEL INVOLVED:

V.P. Sales	E.H. Glascock
Eastern Regional Sales Manager	Howell K. Cargile (recently Service Manager)
Chief Engineer	Richard Smalley
Chief Application Engineer	Peter Spock
Visitor	H.W. Hanners University of Dayton

The Alco attitude toward the business of diesel generator (DG) units in nuclear power plants has been one of commitment to insuring that proper and acceptable performance was given.

ENGINE DEVELOPMENT

The Alco engine was originally designed and developed as a railroad locomotive engine. Other fields of application have been for marine propulsion, and electric power previous to the DG nuclear power plant standby service. It is a four cycle diesel engine also has different characteristics from the two cycle engines; differing in design, characteristics, and certain aspects of performance.

SALES AND SERVICE POLICY

The Alco engine is sold with a generator and associated electrical equipment as chosen by the customer and the responsibility for the electrical equipment is borne by the manufacturer. The post-sale updating of specifications and the considerable increase of expense in meeting the particular interpretations of NRC specifications results in a discouraging financial outcome.

The very large transient loads during starting of the large water pumps in the required sequence translates into a requirement of 125% of the rating in actual full load capability. This is not spelled out in the rating as such, and is a factor in the costs. Competition is frequently from packagers engaging in the assemblage of various components and with a lack of knowledge of the equipment and responsibility in the performance. Alco seemed to be very sensitive on this point.

The utilities in general were said to follow the manufacturer's recommendations fairly well and Alco has a contract with the R.E. Ginna plant for a yearly examination and inspection of the DG units and associated equipment.

PROBLEMS

Most of the problems have been resolved and currently only minor ones remain with only very few of a repetitive nature.

AIR STARTING

The air starting motors are made by Ingersoll-Rand with replaceable, easily serviced plastic vanes. The starting air tanks are large with one or two per engine with the air storage pressure about double that used at the air motors. Air is fed through reducing type pressure regulators to the air motors. (The higher storage pressure does result in the condensation of more water from the air because of the inherent thermodynamic relationship and a slight reheat of the air from turbulence when passing through the regulator.) The refrigeration of the air passing through the pressure reducer and the air motors has been enough to have caused an icing problem in the exhaust mufflers from the motors which was easily resolved. The starting of the engines is greatly aided by the automatic setting of the injection fuel pump racks to the full position by hydraulic pressure. Pete Spock said that 300 successful starts were made on some engines during the acceptance tests.

LIGHT LOAD OPERATION

Light load operation is opposed in principle, but no formal objections are expected to be made because of a relatively favorable Alco performance when compared to that of competitors under the same conditions.

At least 25 percent load and up to 50 percent load is recommended during the surveillance testing at two week intervals.

MAINTENANCE

A careful yearly inspection and examination of the engine without dismantling except for a direct cause is recommended when all adjustments and settings should be rigidly made to the factory standards. Do not change or adjust the engine or components except for direct cause or at the yearly inspection when performance is satisfactory. Before doing any work on the engine be sure to read all instructions supplied. (All Alco units are in plants which have relatively clean air with no construction next door.)

FUEL OIL AND LUBE OILS

No remarks. Questions not raised.

DIESEL SCHOOL

Alco maintains an excellent school and school room facility with "cut-away" displays. Both visual part inspection and verbal instruction is given with accompanying printed references. Attendance is invited to operators and others interested.

SUMMARY, IMPORTANT ITEMS, AND RECOMMENDATIONS

Improved guide lines desired especially regarding updating from utility interpretations of NRC requirements with recognition of the financial impact.

In maintenance, make no changes except for direct cause or at yearly inspections.

Attendance at the diesel school is strongly urged.

VISIT TO COOPER-BESSEMER OF COOPER ENERGY SERVICES
at Mt. Vernon, Ohio on July 12, 1978

PERSONNEL INVOLVED:

V.P. Engineering	Melvin Helmich
V.P. Marketing	Dick Spetka
V.P. Service	J.C. (Rusty) Creekmore
Engineer	Lawrence (Larry) Ulery
Visitor	H.W. Hanners University of Dayton

Melvin Helmich a long-time engineer with Cooper-Bessemer, gave the background, engine characteristics, performance capability, specifications, etc., of the Cooper-Bessemer (CB) engines sold for nuclear power plant standby service. He also presented the corporate attitude toward the business and problems encountered. CB has developed diesel generator (DG) characteristics and operating instructions especially applicable to the nuclear power plant standby service.

ENGINE DEVELOPMENT

The CB engine was specifically designed and developed for high output diesel generator service in a program which extended over a number of years. It is a four stroke cycle type engine with a rotating speed somewhat slower than the locomotive type engine.

SALES AND SERVICE POLICY

CB made a corporate decision to actively enter the nuclear power plant business with a DG unit which would meet the NRC specifications and performance requirements. Accompanying operating instructions and trouble shooting procedures to suit this special service were also developed. The basic problem was extreme reliability of a very high output quick-start engine

with unusually high transient overload capability (20 percent overload or more). Standby engines run only a few hundred hours per year making incipient problems very difficult to detect.

An exhaustive detailed trouble shooting guide was evolved and a technical paper written expressing an overall approach to the problems and the manner and means best suited for the solution. This paper was presented at a Diesel Gas Power (DGP) Division meeting of the ASME in 1977 as #77DGP-14 by Melvin Helmich.

CB is now processing five separate orders for nuclear power plant DG units. Although there is only one NRC set of requirements and specifications, there are five different interpretations by the utilities and/or contractors which results in five somewhat different sets of equipment and instructions which ostensibly could very well be identical. The increase in expense is obvious and any advantage is dubious.

PROBLEMS - GENERAL

The operating problems of the utilities with different specifications complicate the advice and instructions which must be supplied by the manufacturer.

NRC nor the utilities do not always respond to or agree with suggestions from the manufacturer.

Component durability is most important and usually more prone to cause trouble than the basic system. Adjustment or merely a normal maintenance practice may be needed rather concern regarding a major component. For example low lube oil pressure may be caused by a dirty partially plugged oil filter rather than an oil pump failure, or an electrical relay may fail instead of a fault in the control design logic.

LOAD LIMITING

Load limiting by fuel stops on the injection pump rank is not considered very practical because of the large transient overload capability required, 20 percent overload or more. Because of of the 20 percent overload capability requirement (120 percent rated load) we inquired about the probable maximum load capability of engines used in emergency standby power applications. From factory records, it was estimated that the engines have approximately a 150 percent rated load capability.

MAINTENANCE

Emphasis was placed on the importance of complete logs or records of all pertinent engine characteristics such as temperature, pressure, power output, etc., during all surveillance testing. The readings as observed can be of direct importance, but noticeable specific changes from one surveillance test to the next can be of very significant importance and should be watched closely by comparing the logs of successive surveillance tests at the same load.

LIGHT LOAD OPERATION

CB is opposed to sustained no load and light load operation because of unburned fuel and lube oil in the exhaust system and cylinder deposits in general. Some of the early CB engines did have some lube oil leakage into the intake manifold and exhaust at no load and light loading because of oil leakage from the turbocharger bearings because of a lack of sufficient air pressure to balance the oil pressure around the annulus at the end of the bearing and/or simply excessive oil pressure. This was remedied by adding a small oil pressure regulator at a very nominal cost to the turbocharger oil supply for current production. (This actually was retrofitted at the Cooper-1 Nuclear Power Station.)

STARTING PROBLEMS - STARTING AIR

Starting problems caused by water and debris in the starting air has been minimal because the starting air is admitted directly to the engine cylinders. Nevertheless air driers are now either recommended or supplied as part of the starting air supply system.

FUEL AND LUBE OIL

Fuel and lube oil were not discussed and tacit approval was given to current field practices as recommended.

The fuel oil supply pump to the engine is driven from the 132 vdc battery system for assured starting.

DIESEL SCHOOL

CB does have and maintains a school for operators and invites inquiry about schedules available. The training is now of a general nature covering all aspects of the diesel generator emergency power plant and auxiliary equipment rather than specialist training. The general training fits into the usual organization in the power plants. There is an established fee for the training course. A new and improved training center has been planned.

SUMMARY, IMPORTANT ITEMS, AND RECOMMENDATIONS

More definitive annunciation needed in the power plants to more quickly identify any problems and give immediate warning. Additional annunciators may be desirable to indicate the functioning of components or indicate the existence of certain conditions.

Better acceptance of manufacturer's recommendations by NRC and the utilities would improve performance.

Diesel Engine Manufacturers Association (DEMA) recommendations and handbook should be followed more closely.

CB believes that the "new generation" DG unit designed to meet the basic NRC guidelines should be used as designed instead of being modified to meet the various interpretations of these guidelines by the utilities.

Most utility personnel in charge of DG units have some need for further training.

TASK IV - COMPARATIVE STUDY
EXISTING OPERATING AND MAINTENANCE PRACTICES VERSUS "GOOD PRACTICE"

Practices depend on equipment, utility rules, NRC regulations, as well as personnel knowledge and specific action taken. This Comparative Study of the operating and maintenance practices covering both differences and comparisons in the nuclear power plants is based on information from:

1. LER's
2. Visits to power plants
3. Visits to manufacturers
4. Telephone calls to manufacturers regarding this question
5. Personal experience and practices of other users of emergency diesel-generators

Many of these items have been previously mentioned in the reports on Tasks I, II, and/or III, and some will obviously be considered again in Task V, Recommendations.

1. Concurrence Among Engine Manufacturers' Suggested Good Practices

   a. Water content in the starting air should be very greatly reduced or eliminated to minimize engine starting troubles. Present operating and maintenance practices in water removal and air filtering appear to be inadequate. The equipment for supplying the starting air does not effectively remove the water to a sufficient degree. Both practices and equipment appear to generally be deficient, and in most plants constitute efforts to live with the bad conditions rather than trying to eliminate the water.

   b. The common practice of extended periods of light load and/or no load operation is very detrimental. Incomplete combustion causes varnish and gum to form which deposit on critical engine parts such

as pistons, piston rings, cylinder walls, valves, etc. Such operation should be restricted to no more than required for the engine loading procedure. Objections to light load operation were expressed by each of the diesel engine manufacturers visited as reported in Task III: pages III-5 and III-7 by Fairbanks Morse (FM), page III-12 by Electromotive Division of General Motors (EMD-GM), page III-16 by ALCO, and page III-20 by Cooper-Bessemer (C-B).

c. Test records and logs are not critically examined with respect to progressive changes in readings under similar conditions which might give clues to impending difficulties. (See 10 CFR Part 50 Appendix B - Quality Assurance pages 297, 298, and 299.) In some plants all test records are turned over to the Quality Assurance (Q.A.) responsibility, leaving the operating and maintenance personnel without references for any action such as change or adjustment. The Q.A. activity appears to be primarily a statistical and record keeping function rather than becoming involved in the details of proper electrical and mechanical functioning and furthermore without specific authority over maintenance. This state of affairs tends to defeat the very reason for a Q.A. responsibility in a power plant.

d. Pre-lube of Engines (prior to all starts except emergency). The pumping of lubricating oil through the engines by means of a separately driven pump or "pre-lube" of the engine before starting is considered very important to ensure good engine bearing life. Also of importance in this regard is maintenance of at least 120°F temperature of the lubricating oil in the oil sump of the engine. An abuse of this practice is an excessively long pre-lube

period up to 2 hours in some cases. In one make of engine this is the major contributing factor in causing fires from lube oil on the exhaust manifolds. The manufacturer of this particular engine suggests a pre-lube period of about 3 to 5 minutes, but this has not been explored with the other manufacturers who do agree that the pre-lube period tends to be excessively long. On the other hand, engine crank-pin bearings and turbocharger bearings tend to be vulnerable to premature wear and failure in the absence of pre-lube. Turbocharger bearings in those engines with gear driven turbochargers which attain nearly full speed with no load on the engine could tend to be especially sensitive.

e. The utilities do not always follow the advice and recommendations of the manufacturers. This complaint was made by all the supplying manufacturers. The practices in operating and maintenance followed by the utilities ranged from direct conflict to agreement and compliance, and while sometimes not actually wrong did require reevaluation. Occasionally this resulted in reluctant acceptance by the manufacturers of practices less than optimum especially in test runs.

f. Component Problems, Malfunctions or Failures. Component failures or malfunctions may give rise to various difficulties as generally agreed among the several manufacturers who supplied the equipment to the nuclear power plants. When a failure or malfunction occurs and a component, whether electrical or mechanical is involved, it must then be adjudged whether a fault in the component itself or some extraneous influence is the basic cause. In either case the component may need to be replaced and

should successive failure occur then the obtaining of replacement parts may become a problem. It is the opinion of several manufacturers that they are not always informed or at least not made fully aware of such failures. Consequently, these manufacturers despite their broader background cannot help in deciding whether the component in question needs to be upgraded or improved. In a few instances it is believed that replacement parts were being purchased on the open market by the original part numbers but not by NRC qualification on matters such as traceability, etc. The manufacturer is thus denied the opportunity to aid in improving the operation record on which may depend the obtaining of future busines.

g. Personnel Knowledge and Training. The recognition of root causes of current or potential problems depends on specific knowledge and familiarity with the machinery by all the personnel concerned. There appears to be a general lack of such expertise in many plants. It is also very difficult to develop and even maintain such skills in the operating and maintenance personnel in a plant where the diesel-generators operate only a few hours per month; nor is it practical to operate this machinery more than the minimum required time to assure emergency response when it may be needed.

h. The practice of diesel power plant personnel attendance to engine manufacturers' schools has not measured up to the expectations of the manufacturers.

The diesel-generator personnel have various experience backgrounds. Many have experience backgrounds such as: nuclear submarines, fossil fuel steam power plant seniority, or simply

a general experience on machinery, where only a very few have previous diesel-generator plant experience. A high school edcuation is an educational minimum. This requires a general dependence upon "on the job training" and attendance for a few days to the schools provided by the manufacturers. It was encouraging to learn that at one engine manufacturer's school one half the attendees were from nuclear power plants. The need for continued intensive training is indicated by an all too frequent failure to find the "root cause" of problems. This may result in replacement of parts with duplicates of those which failed with subsequent repetitive failures. Mistakes in identification of the "root cause" or ascribing the responsibility to personnel rather than faulty equipment are other evidences of the lack of knowledge and experience.

The top supervisor is frequently educated formally and in nuclear and electrical systems but not specifically in machinery and machinery components thus diverting attention away from the diesel generators.

2. Differences Among Engine Manufacturers' Suggested Practices

a. The manufacturers' suggested practices are in general agreement except for the testing of the diesel generator units.

b. Testing frequency varies from weekly to monthly.

c. Test loading varies from full load to about 30 to 35 percent of full load or rated load.

d. Suggested testing of the DG units vary, among the various manufacturers, from weekly at full load to monthly at about 30 percent load. Power plant visits also revealed that differences in attitude existed among the personnel in the different power plants. In several plants it was frankly admitted that the testing practices followed were such as to generate the best operating record

including the LER records and in other plants the emphasis was on the condition of the equipment with the LER records simply relating the steps taken even to small practically inconsequential details such as tightening a fitting to stop a very minor drip of fuel oil. The wording of Regulatory Guide 1.108 apparently leads to such extremely different attitudes and resulting practices.

e. It appears that the reasons for such different practices should be explored further though perhaps beyond the scope of this reliability survey.

f. A policy of very careful yearly adjustment to the factory standards was advised by one manufacturer. Then no checking and changes were to be made during the interim except for direct cause or malfunction. The attitude was that extreme care during the yearly test and examination was preferable to less careful frequent small changes for no particular reason.

g. On certain engines there may be a "drain back" of fuel from the fuel manifold supplying the injection pumps or injection units leaving the fuel manifold filled with air and no fuel until after a certain amount of cranking at the time of an intended start. This condition may also prevail on any engine after servicing of a fuel system prior to the first subsequent start. Fuel must get to the injection units or else the engine will not fire when first cranked and the starting air might thus be completely used with no start.

An electrically driven fuel pump is commonly used to assure fuel to the engine fuel system during the start. Such a pump may be driven by an a.c. motor from the a.c. power system, or a d.c. motor from the 125 to 132 v.d.c. station battery or there may be a gravity feed from the day tank. If such a pump is used it would appear that it should be driven by a battery powered motor. In any case there should also be an engine driven pump. A.C. motors are not favored for this service since their dependence for power is on the very system for which the diesel generator serves as emergency power stand-by.

3. Practices/Problems Related to Specific Engines

These items have been covered in detail in previous reports so will only be listed here.

a. Fairbanks Morse prefers a prelube period on the engines of about 3 minutes to eliminate the exhaust manifold fires. Much longer prelube periods are practiced at some power plants.

b. Change to the heavy duty 18-1/2 to 1 gear train for the blower drive on all EMD-GM engines following the recommendations given in the EMD letter of October 18, 1978 giving detailed procedures. The limitations of the present engine construction precludes the use of them beyond the minimum time schedule available for the parts and changes. Other factors possibly involved are beyond the scope and responsibility of this reliability survey. This subject will be discussed further in Task V, Recommendations.

4. Investigators Opinions

a. There appears to be a practice of trying to "live with" the problem of dirt in contactors and relays in the control and monitoring systems of the diesel generator units. Based on the LERs the malfunction of relays and contactors is generically second only to the general starting problem and deserves prime attention. It is the investigator's opinion that by far most of these problems are caused by dirt and grit between the electrical contacts in these components. The ambient operating conditions and the shortcomings of certain design and construction practices at some plants create very difficult operating and maintenance problems for the personnel. Typical contributing conditions are:

1. Ambient conditions frequently include dry, dusty earth not wetted down and directly adjacent to an operating plant, especially when an additional power plant requires years for completion.

2. The design and construction of the power plant building and ventilating system exaggerate and intensify the conditions of (1) above.

3. Many electrical cabinets have few or no gaskets to exclude dirt.

4. Many open contactors and relays have no integral covers.

   This will be discussed further in Task V, Recommendations.

5. Contactor basic designs are not the best and could have bifurcated contacts.

b. Carelessness and/or forgetfulness of personnel in leaving the diesel-generator units in a non-operative condition appears to be dutifully and honestly reported in various LER's. Safety precautions especially in electrical systems account for most of these items which are not returned to operating conditions. This subject was previously mentioned in detail and will be covered further in Task V, Recommendations.

c. A number of diesel generator units were purchased through "packagers" or agents who assembled and integrated the engine, generator and related subsystems rather than purchasing the diesel generator units directly from the manufacturers. This gives rise to delays and divided financial responsibility. No remedy is suggested or readily at hand and is only mentioned because it does bear on the practices observed. This subject will also be covered further in Task V, Recommendations.

5. NRC Procedures and Practices

It is believed that the differing interpretations of several NUREG's could be narrowed resulting in better understanding and more consistent practices by a review of selected regulatory guides and rewording them without being restrictive or dictatorial. This subject more properly involves Recommendations, Task V.

6. General Comments

Criticism of practices in the various diesel generator emergency power installations should not be construed as indicating generally poor practices and operating conditions. Actually the conditions are relatively good. The responsibilities of this contractural effort are to point out those things which could and/or should be up-graded to improve the reliability of these installations enabling the earnest and dedicated efforts of the power plant personnel to be made more effective.

TASK V - RECOMMENDATIONS

The recommendations discussed below bear on subjects or items which have been previously covered at least to some degree in the reports on Tasks I, II, III, or IV. All are based on the prime concept of improving the reliability of the emergency diesel generator (DG) units from the standpoint of changes in system or component design, operation, and/or maintenance. The classification and sequence of listing of the recommendations are based on the relative importance assigned to each item.

It must be emphasized that the intent of this program was one of arriving at specific recommendations aimed toward the solution of DG operational problems. Consequently, statistical analysis was limited to only that necessary to categorize and weight the severity of the various operational problems as identified in LER's. Since the implementation of the recommendations is subject to numerous and varied decisions, the impact upon the net improvement in the numerical reliability of the DG units has not been established.

The recommendations submitted are classified into three basic categories based upon the urgency of the suggested corrective action.

A. Most Significant Corrective Action
B. Significant Corrective Action
C. Additional Corrective Action

A. Most Significant Corrective Action

The most significant corrective actions are those actions which, if implemented, can have a very substantial effect upon the reliable operation of the emergency DG units. Consequently, the implementation of these actions should be considered of high priority. The majority of these actions require rather

significant hardware changes accompanied by the related economic considerations associated with equipment cost, installation cost, and the effects upon operating procedures.

1. Air Driers in Compressed Air Starting Systems

The current reliability survey of the emergency DG units indicates that engine starting failure is the most frequent malfunction. Water in the starting air either directly or indirectly is the "root cause" of most of the trouble. Relatively few instances are caused by electrical components such as contactors, solenoid valves, electrical faults, etc.

Water wetted surfaces in the presence of air promote rapid oxidation which is especially serious with steel pipe. This causes rust, pipe scale, dirt and the water itself to corrode, score, and jam the internal surfaces of the air starting motors and the sliding of the vanes of the air motors thus preventing rotation. Double sets of air motors, with alternate operation in case of failure to start, has been only partially effective. Sticking and/or jamming of control valves and pilot valves occur occasionally in all air starting systems from the same causes; also, damage is possible to cylinder walls in engines where starting air is admitted directly to the engine cylinders. Periodic draining of the water condensate from the air storage tanks and the use of air strainers and filters have also been only partially effective. The formation of the water condensate in the compressed air is an inherent and inescapable thermodynamic relationship. Water vapor is present in the atmosphere in all climates and the amount depends on the relative humidity, ambient temperature, and barometric pressure. Thus, the problem is general and varies only in degree among all the power plant locations.

The most effective methods of moisture removal from air are air driers of the dessicant type and the refrigerated type. Air driers have been used in science and industry for over a half century. The deliquescent type using dessicants perhaps of a crystalline nature are commonly used for pneumatic

controls and instrumentation, but are not suitable for handling large flows and quantities of air. Furthermore, oil carry over from the compressors tends to foul the dessicants. The refrigerated type using Freon 12 or 22 are used extensively in compressed air systems for air tools of various types using rotary air motors and air cylinders for linear motion, etc.

The refrigerated type air driers are standardized commercial products available with specified performance in as many as 22 closely spaced sizes of flow capacity ranging from 5 SCFM to 5000 SCFM (Standard Cubic Feet per Minute at 29.92 inch Hg and 60°F). These driers are available under about eight different brand names with national distribution although it is believed that most driers come from not more than four manufacturers.

A size of 250 SCFM or larger is recommended for several reasons. The flow capacity with respect to minimal practical restriction, pipe size, and match to the installed starting air compressor should be considered in detail. Also smaller flow capacity sizes tend to omit certain desirable components from the unit in the interest of cost and may thus compromise performance. Furthermore, the cost of about $4000 for such a unit does not decrease commensurately for smaller units.

Typical Information for Refrigerated Air Driers - 250 SCFM

Flow Capacity SCFM	Air Pressure Psi. Ga.	Pipe Size inches	Motor Hp.	Floor Space feet	Inlet Temp. Max°F	Dew Point °F	Appr. Cost
250[1]	150 max[2]	2"	2	3'x5'	100°F[3]	50°F[4]	$4000

[1] Not smaller, but larger to match total compressor capacity as installed.

[2] Higher pressure available at increased cost.

[3] After cooler must be supplied at compressor discharge. May be combined with the reheat air to air heat exchanger.

[4] Dew point of 35°F adds about 60 percent to cost. Use reheat instead. See the diagram in Appendix E. The reheat tends to eliminate any "carry over" of water droplets from the cooler which operates at saturation.

No power plant visited had a refrigerated air drier for starting air. Nevertheless, refrigerated starting air driers are strongly recommended, between the air compressors and the air storage tanks, and favored by at least two engine manufacturers. The relatively long shut down time for water to accumulate between operating periods and the extreme reliability requirements make a refrigerated air drier highly advisable. All present water drains, strainers, filters, and lubricators and their use should be continued. Any modification of the air driers with respect to substituting manual water drains in place of automatic drains, etc. is not considered advisable. The use of well developed commercial items, available with alternate and equivalent performance and with multisources of supply, does simplify the choice and installation of the equipment.

References:

Included in Appendix E is additional information including:

a. Selected pages of preengineered commercially available air driers are copied from two manufacturers' catalogs because the information was in a convenient form with the understanding that essentially equivalent equipment is available from other manufacturers.

b. The flow diagram reproduced is typical.

c. A partial list of such air driers by other manufacturers.

2. Air Quality in Diesel Generator Room

Malfunction or failure of the contactors and relays to function properly is second only to the starting problem. The root cause is usually dust, dirt, and grit between the electrical contact surfaces. In fact, a few of the failures to crank and start have been caused by this problem.

In the 15 power plants visited, the DG room was a considerably different and less favorable environment for electrical equipment than the main power plant control room which was always clean and protected. The DG rooms frequently had a thin coating of dust over everything especially when the combustion air was taken from the engine room. In general, the contactors and relays in these two rooms are very similar and the operating voltages the same. The exposure to dust, dirt, and grit was much greater in the DG room yet need for proper functioning with respect to safety and reliability is the same for either set of equipment. Two plants visited had enclosed relays and contactors. Another plant also had fully gasketed doors on the electrical cabinets.

A.C. generators equipped with static exciters and static voltage reulators also have generator "field flasher" contactors or circuit breakers which momentarily connect the field terminals to the 125-132 v.d.c. station batteries (associated Class 1-E) during the start of the DG unit. The residual magnetism following the field flashing of the generator field then makes the generator self exciting. The exciter-regulator components usually are enclosed in a steel cabinet with a door and ventilation louvers for cooling. Some power plants had failure of voltage to build up because the field flasher contacts did not close. This trouble is also attributed to dust, dirt, and grit between the contact surfaces.

Experience has shown that bifurcated contacts with a contact on each branch of a two pronged leaf type spring is preferrable to a single contact design. This was also recommended by the Bell Telephone Laboratories. Struthers-Dunn manufactures dust tight enclosed contactors and relays of this type which have provided good service.

Recommendations:

a. All contactors and relays should have dust tight enclosed electrical contacts of the bifurcated type as manufactured by Struthers-Dunn or equal.

b. All contactors and relays for the DG equipment are to be enclosed in dust-tight steel cabinets having fully gasketed doors and other openings. Other equipment which may have louvers for ventilation, etc., such as the static exciter cabinets should also have dust tight gasketed doors and filter equipped louvers of sufficient number for proper cooling and protection of the field flasher contacts.

c. Ventilating air for the DG room should be taken about 20 feet above the adjacent ground surface because of dust blown about by wind and/or passing vehicles.

d. Where construction work is being done adjacent to an operating power plant, the practice of wetting down the ground periodically to minimize the blowing about of dust and dirt should be adopted.

3. Turbocharger Heavy Duty Gear Drive - (Change-over)

This subject has been discussed at length in Tasks I, II, and III. Recommendations of the engine manufacturer should be followed as given in Appendix F.

4. Personnel Training

There is a particularly difficult problem in developing knowledge and maintaining skills of the operators and maintenance personnel of the DG units. These units normally operate only during surveillance and trouble shooting tests to give assurance of readiness should an emergency arise. The relatively short exposure to an operating unit makes "on the job" training

especially difficult. When a nuclear power plant is put into operation, the operators having the DG responsibilities may have little or no related skills on such units. Answers to the questionnaire also indicate a need for specific training on the DG units. In this field of employment as in many others, the skilled or expert personnel are distinguished by subtle and almost intangible differences and understanding which can be developed only through experience as well as training.

Recommendations:

Training of the operators and maintenance personnel and especially their immediate supervisors should be done in an intensive and continuing program. This would serve to develop knowledge and skills among those less experienced and act as "refresher training" to maintain the familiarity and skills of the qualified personnel. Only in this way can it be expected that malfunctions and identification of "root causes" will be improved. The survey and visits to the power plants indicated a notable lack of knowledge and understanding of the machinery among some supervisors even though their subordinates appeared to be very competent. In some cases the qualifications of the supervisors seemed to be marginal so training of the supervisors should also be on a continuing basis to maintain specific familiarity with the machinery.

a. The Quality Assurance (Q.A.) function as such is rather obscure in the operating nuclear power plants. Unless the Q.A. personnel have skills, knowledge, experience, understanding, and especially judgement which are equal or superior to the operators, maintenance, and supervisory personnel the action of any Q.A. responsibility can be negative or at least confusing. It is, therefore, recommended that the basic record system be in the hands of the operators and/or maintenance responsibility consistent with the utility power plant organization.

b. It is strongly urged that all operators, maintenance, direct supervisors, and Q.A. key personnel responsible for the DG units should be involved in a continuing program of training. The emphasis should be that of familiarity with the start and running characteristics of the normal DG unit. This should include the rapid sequence of the transient events in the start which normally occur in seconds or fractions of a second as well as the "logs" or operating records of the DG unit on normal steady loads during surveillance tests. Very intensive attention should be given to the functioning of all components of the DG units during simulated emergency quick start and load tests.

c. The diesel engine manufacturers maintain schools which give good advice and training regarding the use of the DG units with the usual emphasis on industrial, severe duty service. The nuclear power plant emergency standby service is also severe duty in other aspects. It is, therefore, recommended the several manufacturers of the DG units be urged to offer DG instruction which is particularly suited to the specific performance requirements of the quick start and probable immediate overload likely to be encountered in the DG units during emergency conditions in a nuclear power plant.

B. Significant Corrective Action

Those corrective actions identified below are actions which are basically procedural in nature; consequently, their applicability is greatly influenced by the present operating procedures being practiced by the various licensees. The adoption of these

recommended corrective actions have to be necessarily selective due to the differences in equipment and operating procedures among the licensees.

1. Pre-Lube -- All Engine Starts Except True Emergency

It is recommended that pre-lube periods for general engine lubrication of a maximum of approximately 3 to 5 minutes be required preceding all engine starts except for an actual or simulated emergency start. Pre-lube periods of more than approximately 5 minutes are to be only by specification or recommendation of the particular engine manufacturer. (Various engine problems may be caused by excessively long pre-lube periods.)

2. Pre-Lube -- All Engine Starts Including Actual or Simulated Emergency Starts

A long "drain down" concurrent with an engine shut down of several days to several weeks can result in a nearly empty engine lube oil piping system. As much as 5 to 14 seconds may elapse from the start of cranking until full lube oil pressure is attained even though full engine speed may simultaneously be reached in less than 5 seconds. The resulting momentary lack of lubrication may result in metal-to-metal contact in bearings such as the engine crankpin bearings and turbocharger bearings causing damage in "pulling" or "wiping" the bearing surface producing incipient or actual failure. Immediate full speed with nearly dry bearing surfaces is a much more severe condition than a more gradual speed increase. However, the emergency condition of readiness does require immediate full speed for generator service. Starting of the pre-lube oil pump at the same instant as the start of any engine cranking under all circumstances would add to the oil flow displacement of the engine lube oil pump and would expel the air and establish the necessary oil film in the bearings as quickly as possible.

An electrically driven pre-lube oil pump accelerates to full speed quite rapidly with full delivery while the engine

driven pump acclerates more slowly with the engine and with the correspondingly slower initial pumping rate.

Recommendations:

It is recommended that the engine pre-lube pump be started by the same signal which initiates the cranking of the engine and be stopped when the engine stops cranking. An alternative approach would be to start the pre-lube pump by the same signal but stop the pump when the pressure in the engine lube oil header has achieved a predetermined level. In either case, the implementation of this recommendation should be carried out in close consultation with the respective engine manufacturer. On some engines, the pre-lube pump is an integral part of the engine lube oil heating system used while the DG unit is in the standby mode.

3. Testing, Test Loading, and Preventive Maintenance

Testing and test loading are the essence of the surveillance tests as practiced in the nuclear power plants. The basic function and value of a surveillance test on a DG unit is to "demonstrate the operability of the unit" according to the 1974 report on Operating Experience, AEC-OOE-ES-002, pages 2 and 3. This is covered further in Regulatory Guide 1.108 Revision 1, August 1977, especially with respect to operating capability (as well as operability) on pages 1.108-2, 1.108-3, and 1.108-4.

In this investigation regarding "Emergency Diesel Generator Reliability" different and even somewhat diverse interpretations and practices have been found with respect to the definitions and guide lines of the report and the regulatory guide mentioned above and, also the instructions and guide lines for LER record keeping. This is true not only among the utilities, but also among the engine manufacturers. Formulation of rules and regulations which are not unduly restrictive and constrictive unfortunately tend to generate such conditions.

Recommendations:

The following suggestions and/or recommendations are presented with the intent to be constructive in resolving the differences in the practices as well as the general approach in surveillance testing and engine operation.

a. No Load and Light Load Operation. No load and light load operation causing incomplete combustion should be minimized as much as possible in the interest of reducing the formation of gum and varnish deposits on the engine cylinder walls, valves, piston rings, etc. of all engines, and also reduce the likelihood of certain mechanical failures. Minimum loading should be at least 25 percent of rated load.

b. Engine Manufacturers" Recommendations. The surveillance tests should be within the NRC guide lines and the frequency of testing, size of the test load, and duration should generally follow the recommendations of the respective engine manufacturers.

c. Preventative Maintenance. Better recognition should be given to the need and advisability of doing investigative testing, replacement, and adjustment as a part of preventative maintenance Testing as such is not a corrective measure and serves only as confirmation of readiness and operability, or as an indication of the need for corrective action. In the presence of the intermittent type of failure, another trial or test may be successful yet does nothing to eliminate or alleviate the problem.

d. "Check off Test". The final step after any "corrective action:, adjustment, change, etc. should be an actual "check off test" of start, run, and load before considering a DG unit to be in a condition of readiness for an emergency. The LERs relate a number of instances of mistakes or errors such as: test leads left on the wiring producing a short circuit, wiring disconnected, a fuse removed or unscrewed, a circuit breaker or switch open, a starting air valve or fuel valve left closed, etc. An actual start, run and load test would guard against such occurrences.

4. "Root Cause" and Corrective Action

Improvement in reliability hinges on identification of the basic problem or "root cause" and the proper choice of corrective action. The effectiveness of all efforts to improve reliability depends on the proper execution in finding the true root cause of problems. This is especially difficult because of the usual chain of related cause and effect relationships. Even testing of various types has a principal value in ferreting out the "root causes" or problems. Unfortunately testing is too often used with its only function being to provide assurance of operability.

Recommendations:

a. Identification. It is recommended that the obvious cause always be suspect as the "root cause". To be sure, the obvious is usually the direct cause of failure or malfunction. The possible chain of cause and effect may fail to be investigated. Several such instances were related in previous task reports. An overspeed governor may trip because the fuel control speed governor allows an excessive speed surge with a substantial load rejection; overheating may occur because of

recirculation of cooling air; or a standard 125 v.d.c. component may burn out in a non-standard 140 v.d.c. system, etc.

b. Repetitive Component Failure. It is recommended that closely spaced component failures not be acceptable unless accompanied by specific assurance of absence of contributing cause and that alternate improved components are unavailable. In other words the practice of "living with a problem" should be unacceptable.

c. LER Records vs. Reliability Index. The LER system and the records so produced have proven to be the best single source of information on the reliability status of the emergency standby diesel generators. Unfortunately, the number of LERs per unit time in the record of a nuclear power plant may also be used as an index number with respect to reliability. In this survey, a visit to one power plant was chosen because of the exceptionally small number of LER's per unit time and another because the LERs were generally rather vague. In both plants, apprehensions were substantiated yet both of these plants also had overall good operating records. Thus, the LER records do not always serve as an indication of reliability. It is recommended that reliance be continued on the LER records as a partial basis for evaluation of reliability.

The impression was generated in several power plants that the number of tests and the extent of the tests were related to the number of LERs possibly generated.

The LER system and the regulatory guides are basically set up and worded with emphasis on failures and malfunction. A corollary of this approach to the reliability problem is that:

a test that is not made cannot fail, which in turn leads to limiting tests to only those which are necessary and required. It is recommended that caution be exercised in the use of LER records as a Reliability Index in a statistical analysis.

C. Additional Corrective Action

Plans for future improvement in the reliability of the DG units should include items and subjects not previously covered as such in reports on Tasks I, II, III, and IV. These suggestions and recommendations are intended to be constructive especially with respect to capitalizing on the experience gained from the operation of the present fully licensed nuclear power plants. Most of the recommendations can be incorporated into existing operating power plants and all can apply directly or indirectly with respect to future power plants.

1. DG Room Ventilation and Combustion Air Inlet

The problems resulting from outside air entering the DG room has been covered separately with respect to the effect of dirt between electrical contacts in relays, contactors and circuit breakers. Some of the power plants visited had very large capacity room cooling units to carry away the heat resulting from the hot summer weather as well as the heat from the engine and generator. The use of room cooling units reduced the amount of air and dirt drawn into the room for ventilation purposes. The apprehensions generated by the previously mentioned thick layer of dust, dirt and grit observed in DG rooms and the reporting of such conditions is considered to be both responsible and responsive. It would seem that more concern should exist about the detrimental effects of such conditions. It is also recognized that many of the installed DG units take the combustion air from the engine room regardless of the extent of air-borne dirt and the arrangement of the Cardox fire protection system. Some even have an inherent recirculation

of: hot cooling system air, hot room ventilation air, and even hot exhaust gas back into the DG room. On the other hand, a number of power plants visited also had practically ideal building and piping design with correspondingly better operating conditions.

Recommendations:

a. Engine combustion air should preferably be through piping directly from outside the building and at least 20 feet from the ground level through proper filters.

b. Room ventilation air should be filtered and taken from a level at least 20 feet above ground level. The piping for the room ventilation air should be separate from that used for the engine combustion air.

c. Room ventilation air, hot cooling system air, and/or engine exhaust gas should not be permitted to circulate back into the DG room, fuel storage room, or into any other part of the power plant building.

2. Fuel Storage and Handling

Answers to the questionnaire and power plant visits indicated that sufficient provision was not made in all plants for removal of water from the bottom of the bulk storage fuel tanks. Water will accumulate gradually in a bulk fuel storage tank either in very small increments from new bulk supplies of fuel, and by condensation of moisture in the air due to the "breathing" through the atmospheric vent because of temperature and barometric pressure changes. Accumulation by the latter cause can be considerable where fuel is stored for long periods of time in areas with a humid climate.

Some power plants also depend on a.c. motors for fuel transfer to the engine fuel system even though these motors

are on the very same system for which the DG units serve standby power needs.

Recommendations:

a. It is recommended that all bulk fuel tanks have a gravity drain from the very bottom of the tank or else in buried fuel tanks a pipe extends next to the bottom of the tank arranged so that any water can be pumped out. The fuel outlet pipe or opening should be approximately 2 or 3 inches above the bottom end of the water outlet pipe to allow some tank volume for settling of any water.

b. Fuel supply pumps for the engine fuel system should be engine driven and the fuel supply to this engine driven pump should either be an assured gravity fed supply or else by a booster pump powered from a, Class 1-E, station battery for assured priming, and not by an a.c. powered pump.

3. High Temperature Insulation for Overload

The very nature of the emergency standby DG unit duty includes a possibility of large overloads which extend longer than simply the time required to start large water pumps, etc. The engines are chosen and rated to cover this possible eventuality. It is believed that it would be fully consistent that the generators also be constructed with such possible duty in mind. There is a possibility of overheating from such extreme emergency overloads causing a generator fire. High temperature rated generator insulation could reduce this hazard considerably.

Recommendations:

It is recommended that the electrical insulation and generator construction be such as to withstand 105°C temperature rise (resistance method) for an ambient temperature of 40°C. Also, Class H insulation is suggested in the standard frame size normally used for 50°C to 60°C temperature rise (resistance

method) at 40°C ambient with special attention given to resistance to fire possibly induced by electrical overload.

4. Engine Cooling Water Temperature Control

Power plant visits and replies to our questionnaire indicate several engine cooling water temperature control arrangements. A water thermostat of the "3-way" or bypass-type splits the water flow so only as much water passes through the cooler or radiator as needed to maintain the proper water outlet temperature. The remainder of the water bypasses the cooler and returns directly to the water pump so that the total water flowing through the pump and engine remains essentially constant regardless of the ambient temperature or engine loading. The "3-way" water thermostat arrangement was used in most of the power plants and also was the only one which gave no indication of trouble. This confirms its consistently excellent record in the heavy duty engine industry. These thermostats use an expanding contracting temperature sensitive wax filled element for the valve control. This type of thermostat is manufactured by at least two or more manufacturers. Other methods of temperature control have not proven to be as reliable (i.e., the problems with shutter controls on radiators as reported in the LER's).

Recommendations:

It is recommended that all engine cooling water temperature control be by means of 3-way thermostat for directing the engine water to the bypass or cooler as required and of the "Amot" brand or equal with an expanding wax type temperature sensitive element.

5. Concrete Floors - Painting

Concrete floors and especially new concrete floors tend to have the surface "skin" crumble enough to shed abrasive dust of sufficient particulate size to not only become air bourne, but also to enter electrical cabinets and prevent electrical contacts from completely closing. Some of the power plants visited did have painted floors to minimize this problem.

Recommendations:

It is recommended that the floors be painted with concrete or masonry type paint in all rooms of the DG units which house any electrical contactors, relays, circuit breakers or other devices having electrical contacts which are part of the DG systems.

6. Instruments and Control or Monitoring Elements - Mounting and Support

The instruments and control or monitoring elements for: lube oil pressure, cooling water temperature, etc., for control, safety, or indicating functions were mounted on the engines or engine skids in many plants. Other installations had the same kind of devices in free standing units directly floor mounted to minimize damage induced by engine vibration. Some actual major engine damage has resulted from vibration induced wear in a skid mounted control element.

Recommendations:

It is recommended that the instruments, control, monitoring, or indicating elements be supported in or on a free standing, directly floor mounted, panel to the extent functionally practical except for the necessary sensors in piping, etc.

7. Comments on Specifically Applicable Documents

It is recommended that attention be given to the brief comments in Appendix H on documents which are judged to be particularly relevant to the program. These comments are appropriate in that these documents either (1) support the basis for the program, (2) reveal the excessively long time prior existence of DG operational problems, or (3) strengthen the observations and/or conclusions. There are a number of the other numerous documents listed in Appendix B which are also relevant, but to a lesser degree.

8. Evaluation and Implementation of Recommendations

Recommendations:

It is strongly recommended that a program of selection, evaluation, and implementation of the recommendations of this report be expedited. The similarity of this report and that of OOE-ES-002 in 1974 is notable except in scope and elaboration. Overall active corrective action in the same sense as given in the basic regulations for the LER system should be given high priority.

APPENDIX A

LER CLASSIFICATION
BY OPERATING PLANT

LER CLASSIFICATION BY PLANT

(1969 to Sept. 28, 1977 Compilation)

Facility-Name	Engine and Related						Electrical				General		
	Starting	Fuel System	Lube Oil System	Cooling	Governor	Misc.	Relays/ Breakers	Conn. & Term.	Exciter/ Volt. Reg.	Misc.	Design Logic	Procedure	Personnel
Arkansas			1		1		2			2			1
Beaver Valley 1	2						7	1		3		2	1
Brown's Ferry 1	5				3		2	1	1		1	1	3
Brown's Ferry 2												1	1
Brown's Ferry 3							1						
Brunswick 1			2	2	1								
Brunswick 2	2	1				1	1	1					13
Calvert Cliffs 1	1	2		6		5	3	2		3			3
Calvert Cliffs 2	3	1	1	1				1		1			1
Cooper 1	3	1			1	2	4	1		1		1	
Crystal River 3		1										1	
D. C. Cook 1			2			1		1		3		3	1
Davis-Besse					1						1	1	1
Dresden 1	1	3	2	1			1					1	1
Dresden 2	11			2	3	2	3	2	1	2		3	
Dresden 3	2		1	3	3	1	2	1		1		3	
Duane Arnold	1			1		5	3					2	1

LER CLASSIFICATION BY PLANT

(1969 to Sept. 28, 1977 Comp: lation)

Facility-Name	Engine and Related						Electrical				General		
	Starting	Fuel System	Lube Oil System	Cooling	Governor	Misc.	Relays/ Breakers	Conn. & Term.	Exciter/ Volt. Reg.	Misc.	Design Logic	Procedure	Personnel
Edwin Hatch 1	6	1	0	1	1	2		1	3	1		1	1
Fitzpatrick 1	2	2	2	1	2	1	6			3	1	1	1
Ft. Calhoun 1	9	1			1		2			2	1		2
Ft. St. Vrain 1	2	1	1	1	1	2	2	1		1		2	5
H. B. Robinson 2	2	1	1	1	1	1				1			
Haddam Neck 1					1	1	4			1	1		1
Humbolt Bay				1									
Indian Pt. 2	1		2		1		3	1	1	1			
Indian Pt. 3			1		2		1	1					1
Kewaunee 1	3								1	1		2	
LaCrosse BWR	5	1		2		1		1				1	1
Maine Yankee					1	1							1
Millstone 1		1				1							
Millstone 2	2	2	3	4	3	5				1		1	3
Monticello 1	9	1				1	1						1
Nine Mile Pt. 1													1
North Anna 1										1			

LER CLASSIFICATION BY PLANT

(1969 to Sept. 28, 1977 Compilation)

Facility-Name	Engine and Related: Starting	Fuel System	Lube Oil System	Cooling	Governor	Misc.	Electrical: Relays/ Breakers	Conn. & Term.	Exciter/ Volt. Reg.	Misc.	General: Design Logic	Procedure	Personnel
Oyster Creek 1	5	2		2	1		2			2	1		1
Palisades 1	1		1	1	3	2		1		1		2	
Peach Bottom 1										1			
Peach Bottom 2	1					1	3			1			1
Peach Bottom 3	1						1						
Pilgrim 1	1			1	1	5		1			1		
Point Beach 1						2	4						
Prairie Island 1	1				2	3		1		3		2	1
Prairie Island 2						1	1			1			2
Quad Cities 1	3	1		1					2	1		2	2
Quad Cities 2	1					1	2		2				
Rancho Seco 1	5			1	2		3			1			
Robt. E. Ginna 1	1						2						
Salem 1				1			1						
San Onofre 1		3		2		2			1				
Sequoyah 1						1							
St Lucie 1	4					1	1				1		1

LER CLASSIFICATION BY PLANT

(1969 to Sept. 28, 1977 Compilation)

Facility Name	Engine and Related						Electrical				General		
	Starting	Fuel System	Lube Oil System	Cooling	Governor	Misc.	Relays/ Breakers	Conn. & Term.	Exciter/ Volt. Reg.	Misc.	Design Logic	Procedure	Personnel
Surry 1	2	1				7	1						1
Surry 2		1						1					1
3 Mile Isl. 1	1		2		1	2	2			2	1	1	1
Vermont Yank 1	1	2				2							
Yankee Rowe	3			3		1				1			
Trojan 1	6		1	1	3	1					2	3	1
Turkey Point 3	5	1		1			4				1		2
Turkey Point 4	1						1				1		
Zion 1	5	1	1		2	3	3	2	3				
Zion 2	2		1		1	7	1			2			

APPENDIX B

LISTING OF SELECTED DOCUMENTS BY DATA BASE

LIST OF DOCUMENTS FROM OTHER SOURCES
(NOT A DIRECT RESULT OF THE LITERATURE SEARCH)

1. Report entitled, "Deterioration of Fuels and Fuel-Using Equipment" dated August 1967, Battelle Memorial Institute No. AS 662266.

2. Manual on Requirements, Handling, and Quality Control of Gas Turbine Fuel, ASTM Special Technical Publication STP 531.

3. Diesel Engines for Use with Generators to Supply Emergency and Short-Term Electric Power, National Academy of Sciences. National Research Council Publication 1132.

4. Maintenance and Operation of Nuclear Diesel Generator Systems.
September 18-22, 1977
AUTHOR: M.J. Helmich.

5. Standardize Diesel Preventive Maintenance.
September 1970
AUTHOR: P.D. Johnson.

6. A Versatile Two-Cycle Diesel Engine-The EMD Model 645 Series.
December 11, 1975
AUTHOR: M. Ephraim, Jr.; J.J. Kotlin; J.A. Williams, Jr.

7. Safety and Failure of Components.
Proceeding 1969-70. Volume 184. Part 3B
AUTHOR: I. Mech. E./London.

8. IEEE Power Engineering Society - Conference Papers from the Joint Power Generation Conference. 74CH0949-8 PWR.
Miami Beach, Florida.
September 15-19, 1974.

9. Paper entitled, "Dormancy VS. Over-Testing and the Effect on Diesel Generator Availability" .
ASME/ASCE Joint Power Generation Conference, Buffalo, N.Y.
September 19-23, 1976
AUTHOR: L.E. Booth, Member IEEE.

10. Production Engineering Division Newsletter
Article entitled, "Quality Assurance-The Critical Function"
Winter 1978
AUTHOR: Clifford L. Harrison.

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1. A Study of Fuel Economy and Emission Reduction Methods for Marine and Locomotive Diesel Engines.
   Interim Rept. Nov. 74-May 75 PB-246 725/6ST
   AUTHOR: Storment, J.O.; Wood, C.D.; Mathis, R.J.

2. Guidelines for Quality Assurance Programs for Mobile Source Emissions Measurement Systems: Phase III. Light-Duty Diesel-Powered Vehicles - Quality Assurance Guidelines.
   Final Rept. Jun 75 24p PB-251 562/5ST
   AUTHOR: Wimette, Harold; Pilkington, Rod; Kelly, Tom.

3. Guidelines for Quality Assurance Programs for Mobile Source Emissions Measurement Systems. Phase II. Heavy-Duty Diesel Engines-Test Procedures.
   Final Rept. Jun 75 185p PB-251 333/1ST
   AUTHOR: Pilkington, Rod; Kelly, Tom; Wimette, Harold.

4. Guidelines for Quality Assurance Programs for Mobile Source Emissions Measurement Systems: Phase II. Heavy-Duty Diesel Engines.
   Final Rept. Jun 75 296p PB-251 332/3ST
   AUTHOR: Pilkington, Rod; Kelly, Tom; Wimette, Harold.

5. Guidelines for Quality Assurance Programs for Mobile Source Emissions Measurement Systems: Phase IV. Heavy-Duty Gasoline Engines - Quality Assurance Guidelines.
   Final Rept. Jun 75 43p PB-251 564/1ST
   AUTHOR: Pilkington, Rod; Kelly, Tom; Wimette, Harold.

6. Cost Effectiveness Comparison of Gas Turbine and Diesel Engines.
   Maintenance Analysis Rept. 1 Jan-31 Dec 68. AD-864 264/7ST.

7. Feasibility Study for a Diesel Engine Condition Monitoring System for 1179 Class LSTs.
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   AUTHOR: Peterson, M.B.; Hegner, H.R.; Frarey, J.L.; Dominy, D.; Burnett, H.C.

8. Fuel and Lubricant Compatibility Studies for Army High-Output Two-Cycle Diesel Engines.
   Interim Rept. Sep 72-Sep 75 AD-A031 885/7ST
   AUTHOR: Lestz, Sidney J.; Bowen, Thomas C.; LePera, Maurice E.

9. Extended Oil and Oil Filter Change Interval for DOD 5- to 200-Kilowatt DED Generator Sets --- Interim Report on 60- and 100-Kilowatt Sets
   Interim Rept. 1972-1975 AS-A016 125/7ST
   AUTHOR: Dreger, John W.; Levine, Sidney; Zanedis, Basil.

10. Proceedings of the Meeting of the Mechanical Failures Prevention Group (16th) Held at the National Bureau of Standards. Gaithersburg, Md. on 2-4 November 1971
Technical Rept. 1 Feb 72 74p AD-738 855
AUTHOR: Sawyer, W.T.

11. Uninterruptible Power System Module Analysis
Interim Rept. Nov 67 74p AS-666 823
AUTHOR: Pledger, E.R.

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13. Sentinel Power Plant Systems Effectiveness Final Technical Report for the Contract Period.
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Dec 74 8p GA-A-13284
AUTHOR: Fleming, K.N.

16. Survey of Lube Oil Analysis Techniques to be Used at the Department of Housing and Urban Development Total Energy Plant, Hersey City, New Jersey.
Interim Rept. Sep 73 21p COM-74-10929/9
AUTHOR: Burchill, Richard F.

17. Evaluation of Failure of High Lift Diesel No. 2
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AUTHOR: Loundagin, R.L.

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4. ID No. - EI740206361 406361
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Benefits of Modern Diesel Engine Diagnostic Tools in Fleet Maintenance and Engine Testing of Fuels and Lubricants.
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19. ID No. - EI740632741 432741
Recent Experiences with Sulfur in Distillate Type Fuels Burned in U.S. Navy Diesel Engines.
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21. ID No. - EI750317476 517476
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29. ID No. - EI70X150001 050001
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Heavy Fuel Operation with Pielstick Engines.
Shipbldg & Shipg Rec v 114 n 24 Dec 19-25 1969 p 27.

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32. ID No. - EI71X049333 149333
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33. ID No. - EI770316070 716070
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34. ID No. - EI72X071471 271471
Fuel Feed Pumps and Filters for Low-pressure Fuel Supply.
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35. ID No. - EI72X048763 248763
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SAE Prepr n 760717 Oct 18-22 1976 27p.

41. ID No. - EI760637425 637425
Condition Monitoring of Diesel Engines.
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42. ID No. - EI760530305 630305
Influence of Fuel Filterability on Service Life of Diesel Engine Filters.
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43. ID No. - EI72X044798 244798
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Diesel Eng. Users Assoc, Publ n 344 Sep 1971 p 3-11.

44. ID No. - EI72X024082 224082
Care of Fuel Ignition Systems.
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"Air Filter Requirements for Diesel Heavy Truck Engines".
Automobiltech Z v 74 n 3 Mar 1972 p 117-123.

47. ID No. - EI740418850 418850
Engine Exhaust Provides Clue to Proper Performance.
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48. ID No. - EI740206359 406359
Cooling Systems.
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49. ID No. - EI750639566 539566
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"Assuring Auxiliary Service and Emergency Power Supply in Power Stations"
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Air Filtration for Modern Locomotives.
ASME Paper 73-RT-4 for Meet Apr 11-12 1973 8 p.

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Automatic Diesel Engine Driven Standby Electric Generator Plant.
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52. ID No. EI72X050215 250215
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Sulzer Tech Rev Research Number 1971 p 53-63.

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Use of Fuel Additives to Reduce Diesel Exhaust Smoke.
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APPENDIX C

QUESTIONNAIRE WITH SELECTED SUMMARIZED RESULTS

NOTE: The questionnaire that follows is a limited summary of the 43 responses to the questionnaire. It applies particularly to those questions answerable by "yes", "no", "NA" or "UN". Questions marked with an asterisk (*) identify those questions having almost as many different answers as there were responses and consequently do not lend themselves to summarizing. Those questions where the responses varied considerably but fell within a particular range, the range has been given to indicate it accordingly followed by a number in parentheses showing the number of responses which fell in that particular range.

Questionnaire

for

NUCLEAR REGULATORY COMMISSION
RELIABILITY STUDY

of

Standby Diesel Generator Units

Date Questionnaire Completed: ______________________

Plant Name: ______________________ Unit No. __________

Diesel Manufacturer: __________________ Model: __________

Number of Units: ________

Size Kw/Unit: ______________ Rated Speed: __________

Average Operating Hours Per Unit to Date: ______________

DIESEL GENERATOR STATUS

A. Engine:

1. Problems are caused chiefly by (give estimated number)

   a. Defective parts 1-40 (35) 4 UN 4 NA
   b. Installation errors: 1-11 (37) 1 UN 4 NA
   c. Failure of system to respond properly in function or sequence: 1-3 (38) 1 UN 4 NA
   d. Faulty adjustment: 1-13 (39) 4 NA

2. Would more stringent inspection and testing requirements during acceptance or preoperational tests significantly improve the diesel-generator power plant performance?
   Yes 2 No 38
   2 NA 1 UN

B. Starting Systems (indicate which):

1. Air-to-cylinder cranking. 19
   Air cranking motor 20 Mfr. — Model No. —
   Electric cranking motor 4 Mfr. — Model No. —

2. If air cranking, then:

Give size of starting air tank: Length 66"-258" Diameter 20"-66" (35) 1 UN 7 NA

Normal standby air tank pressure 200-400 psi. (37) 6 NA

Is pressure reducer used? Yes 15 No 22 6 NA
Reducer pipe size? 1-3 inches. (15) 28 NA

Starting air control admission valve pipe size in air piping system, 0-7 inches. (36) 2 UN 5 NA

Minimum air tank pressure for engine cranking 50-225 psi. 3 UN 8 NA

Number of five-second cranking periods between above pressures with no tank recharging 2-6. (20) 5 UN 18 NA

Number of air tanks per engine 1-6. (36) 7 NA

Can starting air tanks serve more than one engine?
Yes 27 No 10 6 NA

Is air pipe to engine from top of air tank? Yes 27 No 10 6 NA

Does starting air tank have water condensate drain?
Yes 37 No 0 6 NA

Does starting air pipe have water condensate trap and drain near engine? Yes 9 No 28 6 NA

Is starting air piping horizontal? Yes 34 No 2 7 NA

Does it slant toward drain? Yes 6 No 25 11 NA 1 UN

If water condensate drains are provided, then is draining:

a. Automatic through float valve? Yes 7 No 24 12 NA
b. Manual by hand valve? Yes 32 No 1 10 NA
c. If manual, then is draining water condensate done:

3 times day 5
daily? 13
weekly? 7
monthly? 3
before each start if manual? 1
no procedure? 3
Bi-weekly 1 10 NA

Is dirt and rust filter provided in starting air pipe?
Yes 25 No 13 5 NA

* If provided, where installed? NA 16

* How is it cleaned? NA 16

* How often and when? NA 17

Give pipe size of filter: 1-5" NA 17 inches.

* How is it known whether filter is plugged or has high pressure drop? NA 19

Is starting air pipe to engine positioned:

a. Below floor? 4 On floor and overhead 6
b. On the floor? 4 Below and on floor 2
c. Overhead? 23 NA 4

What is air pressure drop from air tank to engine during cranking 0-95 psi (17) 15 UN 11 NA

Give approximate length (nearest ten feet) of starting air pipe for individual engine or all engines from air tank to:

a. Nearest engine 10-90 feet (37) 6 NA
b. Furthest engine 2-98 feet (22) 21 NA

Diameter of starting air pipe from:
(1.50"-3.00")
a. Air tank to starting valve ↓ inches (37) 6 NA
b. At air starting valve * inches (37) 6 NA *(.25-3.00)
c. At engine * inches (37) 6 NA *(.25-3.00)

*What is the primary source of power for the starting air system? ______

Is there a duplicate and redundant motor and air compressor set? Yes 25 No 11 7 NA

What is the time required to recharge one air tank?
2-60 minutes (30) 6 UN 7 NA

Does starting air supply system have independent secondary power supply for compressor? Yes 16 No 21 6 NA

If yes, then by:

a. Gasoline engine? 2
b. Motor driven? 2
c. Other? (Specify) DIESEL 10 29 NA

3. If electric (Battery powered) cranking, then:

a. Battery charging: Continuous trickle charger 4
Intermittent charging 0
BOTH 1 38 NA

If so, how is charging requirement determined?

Time cycle 1
Test 1
Other 1
BOTH 1 39 NA

b. Battery used: Common Plant 0
Individual Unit 5
Other 0 38 NA

(.25-.75)
Starting cable size ↓ ; Length: 5 Battery to engine 38 NA
(longest) ______

40"-18' 3
Eng. & Elec. 1
Propane Gas Press 1

38 NA

C. Fuel Oil System: Bulk Tank to Day Tank

1. Does the bulk tank to day tank fuel supply system (viz: pump, motor, etc.) have redundant independent power supplies? Yes 28 No 15

   Does this system have a hand-operated emergency fuel pump? Yes 3 No 39 1 NA

   If yes, is this hand-operated pump and piping in immediate operating condition? Yes 3 No 40

2. Is there a water and sediment drain from the very bottom of the:

   a. Bulk tank? Yes 13 No 30
   b. Day tank? Yes 36 No 6 1 NA

3. Is the regular functional fuel oil outlet slightly above (two to three inches) the bottom of the:

   a. Bulk tank? Yes 38 No 5
   b. Day or integral tank? Yes 31 No 10 1 NA 1 UN

4. Is bottom of day tank and/or integral tank above all parts and piping of the engine fuel injection systems? Yes 11 No 31 1 NA

   If yes, (11) 32 NA

   Give approximate amount inches 1-36 feet ____

5. Does the engine fuel system have a fuel bleed return line to the fuel day tank and/or integral tank? Yes 40 No 2 1 NA

   During extended operation, such as more than two to three hours, does the fuel in the day tank become: (yes or no)

   a. Warm? 15 YES 19 NO 8 UN 1 NA
   b. Hot? *→→→ (above 130°F) *1 YES 32 NO 9 UN 1 NA

What is fuel oil return line size (nominal)?

a. Pipe size (.5-2.0) __*__ inches (29) 14 NA
b. Tubing size __*__ inches (14) 25 NA *(.25"-3.0")

6. Do engine fuel oil filters have air bleed or vent valves readily accessible? Yes __20__ No __21__ 2 NA

7. How is fuel transferred from day tank to engine fuel system?

GRAVITY & ENG. __3__ 1 UN
ENG. & ELECT. __7__ 1 UN
PROPANE GAS __1__

a. By gravity __4__
b. Engine driven pump __19__
c. Electric motor driven pump __3__
A, B, & C (all of above) __4__ d. Is a manual pump also provided for injection system filling and/or air venting after servicing or replacement of parts in the fuel injection system? Yes __14__ No __28__ 1 NA

If yes, is the manual pump in immediate operating condition?
Yes __14__ No __29__

NO. 1 __1__
NO. 2 __40__ 1 NA

8. Type of fuel (e.g., #1, #2, #3, JP-4, etc.) PROPANE __1__.

9. Approximate bulk tank capacity, __120-25,000__ gallons. (42) 1 NA

10. Typical frequency of refilling (weekly, monthly, etc.) week __2__ month __9__
s need. __4__ Biann. __2__ Year __4__ Bimonth __5__ Quart. __6__ Semimonth __2__ Semiann. __6__ 3 UN

11. Typical refill (gallons), __5-3000 (36) 4 UN 3 NA__.

D. Lube Oil System

1. Lube oil

* a. Type ______
* b. Viscosity ______
* c. Specification number ______
d. Oil change determined by:

Time interval: Yes __14__ No __24__ 5 NA
Give interval __30 NA__ monthly, yearly yearly- __11__ 6 mos. __2__
By oil analysis: Yes __36__ No __6__ 1 NA

2. Lube oil filters are:

   a. Full flow 32
   b. Bypass 2
   c. Combination 9

3. Interval and/or basis for changing filter cartridge:

   a. Monthly 2 — 6 months 1
   b. Yearly 21 — 18 NA 1 UN
   c. By running time 250-350 hours (2) 41 NA
   d. By oil analysis. Yes 15 No 12 16 NA
   e. By pressure drop. Yes 28 No 9 6 NA
   f. Does provisions exist for changing cartridges during engine operation? Yes 7 No 33 1 UN 2 NA

4. Oil Pressure Monitoring

   a. Normal operating pressure 20-950 ↑ psi (42) 1 NA
   b. Alarm 16-60 psi (39) 4 NA
   c. Shutdown 0-60 psi (38) 5 NA

5. Oil temperature control:

   a. By standby heater in engine sump 85-150 °F. (31) 12 NA
   b. Heating means for maintaining standby temperature:

      Direct in oil Y-16 N-21 6 NA
      Oil-to-water heat exchanger Y-18 N-17 8 NA
      Other (Specify) Y-1 N-2 14 NA

E. <u>Cooling System - Engine Water</u>

1. Temperature control by:

   a. By thermostat in water? Yes 40 No 3

      If yes, then:

      Bypass thermostat? Yes 34 No 7 2 NA
      Throttle thermostat? Yes 5 No 35 3 NA

b. By radiator shutter:

Automatic 2
Manual 1
Other (give type) 40 NA

2. Corrosion control (water additive)? Yes 41 No 1 1 NA

If yes, give chemical additive or name of compound.

*

Proportion or concentration control:

a. By additive measurement? Yes 15 No 25 3 NA
b. By water coolant analysis? Yes 30 No 11 2 NA

3. Engine cooling water cooled by:

a. Radiator? 9
b. Heat exchanger from sea, river or other water? 31
c. Other? (give type) 1 BOTH 1 1 NA

4. Engine cooling water temperature-monitoring

a. Standby temperature 50-150°F (42) 1 NA
b. Normal operating temperature 128-205°F (42) 1 NA
c. Alarm temperature 170-205 °F (40) 3 NA
d. Shutdown temperature 0-205°F (28) 15 NA
e. Water circulation during standby:

Thermo-syphon 15 OTHER 1
Pump 24 3 NA

5. Water Pressure Monitoring: Yes 32 No 10 1 NA

a. Alarm 9-45 psi (9) 29 UN 5 NA
b. Shutdown 10-70 psi (8) 27 UN 8 NA
c. Both 9-35 psi (4) 32 UN 7 NA

6. Water temperature Sensor Position:

   a. In piping from engine 31
   b. In engine piping 7
   c. In engine direct 3
   BOTH 2

7. Water surge or supply tank in system. Yes 42 No 1

   If yes, then bottom connected to:

   a. Water pump suction? Yes 25 No ____
   b. Top of system? Yes 4 No ____
   c. Both of above? Yes 12 No ____ NONE 1 1 NA
   d. Is bottom of surge tank above top of engine system? Yes 31 No 11 (1)
   e. Does engine have constant air bleed from top of engine water piping to surge or supply tank? Yes 37 No 5 1 NA
   f. Give size of bleed or vent line, 0-4 inches. (34) 9 NA
   g. Manual air bleed only? Yes 10 No 30 3 NA

F. Governor - Speed Control

*Manufacturer ____________
Electric (speed sensing) 4
Hydraulic 18 BOTH 21
*Type or code (such as EGB-35, LSG-10, etc.) ____________
Automatic load sharing? Yes 21 No 20 2 NA

1. Is compensation or stability control and/or speed of response manually adjustable? Yes ____ No ____

   If yes, adjusted by:

   a. Eye and ear? 7
   b. Test and specification? 31
   c. Other? (Specify) 3 . 2 NA

2. Engine - generator normal shutdown or stopping means and method.

Is the engine stopped:

a. Manually? Yes 34 No 8 1 NA

If yes, then:

Directly at engine? Yes 7 No 0
Through local control panel? Yes 9 No 0
BOTH 16 NEITHER 7 8 NA

b. Automatically through the controls in the control room? Yes 28 No 18 1 NA

c. By setting governor to "fuel-off" position?
Yes 13 No 29 1 NA

d. By over-ride of governor settings and control position directly to fuel injection pumps?
Yes 11 No 27 1 UN 4 NA

e. Other means. Describe briefly. 16

____

3. When engine is stopped, is fuel control in:

a. Full fuel or maximum fuel position? 11
b. Full off or no fuel position? 28
c. Intermediate? 2
d. Random? 1 1 NA

(If not consistent and typical in above, then give the usual.)

4. When starting from the standby condition after shutdown for at least 24 hours, give number of seconds from start-to-crank to full fuel or maximum fuel position of governor and fuel control, 0-30 seconds. (36) 2 UN 5 NA

G. Governor - Overspeed (shutdown)

1. Speed sensing?

   a. Electrical 5
   b. Flyball 24
   c. Other (Specify) 13 NONE 1

2. Fuel shutoff force generated by:

   a. Spring? 16
   b. Air? 1
   c. Hydraulic? 9
   d. Electrical? 9
   e. Other? (Specify) 7 1 NA

3. Overspeed sensing setting? (in terms of full speed)

   a. 115% ____
   b. 110% ____ 110-122 (42) 1 NA
   c. Other (Specify) ____________

4. Is overspeed tripping set point tested periodically?
   Yes 34 No 0 9 NA

   * If yes, then how often? ________ (yearly, monthly, etc.)

H. 1.* Generator Mfr. ____________ Model No. ____________
   Single bearing or two bearings? 1-(33) 2-(9) 3-(1)
   Does generator have damper windings? Yes 19 No 21 3 UN

2. Does generator have any obvious fault or difficulty?
   Yes 3 No 40

   Is problem repetitive? Yes 2 No 3 38 NA

   * If yes, then describe briefly. ________________

I. Exciter and Voltage Regulator

1. *Exciter Manufacturer: ______________ * Model ______________

   Type: Rotating ____3____ Static ____39____ 1 NA

   If rotating drive? Direct __1__
   Belt or Chain __0__
   DC with field control __0__
   Brushless with rectifier __1__
   Direct & Brushless __3__ 39 NA

2. Voltage Regulator: * Manufacturer ______________ * Model ________

   Type: Mechanical ____0____ Static ____42____ 1 NA

3. Are paralleled units of automatic load sharing control of fully automatic type? Yes __14__ No __11__ 18 NA

   If yes, has any obvious influence or interrelationship been noted between the stability and response time of the engine governor and the stability and voltage control of the generators? Yes __4__ No __11__ 28 NA

4. Have engine governor and voltage regulator/exciter adjustments been made on the site or under any conditions since any of the units have been placed in service? Yes __25__ No __13__ 5 NA

   * If yes, by means of what tests and what standards? Give name or very brief description. ____________

   ____

5. If any difficulties have occurred, give approximate number of problems.

   a. Components __0-10__ (40) 3 NA
   b. Wiring __0-3__ (39) 4 NA
   c. Other (damage in service or dropping of miscellaneous hardware into switchboard, etc.) ____38____. 5 NA

J. Paralleling: Engine-Generator Units

1. Do all units consistently have the proper voltage output?
   Yes 25 No 0 18 NA

2. Do all units automatically share both the "real" or in-phase load and also the reactive load reasonably well? Yes 19 No 5 19 NA

3. At the same Kw load, are both the field and the armature line currents of the several units consistently close to the same value? Yes 21 No 1 21 NA

   If no, approximate percent difference. 2 UN 41 NA

4. Synchronizing

   a. In automatic synchronizing do circuit breakers close immediately after reaching full synchronous speed?
      Yes 12 No 3 28 NA

   b. If "no" above then, does speed of some units drift slowly while failing to synchronize and close circuit breakers?

      How many seconds? 3 secs. (1) 42 NA

      { Occasionally ____ } 1
      { Always ____
      Never 1 41 NA

K. Switch Gear and Electrical Con (other than exciter/ voltage regulator)

1. If any difficulties have occurred, then give approximate number of problems.

   a. Components -9 (39) 4 NA
   b. Wiring 0-2 (39) 4 NA
   c. Other (damage in service or dropping of miscellaneous hardware into switchboard, etc.) 0-5 (36) 1 UN 6 NA
   d. Design concept faults. That is, does the switch gear and its controls perform the proper functions and in proper sequence and timing. 0-4 (39) 4 NA

2\. a. Do the on-site diesel generator units and related support equipment have any storage battery power systems for any service whatsoever? Yes 36 No 6 1 NA

b.* Identify each storage battery power system associated with the on-site diesel generator unit and its function. ____________________

____

____

c. Does each system identified above adequately fulfill the service requirements for which it is intended? Yes 39 No 4

* If no, briefly describe. ____________________

____

____

d. Is there a DG battery maintenance program? Yes 28 No 3 12 NA

L. Safety Shut downs

Give safety shut down settings compared to equilibrium operating conditions.

1\. Engine and generator speed. Give rpm or hertz:

a. Synchronous and usual 45-180 (42) ↑ 1 NA rpm or 60 (26) Hz 1 UN 16 NA
b. Overspeed shutdown setting 56-990 (42) 1 NA rpm or 66-73 Hz (15) 1 UN 27 NA

2\. Engine cooling water (see E.4)

a. Equilibrium 123-193°F (41) 2 NA
b. Alarm 170-205°F (39) 4 NA
c. Shut down 0-205 °F (30) 14 NA

3\. Lube oil pressure (see D.4)

a. Equilibrium 26-100 psi (41) 2 NA
b. Alarm 16-75 psi (38) 5 NA
c. Shut down 0-60 psi (38) 5 NA

4. Lube oil temperature

   a. Equilibrium 120-220°F (39) 1 UN 3 NA
   b. Alarm 52-250°F (36) 1 UN 6 NA
   c. Shutdown 0-230 °F (12) 1 UN 30 NA

5. Indicate all other protective interlocks (give name and;)

   * a. Usual or proper condition ______________________

   ____

   * b. Shutdown condition ______________________

   ____

6. *a. What source of power is provided to operate alarms and shutdown controls? (See G.2) ____________

   b. Do the generator units automatically shutdown in case of the electrical power loss to its control system? Yes 12 No 31

M. Emergency or Alert Conditions

1. Are all safety shutdown and safety interlocks bypassed during emergency conditions? Yes 1 No 42

*2. If "no" above, then which are not bypassed. Name items.

____

____

3. For each interlock not bypassed is coincident logic used? Yes 2 No 38 3 NA

   If yes, is it testable? Yes 1 No 2 40 NA

N. Maintenance

1. Does plant have regularly scheduled maintenance procedures? YES-41 NO - 2

   * If so, return copy of these procedures with questionnaire.

2. When need for minor adjustments obviously exists, then:

   a. Is remedial action taken immediately or at earliest practical opportunity? Yes 42 No 0 1 NA

   b. Is remedial action taken only at periodic prescheduled or programmed times and conditions? Yes ____ No 41 2 NA

   c. For best performance record which of above appears better:

      immediate or early action? 39
      as scheduled only? 0 BOTH 1 1 UN 2 NA

   d. Must permission for minor maintenace be obtained from some higher out-of-plant authority? Yes 0 No 42 1 NA

   e. Is maintenance referred to above allowed and encouraged? Yes 42 No 0 1 NA

   f. In periodic surveillance tests, simulated alert standby tests, etc., is the criteria "pass/not pass" the test used? Yes 37 No 4 2 NA

   g. Is there a conscious continuing policy to detect and remedy marginal conditions or imminent trouble: for examples: lube oil pressure shutdown only two to five psi below operating pressure or, perhaps overspeed governor setting only one or two percent above starting speed surge or etc.? Yes 40 No 2 1 NA

   h. Are efforts to remedy marginal or questionable conditions as mentioned above encouraged by plant management? ______

      Yes 42 No 0 1 NA

   i. Are remedial steps on items similar to the above taken or allowed when the unit has started and operated satisfactorily within specified limits or conditions? Yes 40 No 2 1 NA

O. Starting Conditions

1. Give starting or necessary cranking time as experienced.

   a. Starting time per specification 5-15 seconds (39) 4 NA
   b. Usual starting time 4 - 12 seconds (42) 1 NA
   c. Maximum starting time observed 6-30 seconds (40) 2 UN 1 NA

2. Give usual time intervals as follows:

   a. Time from start-to-crank to first firing of any cylinder. 1 - 10 seconds (30) 12 UN 1 NA

   b. Time from start-to-crank to approximate full firing of all cylinders. 1-10 seconds (31) 12 UN

3. Give maximum speed surge when starting; use both tachometer and frequency meter if possible.

   a. Usual conditions 5-927 rpm (20) 18 UN 5 NA
      ----- Hz
   b. Maximum observed 8-990 rpm (19) 19 UN 5 NA
      60-68 Hz (21) 17 UN 5 NA

4. During a surveillance test, give time from start-to-crank to when steady synchronous speed is attained and maintained.

   a. Usual 4-40 seconds (35) 7 UN 1 NA
   b. Maximum 5-40 seconds (35) 7 UN 1 NA
   c. As specified 8-40 seconds. (30) 7 UN 6 NA

5. Give briefly the most troublesome problems in starting.

   * a. Most troublesome ______________________.

   * b. Next to most troublesome ______________________.

P. Air Cleaner or Air Filter - Combustion Air

1. Combustion air source: taken from engine room or inside the building, or from outdoors?

   a. Indoors 19
   b. Outdoors 24

2. Give type and make of air cleaners or air filters:

   a. Oil bath 14 * Make ______
   b. Oil wetted screen 5 * Make ______
   c. Paper 10 * Make ______
   d. Other 13 * Make ______
   e. Precleaner: Yes 6 No 16 21 NA

3. Excessive air flow restriction and servicing need determined by?

   a. Instrument such as:

      manometer 2
      If other give type ______
   b. Personal judgement by appearance, etc. 11
   c. By smoking exhaust 5
   d. Time schedule 10
   e. Other (Specify) 9 6 NA

4. Are climatic extremes normally experienced such as:

   a. Air heavily loaded with water mist, high humidity and low temperature? Yes 9 No 33 1 NA
   b. Blowing sand and dust? Yes 2 No 40 1 NA
   c. Blowing snow (blizzards)? Yes 8 No 34 1 NA
   d. Other-Name 3 40 NA

5. Are climatic extremes potentially possible such as:

   a. Air heavily loaded with water mist, high humidity and low temperature? Yes 27 No 15 1 NA
   b. Blowing sand and dust? Yes 15 No 27 1 NA
   c. Blowing snow (blizzards)? Yes 0 No 0
   d. Other-Name 0

Q. Temperature Conditions

1. Ambient outside hottest 80-115°F. (42) 1 NA

2. Ambient outside coldest 0-38 °F. (31) 1+22° 1+25° 6+10° 1 NA

3. Engine-generator room hottest 8-140 °F. (38) 3 UN 2 NA

4. Engine-generator room coldest 0-75 °F. (37) 3 UN 3 NA

5. Inside switch gear hottest 70-133 (33) 9 UN 1 NA

6. Inside voltage regulator or ambient near voltage regulator hottest 78-133 °F (30) 8 UN 5 NA

7. Ambient at exciter hottest 76-123 °F (30) 8 UN 5 NA

R. Operator Qualifications (as presently exists, and suggested minimums if different)

1. Minimum education required (check)

	Existing 3NA	Suggested 3NA
a. High School	36	24
b. Trade School	0	0
c. Technical School	5	3
d. No minimum	2	1

2. Minimum Years of operating experience (diesel electric generator)

	Existing 3NA	Suggested 3NA
a. 0-3	32	18
b. 3-6	9	1
c. 6-10	2	0
d. 10-15	1	0

3. Operator training

	Existing 1NA	Suggested 1NA
a. Military	1	1
b. Industrial		
c. On-the-job	16	23
d. Combination of a, b, and c (indicate which)		
c & a	7	3
comb req	1	1
b & c	3	3
comb 1,2,3	14	11

4. Licensing required

	Existing	Suggested
a. State	1	2
b. Federal	6	6
c. Utility or self	5	5
d. None	28	27
a & b	3	2

1 NA

S. Are any foreign gases such as propane, freon, halon, carbon dioxide, etc. stored in the: Diesel Engine room?
Yes 4 No 38 or adjacent buildings? Yes 18 No 24
1 NA 1 NA

If yes, (other than hand portable fire extinguishers), then identify gases and give approximate tank size.

* Gases ____________ *Volume (ft^3) ____________

T. Does control system automatically bypass, in emergency starting, any engine temporarily out of service for maintenance? Yes 2 No 34 6 NA 1 - O

If yes, then how many failures to bypass have occured?
3 Report 0 1 Report 1 39 NA

U. Does the control system automatically override the test mode under emergency conditions? Yes 24 No 13 6 NA

V. Have repetitive mechanical failures occurred in any component part or subsystem of the engine, generator, or switch gear, etc.?
Yes 22 No 18 2 NA 1-O

* If yes, then which part or subsystem? ____________

How many failures? 1-70 (23) 1 UN 19 NA

* Give nature of failure. ____________

W. Would periodic (yearly or other) evaluation and/or testing by "outside experts" contribute significantly to the diesel-generator reliability? Yes 10 No 30 2 NA 1-O

* Give brief reasons for the answer. ____________

X. 1. Give the accumulated time-load operating record for each diesel-generator unit from installation to the present (Running Hours):

* Preoperational test Date ____________

Engine Serial No.	Surv. Testing & Maintenance Hrs. No Load	Surv. Testing & Maintenance Hrs. Loaded	Emergency and Other Service Hrs.	Total Hours
1st engine		5-530 (30) 12UN 1NA	0-567 (29) 13 UN 1 NA	45-998 (38) 5 UN 0 NA
2nd engine	0-300 (23) 17 UN 3NA	8-945 (29) 12UN 2NA	0-991 (27) 13 UN 3 NA	44-975 (36) 5 UN 2 NA
3rd engine	0-300 (8) 9 UN 26NA	10-689 (10) 8 UN 25NA	0-738 (8) 8 UN 27 NA	47-915 (11) 6 UN 26NA
4th engine	0-300 (5) 6 UN 32NA	10-388 (5) 6 UN 32NA	0-824 (5) 6 UN 32 NA	45-647 (4) 6 UN 33NA
5th engine	0-194 (3) 9 UN 31NA	10-388 (3) 9 UN 31NA	0-65 (3) 9 UN 31 NA	48-991 (4) 9 UN 30NA

* 2. Surveillance test load (percent of continuous rating) __________

3. Give the projected or planned time-load operation for each diesel-generator unit during the next 12 months.

Surveillance & Maintenance Hrs.	Emergency and other Service Hrs.	Total Hours	
0-100 (41) 1 UN 1 NA	12-508 (42) 1 NA	0-880 (39) 3 UN 1NA	

4. Provide the following summary of the periodic surveillance testing experience:

* a. Starting date of surveillance testing (OL date) ____________
* b. Periodic test interval ______________
* c. Total number of surveillance tests performed ____________
d. Total number of test failures 3-998 (39) 3 UN 1 NA

failure to start 0-36 (39) 3 UN 1 NA failure to accept load 0-19 (38) 3 UN 2 NA failure to carry load 0-9 (37) 3 UN 3 NA failures due to operator error 0-7 (37) 3 UN 3 NA failure due to equipment not being operative during emergency conditions 0-6 (37) 3 UN 3 NA

* e. Supply a copy of the surveillance test procedures with this completed questionnaire.

* Additional Comments

____

____

____

____

____

____

* Y. General Suggestions

Briefly give constructive criticism or suggestions as to improvement in reliability of the diesel generators. These remarks may cover tests, maintenance, practices, orders, policy, adjustments, etc.

APPENDIX D
SELECTED CROSS-TABULATIONS

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V26 NORMAL STANDBY AIR TANK PRESSURE BY V6 DIESEL MNFT
* PAGE 1 OF 2

V26 \ V6 (COUNT / COL PCT)	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
200.	0	0	0	1	0	4	0	0	0	1	6
	0.0	0.0	0.0	33.3	0.0	25.0	0.0	0.0	0.0	50.0	14.0
210.	0	0	0	0	0	1	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	2.3
220.	0	1	0	0	0	1	1	0	0	0	3
	0.0	10.0	0.0	0.0	0.0	6.3	100.0	0.0	0.0	0.0	7.0
230.	0	0	1	0	1	1	0	0	0	0	3
	0.0	0.0	100.0	0.0	16.7	6.3	0.0	0.0	0.0	0.0	7.0
235.	0	0	0	1	2	0	0	0	0	0	3
	0.0	0.0	0.0	33.3	33.3	0.0	0.0	0.0	0.0	0.0	7.0
237.	0	1	0	0	0	0	0	0	0	0	1
	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
240.	0	1	0	0	0	0	0	0	0	0	1
	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
245.	0	0	0	0	0	1	0	0	1	0	2
	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	50.0	0.0	4.7
250.	0	7	0	1	1	3	0	0	1	0	13
	0.0	70.0	0.0	33.3	16.7	18.8	0.0	0.0	50.0	0.0	30.2
280.	0	0	0	0	2	0	0	0	0	0	2
	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	4.7
325.	0	0	0	0	0	0	0	1	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	2.3
COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
	2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V26 NORMAL STANDBY AIR TANK PRESSURE BY V6 DIESEL MNFT
* PAGE 2 OF 2

V26	COUNT / COL PCT	V6: CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
	400.	0	0	0	0	0	1	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	2.3
	999.	1	0	0	0	0	4	0	0	0	1	6
NA		100.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	50.0	14.0
	COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
		2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * C R O S S T A B U L A T I O N O F * * * * *

V27 USE PRESSURE REDUCER BY V6 DIESEL MNFT

* * * * * PAGE 1 OF 1

V27 \ V6 (COUNT / COL PCT)	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
1. YES	0	0	0	2	6	5	0	1	0	1	15
	0.0	0.0	0.0	66.7	100.0	31.3	0.0	100.0	0.0	50.0	34.9
2. NO	0	10	1	1	0	7	1	0	2	0	22
	0.0	100.0	100.0	33.3	0.0	43.8	100.0	0.0	100.0	0.0	51.2
3. NA	1	0	0	0	0	4	0	0	0	1	6
	100.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	50.0	14.0
COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
	2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V62 INDEP SECONDARY POWER SUPPLY S BY V6 DIESEL MNFT
* PAGE 1 OF 1

V62 \ V6 (COUNT / COL PCT)	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
1. GAS ENG	0	0	0	0	2	0	0	0	0	0	2
	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	4.7
2. MOTOR DRIVEN	0	1	0	0	0	1	0	0	0	0	2
	0.0	10.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	4.7
3. DIESEL	0	3	0	1	0	4	0	0	1	1	10
	0.0	30.0	0.0	33.3	0.0	25.0	0.0	0.0	50.0	50.0	23.3
9. NA	1	6	1	2	4	11	1	1	1	1	29
	100.0	60.0	100.0	66.7	66.7	68.8	100.0	100.0	50.0	50.0	67.4
COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
	2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V75 BTM DAY TANK ABOVE ENG FUE BY V6 DIESEL MNFT
* PAGE 1 OF 1

V75 (COUNT / COL PCT) \ V6	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
1. YES	1	2	1	0	3	3	1	0	0	0	11
	100.0	20.0	100.0	0.0	50.0	18.8	100.0	0.0	0.0	0.0	25.6
2. NO	0	8	0	3	3	13	0	1	2	1	31
	0.0	80.0	0.0	100.0	50.0	81.3	0.0	100.0	100.0	50.0	72.1
3. NA	0	0	0	0	0	0	0	0	0	1	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	2.3
COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
	2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F *
V83 HOW FUEL TRANSFERRED BY V6 DIESEL MNFT
* PAGE 1 OF 1

V83 \ V6 (COUNT / COL PCT)	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
1. BY GRAVITY	0 0.0	1 10.0	0 0.0	0 0.0	2 33.3	1 6.3	0 0.0	0 0.0	0 0.0	0 0.0	4 9.3
2. ENG DRIVEN	1 100.0	9 90.0	1 100.0	2 66.7	1 16.7	4 25.0	0 0.0	0 0.0	1 50.0	0 0.0	19 44.2
3. ELE MOTOR	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	2 12.5	0 0.0	0 0.0	0 0.0	1 50.0	3 7.0
4. ALL OF ABOVE	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	4 25.0	0 0.0	0 0.0	0 0.0	0 0.0	4 9.3
5. GRAVITY AND ENG	0 0.0	0 0.0	0 0.0	0 0.0	2 33.3	0 0.0	1 100.0	0 0.0	0 0.0	0 0.0	3 7.0
6. ENG AND ELECT	0 0.0	0 0.0	0 0.0	1 33.3	1 16.7	3 18.8	0 0.0	1 100.0	1 50.0	0 0.0	7 16.3
7. PROPANE GAS PRES	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 50.0	1 2.3
8.	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 6.3	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
9.	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 6.3	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
COLUMN TOTAL	1 2.3	10 23.3	1 2.3	3 7.0	6 14.0	16 37.2	1 2.3	1 2.3	2 4.7	2 4.7	43 100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

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V86 TYPE OF FUEL BY V6 DIESEL MNFT
* PAGE 1 OF 1

V86	COUNT / COL PCT	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
NO.1	1.	0	1	0	0	0	0	0	0	0	0	1
		0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
NO. 2	2.	1	9	1	3	6	15	1	1	2	1	40
		100.0	90.0	100.0	100.0	100.0	93.8	100.0	100.0	100.0	50.0	93.0
PROPANE	5.	0	0	0	0	0	0	0	0	0	1	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	2.3
	9.	0	0	0	0	0	1	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	2.3
	COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
		2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

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V90 TYPE LUBE OIL BY V6 DIESEL MNF1

* PAGE 1 OF 2

V90	COUNT / ROW PCT / COL PCT / TOT PCT	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
0. AMERICAN MOTOR D	COUNT	1	0	0	0	0	0	0	0	0	0	1
	ROW PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1. SAE	COUNT	0	4	0	1	0	1	0	0	0	1	7
	ROW PCT	0.0	57.1	0.0	14.3	0.0	14.3	0.0	0.0	0.0	14.3	16.3
	COL PCT	0.0	40.0	0.0	33.3	0.0	6.3	0.0	0.0	0.0	50.0	
	TOT PCT	0.0	9.3	0.0	2.3	0.0	2.3	0.0	0.0	0.0	2.3	
2. CHEVRON DELCO	COUNT	0	0	1	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3. ESTER GLX-30	COUNT	0	1	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4. MOBILE GUARD-PR	COUNT	0	3	0	2	3	9	1	1	2	1	22
	ROW PCT	0.0	13.6	0.0	9.1	13.6	40.9	4.5	4.5	9.1	4.5	51.2
	COL PCT	0.0	30.0	0.0	66.7	50.0	56.3	100.0	100.0	100.0	50.0	
	TOT PCT	0.0	7.0	0.0	4.7	7.0	20.9	2.3	2.3	4.7	2.3	
5. GULF DIESEL MOT	COUNT	0	0	0	0	0	3	0	0	0	0	3
	ROW PCT	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	7.0
	COL PCT	0.0	0.0	0.0	0.0	0.0	18.8	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	
6. AMOCO ALKALUB	COUNT	0	1	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
		2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

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V90 TYPE LUBE OIL BY V6 DIESEL MNFT
* PAGE 2 OF 2

V90	V6 COUNT / ROW PCT / COL PCT / TOT PCT	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM-EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
SHELL CAPRINUS	7.	0	0	0	0	2	1	0	0	0	0	3
		0.0	0.0	0.0	0.0	66.7	33.3	0.0	0.0	0.0	0.0	7.0
		0.0	0.0	0.0	0.0	33.3	6.3	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	4.7	2.3	0.0	0.0	0.0	0.0	
EXXON DIOT RDX	8.	0	0	0	0	1	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	
URSA-ED-40	9.	0	1	0	0	0	2	0	0	0	0	3
		0.0	33.3	0.0	0.0	0.0	66.7	0.0	0.0	0.0	0.0	7.0
		0.0	10.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	
		0.0	2.3	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
		2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

FILE NUCLEAR (CREATION DATE = 08/24/78)

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V112 THERMOSTAT IN WATER TEMPERA CONTROL BY V6 DIESEL MNFT
* PAGE 1 OF 1

V112 (COUNT / COL PCT)	V6: CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
1. YES	1	10	1	3	5	15	1	1	2	1	40
	100.0	100.0	100.0	100.0	83.3	93.8	100.0	100.0	100.0	50.0	93.0
2. NO	0	0	0	0	1	1	0	0	0	1	3
	0.0	0.0	0.0	0.0	16.7	6.3	0.0	0.0	0.0	50.0	7.0
COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
	2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

FILE NUCLEAR (CREATION DATE = 08/24/78)

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V113 BYPASS THERMOSTAT BY V6 DIESEL MNFT
* PAGE 1 OF 1

V113 \ V6 (COUNT / COL PCT)	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WURTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
1. YES	1	10	1	3	2	13	1	1	2	0	34
	100.0	100.0	100.0	100.0	33.3	81.3	100.0	100.0	100.0	0.0	79.1
2. NO	0	0	0	0	4	2	0	0	0	1	7
	0.0	0.0	0.0	0.0	66.7	12.5	0.0	0.0	0.0	50.0	16.3
9. NA	0	0	0	0	0	1	0	0	0	1	2
	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	50.0	4.7
COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
	2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

FILE NUCLEAR (CREATION DATE = 08/24/78)

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V115 COOLING SYSTEM RADIATOR SHUTTER BY V6 DIESEL MNFT
* PAGE 1 OF 1

V115 \ V6 (COUNT / COL PCT)		CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
AUTOMATIC	1.	0	0	0	0	0	1	0	0	0	1	2
		0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	50.0	4.7
OTHER	3.	0	0	0	0	1	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	2.3
NA	9.	1	10	1	3	5	15	1	1	2	1	40
		100.0	100.0	100.0	100.0	83.3	93.8	100.0	100.0	100.0	50.0	93.0
COLUMN TOTAL		1	10	1	3	6	16	1	1	2	2	43
		2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

FILE NUCLEAR (CREATION DATE = 08/24/78)

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V148 FUEL CONT ENG STOPPED BY V6 DIESEL MNFT
* PAGE 1 OF 1

V148	V6 COUNT / COL PCT	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
FULL FUEL	1.	1	2	0	0	0	7	0	0	0	1	11
		100.0	20.0	0.0	0.0	0.0	43.8	0.0	0.0	0.0	50.0	25.6
FULL OFF	2.	0	6	1	3	6	7	1	1	2	1	28
		0.0	60.0	100.0	100.0	100.0	43.8	100.0	100.0	100.0	50.0	65.1
INTERMEDIATE	3.	0	2	0	0	0	0	0	0	0	0	2
		0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
FULL OFF AND RAN	5.	0	0	0	0	0	1	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	2.3
	9.	0	0	0	0	0	1	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	2.3
	COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
		2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

FILE NUCLEAR (CREATION DATE = 08/24/78)

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V239 MOST TROUBLESOME START PROBLEM BY V6 DIESEL MNFT

* PAGE 1 OF 2

V239 / V6 (COUNT / COL PCT)	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSEMER 8.	INTERN HARVESTER 9.	ROW TOTAL
1. A R START DISTR	0	1	0	0	0	0	0	0	0	0	1
	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
2. PLUGGED FUEL FIL	0	0	1	0	0	0	0	0	0	0	1
	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
3. LUBE OIL PRESS S	0	1	0	0	0	0	0	0	0	0	1
	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
4. STARTER MOTORS	0	0	0	1	0	6	0	0	1	1	9
	0.0	0.0	0.0	33.3	0.0	37.5	0.0	0.0	50.0	50.0	20.9
5. BINDING AIR STAR	0	1	0	0	0	1	0	0	0	0	2
	0.0	10.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	4.7
6. RUST IN AIRLINE	0	1	0	0	0	0	0	0	0	0	1
	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
7. AT 900RPM CRANKC	0	1	0	0	0	0	0	0	0	0	1
	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
8. AIR START CONDEN	0	0	0	0	0	1	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	2.3
9. AIR LEAKES COPPE	0	0	0	0	0	0	0	0	1	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	2.3
10. MOISTURE IN FUEL	0	1	0	0	0	0	0	0	0	0	1
	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
11. FUEL RACK RESETT	0	0	0	0	1	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	2.3
COLUMN TOTAL	1	10	1	3	6	16	1	1	2	2	43
	2.3	23.3	2.3	7.0	14.0	37.2	2.3	2.3	4.7	4.7	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/24/78)

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V239 MOST TROUBLESOME START PROBLEM BY V6 DIESEL MNFT
* PAGE 2 OF 2

V239 (COUNT / COL PCT) \ V6	CATERPILLAR 0.	FAIRBANKS MORSE 1.	DE LEVAL 2.	BRUCE GM EMD 3.	ALCO IND INC 4.	GEN MOTORS CORP 5.	WORTHINGTON 6.	NORDBERG 7.	COOPER BESSMER 8.	INTERN HARVESTER 9.	ROW TOTAL
12. GOV HYDRAULIC BD	0 0.0	0 0.0	0 0.0	0 0.0	1 16.7	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
13. GOVERNOR	0 0.0	0 0.0	0 0.0	1 33.3	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
14. FUEL INJECTOR	0 0.0	1 10.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
15. GUM DEPOSIT PROP	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 50.0	1 2.3
16. STARTER MECHANIS	1 100.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
17. SPURIOUS TRIPS	0 0.0	1 10.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
19. ENJ TACHOMETER	0 0.0	0 0.0	0 0.0	1 33.3	0 0.0	1 6.3	0 0.0	0 0.0	0 0.0	0 0.0	2 4.7
88. UN	0 0.0	0 0.0	0 0.0	0 0.0	2 33.3	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	2 4.7
99. NA	0 0.0	2 20.0	0 0.0	0 0.0	2 33.3	7 43.8	1 100.0	1 100.0	0 0.0	0 0.0	13 30.2
COLUMN TOTAL	1 2.3	10 23.3	1 2.3	3 7.0	6 14.0	16 37.2	1 2.3	1 2.3	2 4.7	2 4.7	43 100.0

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *

V239 MOST TROUBLESOME START PROBLEM BY V4 PLANT NAME

*

V239 / V4 COUNT / COL PCT	CALVERT CLIFFS 1.	SAN OROF RE 2.	THREE MILE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADES 6.	PEACH BOTTOM 7.	PRAIRIE ISLAND 8.	QUAD CITIES 9.	BEAVER VALLEY 10.	ROW TOTAL
1.	1	0	0	0	0	0	0	0	0	0	1
A R START DISTR	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
2.	0	1	0	0	0	0	0	0	0	0	1
PLUGGED FUEL FIL	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
3.	0	0	1	0	0	0	0	0	0	0	1
LUBE OIL PRESS S	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
4.	0	0	0	1	0	0	0	0	1	0	9
STARTER MOTORS	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	0.0	20.9
5.	0	0	0	0	1	0	0	0	0	0	2
BINDING AIR STAR	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	4.7
6.	0	0	0	0	0	0	1	0	0	0	1
RUST IN AIRLINE	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	2.3
7.	0	0	0	0	0	0	0	1	0	0	1
AT 900RPM CRANKC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	2.3
8.	0	0	0	0	0	0	0	0	0	1	1
AIR START CONDEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	2.3
9.	0	0	0	0	0	0	0	0	0	0	1
AIR LEAKES COPPE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
10.	0	0	0	0	0	0	0	0	0	0	1
MOISTURE IN FUEL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
11.	0	0	0	0	0	0	0	0	0	0	1
FUEL RACK RESETT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
COLUMN	1	1	1	1	1	1	1	1	1	1	43
TOTAL	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F *
V239 MOST TROUBLESOME START PROBLEM BY V4 PLANT NAME
* PAGE 2 OF 10

V239	COUNT / COL PCT	V4: DONALD C . 11.	BRUNSWICK STEAM 12.	COOPER NUCLEAR 13.	EDWIN I HATCH 14.	INDIAN POINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GINNA NUCLE 18.	RANCHO SECO 19.	OYSTER CREEK NUC 20.	ROW TOTAL
1. A R START DISTR	COUNT	0	0	0	0	0	0	0	0	0	0	1
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
2. PLUGGED FUEL FIL	COUNT	0	0	0	0	0	0	0	0	0	0	1
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
3. LUBE OIL PRESS S	COUNT	0	0	0	0	0	0	0	0	0	0	1
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
4. STARTER MOTORS	COUNT	0	0	0	0	0	0	0	0	0	0	9
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.9
5. BINDING AIR STAR	COUNT	0	0	0	0	0	0	0	0	0	0	2
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
6. RUST IN AIRLINE	COUNT	0	0	0	0	0	0	0	0	0	0	1
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
7. AT 900RPM CRANKC	COUNT	0	0	0	0	0	0	0	0	0	0	1
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
8. AIR START CONDEN	COUNT	0	0	0	0	0	0	0	0	0	0	1
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
9. AIR LEAKES COPPE	COUNT	0	0	1	0	0	0	0	0	0	0	1
	COL PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
10. MOISTURE IN FUEL	COUNT	0	0	0	1	0	0	0	0	0	0	1
	COL PCT	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
11. FUEL RACK RESETT	COUNT	0	0	0	0	0	0	1	0	0	0	1
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	2.3
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/24/78)

* C R O S S T A B U L A T I O N O F *
V239 MOST TROUBLESOME START PROBLEM BY V4 PLANT NAME
* PAGE 3 OF 10

V239 (COUNT / COL PCT)	V4: DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESSE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
1. A R START DISTR	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
2. PLUGGED FUEL FIL	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
3. LUBE OIL PRESS S	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
4. STARTER MOTORS	0	0	0	0	1	1	0	1	0	0	9
	0.0	0.0	0.0	0.0	100.0	100.0	0.0	100.0	0.0	0.0	20.9
5. BINDING AIR STAR	0	0	0	0	0	0	0	0	0	0	2
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
6. RUST IN AIRLINE	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
7. AT 900RPM CRANKC	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
8. AIR START CONDEN	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
9. AIR LEAKES COPPE	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
10. MOISTURE IN FUEL	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
11. FUEL RACK RESETT	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V239 MOST TROUBLESOME START PROBLEM BY V4 PLANT NAME
* PAGE 4 OF 10

V239 / V4 (COUNT / COL PCT)	NINE MILE POINT 31.	MONTICELLO 32.	MILLSTONE 33.	KEWAUNEE 34.	MAINE YANKEE 35.	JAMES A FITZPATR 36.	INDIAN POINT 37.	SURRY POWER 38.	POINT BEACH 39.	BROWNS FERRY 40.	ROW TOTAL
1. A R START DISTR	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
2. PLUGGED FUEL FIL	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
3. LUBE OIL PRESS S	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
4. STARTER MOTORS	0	1	0	1	0	0	0	1	0	0	9
	0.0	100.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	20.9
5. BINDING AIR STAR	0	0	0	0	0	0	0	0	0	1	2
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	4.7
6. RUST IN AIRLINE	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
7. AT 900RPM CRANKC	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
8. AIR START CONDEN	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
9. AIR LEAKES COPPE	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
10. MOISTURE IN FUEL	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
11. FUEL RACK RESETT	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * CROSSTABULATION OF * * * * *
V239 MOST TROUBLESOME START PROBLEM BY V4 PLANT NAME

V239 (COUNT / COL PCT)	V4: JOSEPH M I. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
1. A R START DISTR	0 / 0.0	0 / 0.0	0 / 0.0	1 / 2.3
2. PLUGGED FUEL FIL	0 / 0.0	0 / 0.0	0 / 0.0	1 / 2.3
3. LUBE OIL PRESS S	0 / 0.0	0 / 0.0	0 / 0.0	1 / 2.3
4. STARTER MOTORS	0 / 0.0	0 / 0.0	1 / 100.0	9 / 20.9
5. BINDING AIR STAR	0 / 0.0	0 / 0.0	0 / 0.0	2 / 4.7
6. RUST IN AIRLINE	0 / 0.0	0 / 0.0	0 / 0.0	1 / 2.3
7. AT 900RPM CRANKC	0 / 0.0	0 / 0.0	0 / 0.0	1 / 2.3
8. AIR START CONDEN	0 / 0.0	0 / 0.0	0 / 0.0	1 / 2.3
9. AIR LEAKES COPPE	0 / 0.0	0 / 0.0	0 / 0.0	1 / 2.3
10. MOISTURE IN FUEL	0 / 0.0	0 / 0.0	0 / 0.0	1 / 2.3
11. FUEL RACK RESETT	0 / 0.0	0 / 0.0	0 / 0.0	1 / 2.3
COLUMN TOTAL	1 / 2.3	1 / 2.3	1 / 2.3	43 / 100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F *
V239 MOST TROUBLESOME START PROBLEM BY V4 PLANT NAME
* PAGE 6 OF 10

V239 / V4: COUNT, COL PCT	CALVERT CLIFFS 1.	SAN ONOFRE 2.	THREE MILE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADES 6.	PEACH BOTTOM 7.	PRAIRIE ISLAND 8.	QUAD CITIES 9.	BEAVER VALLEY 10.	ROW TOTAL
12.	0	0	0	0	0	0	0	0	0	0	1
GOV HYDRAULIC BO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
13.	0	0	0	0	0	0	0	0	0	0	1
GOVERNOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
14.	0	0	0	0	0	0	0	0	0	0	1
FUEL INJECTOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
15.	0	0	0	0	0	0	0	0	0	0	1
GUM DEPOSIT PROP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
16.	0	0	0	0	0	0	0	0	0	0	1
STARTER MECHANIS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
17.	0	0	0	0	0	0	0	0	0	0	1
SPURIOUS TRIPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
19.	0	0	0	0	0	0	0	0	0	0	2
ENJ TACHOMETER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
88.	0	0	0	0	0	1	0	0	0	0	2
UN	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	4.7
99.	0	0	0	0	0	0	0	0	0	0	13
NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.2
COLUMN	1	1	1	1	1	1	1	1	1	1	43
TOTAL	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V239 MOST TROUBLESOME START PROBLEM BY V4 PLANT NAME
* PAGE 7 OF 10

V239 \ V4 (COUNT / COL PCT)	DONALD C I. 11.	BRUNSWICK STEAM 12.	COOPER NUCLEAR 13.	EDWIN I HATCH 14.	INDIAN POINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GINNA NUCLE 18.	RANCHO SECO 19.	OYSTER CREEK NUC 20.	ROW TOTAL
12.	0	0	0	0	0	0	0	1	0	0	1
GOV HYDRAULIC BO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	2.3
13.	0	0	0	0	0	0	0	0	1	0	1
GOVERNOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	2.3
14.	0	0	0	0	0	0	0	0	0	0	1
FUEL INJECTOR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
15.	0	0	0	0	0	0	0	0	0	0	1
GUM DEPOSIT PROP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
16.	0	0	0	0	0	0	0	0	0	0	1
STARTER MECHANIS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
17.	0	0	0	0	0	0	0	0	0	0	1
SPURIOUS TRIPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
19.	0	0	0	0	0	0	0	0	0	0	2
ENJ TACHOMETER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
88.	0	0	0	0	0	0	0	0	0	0	2
UN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
99.	1	1	0	0	1	1	0	0	0	1	13
NA	100.0	100.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0	100.0	30.2
COLUMN	1	1	1	1	1	1	1	1	1	1	43
TOTAL	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V239 MOST TROUBLESOME START PROBLEM BY V4 PLANT NAME
* PAGE 8 OF 10

V239 (COUNT / COL PCT) \ V4	DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
12. GOV HYDRAULIC BO	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
13. GOVERNOR	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
14. FUEL INJECTOR	0 0.0	1 100.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
15. GUM DEPOSIT PROP	0 0.0	0 0.0	1 100.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
16. STARTER MECHANIS	0 0.0	0 0.0	0 0.0	1 100.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
17. SPURIOUS TRIPS	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 2.3
19. ENJ TACHOMETER	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	2 4.7
88. UN	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 100.0	0 0.0	2 4.7
99. NA	1 100.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	1 100.0	0 0.0	0 0.0	1 100.0	13 30.2
COLUMN TOTAL	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	43 100.0

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STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES SPSSH - VERSION 6.01 08/25/78 PAGE 14

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F *
V239 MOST TROUBLESOME START PROBLEM BY V4 PLANT NAME
* PAGE 9 OF 10

V239	COUNT / COL PCT	V4: NINE MILE POINT 31.	MONTICELLO 32.	MILLSTONE 33.	KEWAUNEE 34.	MAINE YANKEE 35.	JAMES A FITZPATR 36.	INDIAN POINT 37.	SURRY POWER 38.	POINT BEACH 39.	BROWNS FERRY 40.	ROW TOTAL
GOV HYDRAULIC BO	12.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
GOVERNOR	13.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
FUEL INJECTOR	14.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
GUM DEPOSIT PROP	15.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
STARTER MECHANIS	16.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
SPURIOUS TRIPS	17.	0	0	1	0	0	0	0	0	0	0	1
		0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
ENJ TACHOMETER	19.	0	0	0	0	0	1	0	0	1	0	2
		0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	4.7
UN	88.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
NA	99.	1	0	0	0	1	0	1	0	0	0	13
		100.0	0.0	0.0	0.0	100.0	0.0	100.0	0.0	0.0	0.0	30.2
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/24/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V239 MOST TROUBLESOME START PROBLEM BY V4 PLANT NAME
* PAGE 10 OF 10

V239 (COUNT / COL PCT)	V4: JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
12. GOV HYDRAULIC BO	0 0.0	0 0.0	0 0.0	1 2.3
13. GOVERNOR	0 0.0	0 0.0	0 0.0	1 2.3
14. FUEL INJECTOR	0 0.0	0 0.0	0 0.0	1 2.3
15. GUM DEPOSIT PROP	0 0.0	0 0.0	0 0.0	1 2.3
16. STARTER MECHANIS	0 0.0	0 0.0	0 0.0	1 2.3
17. SPURIOUS TRIPS	0 0.0	0 0.0	0 0.0	1 2.3
19. ENJ TACHOMETER	0 0.0	0 0.0	0 0.0	2 4.7
88. UN	0 0.0	0 0.0	0 0.0	2 4.7
99. NA	1 100.0	1 100.0	0 0.0	13 30.2
COLUMN TOTAL	1 2.3	1 2.3	1 2.3	43 100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N   O F * * * * * * * * * * * * * * * * * *

V213 SAFETY INERLOCKS BY V4 PLANT NAME

* PAGE 1 OF 5

V213	COUNT / ROW PCT / COL PCT / TOT PCT	V4: CALVERT CLIFFS 1.	SAN ONOFRE 2.	THREE MILE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADES 6.	PEACH BOTTOM 7.	PRAIRIE ISLAND 8.	QUAD CITIES 9.	BEAVER VALLEY 10.	ROW TOTAL
YES	1.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NO	2.	1	1	1	1	1	1	1	1	1	1	42
		2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	97.7
		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F *
V213 SAFETY INTERLOCKS BY V4 PLANT NAME
* PAGE 2 OF 5

V213	COUNT / ROW PCT / COL PCT / TOT PCT	V4: DONALD C. 11.	BRUNSWICK STEAM 12.	COOPER NUCLEAR 13.	EDWIN I HATCH 14.	INDIAN POINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GINNA NUCLE 18.	RANCHO SECO 19.	OYSTER CREEK NUC 20.	ROW TOTAL
YES	1.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NO	2.	1	1	1	1	1	1	1	1	1	1	42
		2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	97.7
		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * *
V213 SAFETY INERLOCKS BY V4 PLANT NAME
* * * * * * * * * * PAGE 3 OF 5

V213	COUNT / ROW PCT / COL PCT / TOT PCT	DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESSE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
YES	1.	1	0	0	0	0	0	0	0	0	0	1
		100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NO	2.	0	1	1	1	1	1	1	1	1	1	42
		0.0	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	97.7
		0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
		0.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V213 SAFETY INERLOCKS BY V4 PLANT NAME
* PAGE 4 OF 5

V213	COUNT / ROW PCT / COL PCT / TOT PCT	NINE MIL E POINT 31.	MONTICEL LO 32.	MILLSTON E 33.	KEWAUNEE 34.	MAINE YA NKEE 35.	JAMES A FITZPATR 36.	INDIAN P OINT 37.	SURRY PO WER 38.	POINT BE ACH 39.	BROWNS F ERRY 40.	ROW TOTAL
YES	1.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NO	2.	1	1	1	1	1	1	1	1	1	1	42
		2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	97.7
		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V213 SAFETY INERLOCKS BY V4 PLANT NAME
* PAGE 5 OF 5

V213	V4 COUNT / ROW PCT / COL PCT / TOT PCT	JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
YES	1.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
NO	2.	1 2.4 100.0 2.3	1 2.4 100.0 2.3	1 2.4 100.0 2.3	42 97.7
	COLUMN TOTAL	1 2.3	1 2.3	1 2.3	43 100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V214 FIRST ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 1 OF 10

V214	COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOFRE 2.	THREE MILE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADES 6.	PEACH BOTTOM 7.	PRAIRIE ISLAND 8.	QUAD CITIES 9.	BEAVER VALLEY 10.	ROW TOTAL
1. OVERSPEED	COUNT	1	0	0	1	0	1	0	1	1	1	19
	ROW PCT	5.3	0.0	0.0	5.3	0.0	5.3	0.0	5.3	5.3	5.3	44.2
	COL PCT	100.0	0.0	0.0	100.0	0.0	100.0	0.0	100.0	100.0	100.0	
	TOT PCT	2.3	0.0	0.0	2.3	0.0	2.3	0.0	2.3	2.3	2.3	
2. GEN DIFF	COUNT	0	1	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3. LO LUBE OIL PRES	COUNT	0	0	1	0	0	0	0	0	0	0	8
	ROW PCT	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.6
	COL PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7. REVERSE POWER	COUNT	0	0	0	0	0	0	1	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	
8. ELE GROUND FAULT	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10. GEN TRIP	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
13. ELECTRICAL	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V214 FIRST ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 2 OF 10

V214	COUNT / ROW PCT / COL PCT / TOT PCT	DONALD C I. 11.	BRUNSWIC K STEAM 12.	COOPER N UCLEAR 13.	EDWIN I. HATCH 14.	INDIAN P OINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GIN NA NUCLE 18.	RANCHO S ECO 19.	OYSTER C REEK NUC 20.	ROW TOTAL
OVERSPEED	1.	0	0	1	0	0	1	0	1	0	0	19
		0.0	0.0	5.3	0.0	0.0	5.3	0.0	5.3	0.0	0.0	44.2
		0.0	0.0	100.0	0.0	0.0	100.0	0.0	100.0	0.0	0.0	
		0.0	0.0	2.3	0.0	0.0	2.3	0.0	2.3	0.0	0.0	
GEN DIFF	2.	0	0	0	0	0	0	0	0	1	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	
LO LUBE OIL PRES	3.	1	1	0	1	0	0	0	0	0	0	8
		12.5	12.5	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	18.6
		100.0	100.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
		2.3	2.3	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
REVERSE POWER	7.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ELE GROUND FAULT	8.	0	0	0	0	0	0	1	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	
GEN TRIP	10.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ELECTRICAL	13.	0	0	0	0	1	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V214 FIRST ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 3 OF 10

V4 COUNT / ROW PCT / COL PCT / TOT PCT

V214		DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
OVERSPEED	1.	0	0	1	0	1	1	1	1	1	1	19
		0.0	0.0	5.3	0.0	5.3	5.3	5.3	5.3	5.3	5.3	44.2
		0.0	0.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	
		0.0	0.0	2.3	0.0	2.3	2.3	2.3	2.3	2.3	2.3	
GEN DIFF	2.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
LO LUBE OIL PRES	3.	0	0	0	1	0	0	0	0	0	0	8
		0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	18.6
		0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
REVERSE POWER	7.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ELE GROUND FAULT	8.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GEN TRIP	10.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ELECTRICAL	13.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V214 FIRST ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 4 OF 10

V214	COUNT / ROW PCT / COL PCT / TOT PCT	NINE MILE POINT 31.	MONTICELLO 32.	MILLSTONE 33.	KEWAUNEE 34.	MAINE YANKEE 35.	JAMES A FITZPATR 36.	INDIAN POINT 37.	SURRY POWER 38.	POINT BEACH 39.	BROWNS FERRY 40.	ROW TOTAL
OVERSPEED 1.	COUNT	0	1	0	0	0	0	0	1	0	0	19
	ROW PCT	0.0	5.3	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	44.2
	COL PCT	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	
	TOT PCT	0.0	2.3	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	
GEN DIFF 2.	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
LO LUBE OIL PRES 3.	COUNT	0	0	1	0	0	0	0	0	1	0	8
	ROW PCT	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	12.5	0.0	18.6
	COL PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	
	TOT PCT	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	2.3	0.0	
REVERSE POWER 7.	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ELE GROUND FAULT 8.	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GEN TRIP 10.	COUNT	0	0	0	0	0	0	0	0	0	1	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	
ELECTRICAL 13.	COUNT	0	0	0	0	0	0	1	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V214 FIRST ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 5 OF 10

V214 (COUNT / ROW PCT / COL PCT / TOT PCT)	V4: JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
1. OVERSPEED	0	1	0	19
	0.0	5.3	0.0	44.2
	0.0	100.0	0.0	
	0.0	2.3	0.0	
2. GEN DIFF	0	0	0	2
	0.0	0.0	0.0	4.7
	0.0	0.0	0.0	
	0.0	0.0	0.0	
3. LO LUBE OIL PRES	1	0	0	8
	12.5	0.0	0.0	18.6
	100.0	0.0	0.0	
	2.3	0.0	0.0	
7. REVERSE POWER	0	0	1	2
	0.0	0.0	50.0	4.7
	0.0	0.0	100.0	
	0.0	0.0	2.3	
8. ELE GROUND FAULT	0	0	0	1
	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	
	0.0	0.0	0.0	
10. GEN TRIP	0	0	0	1
	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	
	0.0	0.0	0.0	
13. ELECTRICAL	0	0	0	2
	0.0	0.0	0.0	4.7
	0.0	0.0	0.0	
	0.0	0.0	0.0	
COLUMN TOTAL	1	1	1	43
	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V214 FIRST ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 6 OF 10

V214	V4: COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOF RE 2.	THREE MI LE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADE S 6.	PEACH BO TTOM 7.	PRAIRIE ISLAND 8.	QUAD CIT IES 9.	BEAVER V ALLEY 10.	ROW TOTAL
SEQUENCE FAULTS 16.	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GEN LOCKOUT 18.	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
FIRE 22.	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
LO H2O PRESS SW 25.	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NA 99.	COUNT	0	0	0	0	1	0	0	0	0	0	4
	ROW PCT	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	9.3
	COL PCT	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V214 FIRST ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 7 OF 10

V214 \ V4 (COUNT / ROW PCT / COL PCT / TOT PCT)	DONALD C 11.	BRUNSWICK STEAM 12.	COOPER NUCLEAR 13.	EDWIN I HATCH 14.	INDIAN POINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GINNA NUCLE 18.	RANCHO SECO 19.	OYSTER CREEK NUC 20.	ROW TOTAL
16. SEQUENCE FAULTS	0	0	0	0	0	0	0	0	0	1	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	
18. GEN LOCKOUT	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22. FIRE	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
25. LO H2O PRESS SW	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
99. NA	0	0	0	0	0	0	0	0	0	0	4
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* C R O S S T A B U L A T I O N O F *
V214 FIRST ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 8 OF 10

V214	COUNT / ROW PCT / COL PCT / TOT PCT	DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBULT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
16. SEQUENCE FAULTS	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
18. GEN LOCKOUT	COUNT	0	1	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22. FIRE	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
25. LO H2O PRESS SW	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
99. NA	COUNT	1	0	0	0	0	0	0	0	0	0	4
	ROW PCT	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.3
	COL PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V214 FIRST ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 9 OF 10

V214	COUNT / ROW PCT / COL PCT / TOT PCT	NINE MIL E POINT 31.	MONTICEL LO 32.	MILLSTON E 33.	KEWAUNEE 34.	MAINE YA NKEE 35.	JAMES A FITZPATR 36.	INDIAN P OINT 37.	SURRY PO WER 38.	POINT BE ACH 39.	BROWNS F ERRY 40.	ROW TOTAL
SEQUENCE FAULTS	16.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GEN LOCKOUT	18.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
FIRE	22.	0	0	0	1	0	0	0	0	0	0	1
		0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
LO H2O PRESS SW	25.	1	0	0	0	0	0	0	0	0	0	1
		100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NA	99.	0	0	0	0	1	1	0	0	0	0	4
		0.0	0.0	0.0	0.0	25.0	25.0	0.0	0.0	0.0	0.0	9.3
		0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	2.3	2.3	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * *
V214 FIRST ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 10 OF 10

V214 / V4 COUNT, ROW PCT, COL PCT, TOT PCT	JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
16. SEQUENCE FAULTS	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
18. GEN LOCKOUT	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
22. FIRE	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
25. LO H2O PRESS SW	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
99. NA	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 9.3
COLUMN TOTAL	1 2.3	1 2.3	1 2.3	43 100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 1 OF 15

V215	V4 COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOF RE 2.	THREE MI LE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADE S 6.	PEACH BO TTOM 7.	PRAIRIE ISLAND 8.	QUAD CIT IES 9.	BEAVER V ALLEY 10.	ROW TOTAL
1. OVERSPEED	COUNT	0	1	0	0	0	0	0	0	0	0	7
	ROW PCT	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3
	COL PCT	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2. GEN DIFF	COUNT	0	0	0	0	0	0	0	0	0	1	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	
3. LO LUBE OIL PRES	COUNT	1	0	0	0	0	0	0	0	0	0	3
	ROW PCT	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0
	COL PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4. CRANK PRESS HI	COUNT	0	0	1	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5. ELECTR OUTLET	COUNT	0	0	0	1	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
6. OVERCRANK	COUNT	0	0	0	0	0	1	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	
8. ELE GROUND FAULT	COUNT	0	0	0	0	0	0	0	1	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 2 OF 15

V215	COUNT / ROW PCT / COL PCT / TOT PCT	DONALD C COOK 11.	BRUNSWICK STEAM 12.	COOPER NUCLEAR 13.	EDWIN I HATCH 14.	INDIAN POINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GINNA NUCLE 18.	RANCHO SECO 19.	OYSTER CREEK NUC 20.	ROW TOTAL
OVERSPEED	1.	0	0	0	1	0	0	0	0	0	0	7
		0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	16.3
		0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
GEN DIFF	2.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
LO LUBE OIL PRES	3.	0	0	0	0	0	1	0	0	0	0	3
		0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	7.0
		0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	
CRANK PRESS HI	4.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ELECTR OUTLET	5.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
OVERCRANK	6.	0	0	0	0	0	0	0	1	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	
ELE GROUND FAULT	8.	0	0	0	0	0	0	0	0	1	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 3 OF 15

V215 \ V4: COUNT / ROW PCT / COL PCT / TOT PCT	DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESSE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
1. OVERSPEED	0	1	0	0	0	0	0	0	0	0	7
	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3
	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2. GEN DIFF	0	0	0	0	0	0	0	0	0	1	2
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	4.7
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	
3. LO LUBE OIL PRES	0	0	0	0	0	0	0	0	0	0	3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4. CRANK PRESS HI	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5. ELECTR OUTLET	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6. OVERCRANK	0	0	0	0	0	0	0	0	0	0	2
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8. ELE GROUND FAULT	0	0	0	0	0	0	0	0	0	0	2
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 4 OF 15

V215	COUNT / ROW PCT / COL PCT / TOT PCT	NINE MILE POINT 31.	MONTICELLO 32.	MILLSTONE 33.	KEWAUNEE 34.	MAINE YANKEE 35.	JAMES A FITZPATR 36.	INDIAN POINT 37.	SURRY POWER 38.	POINT BEACH 39.	BROWNS FERRY 40.	ROW TOTAL
1. OVERSPEED	COUNT	0	0	1	0	0	0	0	0	0	1	7
	ROW PCT	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	14.3	16.3
	COL PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	
	TOT PCT	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	2.3	
2. GEN DIFF	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3. LO LUBE OIL PRES	COUNT	0	0	0	0	0	0	0	0	0	0	3
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4. CRANK PRESS HI	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5. ELECTR OUTLET	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6. OVERCRANK	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8. ELE GROUND FAULT	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 5 OF 15

V215	COUNT / ROW PCT / COL PCT / TOT PCT	V4: JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
1. OVERSPEED	COUNT	1	0	1	7
	ROW PCT	14.3	0.0	14.3	16.3
	COL PCT	100.0	0.0	100.0	
	TOT PCT	2.3	0.0	2.3	
2. GEN DIFF	COUNT	0	0	0	2
	ROW PCT	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	
3. LO LUBE OIL PRES	COUNT	0	1	0	3
	ROW PCT	0.0	33.3	0.0	7.0
	COL PCT	0.0	100.0	0.0	
	TOT PCT	0.0	2.3	0.0	
4. CRANK PRESS HI	COUNT	0	0	0	1
	ROW PCT	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	
5. ELECTR OUTLET	COUNT	0	0	0	1
	ROW PCT	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	
6. OVERCRANK	COUNT	0	0	0	2
	ROW PCT	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	
8. ELE GROUND FAULT	COUNT	0	0	0	2
	ROW PCT	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	43
		2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 6 OF 15

V215	V4: COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOF RE 2.	THREE MI LE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADE S 6.	PEACH BO TTOM 7.	PRAIRIE ISLAND 8.	QUAD CIT IES 9.	BEAVER V ALLEY 10.	ROW TOTAL
9. LO FUEL OIL PRES	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10. GEN TRIP	COUNT	0	0	0	0	0	0	1	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	
11. 986 DG	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
12. DIFF CURRENT	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
17. GEN PROTECT RELA	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
19. HI WATER TEMP	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
21. BEARING OIL PRES	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 7 OF 15

V215 / V4 (COUNT / ROW PCT / COL PCT / TOT PCT)		DONALD C. 11.	BRUNSWICK STEAM 12.	COOPER NUCLEAR 13.	EDWIN I HATCH 14.	INDIAN POINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GINNA NUCLE 18.	RANCHO SECO 19.	OYSTER CREEK NUC 20.	ROW TOTAL
9. LO FUEL OIL PRES	COUNT	1	0	0	0	0	0	0	0	0	0	1
	ROW PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10. GEN TRIP	COUNT	0	1	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
11. 986 DG	COUNT	0	0	1	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
12. DIFF CURRENT	COUNT	0	0	0	0	0	0	1	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	
17. GEN PROTECT RELA	COUNT	0	0	0	0	0	0	0	0	0	1	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	
19. HI WATER TEMP	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
21. BEARING OIL PRES	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *

V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME

* PAGE 8 OF 15

V215 \ V4: COUNT / ROW PCT / COL PCT / TOT PCT	DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
9.	0	0	0	0	0	0	0	0	0	0	1
LO FUEL OIL PRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10.	0	0	0	0	0	0	0	0	0	0	2
GEN TRIP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
11.	0	0	0	0	0	0	0	0	0	0	1
986 DG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
12.	0	0	0	0	0	1	0	0	0	0	2
DIFF CURRENT	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	4.7
	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	
17.	0	0	0	0	0	0	0	0	0	0	1
GEN PROTECT RELA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
19.	0	0	1	1	0	0	0	0	0	0	2
HI WATER TEMP	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	2.3	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
21.	0	0	0	0	0	0	0	0	0	0	1
BEARING OIL PRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN	1	1	1	1	1	1	1	1	1	1	43
TOTAL	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 9 OF 15

V215	V4 COUNT / ROW PCT / COL PCT / TOT PCT	NINE MIL E POINT 31.	MONTICEL LO 32.	MILLSTON E 33.	KEWAUNEE 34.	MAINE YA NKEE 35.	JAMES A FITZPATR 36.	INDIAN P OINT 37.	SURRY PO WER 38.	POINT BE ACH 39.	BROWNS F ERRY 40.	ROW TOTAL
9. LO FUEL OIL PRES	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10. GEN TRIP	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
11. 986 DG	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
12. DIFF CURRENT	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
17. GEN PROTECT RELA	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
19. HI WATER TEMP	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
21. BEARING OIL PRES	COUNT	1	0	0	0	0	0	0	0	0	0	1
	ROW PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 10 OF 15

V215 \ V4: COUNT / ROW PCT / COL PCT / TOT PCT	JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
9. LO FUEL OIL PRES	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
10. GEN TRIP	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 4.7
11. 986 DG	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
12. DIFF CURRENT	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 4.7
17. GEN PROTECT RELA	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
19. HI WATER TEMP	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 4.7
21. BEARING OIL PRES	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
COLUMN TOTAL	1 2.3	1 2.3	1 2.3	43 100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 11 OF 15

V215	COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOFRE 2.	THREE MILE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADES 6.	PEACH BOTTOM 7.	PRAIRIE ISLAND 8.	QUAD CITIES 9.	BEAVER VALLEY 10.	ROW TOTAL
23. LO JACK PRESS	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24. LOSS OF FIELD	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26. GEN DIFF FAULT	COUNT	0	0	0	0	0	0	0	0	1	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	
99. NA	COUNT	0	0	0	0	1	0	0	0	0	0	12
	ROW PCT	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	27.9
	COL PCT	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 12 OF 15

V215 / V4 (COUNT / ROW PCT / COL PCT / TOT PCT)	DONALD C I. 11.	BRUNSWICK STEAM 12.	COOPER NUCLEAR 13.	EDWIN I HATCH 14.	INDIAN POINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GINNA NUCLE 18.	RANCHO S ECO 19.	OYSTER CREEK NUC 20.	ROW TOTAL
23. LO JACK PRESS	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24. LOSS OF FIELD	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26. GEN DIFF FAULT	0	0	0	0	0	0	0	0	0	0	1
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
99. NA	0	0	0	0	1	0	0	0	0	0	12
	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	27.9
	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 13 OF 15

V215	COUNT / ROW PCT / COL PCT / TOT PCT	DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESSE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
LO JACK PRESS	23.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
LOSS OF FIELD	24.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GEN DIFF FAULT	26.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NA	99.	1	0	0	0	1	0	1	1	1	0	12
		8.3	0.0	0.0	0.0	8.3	0.0	8.3	8.3	8.3	0.0	27.9
		100.0	0.0	0.0	0.0	100.0	0.0	100.0	100.0	100.0	0.0	
		2.3	0.0	0.0	0.0	2.3	0.0	2.3	2.3	2.3	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *

V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME

* PAGE 14 OF 15

V215	V4 COUNT ROW PCT COL PCT TOT PCT	MINE MIL IE POINT 31.	MONTICEL LO 32.	MILLSTON E 33.	KEWAUNEE 34.	MAINE YA NKEE 35.	JAMES A FITZPATR 36.	INDIAN P OINT 37.	SURRY PO WER 38.	POINT BE ACH 39.	BROWNS F ERRY 40.	ROW TOTAL
LO JACK PRESS	23.	0	0	0	1	0	0	0	0	0	0	1
		0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
LOSS OF FIELD	24.	0	0	0	0	0	0	0	0	1	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	
GEN DIFF FAULT	26.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NA	99.	0	1	0	0	1	1	1	1	0	0	12
		0.0	8.3	0.0	0.0	8.3	8.3	8.3	8.3	0.0	0.0	27.9
		0.0	100.0	0.0	0.0	100.0	100.0	100.0	100.0	0.0	0.0	
		0.0	2.3	0.0	0.0	2.3	2.3	2.3	2.3	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V215 SECOND ITEM NOT BYPASSED BY V4 PLANT NAME
* PAGE 15 OF 15

V215 / V4 (COUNT, ROW PCT, COL PCT, TOT PCT)	JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
23. LO JACK PRESS	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
24. LOSS OF FIELD	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
26. GEN DIFF FAULT	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
99. NA	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	12 27.9
COLUMN TOTAL	1 2.3	1 2.3	1 2.3	43 100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

* C R O S S T A B U L A T I O N O F *
V216 USE OF COINCIDENT BY V4 PLANT NAME
* PAGE 1 OF 5

V216	V4: COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOFRE 2.	THREE MILE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADES 6.	PEACH BOTTOM 7.	PRAIRIE ISLAND 8.	QUAD CITIES 9.	BEAVER VALLEY 10.	ROW TOTAL
1.	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.	COUNT	1	1	1	1	1	1	1	1	1	1	38
	ROW PCT	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	88.4
	COL PCT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	TOT PCT	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	
9.	COUNT	0	0	0	0	0	0	0	0	0	0	3
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * C R O S S T A B U L A T I O N O F * * * * *

V216 USE OF COINCIDENT BY V4 PLANT NAME

* * * * * PAGE 1 OF 5

V216	COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOFRE 2.	THREE MILE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADES 6.	PEACH BOTTOM 7.	PRAIRIE ISLAND 8.	QUAD CITIES 9.	BEAVER VALLEY 10.	ROW TOTAL
1.	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.	COUNT	1	1	1	1	1	1	1	1	1	1	38
	ROW PCT	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	88.4
	COL PCT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	TOT PCT	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	
9.	COUNT	0	0	0	0	0	0	0	0	0	0	3
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V216 USE OF COINCIDENT BY V4 PLANT NAME
* PAGE 2 OF 5

V216	COUNT / ROW PCT / COL PCT / TOT PCT	DONALD C. 11.	BRUNSWICK STEAM 12.	COOPER NUCLEAR 13.	EDWIN I HATCH 14.	INDIAN POINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GINNA NUCLE 18.	RANCHO SECO 19.	OYSTER CREEK NUC 20.	ROW TOTAL
1.	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.	COUNT	1	1	1	1	1	1	0	1	0	1	38
	ROW PCT	2.6	2.6	2.6	2.6	2.6	2.6	0.0	2.6	0.0	2.6	88.4
	COL PCT	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	0.0	100.0	
	TOT PCT	2.3	2.3	2.3	2.3	2.3	2.3	0.0	2.3	0.0	2.3	
9.	COUNT	0	0	0	0	0	0	1	0	1	0	3
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	33.3	0.0	7.0
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	100.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	2.3	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F *
V216 USE OF COINCIDENT BY V4 PLANT NAME
* PAGE 3 OF 5

V216	COUNT / ROW PCT / COL PCT / TOT PCT	DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESSE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
1.	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.	COUNT	1	1	1	1	0	1	1	1	1	1	38
	ROW PCT	2.6	2.6	2.6	2.6	0.0	2.6	2.6	2.6	2.6	2.6	88.4
	COL PCT	100.0	100.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0	
	TOT PCT	2.3	2.3	2.3	2.3	0.0	2.3	2.3	2.3	2.3	2.3	
9.	COUNT	0	0	0	0	1	0	0	0	0	0	3
	ROW PCT	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	7.0
	COL PCT	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F *
V216 USE OF COINCIDENT BY V4 PLANT NAME
* PAGE 4 OF 5

V216	COUNT / ROW PCT / COL PCT / TOT PCT	V4: NINE MIL E POINT 31.	MONTICEL LO 32.	MILLSTON E 33.	KEWAUNEE 34.	MAINE YA NKEE 35.	JAMES A FITZPATR 36.	INDIAN P OINT 37.	SURRY PO WER 38.	POINT BE ACH 39.	BROWNS F ERRY 40.	ROW TOTAL
1.	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.	COUNT	1	1	1	1	1	1	1	1	1	1	38
	ROW PCT	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	88.4
	COL PCT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	TOT PCT	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	
9.	COUNT	0	0	0	0	0	0	0	0	0	0	3
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V216 USE OF COINCIDENT BY V4 PLANT NAME
* PAGE 5 OF 5

V216 (COUNT / ROW PCT / COL PCT / TOT PCT)	V4: JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
1.	1	1	0	2
	50.0	50.0	0.0	4.7
	100.0	100.0	0.0	
	2.3	2.3	0.0	
2.	0	0	1	38
	0.0	0.0	2.6	88.4
	0.0	0.0	100.0	
	0.0	0.0	2.3	
9.	0	0	0	3
	0.0	0.0	0.0	7.0
	0.0	0.0	0.0	
	0.0	0.0	0.0	
COLUMN TOTAL	1	1	1	43
	2.3	2.3	2.3	100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V217 IS COINCIDENT LOGIC TESTABLE BY V4 PLANT NAME
* PAGE 1 OF 5

V217	V4: COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOFRE 2.	THREE MILE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADES 6.	PEACH BOTTOM 7.	PRAIRIE ISLAND 8.	QUAD CITIES 9.	BEAVER VALLEY 10.	ROW TOTAL
YES	1.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NO	2.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NA	9.	1	1	1	1	1	1	1	1	1	1	40
		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	93.0
		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V217 IS COINCIDENT LOGIC TESTABLE BY V4 PLANT NAME
* PAGE 2 OF 5

V217	V4 COUNT / ROW PCT / COL PCT / TOT PCT	DONALD C I. 11.	BRUNSWIC K STEAM 12.	COOPER N UCLEAR 13.	EDWIN I HATCH 14.	INDIAN P OINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GIN NA NUCLE 18.	RANCHO S ECO 19.	OYSTER C REEK NUC 20.	ROW TOTAL
YES	1.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
NO	2.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 4.7
NA	9.	1 2.5 100.0 2.3	1 2.5 100.0 2.3	1 2.5 100.0 2.3	1 2.5 100.0 2.3	1 2.5 100.0 2.3	1 2.5 100.0 2.3	1 2.5 100.0 2.3	1 2.5 100.0 2.3	1 2.5 100.0 2.3	1 2.5 100.0 2.3	40 93.0
	COLUMN TOTAL	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	1 2.3	43 100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V217 IS COINCIDENT LOGIC TESTABLE BY V4 PLANT NAME
* PAGE 3 OF 5

V217		V4 COUNT / ROW PCT / COL PCT / TOT PCT	DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
YES	1.	Count	0	0	0	1	0	0	0	0	0	0	1
		Row pct	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		Col pct	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
		Tot pct	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
NO	2.	Count	0	0	0	0	0	0	0	0	0	0	2
		Row pct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		Col pct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		Tot pct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NA	9.	Count	1	1	1	0	1	1	1	1	1	1	40
		Row pct	2.5	2.5	2.5	0.0	2.5	2.5	2.5	2.5	2.5	2.5	93.0
		Col pct	100.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	
		Tot pct	2.3	2.3	2.3	0.0	2.3	2.3	2.3	2.3	2.3	2.3	
		COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
			2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V217 IS COINCIDENT LOGIC TESTABLE BY V4 PLANT NAME
* PAGE 4 OF 5

V217	COUNT / ROW PCT / COL PCT / TOT PCT	NINE MILE POINT 31.	MONTICELLO 32.	MILLSTONE 33.	KEWAUNEE 34.	MAINE YANKEE 35.	JAMES A FITZPATR 36.	INDIAN POINT 37.	SURRY POWER 38.	POINT BEACH 39.	BROWNS FERRY 40.	ROW TOTAL
1. YES	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2. NO	COUNT	0	0	0	0	0	0	0	0	0	0	2
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9. NA	COUNT	1	1	1	1	1	1	1	1	1	1	40
	ROW PCT	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	93.0
	COL PCT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	TOT PCT	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V217 IS COINCIDENT LOGIC TESTABLE BY V4 PLANT NAME
* PAGE 5 OF 5

V217	V4 COUNT / ROW PCT / COL PCT / TOT PCT	JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
YES	1.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
NO	2.	1 50.0 100.0 2.3	1 50.0 100.0 2.3	0 0.0 0.0 0.0	2 4.7
NA	9.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.5 100.0 2.3	40 93.0
	COLUMN TOTAL	1 2.3	1 2.3	1 2.3	43 100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V267 OPERATORQUAL-MIN ED BY V4 PLANT NAME
* PAGE 1 OF 5

V267	COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOFRE 2.	THREE MILE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADES 6.	PEACH BOTTOM 7.	PRAIRIE ISLAND 8.	QUAD CITIES 9.	BEAVER VALLEY 10.	ROW TOTAL
HS	1.	1	0	1	0	1	1	1	0	1	1	34
		2.9	0.0	2.9	0.0	2.9	2.9	2.9	0.0	2.9	2.9	79.1
		100.0	0.0	100.0	0.0	100.0	100.0	100.0	0.0	100.0	100.0	
		2.3	0.0	2.3	0.0	2.3	2.3	2.3	0.0	2.3	2.3	
HS AND TRADE SCH	4.	0	1	0	0	0	0	0	1	0	0	2
		0.0	50.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	4.7
		0.0	100.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	
		0.0	2.3	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	
	5.	0	0	0	1	0	0	0	0	0	0	5
		0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	11.6
		0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
	6.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NA	9.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V267 OPERATORQUAL-MIN ED BY V4 PLANT NAME
* PAGE 2 OF 5

V267	COUNT / ROW PCT / COL PCT / TOT PCT	V4: DONALD C I. 11.	BRUNSWICK STEAM 12.	COOPER NUCLEAR 13.	EDWIN I HATCH 14.	INDIAN POINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GINNA NUCLE 18.	RANCHO SECO 19.	OYSTER CREEK NUC 20.	ROW TOTAL
HS	1.	1	1	1	1	0	1	1	1	0	1	34
		2.9	2.9	2.9	2.9	0.0	2.9	2.9	2.9	0.0	2.9	79.1
		100.0	100.0	100.0	100.0	0.0	100.0	100.0	100.0	0.0	100.0	
		2.3	2.3	2.3	2.3	0.0	2.3	2.3	2.3	0.0	2.3	
HS AND TRADE SCH	4.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	5.	0	0	0	0	1	0	0	0	1	0	5
		0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	20.0	0.0	11.6
		0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	
		0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	2.3	0.0	
	6.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NA	9.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V267 OPERATORQUAL-MIN ED BY V4 PLANT NAME
* PAGE 3 OF 5

V267	COUNT / ROW PCT / COL PCT / TOT PCT	V4: DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESSE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
HS	1.	1	1	1	1	0	1	1	1	0	1	34
		2.9	2.9	2.9	2.9	0.0	2.9	2.9	2.9	0.0	2.9	79.1
		100.0	100.0	100.0	100.0	0.0	100.0	100.0	100.0	0.0	100.0	
		2.3	2.3	2.3	2.3	0.0	2.3	2.3	2.3	0.0	2.3	
HS AND TRADE SCH	4.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	5.	0	0	0	0	1	0	0	0	0	0	5
		0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	11.6
		0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	
	6.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NA	9.	0	0	0	0	0	0	0	0	1	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V267 OPERATORQUAL-MIN ED BY V4 PLANT NAME
* PAGE 4 OF 5

V267	COUNT / ROW PCT / COL PCT / TOT PCT	NINE MILE POINT 31.	MONTICELLO 32.	MILLSTONE 33.	KEWAUNEE 34.	MAINE YANKEE 35.	JAMES A. FITZPATR 36.	INDIAN POINT 37.	SURRY POWER 38.	POINT BEACH 39.	BROWNS FERRY 40.	ROW TOTAL
HS	1.	1	0	1	1	0	1	1	1	1	1	34
		2.9	0.0	2.9	2.9	0.0	2.9	2.9	2.9	2.9	2.9	79.1
		100.0	0.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0	
		2.3	0.0	2.3	2.3	0.0	2.3	2.3	2.3	2.3	2.3	
HS AND TRADE SCH	4.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	5.	0	0	0	0	1	0	0	0	0	0	5
		0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	11.6
		0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	
	6.	0	1	0	0	0	0	0	0	0	0	1
		0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NA	9.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * *
V267 OPERATORQUAL-MIN ED BY V4 PLANT NAME
* * * * * * * * PAGE 5 OF 5

V267	COUNT / ROW PCT / COL PCT / TOT PCT	V4: JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
HS	1.	1	1	1	34
		2.9	2.9	2.9	79.1
		100.0	100.0	100.0	
		2.3	2.3	2.3	
HS AND TRADE SCH	4.	0	0	0	2
		0.0	0.0	0.0	4.7
		0.0	0.0	0.0	
		0.0	0.0	0.0	
	5.	0	0	0	5
		0.0	0.0	0.0	11.6
		0.0	0.0	0.0	
		0.0	0.0	0.0	
	6.	0	0	0	1
		0.0	0.0	0.0	2.3
		0.0	0.0	0.0	
		0.0	0.0	0.0	
NA	9.	0	0	0	1
		0.0	0.0	0.0	2.3
		0.0	0.0	0.0	
		0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	43
		2.3	2.3	2.3	100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

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V271 MIN OPERATOR TRAIN BY V4 PLANT NAME
* PAGE 1 OF 5

V271	COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOF RE 2.	THREE MI LE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADE S 6.	PEACH BO TTOM 7.	PRAIRIE ISLAND 8.	QUAD CIT IES 9.	BEAVER V ALLEY 10.	ROW TOTAL
3. ON THE JOB	COUNT	0	1	0	0	1	0	1	1	1	0	16
	ROW PCT	0.0	6.3	0.0	0.0	6.3	0.0	6.3	6.3	6.3	0.0	37.2
	COL PCT	0.0	100.0	0.0	0.0	100.0	0.0	100.0	100.0	100.0	0.0	
	TOT PCT	0.0	2.3	0.0	0.0	2.3	0.0	2.3	2.3	2.3	0.0	
4. MILITARY &	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5. MILITARY & ON TH	COUNT	1	0	0	1	0	0	0	0	0	1	7
	ROW PCT	14.3	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	14.3	16.3
	COL PCT	100.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100.0	
	TOT PCT	2.3	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	2.3	
6. COMB AS REQUIRED	COUNT	0	0	1	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7. IND & ON THE JOB	COUNT	0	0	0	0	0	1	0	0	0	0	3
	ROW PCT	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	7.0
	COL PCT	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	
8. COMB OF 1,2,3	COUNT	0	0	0	0	0	0	0	0	0	0	14
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.6
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9. NA	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V271 MIN OPERATOR TRAIN BY V4 PLANT NAME
* PAGE 2 OF 5

V271	COUNT / ROW PCT / COL PCT / TOT PCT	DONALD C . 11.	BRUNSWIC K STEAM 12.	COOPER N UCLEAR 13.	EDWIN I HATCH 14.	INDIAN P OINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GIN NA NUCLE 18.	RANCHO S ECO 19.	OYSTER C REEK NUC 20.	ROW TOTAL
ON THE JOB	3.	0	0	0	0	0	0	0	1	0	1	16
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	6.3	37.2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	100.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	2.3	
MILITARY &	4.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
MILITARY & ON TH	5.	0	0	0	0	0	0	0	0	0	0	7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COMB AS REQUIRED	6.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IND & ON THE JOB	7.	0	0	0	0	0	0	0	0	0	0	3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COMB OF 1,2,3	8.	1	1	1	1	1	1	1	0	1	0	14
		7.1	7.1	7.1	7.1	7.1	7.1	7.1	0.0	7.1	0.0	32.6
		100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	0.0	
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	0.0	2.3	0.0	
NA	9.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V271 MIN OPERATOR TRAIN BY V4 PLANT NAME
* PAGE 3 OF 5

V271	V4: COUNT / ROW PCT / COL PCT / TOT PCT	DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
3. ON THE JOB	COUNT	0	1	1	1	0	0	0	1	0	0	16
	ROW PCT	0.0	6.3	6.3	6.3	0.0	0.0	0.0	6.3	0.0	0.0	37.2
	COL PCT	0.0	100.0	100.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	
	TOT PCT	0.0	2.3	2.3	2.3	0.0	0.0	0.0	2.3	0.0	0.0	
4. MILITARY &	COUNT	0	0	0	0	0	0	0	0	1	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	
5. MILITARY & ON TH	COUNT	0	0	0	0	0	1	0	0	0	1	7
	ROW PCT	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	14.3	16.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	2.3	
6. COMB AS REQUIRED	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7. IND & ON THE JOB	COUNT	1	0	0	0	0	0	0	0	0	0	3
	ROW PCT	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0
	COL PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8. COMB OF 1,2,3	COUNT	0	0	0	0	1	0	1	0	0	0	14
	ROW PCT	0.0	0.0	0.0	0.0	7.1	0.0	7.1	0.0	0.0	0.0	32.6
	COL PCT	0.0	0.0	0.0	0.0	100.0	0.0	100.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	2.3	0.0	2.3	0.0	0.0	0.0	
9. NA	COUNT	0	0	0	0	0	0	0	0	0	0	1
	ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
	COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V271 MIN OPERATOR TRAIN BY V4 PLANT NAME
* PAGE 4 OF 5

V271	COUNT ROW PCT COL PCT TOT PCT	V4 NINE MIL E POINT 31.	MONTICEL LO 32.	MILLSTON E 33.	KEWAUNEE 34.	MAINE YA NKEE 35.	JAMES A FITZPATR 36.	INDIAN P OINT 37.	SURRY PO WER 38.	POINT BE ACH 39.	BROWNS F ERRY 40.	ROW TOTAL
ON THE JOB	3.	0	0	0	1	1	0	0	1	0	1	16
		0.0	0.0	0.0	6.3	6.3	0.0	0.0	6.3	0.0	6.3	37.2
		0.0	0.0	0.0	100.0	100.0	0.0	0.0	100.0	0.0	100.0	
		0.0	0.0	0.0	2.3	2.3	0.0	0.0	2.3	0.0	2.3	
MILITARY &	4.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
MILITARY & ON TH	5.	1	0	1	0	0	0	0	0	0	0	7
		14.3	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3
		100.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		2.3	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COMB AS REQUIRED	6.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IND & ON THE JOB	7.	0	1	0	0	0	0	0	0	0	0	3
		0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0
		0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
COMB OF 1,2,3	8.	0	0	0	0	0	1	1	0	1	0	14
		0.0	0.0	0.0	0.0	0.0	7.1	7.1	0.0	7.1	0.0	32.6
		0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	100.0	0.0	
		0.0	0.0	0.0	0.0	0.0	2.3	2.3	0.0	2.3	0.0	
NA	9.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES SPSSH - VERSION 6.01 09/27/78 PAGE 6

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V271 MIN OPERATOR TRAIN BY V4 PLANT NAME
* PAGE 5 OF 5

V271	V4 COUNT ROW PCT COL PCT TOT PCT	JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
ON THE JOB	3.	1 6.3 100.0 2.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	16 37.2
MILITARY &	4.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
MILITARY & ON TH	5.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	7 16.3
COMB AS REQUIRED	6.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 2.3
IND & ON THE JOB	7.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 7.0
COMB OF 1,2,3	8.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 7.1 100.0 2.3	14 32.6
NA	9.	0 0.0 0.0 0.0	1 100.0 100.0 2.3	0 0.0 0.0 0.0	1 2.3
	COLUMN TOTAL	1 2.3	1 2.3	1 2.3	43 100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V285 BYPASS ENG OUT OF SERVICE BY V4 PLANT NAME
* PAGE 1 OF 5

V285		COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOFRE 2.	THREE MILE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADES 6.	PEACH BOTTOM 7.	PRAIRIE ISLAND 8.	QUAD CITIES 9.	BEAVER VALLEY 10.	ROW TOTAL
	0.	COUNT	0	0	0	0	0	0	0	0	0	1	1
		ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	2.3
		COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	
		TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	
YES	1.	COUNT	0	0	0	0	0	0	0	0	0	0	2
		ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NO	2.	COUNT	1	1	1	1	1	1	1	1	1	0	34
		ROW PCT	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	0.0	79.1
		COL PCT	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	
		TOT PCT	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	0.0	
NA	9.	COUNT	0	0	0	0	0	0	0	0	0	0	6
		ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0
		COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
			2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
V285 BYPASS ENG OUT OF SERVICE BY V4 PLANT NAME
* PAGE 2 OF 5

V285		V4 COUNT / ROW PCT / COL PCT / TOT PCT	DONALD C I. 11.	BRUNSWIC K STEAM 12.	COOPER N UCLEAR 13.	EDWIN I HATCH 14.	INDIAN P OINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GIN NA NUCLE 18.	RANCHO S ECO 19.	OYSTER C REEK NUC 20.	ROW TOTAL
	0.	COUNT	0	0	0	0	0	0	0	0	0	0	1
		ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
YES	1.	COUNT	0	0	0	0	0	0	0	0	0	1	2
		ROW PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	4.7
		COL PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	
		TOT PCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	
NO	2.	COUNT	0	1	1	1	1	1	1	1	1	0	34
		ROW PCT	0.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	0.0	79.1
		COL PCT	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	
		TOT PCT	0.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	0.0	
NA	9.	COUNT	1	0	0	0	0	0	0	0	0	0	6
		ROW PCT	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0
		COL PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		TOT PCT	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL		1	1	1	1	1	1	1	1	1	1	43
			2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
V285 BYPASS ENG OUT OF SERVICE BY V4 PLANT NAME
* PAGE 3 OF 5

V285	V4 COUNT / ROW PCT / COL PCT / TOT PCT	DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
	0.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
YES	1.	0	0	0	0	0	0	1	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	
NO	2.	1	1	0	0	1	1	0	1	1	1	34
		2.9	2.9	0.0	0.0	2.9	2.9	0.0	2.9	2.9	2.9	79.1
		100.0	100.0	0.0	0.0	100.0	100.0	0.0	100.0	100.0	100.0	
		2.3	2.3	0.0	0.0	2.3	2.3	0.0	2.3	2.3	2.3	
NA	9.	0	0	1	1	0	0	0	0	0	0	6
		0.0	0.0	16.7	16.7	0.0	0.0	0.0	0.0	0.0	0.0	14.0
		0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	2.3	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * *
V285 BYPASS ENG OUT OF SERVICE BY V4 PLANT NAME
* PAGE 4 OF 5

V285	COUNT / ROW PCT / COL PCT / TOT PCT	V4: NINE MILE POINT 31.	MONTICELLO 32.	MILLSTONE 33.	KEWAUNEE 34.	MAINE YANKEE 35.	JAMES A FITZPATR 36.	INDIAN POINT 37.	SURRY POWER 38.	POINT BEACH 39.	BROWNS FERRY 40.	ROW TOTAL
	0.	0	0	0	0	0	0	0	0	0	0	1
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
YES	1.	0	0	0	0	0	0	0	0	0	0	2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
NO	2.	1	1	1	0	1	1	1	1	0	1	34
		2.9	2.9	2.9	0.0	2.9	2.9	2.9	2.9	0.0	2.9	79.1
		100.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	0.0	100.0	
		2.3	2.3	2.3	0.0	2.3	2.3	2.3	2.3	0.0	2.3	
NA	9.	0	0	0	1	0	0	0	0	1	0	6
		0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	16.7	0.0	14.0
		0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	0.0	
		0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	2.3	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * *
V285 BYPASS ENG OUT OF SERVICE BY V4 PLANT NAME
* * * * * * * * * * PAGE 5 OF 5

V285	COUNT / ROW PCT / COL PCT / TOT PCT	V4: JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
	0.	0	0	0	1
		0.0	0.0	0.0	2.3
		0.0	0.0	0.0	
		0.0	0.0	0.0	
	1.	0	0	0	2
YES		0.0	0.0	0.0	4.7
		0.0	0.0	0.0	
		0.0	0.0	0.0	
	2.	1	1	0	34
NO		2.9	2.9	0.0	79.1
		100.0	100.0	0.0	
		2.3	2.3	0.0	
	9.	0	0	1	6
NA		0.0	0.0	16.7	14.0
		0.0	0.0	100.0	
		0.0	0.0	2.3	
	COLUMN TOTAL	1	1	1	43
		2.3	2.3	2.3	100.0

FILE NUCLEAR (CREATION DATE = 08/25/78)

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *

V287 CONTROL SYS OVERRIDE EMERG BY V4 PLANT NAME

* PAGE 1 OF 5

V287	COUNT / ROW PCT / COL PCT / TOT PCT	CALVERT CLIFFS 1.	SAN ONOF RE 2.	THREE MI LE ISLAN 3.	TROJAN 4.	VERMONT YANKEE 5.	PALISADE S 6.	PEACH BO TTOM 7.	PRAIRIE ISLAND 8.	QUAD CIT IES 9.	BEAVER V ALLEY 10.	ROW TOTAL
YES	1.	0	1	0	1	0	1	0	1	1	1	24
		0.0	4.2	0.0	4.2	0.0	4.2	0.0	4.2	4.2	4.2	55.8
		0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	100.0	100.0	
		0.0	2.3	0.0	2.3	0.0	2.3	0.0	2.3	2.3	2.3	
NO	2.	0	0	1	0	1	0	0	0	0	0	13
		0.0	0.0	7.7	0.0	7.7	0.0	0.0	0.0	0.0	0.0	30.2
		0.0	0.0	100.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	2.3	0.0	2.3	0.0	0.0	0.0	0.0	0.0	
NA	9.	1	0	0	0	0	0	1	0	0	0	6
		16.7	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	14.0
		100.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	
		2.3	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V287 CONTROL SYS OVERRIDE EMERG BY V4 PLANT NAME
* PAGE 2 OF 5

V287	V4 COUNT ROW PCT COL PCT TOT PCT	DONALD C I. 11.	BRUNSWICK STEAM 12.	COOPER NUCLEAR 13.	EDWIN I HATCH 14.	INDIAN POINT 15.	CRYSTAL RIVER 16.	SALEM 17.	R.E. GINNA NUCLE 18.	RANCHO SECO 19.	OYSTER CREEK NUC 20.	ROW TOTAL
YES	1.	0	1	1	1	0	1	1	0	1	1	24
		0.0	4.2	4.2	4.2	0.0	4.2	4.2	0.0	4.2	4.2	55.8
		0.0	100.0	100.0	100.0	0.0	100.0	100.0	0.0	100.0	100.0	
		0.0	2.3	2.3	2.3	0.0	2.3	2.3	0.0	2.3	2.3	
NO	2.	1	0	0	0	1	0	0	1	0	0	13
		7.7	0.0	0.0	0.0	7.7	0.0	0.0	7.7	0.0	0.0	30.2
		100.0	0.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	
		2.3	0.0	0.0	0.0	2.3	0.0	0.0	2.3	0.0	0.0	
NA	9.	0	0	0	0	0	0	0	0	0	0	6
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

(CONTINUED)

FILE NUCLEAR (CREATION DATE = 08/25/78)

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V287 CONTROL SYS OVERRIDE EMERG BY V4 PLANT NAME
* PAGE 3 OF 5

V287	COUNT / ROW PCT / COL PCT / TOT PCT	V4: DRESDEN NUCLEAR 21.	H B ROBINSON 22.	HUMBOLT BAY 23.	BIG ROCK POINT 24.	CONNECTICUT 25.	DAVIS BESE 26.	DUANE ARNOLD ENE 27.	FORT CALHOUN STA 28.	PILGRIM STATION 29.	NORTH ANNA 30.	ROW TOTAL
YES	1.	1	1	1	0	1	1	1	0	1	0	24
		4.2	4.2	4.2	0.0	4.2	4.2	4.2	0.0	4.2	0.0	55.8
		100.0	100.0	100.0	0.0	100.0	100.0	100.0	0.0	100.0	0.0	
		2.3	2.3	2.3	0.0	2.3	2.3	2.3	0.0	2.3	0.0	
NO	2.	0	0	0	0	0	0	0	1	0	1	13
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	7.7	30.2
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	100.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	2.3	
NA	9.	0	0	0	1	0	0	0	0	0	0	6
		0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	14.0
		0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V287 CONTROL SYS OVERRIDE EMERG BY V4 PLANT NAME
* PAGE 4 OF 5

V287	COUNT / ROW PCT / COL PCT / TOT PCT	V4: NINE MILE POINT 31.	MONTICELLO 32.	MILLSTONE 33.	KEWAUNEE 34.	MAINE YANKEE 35.	JAMES A FITZPATR 36.	INDIAN POINT 37.	SURRY POWER 38.	POINT BEACH 39.	BROWNS FERRY 40.	ROW TOTAL
YES	1.	1	0	0	0	1	0	0	0	0	1	24
		4.2	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	4.2	55.8
		100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	
		2.3	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	2.3	
NO	2.	0	1	0	0	0	1	1	1	0	0	13
		0.0	7.7	0.0	0.0	0.0	7.7	7.7	7.7	0.0	0.0	30.2
		0.0	100.0	0.0	0.0	0.0	100.0	100.0	100.0	0.0	0.0	
		0.0	2.3	0.0	0.0	0.0	2.3	2.3	2.3	0.0	0.0	
NA	9.	0	0	1	1	0	0	0	0	1	0	6
		0.0	0.0	16.7	16.7	0.0	0.0	0.0	0.0	16.7	0.0	14.0
		0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	100.0	0.0	
		0.0	0.0	2.3	2.3	0.0	0.0	0.0	0.0	2.3	0.0	
	COLUMN TOTAL	1	1	1	1	1	1	1	1	1	1	43
		2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	100.0

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FILE NUCLEAR (CREATION DATE = 08/25/78)

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V287 CONTROL SYS OVERRIDE EMERG BY V4 PLANT NAME
* PAGE 5 OF 5

V287	V4 COUNT / ROW PCT / COL PCT / TOT PCT	JOSEPH M. FARLEY 41.	ARKANSAS 42.	ZION STATION 43.	ROW TOTAL
YES	1.	1	0	0	24
		4.2	0.0	0.0	55.8
		100.0	0.0	0.0	
		2.3	0.0	0.0	
NO	2.	0	1	1	13
		0.0	7.7	7.7	30.2
		0.0	100.0	100.0	
		0.0	2.3	2.3	
NA	9.	0	0	0	6
		0.0	0.0	0.0	14.0
		0.0	0.0	0.0	
		0.0	0.0	0.0	
	COLUMN TOTAL	1	1	1	43
		2.3	2.3	2.3	100.0

APPENDIX E

AIR DRIERS - TYPES AND CHARACTERISTICS

AIR DRIERS - TYPES AND CHARACTERISTICS

TYPE	APPLICATIONS	CHARACTERISTICS	COST
Refrigerated	Heavy duty Industrial. Air Driven Tools, etc.	Continuous Operation. Resistant to fouling.	High
Regenerative	Light Duty Industrial. Pneumatic Controls.	Intermittent Availability. Subject to Oil Fouling.	Moderate
Deliquiscent with Dessicants	Scientific Instrumenta-tion. Pneumatic Controls.	Suitable only for low intermittent flow.	Low

All refrigerant type air driers are rated for capacity and dew point performance on an inlet air temperature of 100°F into the drier. This requires an air after-cooler between the compressor and the drier. The after-cooler or cooler may or may not be integral with the air drier.

The air drier should be at the inlet of the starting air tanks. Flow capcity in SCFM of the air-drier should be some what larger than of the air compressor to insure no water "carry-over" in the presence of possible minor fouling by lube oil from the compressor, or dirt in the air, etc. Pipe size should also be considered to avoid "necking down" between the compressor and the air tanks. A 2 to 1 ratio of rated capacity is suggested.

For Reference:

Typical Air Compressor Capacity Versus Driving Motor Horsepower at 150 psi.

Capacity	Driving Motor
466 SCFM	150 hp
80 SCFM	25 hp
35 SCFM	10 hp

AIR DRIERS, REFRIGERATED - PARTIAL LIST

Manufacturer	Location
Norgren	Littleton, Colorado
Miller Flick-Reedy Corp.	Bensonville, Illinois
Wilkerson	
Zeks	
Ingersoll-Rand	
Arrow-Pneumatic	
Van-Air Inc.	Erie, PA.
Zurn Industries, Inc. General Air Division	Erie, PA.
Kellogg-American, Inc.	Oakmont, PA.

Sizes available 5 to 5000 SCFM (Standard Cubic Feet per Minute) rating at the usual sea level standard conditions, 29.92 inch Hg. and 60°F.

These sizes have motor horsepower of 5 to 30 hp in closely spaced sizes of flow capacity as designated by manufacturer and model number with prices according to catalog listing. Pipe sizes vary from 3/8 inch to 8 inch pipe size. Air discharged from the drier has a dew point of 50°F or 35°F as specified which greatly influences cost.

The following reproductions of the Norgren and the Zurn catalog pages are presented as convenient, complete, and typical of similar driers of a number of competitive manufacturers.

NC-1206
July, 1970
Supersedes April, 1969

Type 60-008

Refrigerant Dryer

SPECIFICATIONS

PRESSURE: 200 PSIG MAXIMUM (5 TO 125 SCFM UNITS)
150 PSIG MAXIMUM (250 TO 5000 SCFM UNITS)
TEMPERATURE: *INLET AIR TEMPERATURE 100° F. MAXIMUM
AMBIENT AIR TEMPERATURE 35° F. MIN. TO 100° F. MAXIMUM
REFRIGERANT: FREON 12 OR FREON 22
DEWPOINT: AT 100 PSIG INLET AIR PRESSURE RATED FLOW (SCFM) AND INLET AIR TEMPERATURE OF 100° F., UNITS ARE DESIGNED FOR ATMOSPHERIC DEWPOINT OF -10° F. OR 35° F. AT 100 PSIG.
FLANGES: AMERICAN STANDARD ASSN. (ASA)
150 LB. RATING

*Units can withstand higher temperatures, however, dewpoint suppression will be affected. Contact factory for information.

FEATURES

Units from 5 to 125 scfm equipped with refrigerant analyzer gauge, power "on" light, and automatic drain.

Units from 250 to 5000 scfm are equipped with inlet air pressure gauge, inlet air temperature gauge, refrigerant analyzer gauge, power "on" light, high temperature warning light and automatic drain.

Minimum amount of floor space required.

Easy installation: connect the air lines and electrical power supply to unit.

Unit will deliver clean, dry air in minutes.

Hermetically sealed refrigeration units housed in sturdy cabinet.

Simple design: no switches, timers, or relays.

Dewpoint continuous and assured.

All components and units are factory tested to assure efficient operation.

An exchange of heat at the inlet and outlet precools inlet air and reheats outgoing air.

Reheating reduces the possibility of condensation on downstream piping and increases usable air volume.

Automatic drain removes the condensate from the dryer to prevent carryover.

Units are non-cycling design to assure proper control of dewpoint at all times. Disadvantages of cycling systems are:
A) Cycling systems do not give constant heat exchanges, temperatures, or a constant dewpoint.
B) Reduce equipment life.
C) Uneconomical because of peak load.

NORGREN
LITTLETON, COLORADO ©

ORDER TABLE and SPECIFICATIONS

NORGREN MODEL NO.	SCFM	POWER SUPPLY	A	B	C	D	E	F	G	H	J	WT.LBS.	H.P.	SEE NOTE
60-008-020	5	115-1-60	15	17	17	2	3/8 fpt	2-5/8	11			65	1/6	1
-033	10	115-1-60	15	17	17	2	3/8 fpt	2-5/8	11			70	1/6	1
-021	15	115-1-60	15	17	17	2	1/2 fpt	2-5/8	11			75	1/6	1
-034	25	115-1-60	15	17	17	2	1/2 fpt	1-5/8	13-1/2			100	1/4	1
-022	35	115-1-60 230-1-60	19	21	21	2	3/4 fpt	2-5/8	13-1/2			120	1/4	1
-023	50	115-1-60 230-1-60	19	21	21	2	3/4 fpt	2-5/8	13-1/2			150	1/2	1
-024	75	115-1-60 230-1-60	26	26	27	2	1 fpt	3-3/8	18			200	3/4	1
-042	100	115-1-60 230-1-60	26	26	27	2	1 fpt	3-3/8	18			250	3/4	1
-025	125	230-1-60 208-220 240-3-60	26	26	27	2	1-1/2 fpt	3-3/8	18			285	1	1
-043	150	230-1-60 208-220 240-3-60 440-3-60	26	26	27	2	1-1/2 fpt	3-3/8	18			300	1-1/2	2
-026	250	230-1-60 208-220 240-3-40 440-3-60	46	53	33	6-3/4	2 mpt	12	36	4	5	700	2	2
-027	400	230-1-60 208-220 240-3-60 440-3-60	46	53	33	6-3/4	3 mpt	12	36	4	5	800	3	2
-028	500	230-1-60 208-220 240-3-60 440-3-60	46	53	33	5-1/4	3 mpt	12	36	4	5	900	3	2
-035	600	230-1-60 208-220 240-3-60 440-3-60	46	53	33	5-1/4	3 mpt	12	36	4	5	1100	4	2
-029	750	230-1-60 208-220 240-3-60 440-3-60	48	62	42	4-1/4	4 mpt	12	36	4	5	1200	5	2
-030	1000	208-220 240-3-60 440-3-60 550-3-60	48	62	42	15	6 mpt	14	52	4	6	1800	6	2
-036	1200	208-220 240-3-60 440-3-60 550-3-60	65	80	50	15	6 mpt	14	52	4	6	2000	6	2
-031	1500	208-220 240-3-60 440-3-60 550-3-60	65	80	50	15	6 mpt	14	57	4	6	2400	7-1/2	2
-037	1700	208-220 240-3-60 440-3-60 550-3-60	65	80	50	15	6 mpt	14	57	4	6	2400	7-1/2	2
-032	2000	208-220 240-3-60 440-3-60 550-3-60	65	80	50	15	6 mpt	14	57	4	6	2600	10	2
-038	2800	208-220 240-3-60 440-3-60 550-3-60	80	125	60	17	8 flange	20	68	6	8	3100	20	2
60-008-039	5000	208-220 240-3-60 440-3-60 550-3-60	90	150	70	20	8 glange	22	70	6	8	4300	30	2

*Female pipe connections on units up to 125 scfm

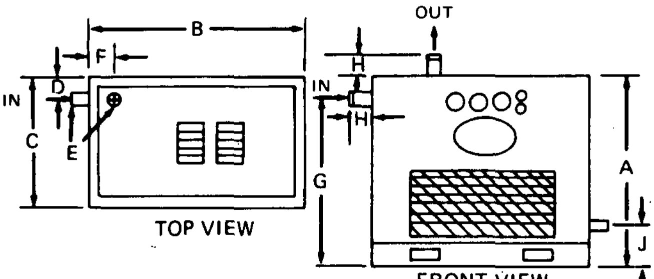
*Male pipe connections on units 250 scfm to 5000 scfm

NOTE:

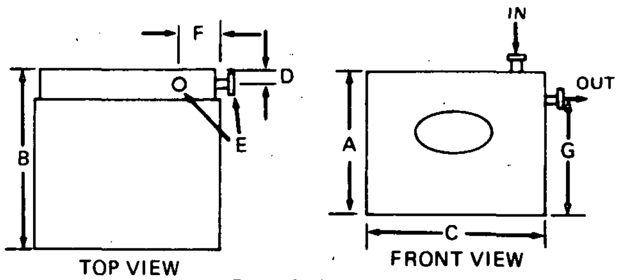
1) These units include (A) refrigerant analyzer gauge, (B) power "on" light, (C) automatic drain

2) These units include (A) refrigerant analyzer gauge, (B) inlet air pressure gauge, (C) inlet air temperature gauge, (D) power "on" light, (E) high temperature indicator warning light (F) automatic drain

DIMENSIONS

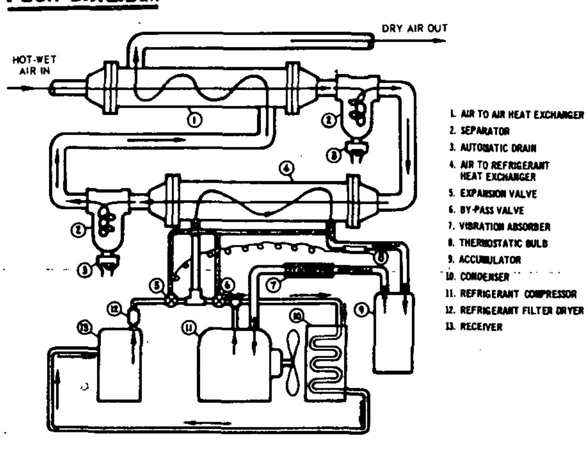


250-2000 SCFM



5-150 SCFM

FLOW DIAGRAM



OPERATION

Hot wet air from the air compressor receiver enters the air to air heat exchanger (1). Inlet air is precooled while outlet air is reheated. Air then passes through a moisture separator (2) (250 scfm and larger units) to remove any moisture condensed in precooler and reduces the load in "air to refrigerant heat exchanger" (4).

Precooled air enters the air to refrigerant heat exchanger (4) and is chilled to 35 F. Condensate is removed from the air in the separator and expelled from the system by an automatic drain. Air then passes back through the air to air heat exchanger and is reheated. Reheating reduces the possibility of condensation on downstream piping and increases the usable air volume.

C. A. NORGREN CO.

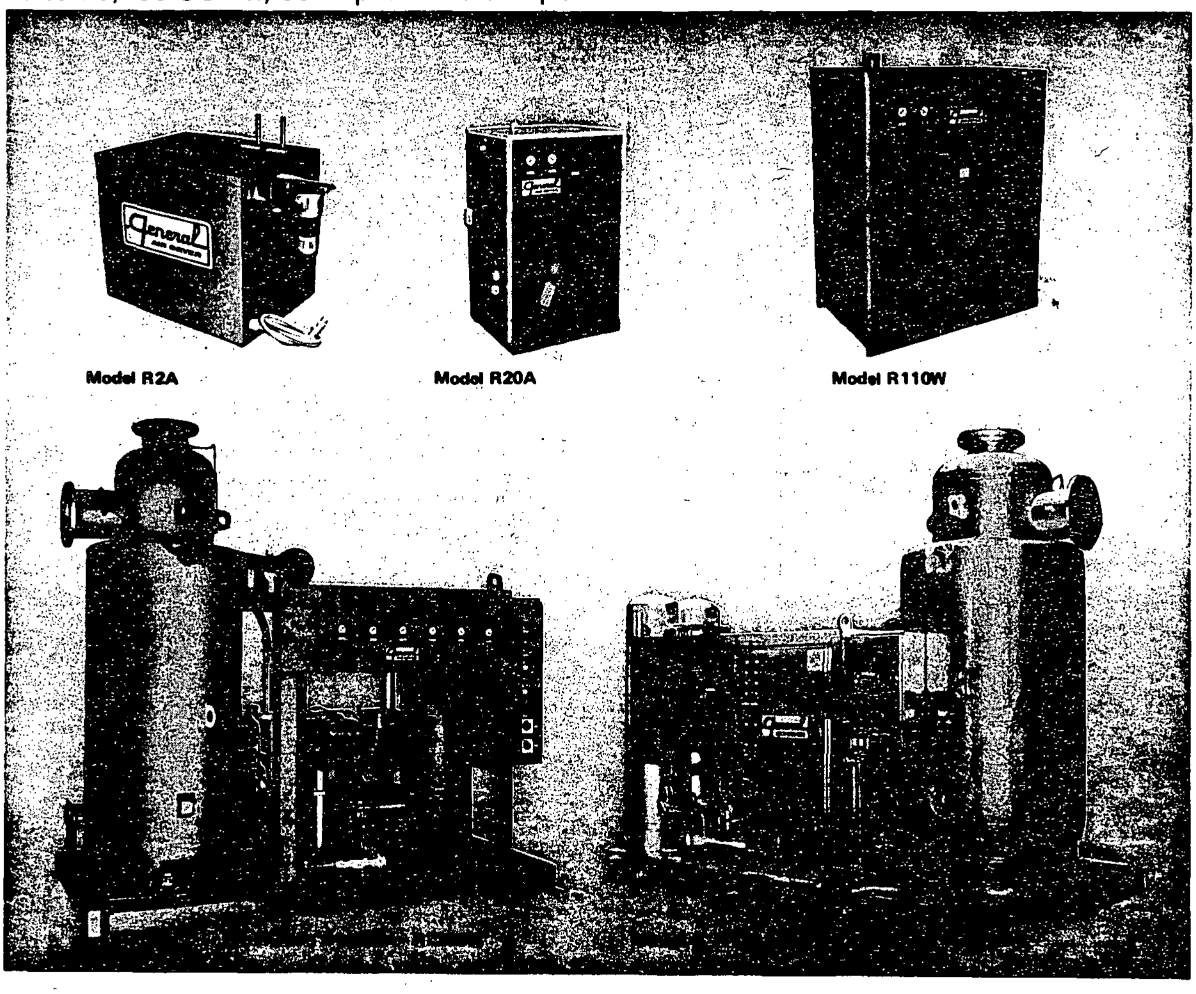
LITTLETON, COLORADO 80120 / 303-794-2611

Printed in U.S.A.

refrigerated type compressed-air dryers

Featuring the unique 5-in-1 integrated air drying module

non-cycling air or water-cooled units,
10 to 29,000 SCFM, 35° F pressure dewpoints



Model R2A Model R20A Model R110W

ZURN a step ahead of tomorrow

ZURN INDUSTRIES, INC.
GENERAL AIR DIV.
ERIE, PA, U.S.A. 16512
PHONE: 814/454-6368

50°F DEWPOINT RATINGS – ENGINEERING DATA

(These units are not designed for lower dewpoints at lower flows)

MODEL NO. (1) and (5)	MWP PSIG (2)	SCFM CAPACITY @ 100 PSIG and 100°F INLET TEMPERATURE	REFRIGERATION DATA		Air Connections Inlet and Outlet	DIMENSIONS (4)			Approximate Weight (lbs.) (6)
			HP	Voltage (3)		Width	Depth	Height	
R90A	200	450	2	208-230/1/60	2" N.P.T.	38-1/4"	29-1/8"	58-1/8"	600
R100W	"	500	2						700
R240A	"	1,200	5	208-230/3/60	3" N.P.T.	68-1/4"	36-1/8"	65"	1375
R260W	"	1,300	5						1275
R430A	"	2,150	7½	208-230/3/60	4" N.P.T.	72-1/8"	36-1/4"	71"	2100
R475W	"	2,400	7½						2060

(1) Suffix Letter "A" indicates Air-Cooled; "W" indicates Water-Cooled.
(2) Higher Working Pressures available.
(3) Voltages shown are standard. Other Voltages available at extra cost.
(4) Dimensions subject to change without notice.
(5) Models are Cabinet Style.
(6) Weights shown are not to be used for positive freight costs; contact factory.

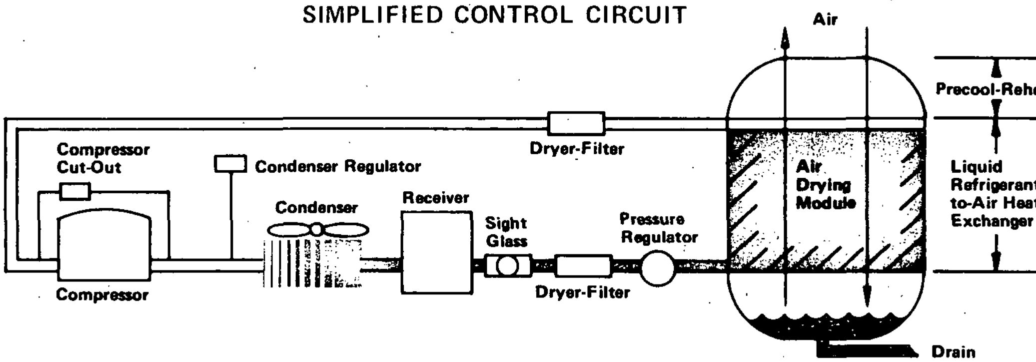
STANDARD FEATURES

All models are equipped with an on/off indicator light,
and "dead-system" air pressure control switch for automatic shutdown/startup on air system pressure loss.

STANDARD INSTRUMENTATION INCLUDED AS SHOWN

Model No.	Exit Air Dewpoint Gauge	Exit Air Pressure Gauge	Inlet Air Temperature Gauge	Refrigerant High and Low Pressure Gauges	High Temperature Red Indicating Light	Automatic Drain Float Trap	Automatic Drain ST-3 Single Timer	Automatic Drain DT-2 Dual Timer
R90A and R100W	X	X				X		
R240A thru R260W	X	X				X		
R430A and R475W	X	X	X	X	X		X	

SIMPLIFIED CONTROL CIRCUIT



All Models include a hot-gas by-pass system to prevent freeze-up on light or no-load operation.

CONSTRUCTION DESIGN includes only the highest quality components. The INTEGRATED AIR DRYING MODULE combines the functions of five separate components found in other types of refrigerated air dryers. This modular design eliminates the need for multiple connections and provides a straight-through flow concept to totally eliminate system clogging resulting from oil varnish and scale accumulations. The module produces a pressure drop of less than 5 psig. Each Dryer is of the constant-running hermetic type for longest life and least maintenance.

SIMPLIFIED CONTROL CIRCUIT includes an automatic pressure regulator for low-flow or no-load to full flow operation. All models (except R2A and R3A) are equipped with an air line pressure control switch for elimination of operation during extended shutdown periods; restart is automatic. Models R940A and larger also include refrigeration units that have various stages of capacity reduction for maximum operating efficiency under various workloads.

CAPACITY DESIGN is based on no flow to constant flow at 100°F inlet air temperature, 100°F ambient temperature and 100 psig. When inlet air temperatures are raised to 150°F, units sized to produce a 35°F pressure dewpoint will produce a 50°F pressure dewpoint, providing controls have been readjusted at reduced capacities.

AUTOMATIC DRAINS ARE STANDARD ON ALL UNITS. Models R2A through R150W are equipped with an automatic float drain. Models R200A through R360W† include an ST-3 Single Timer/Motor Operated Ball Valve, preset to cycle every one or two hours with a ten-second blow-down period. Models R440A† and larger are equipped with the exclusive Model DT-2 Automatic Drain System featuring accurate timing devices with indicator lights and a precision motor-operated ball valve. Two external control knobs permit blowdown settings from 5 to 60 second duration in one-second increments and 30-minute to 6-hour drain cycles in ½-hour increments.

†Except 50°F Dewpoint units.

CLEAN, DRY AIR IS ECONOMICAL

Moisture in any compressed-air system creates above-normal maintenance and increases replacement costs by mixing with lubricants and forming a corrosive, abrasive sludge. Users of compressed air who have analyzed their moisture problems have always experienced many profit gains with the installation of an Air Dryer. WHY? Because all pneumatically-operated equipment is designed to operate most efficiently with greatest durability with clean, dry air and proper lubrication.

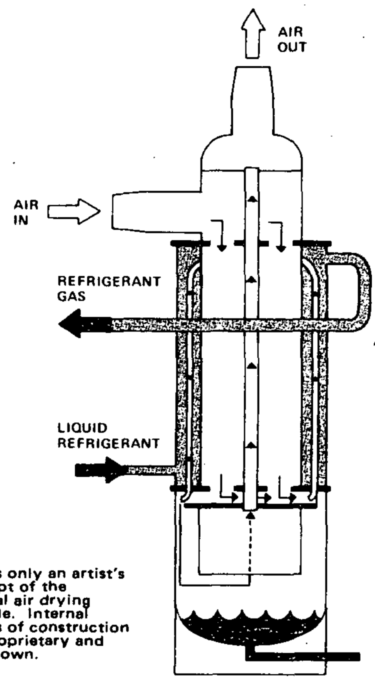
DEWPOINT

. . . is the most critical factor in any compressed-air system. It is the temperature which allows moisture vapors to condense. Reduction of the dewpoint to a temperature lower than that to which your air line is exposed guarantees that condensation will not occur. Zurn Refrigerated Air Dryers provide this lower dewpoint with a wider range of conditions and workloads. Standard units produce 35°F or 50°F pressure dewpoints. For a 5°F pressure dewpoint, ask for Catalog GRDC.

ELIMINATION OF MOISTURE in compressed-air systems is the first step to reduce production downtime, maintenance costs, and repair or replacement of tools, instruments, and valves.

ZURN-GENERAL'S UNIQUE HEAT EXCHANGER MODULE AVE ENERGY

a step ahead of tomorrow . . . and all competition.



This is only an artist's concept of the vertical air drying module. Internal details of construction are proprietary and not shown.

- The real efficiency of an air dryer is achieved in the heat exchanger component(s). All dryers use similar commercially standard refrigeration condensing units.
- Heat exchanger design and efficiency is the real heart of the system.
- For several years, the ZURN-GENERAL previous designed 5-in-1 Air Drying Module has outperformed all competition, most of whom try to simply match commercial heat exchangers, (designed for other applications) to refrigeration systems. The ZURN-GENERAL Module combines into one unit, air precooling, air chilling, moisture separation, condensate removal and air reheating. It has never been matched by competition!
- It took the refrigeration AND compressed air specialists of ZURN-GENERAL to improve the 5-in-1 Heat Exchanger Module, to better efficiency and reduce energy requirements. Only ZURN-GENERAL combines the KNOW-HOW of 30 years refrigeration specialists with 23 years compressed air drying specialists.
- Experience superiority has produced this new and unique, vertical heat exchanger model, with all smooth-wall heat exchange surface areas. Welded joint construction eliminates all conventional design leak areas to provide a maintenance free, non-fouling, self-cleaning flow through concept.
- ZURN-GENERAL energy savings range from 4.5% to 27.5%, drying an average of 206 SCFM per refrigerant horsepower, average based upon all models from 10 SCFM to 2000 SCFM, operating at 100 PSIG, 100°F inlet air, 100°F ambient, and 35°F dewpoint.
- Industry has installed hundreds of these new units and has proved the superiority and reliability of this design. And now, only you can prove it to yourself.

DESIGN RATINGS

DESIGN PRINCIPLE is based upon selection of either air-cooled or water-cooled condensing units and air-to-liquid refrigerant heat exchangers for maximum efficiency under no load to constant or intermittent maximum flow and temperature conditions.

WATER REQUIREMENTS (Water-cooled units only)

Differential Pressure: 20 psig minimum

Cooling Water Temperature:

50°F – .21 gpm/100 scfm	80°F – .46 gpm/100 scfm
60°F – .26 gpm/100 scfm	(max)90°F – .76 gpm/100 scfm
70°F – .33 gpm/100 scfm	

Note: Water flow is automatically modulated from minimum-gpm to maximum-gpm, dependent on workload.

CAPACITIES

No load to constant maximum flow capacity @ 100°F inlet, 100°F ambient.

TEMPERATURES

Ambient temperature range of operation:

Standard unit; 35°F to 110°F, air-cooled.
Standard unit; 35°F to 150°F, water-cooled.
With low-temperature package; -20°F to 110°F

Inlet Air Temperature: 40°F to 150°F (Temperatures above 100°F require special controls and/or adjustments.)

HEAT REJECTION

Air-cooled units:	Approximately 100 BTU/min per 100 scfm to ambient
Water-cooled units:	Approximately 92 BTU/min per 100 scfm to water
Water-cooled units:	Approximately 8 BTU/min per 100 scfm to ambient

Conditions for rating compressed air dryers are in accordance with NFPA Recommended Standard, NFPA/T3.27.2-1975.

35°F DEWPOINT RATINGS – ENGINEERING DATA

Models R15A and larger are manufactured according to the current ASME code

MODEL NO. (1) and (5)	MWP PSIG (2)	SCFM Capacity @ 100 PSIG and 100°F Inlet — DEWPOINT 35°F	SCFM Capacity — DEWPOINT 50°F (6)	REFRIGERATION DATA HP	REFRIGERATION DATA Voltage (3)	Air Connections Inlet and Outlet	DIMENSIONS (4) Width	DIMENSIONS (4) Depth	DIMENSIONS (4) Height	Approximate Weight (lbs.) (7)
R2A	200	10	13	1/8	115/1/60	3/8" O.D. Tubing	18-1/2"	12"	14-3/8"	74
R3A	"	15	15	1/6			19"	14-1/8"	14-1/8"	76
R5A	"	30	39	1/5		5/8" O.D. Tubing	31-1/2"	20"	20"	114
R10A	"	60	60	1/3				20"	20"	151
R15A	"	90	117	1/2	208-230/1/60 Option (A-C)	1" NPT	28-1/4"	22-1/8"	46-1/8"	455
R18W	"	100	130	1/2						450
R20A	"	125	160	3/4	208-230/1/60 Options (C-D) All					465
R25W	"	140	160	3/4						460
R40A	"	200	260	1-(A)		2" NPT	29-1/4"	22-1/8"	50-1/8"	570
R45W	"	225	292	1-(A)						570
R55A	"	275	325	1-1/2	(E)		34-1/4"	24-1/8"	58-1/8"	668
R65W	"	325	325	1-1/2	(E)					734
R100A	"	500	650	2	(E)	3" NPT	52-1/4"	36-1/8"	65"	1,300
R110W	"	550	715	2	(E)					1,460
R140A	"	700	750	3	(E)					1,550
R150W	"	750	750	3	(E)					1,460
R200A	"	1,000	1,300	5	208-230/3/60 Option (D) All	4" NPT	72-1/8"	36-1/4"	71"	2,400
R220W	"	1,100	1,430	5						2,400
R320A	"	1,600	2,080	7-1/2						2,680
R360W	"	1,800	2,200	7-1/2	(E)					2,600
R440A	"	2,200	2,860	10	440/3/60 460/3/60 480/3/60 Other Voltages Optional At Extra Cost	6" FLG.	See Form No. GAD-E-2-76 Rev. (1) or Contact the Factory			
R480W	"	2,400	3,120	10						
R590A	"	2,950	3,835	15						
R660W	"	3,300	4,290	15						
R690A	"	3,450	4,400	17-1/2						
R770W	"	3,850	4,400	17-1/2						
R880W	"	4,400	4,400	20						
R940A	"	4,700	6,110	25		8" FLG.				
R1050W	"	5,250	6,150	25						
R1100A	"	5,500	6,150	30						
R1230W	"	6,150	6,150	30						
R1480A	"	7,400	9,620	40		10" FLG.				
R1650W	"	8,250	10,725	40						
R1980A	"	9,900	11,100	50						
R2200W	"	11,100	11,100	50						
R2640A	"	13,200	17,160	60		12" FLG.				
R3000W	"	15,000	17,500	60						
R3100A	"	15,500	17,500	75						
R3500W	"	17,500	17,500	75						
R4180A	150	20,900	27,170	100						
R4600W	"	23,000	29,000	100						
R5400A	"	27,000	29,000	125						
R5800W	"	29,000	29,000	125						

(1) Suffix Letter "A" indicates Air-Cooled; "W" indicates Water-Cooled.
(2) Higher Working Pressures Available.
(3) Voltages shown are standard. Other Voltages available at extra cost.
(4) Dimensions subject to change without notice.
(5) Models R2A through R360W are Cabinet Style.
(6) Models R2A through R360W for 50°F Dewpoint applications require special factory control settings. 50°F Dewpoint **MUST** be specified on the purchase order. Refer to page 4 for 50°F dewpoint rated units for capacities to 2400 SCFM, or contact the factory for pressure drop-vs-capacity data for flows in excess of the maximum 5-PSI pressure drop ratings. Standard pressure drops range from less than 1-PSI to a maximum 5-PSI.
(7) Weights shown are not to be used for positive freight costs; contact factory.

Optional Voltages:
(A) 115/1/60
(B) 208-230/1/60
(C) 208-230/3/60
(D) 440-480/3/60
(E) 550/3/60

Other 50° F Dewpoint Models are listed on the next page.

STANDARD FEATURES

Model R2A has no start switch. Models R3A and larger have off/on switch. All models except R2A and R3A are equipped with an on/off indicator light, and "dead-system" air pressure control switch for automatic shutdown/startup on air system pressure loss.

STANDARD INSTRUMENTATION INCLUDED AS SHOWN

Model No.	Exit Air Dewpoint Gauge	Exit Air Pressure Gauge	Inlet Air Temperature Gauge	Refrigerant High and Low Pressure Gauges	High Temperature Red Indicating Light	Automatic Drain Float Trap	Automatic Drain ST-3 Single Timer	Automatic Drain DT-2 Dual Timer
R2A thru R10A						X		
R15A thru R110W	X	X				X		
R140A thru R150W	X	X	X	X		X		
R200A thru R360W	X	X	X	X	X		X	
R440A and larger	X	X	X	X	X			X

APPENDIX F

CURRENT ELECTROMOTIVE DIVISION TURBOCHARGER DRIVE CONVERSION POLICY

ELECTRO-MOTIVE

Electro-Motive Division General Motors Corporation LaGrange, Illinois 60525 (312) 387-6000

October 18, 1978

Mr. Harvey W. Hanners
Senior Research Engineer
University of Dayton
300 College Park Ave.
Room 163A
Dayton, OH 45469

Dear Mr. Hanners:

Your October 5 letter asks for confirmation of our information given in our phone conversation approximately a week ago having to do with the conversion of certain turbochargers to the heavy duty gear type. You mentioned particularly 20 cylinder engines.

While many, in fact most, of the engines in emergency standby service at the various nuclear power plants are 20 cylinder left-hand rotation engines, some of these engines are 16 and 12 cylinder and a few are right-hand rotation. The right-hand rotation engines are used where there is a tandem installation with two engines driving a single generator. I am, therefore, including information to cover all of these various types.

A description of the job that would be done and an estimated cost of it for each of the different types are as follows:

Section 1. Conversion of 12, 16, and 20 cylinder turbos from E4 (Industrial, Standard Gear Ratio) left-hand rotation to E9 (Industrial, Heavy Duty Gear Ratio) left-hand rotation.

1A. Gear Conversion Only: $ 9550.

Includes renewal of complete turbine wheel assembly, clutch assembly, carrier shaft assembly, idler gear, idler gear stubshaft and retainer plate, carrier drive gear, and turbine inlet scroll support. Also includes modification to idler gear support and redoweling.

1B. Turbo Upgrade: $ 575.

This includes modifications to bring turbo up to latest E9 specifications, such as pressurized exhaust duct drain arrangement, "no spin" compressor bearing, and chrome sealing rings.

Section 1 (Con't)

1C. Turbo Basic $ 1400.

This includes disassembly, cleaning, inspection, reassembly with new gaskets, seals, nuts and bolts, turbo test and paint.

Since we cannot sell the gear conversion only, as listed in 1A, the total estimated conversion sell price would be the sum of 1A., 1B., and 1C., or $11,525.

1D. Unit Exchange Repairs: $ 3000.

Many of the elements usually included in average turbo repair have already been considered in above conversion breakdown, including turbine wheel and clutch. Additional repairs required will depend on condition of Bad Order Return. However, it is estimated that an additional $3000. will cover "normal" remanufacture for components not previously covered, such as turbine inlet scroll, both diffusers, nozzle ring, impeller cover, and main doweling components. Severe damage to main doweling components will elevate charges past $3000.

Total Unit Exchange charge for remanufacture and conversion is estimated as follows:

Conversion Estimate = $11,525.
Estimated Remanufacture Range = $ 500. to $ 3000.

Section 1. Total = $12,025 to $14,525.

Section 2. Conversion of 12, 16, and 20 cylinder turbos from E5 (Marine, Standard Ratio) right-hand rotation to E5 (Marine, Heavy Duty Ratio) right-hand rotation.

2A. Gear Conversion Only: $ 8900.

Same as 1A., except does not include idler gear renewal, idler gear support modification, or redoweling.

2B. Turbo Upgrade: $ 100.

Includes modification to exhaust duct for pressure drain arrangement.

2C. Turbo Basic: $ 1400.

Same as listed for 1C.

Total estimated conversion sell price $10,400.

2D. Unit Exchange Repairs: $ 3,000.

Same estimate as 1D.

Total unit exchange charge for remanufacture and conversion is estimated as follows

Conversion Estimate = $10,400.
Estimated Remanufacture Range = $ 500. to $ 3,000.

Section 2. total = $10,900. to $13,400.

Please keep in mind that these are not firm prices. These estimates should be considered reasonable until April 1979.

I am also attaching a sheet which is entitled simply "Turbocharger" which lists in the first column the various types of engines and it shows in the other columns part numbers for new and unit exchange turbochargers of both the standard gear and heavy duty type. From this listing anyone owning an engine of this kind can determine which turbocharger he now has and by finding that part number in the second column can refer then to the final column showing the utex number of the heavy duty gear turbocharger that will replace what he now has.

Customer should order the heavy duty gear utex number that he wants from our Rebuild Dept. here at LaGrange and specify that he will be returning the turbocharger under whatever number his turbocharger now bears. This part number is on a nameplate on the turbocharger. At the same time he should order a new drive gear if he needs one and the information for that is also given on this same table.

EMD will ship him the turbocharger he has ordered and once he has this on hand on his property he can then make arrangements to trade the replacement turbo for the one now on the engine, returning the removed turbo to the EMD Rebuild Dept. His invoice, as explained in the cost estimates above, will be partially determined by the condition of the turbo that he returns.

The warranty on any unit exchange turbocharger is for one year starting the day it is placed in service.

Your statement that the gear drive is understood to be capable of carrying the turbocharger drive load with the engine at no load and full speed, as currently practiced in nuclear power plants, is essentially true. There is an estimated time limit of 2000 hours running under these conditions. However, with the way nuclear power plant protection engines are operated, this number of hours represents a good many years of operation.

I would like to state one more time that EMD does not recommend the operation of an engine at full speed no load whether or not it is equipped with heavy duty turbos. Such operation is not only hard on the turbocharger, but will affect the life of many other parts in the engine also. We continue to feel that efforts must be made to eliminate the need for such operation, particularly when the engine is in such critical service as these are.

If there is any other information I can furnish, please advise.

Very truly yours,

W. A. Gardner

W. A. Gardner, Assistant
General Service Manager
Marine & Industrial

WAG/pl

Encl.

TURBOCHARGER

TYPE OF ENGINE	PRESENT NEW	(STANDARD GEAR) UTEX	FUTURE NEW	(HEAVY DUTY GEAR) UTEX
12-645 LH	8386855	8413708	8491383	8492060
16-645 LH	8368223	8372778	8491823	8492861
20-645 LH	8366072	8377586	8491825	8492062

NOTE: THE PRESENT 8419151 DRIVE GEAR MUST BE REPLACED BY 8449231 WHEN ANY OF THE ABOVE TURBOS ARE CONVERTED

12-645 RH	8369663	8379297	9336195	9084531
16-645 RH	8363760	8379295	9084533	9087158
20-645 RH	8374986	8380125	9085863	9093612

NOTE: CONVERSION OF RH ENGINE TURBOS DOES NOT REQUIRE DRIVE GEAR REPLACEMENT, THEY ARE NOW EQUIPPED WITH 8449231

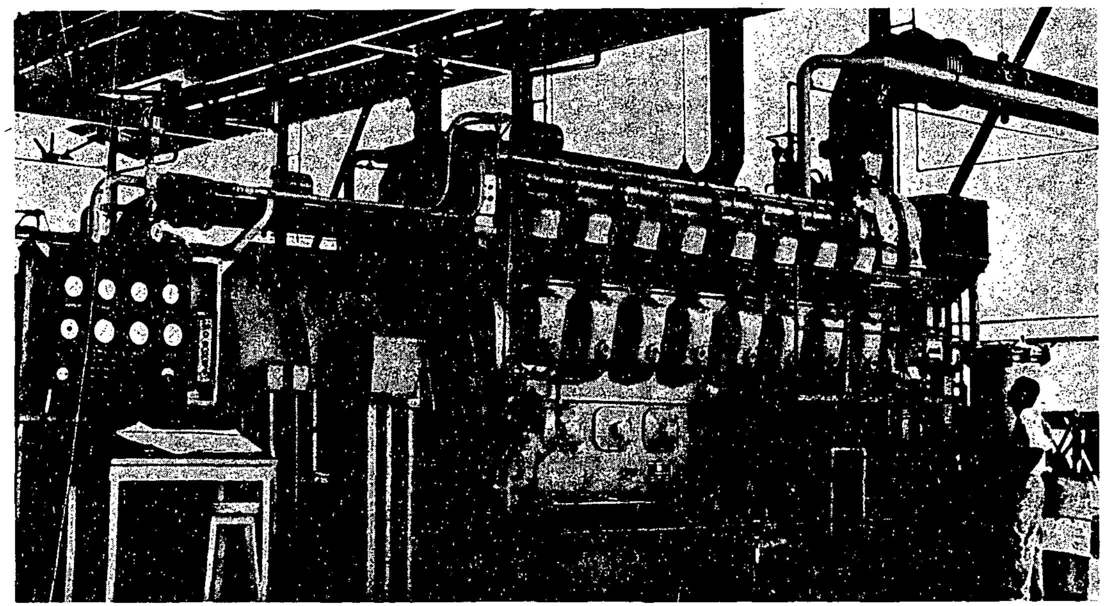
APPENDIX G

DIESEL ENGINE MANUFACTURERS - COPIES OF SELECTED LITERATURE

General Specifications of the Alco 251 diesel.

EMERGENCY STANDBY GENERATOR SETS

No. of Cylinders	6			8			12			16			18	
R.P.M. Range	900—1200			900—1000			900—1200			900—1200			900—1000	
R.P.M.	1200	1000	900	1000	900		1200	1000	900	1200	1000	900	1000	900
B.H.P. Continuous	1535	1415	1275	1650	1500		3070	2830	2550	4100	3520	3150	4400	3970
B.M.E.P. P.S.I.	252	280	280	245	245		252	280	280	252	260	260	290	290
K.W. Continuous	1100	1010	912	1175	1075		2200	2020	1825	2950	2520	2250	3170	2850
Model No.-251	G	G	G	F	F		G	G	G	G	G	G	G	G



ALCO 16-cylinder 9x10½ Model 251 engine generating unit operating in Sumatra.

4-CYCLE ENGINES

All Cooper-Bessemer four cycle engines are turbocharged and intercooled for maximum efficiency, low fuel consumption, and high power-to-space ratio. All utilize a Cooper-Bessemer designed and manufactured turbocharger and can be supplied to operate in the full diesel or dual fuel mode. Spark ignited gas or heavy oil versions are available.

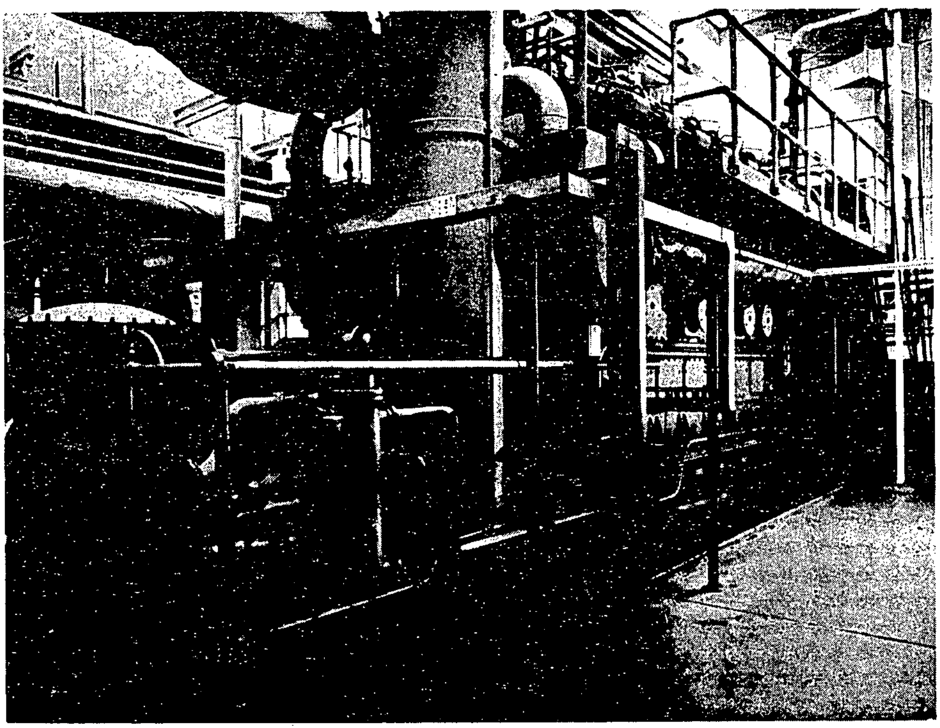
Note that the ratings listed are for continuous duty with an ambient temperature of 100°F from sea level to 5000 feet elevation without derating. Also, the continuous duty rating can be exceeded by 10% for two hours out of twenty-four. Higher than listed ratings may be permitted for intermittent standby or emergency service.

These engines have distinguished themselves for outstanding efficiency, flexibility and reliability in a wide range of applications including electric power generation, compressor drive, pump drive, marine propulsion, and nuclear emergency service.

CONTINUOUS DUTY RATINGS

Model	Cyl.	Bore & Stroke	HP	KW	RPM	Approx. Weight	Bulletin No.
LSV-12	12	15½ x 22	4657	3360	400	197,500	77
LSV-16	16	15½ x 22	6209	4480	400	237,500	77
LSV-20	20	15½ x 22	7762	5600	400	285,500	77
KSV-12	12	13½ x 16½	4294	3100	600	79,500	119
KSV-16	16	13½ x 16½	5725	4130	600	106,000	119
KSV-20	20	13½ x 16½	7157	5165	600	132,000	119

Nebraska Public Power District - Cooper Nuclear Station, Brownville, Nebraska.
KSV-16-T standby diesel generator set. Ratinas of 5560 BHP at 600 RPM.



NUCLEAR STANDBY EMERGENCY GENERATOR UNITS.

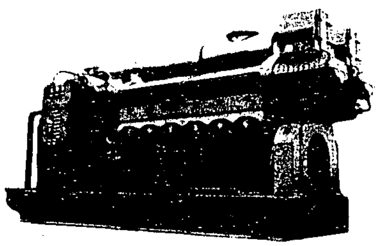
Instead of designing a new diesel to meet the demanding requirements of this situation, we adapted the design of our proven KSV. Peak rated at 3855, 5140, and 6425 k.w., the KSV has the best HP-to-space ratio of any engine in its class. In addition, the KSV is one of the Cooper-Bessemer V-type engines which have proven their dependability in 6,000 applications representing well over nine million HP and 450 million operating hours. Most important of all, the KSV can go from an ambient cold start to full RPM-full voltage in under 10 seconds, and in just 20 more seconds, pick up full load. Also, our KSV standby system meets the strict seismic qualifications of the Atomic Energy Commission.

STATIONARY POWER & INDUSTRIAL APPLICATIONS

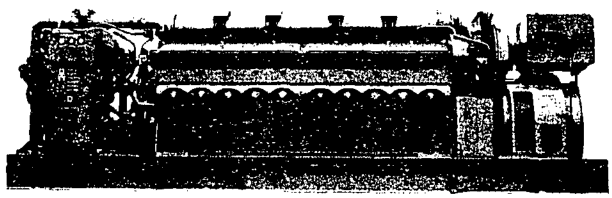
EMD Stationary Units provide 800 to 3600 gross horsepower for generator set and mechanical drive applications using the roots blown type and turbocharged Series 645 engines.

These modern, proven heavy duty units have been applied as base load generating sets in remote locations, emergency standby sets in hospitals and nuclear power generating plants as well as pipeline and dredge pump duty.

S12E1 — Power Take Off Unit



S20E4 Generating Unit



STATIONARY POWER UNIT RATINGS

Model Designation	Engine Model	Full-Load Rated Speed RPM	Brake-HP Continuous	BMEP Nominal
S8E1	8-645E1	720/750	800	85/82
		900	975	83
S12E1	12-645E1	720/750	1200	85/82
		900	1500	85
S16E1	16-645E1	720/750	1575	82/81
		900	1950	83
S8E4	8-645E4	720/750	1200	128/123
		900	1525	130
S12E4	12-645E4	720/750	1830	130/125
		900	2305	131
S16E4	16-645E4	720/750	2460	131/126
		900	3070	130
S20E4	20-645E4	720/750	3055	130/125
		900	3600	123

E1-Engines — Roots Blown Type, E4-Engines — Turbocharged

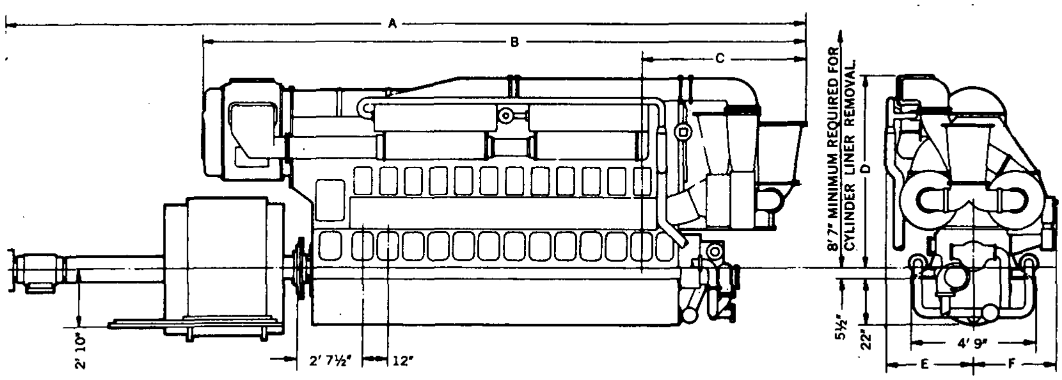
The Stationary Power Units can be provided with the Electro-Motive Model A-20 alternator at 480, 600 and 2400/4160 Volts with a maximum continuous kilowatt rating of 1600, 2100 and 2600 kw 0.8 power factor. The 2400/4160 volt A-20 generator also is available at a 2850 kw 0.8 power factor rating for peaking service (2000 Hr./Yr.).

The turbocharged 645 Series engine is available for tandem applications where power requirements exceed the capability of a single engine.

Fairbanks Morse and Colt-Pielstick Diesels

Colt Industries
Fairbanks Morse Engine Division

MODEL 38D8-1/8 SERIES TURBOCHARGED STATIONARY ENGINES

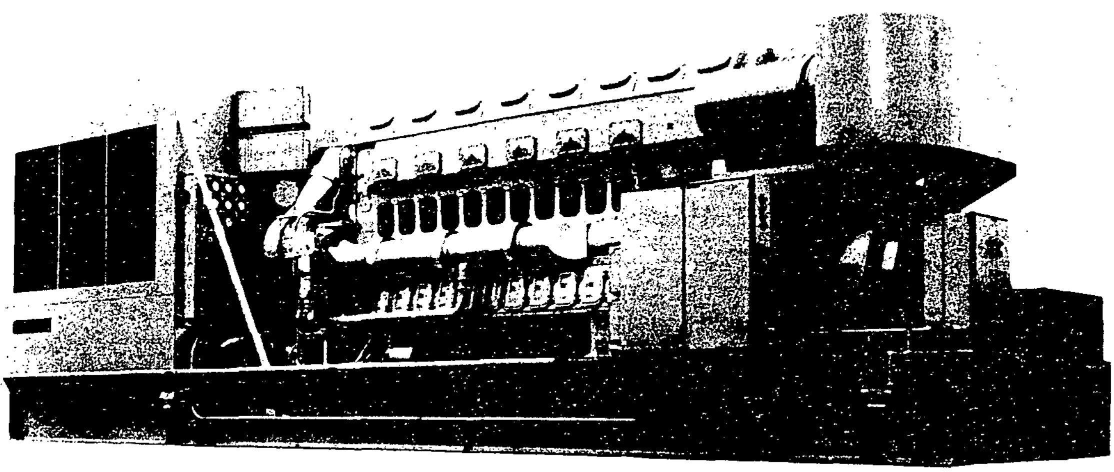


MODELS 38TD8-1/8 TURBOCHARGED OIL DIESEL ENGINE AND 38TDD8-1/8 TURBOCHARGED DUAL FUEL ENGINE GENERATOR SETS

KW	RPM	CYL.	A	B	C	D	E	F
1135/1560	720/900	6	22'6"	15'2"	4'11"	7'6"	3'8"	2'11"
1705/2345	720/900	9	26'0"	19'1"	5'9"	7'8"	3'5"	3'5"
2275/3125	720/900	12	30'3"	23'9"	6'7"	7'10"	3'5"	3'6"

*Dimension A is overall length of unit with engine type alternator and belted exciter. Dimension B is overall length of unit with bracket type alternator and top mounted exciter.

All drawings are for illustrative purposes only. For installations obtain certified prints.



A skid mounted opposed piston engine and alternator. This unit has radiator cooling.

All ratings subject to factory approved application.

APPENDIX H

COMMENTS ON SPECIFICALLY APPLICABLE DOCUMENTS

H-1 Diesel Generator Operating Experience at Nuclear Power Plants
AEC Report No. OOE-ES-002 June 1974.

The above referenced report, AEC Report No. OOE-ES-002 June 1974, was used as a basis in the current reliability survey with considerable expansion in scope and detail with particular emphasis on the "root cause" approach to improvement of reliability. Efforts were concentrated on the identification of the basic causes of operational problems and the recommended solutions to them with only a minimal use of statistics. The common base for both programs was the LER's.

H-2 Dormancy vs. Over-Testing and the Effect on Diesel Generator Availability.
IEEE Paper 76 619-7.

This is an excellent document which takes a more realistic approach to the actual conditions prevailing in a nuclear power plant regarding the diesel-generator emergency standby units. Definitions of terms used are clearly stated and the relationships are expressed in mathematical terms. Particular value is attached to the concept of "Dormant Failures", and that of decreasing reliability caused by "excessive testing". The author clearly presents the proposition that the emergency service requirements of quick starts and high loading may constitute truly severe service.

The statement that operating failures are about a hundred times more prevalent than dormant failures is questioned. For example, when failure to start occurs as a result of water in the starting air formed during the dormant period, then this should be called a dormant failure from a "root cause" standpoint and not an operating failure as defined. Electrical contactor and relay malfunctions caused by dirt getting between the contacts during the dormant period is another example. In fact, water and dirt are the two most common traceable "root causes" of failures. The concept of dormant failure is excellent, but the identification as such is a problem.

H-3 IEEE 1974 Power Generation 74CH0949-8PWR
Conference Papers from the Joint Power Generation Conference
Miami Beach, Florida

Diesel Generation Site Testing for Nuclear Power Plants
C-74502-1

An excellent description of an actual "on the site qualification testing program for the diesel generators" at the Prairie Island Nuclear Generating Station at the Northern States Power Company.

It is interesting to note that the only temporarily disabling mishaps in this test program were the two most prevalent problems encountered in this reliability program of 1977-1978 covering 65 power plants. These problems were: water in the starting air and dirt. Refer to the bottom of page 1, Phase I Test Results items 1 and 2.

Comment: This report is concise and complete.

Fulton Station Plant Dynamic Simulation - C 74503-9

Extreme sophistication of control system is indicated for "design logic."

Comment: This is an excellent reference and should be respected.

Proposed Guidelines for Qualifying A Diesel Generator
Unit for Nuclear Standby - C 74505-4

"Philosophy" is effectively expressed regarding ratings. Paper points out basic troubles are water, dirt, etc. as expressed on page 3, bottom left hand column. Undue emphasis as usual on the seismic.

Comment: Seismic problems tend to be strongly emphasized mathematically and scientifically while overlooking the operational problems caused by dust, dirt, and water.

Design and Manufacture of a Diesel Engine to Meet Design Criteria for Application to Nuclear Power Plants - C 74506-2

Emphasizes need for separate prepositioning of fuel rack control to at least a 50 percent load position as part of the starting requirements.

Comment: Very complete paper on power plant construction with respect to the diesel generators.

Operating Experience with Emergency Diesel Generators at Turkey Point Plant - C 74508-8

Rust in the starting air is a major cause of malfunction. Several "unknown" failures. Emphasis on testing and better matching of original characteristics of components.

Comment: The experience here is all too typical in other plants having GM engines with air cranking motors. The attitude generated by the starting trouble seems to be one of resorting to redundant components. This leads to automatic repetitive start signals and also to duplicate and automatically alternate sets of starting motors operating in pairs with two motors on one side of the engine and the duplicate pair on the other side of the engine.

Protective Relaying - McGuire Nuclear Station - C 74513-8
Duke Power Company

Electrical System Problems and Protection covered only.

Comment: Good coverage.

Electrical Protection Features of The Jocasse Pumped-Storage Plant - C 74514-6

A very good paper on the problems and solutions of starting large motors driving water pumps. Partial voltage and stepped starting schemes are covered to reduce starting shocks and reduced maximum power demands during starting.

Comment: Serious consideration should be given to this possibility. Obviously the very same scheme cannot be used with a diesel generator unit, but the basic principle can apply.

H-4 Maintenance and Operation of Nuclear Diesel Generator Systems
by M.J. Melmich-Cooper Energy Services
ASME Technical Paper 77-DGP-14

A description is given of (1) an engine designed for nuclear power plant standby service; (2) a review of the operating experience of five such engines; and (3) a maintenance and test procedure. Particular attention is called to a systematic procedure for determining the need for attention or servicing of various items as based on operating logs or data. Preventative maintenance is also emphasized. The Cooper-Bessemer KSV engine is also described in detail as a basis for the experience related.

H-5 A Versatile Two-Cycle Diesel Engine - The EMD Model 645 Series
by M. Ephraim, Jr., J.J. Kotlin and H.A. Williams, Jr.
of Electromotive Division of General Motors
ASME Technical Paper 76-DGP-5

The improvements of the current Model 645 engine over that of the previous Model 567 are described in detail both in design and performance. Detailed reasons and explanations are given for the changes made and the improvements obtained in most of the important engine components of this well known locomotive engine now used in a variety of heavy duty services.

H-6 Quality Assurance - The Critical Function
(This article is part of the News Letter)
by Clifford L. Harrison of Avco Lycoming
ASME News Letter
Production Engineering Division - Winter 1978

The relation of the quality assurance (Q.A.) responsibility to other departments of a manufacturing activity is covered as frequently practiced and also attention is called to desirable practices and relationships. Quality assurance requirements are mentioned for many U.S. Federal government agencies such as the military in Mil-Q-9858A, FAA, AEC, FDA, NATO, and NASA. Similar requirements for Marine licensing must be given to: Lloyd's Register of Shipping (British), Norske Veritas (Norwegian), Bureau Veritas (French), and the American Bureau of Shipping (ABS United States).

H-7 Power Generation for High Reliability Quadruple-Diversity Communication Systems, January, 1963 - AD 601252

Comment: Basic planning of an emergency power plant system is given from the standpoints of various power buses and the number of diesel generator units and arrangement or disposition of the several units.

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U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

1. REPORT NUMBER (Assigned by DDC)
NUREG/CR-0660

4. TITLE AND SUBTITLE (Add Volume No., if appropriate)
Enhancement of On-Site Emergency Diesel Generator Reliability #UDR-TR-79-07

2. (Leave blank)

3. RECIPIENT'S ACCESSION NO.

7. AUTHOR(S)
Gerald L. Boner & Harvey W. Hanners, University of Dayton

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9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)
University of Dayton Research Institute
Dayton, Ohio 45469

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Division of Operating Reactors
Washington, D. C. 20555

10. PROJECT/TASK/WORK UNIT NO.

11. CONTRACT NO.
NRC-03-77-192

13. TYPE OF REPORT
This report establishes the Emergency Diesel generator operating difficulties and presents University of Dayton's Recommendations

PERIOD COVERED (Inclusive dates)
1969 to January 1978

15. SUPPLEMENTARY NOTES

14. (Leave blank)

16. ABSTRACT (200 words or less)

The University of Dayton Research Institute has concluded a program designed to provide NRC/DOR with technical assistance in evaluating the factors leading to improved reliability of on-site emergency diesel generator (DG) units. The program consisted of a comprehensive review of DG maintenance and operating experience and a comparative evaluation of the DG manufacturer's recommendations. This information, will enable the NRC to improve the basis on which it makes regulatory decisions. The primary goal of the program is to better identify the main problem areas which decrease the reliability of the DG units and make recommendations.

The report has attained the program objectives by identifying and discussing the more significant problems and presenting the recommended corrective actions. The identified problems have been categorized into three groups as a function of their significance.

17. KEY WORDS AND DOCUMENT ANALYSIS

17a. DESCRIPTORS

17b. IDENTIFIERS/OPEN-ENDED TERMS

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