ATTACHMENT 3 TO TXX-94118

AFFECTED TECHNICAL SPECIFICATION PAGES

(NUREG-1468)

ELECTRICAL POWER SYSTEMS

LIMITING CONDITION FOR OPERATION (Continued)

ACTION (Continued)

offsite source restored, restore at least two offsite circuits to OPERABLE status within 72 hours from time of initial loss or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

f. With two of the above required diesel generators inoperable, demonstrate the OPERABILITY of two offsite A.C. circuits by performing Surveillance Requirement 4.8.1.1.1a. within 1 hour and at least once per 8 hours thereafter; restore at least one of the inoperable diesel generators to OPERABLE status within 2 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours. Restore at least two diesel generators to OPERABLE status within 72 hours from time of initial loss or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.8.1.1.1 Each of the above required independent circuits between the offsite transmission network and the Onsite Class 1E Distribution System shall be:

a. Determined OPERABLE at least once per 7 days by verifying correct breaker alignments, indicated power availability, and

b. Demonstrated OPERABLE at least once per 18 months during shutdown by transferring (manually and automatically) the 6.9 kV safeguards bus power supply from the preferred offsite source to the alternate offsite source.

4.8.1.1.2 Each diesel generator shall be demonstrated OPERABLE:

a. In accordance with the frequency specified in Table 4.8-1 on a STAGGERED TEST BASIS by:

1) Verifying the fuel level in the day fuel tank,

2) Verifying the fuel level in the fuel storage tank,

3) Verifying the fuel transfer pump starts and transfers fuel from the storage system to the day fuel tank,

4) Verifying the diesel starts from ambient condition and accelerates to at least 441 rpm in less than or equal to 10 seconds.* #

Per 184 days. All other engine starts for performance of this surveillance, may use a diesel generator start involving gradual acceleration to synchronous speed as recommended by the manufacturer.

*All planned diesel engine starts for the purpose of this surveillance may be preceded by a prelube period in accordance with vendor recommendations.

The diesel generator start time (10 seconds) shall be verified at least once

ENCLOSURE 1 TO TXX-94118

NUREG-1431 - TECHNICAL SPECIFICATIONS FOR
WESTINGHOUSE PLANTS
SEPTEMBER 1992

PAGES 3.8-6, 3.8-8 AND 3.8-17

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.1.1	Verify correct breaker alignment and indicated power availability for each [required] offsite circuit.	7 days
SR 3.8.1.2	-------------------NOTES------------------- 1. Performance of SR 3.8.1.7 satisfies this SR. 2. All DG starts may be preceded by an engine prelube period and followed by a warmup period prior to loading. [3. A modified DG start involving idling and gradual acceleration to synchronous speed may be used for this SR as recommended by the manufacturer. When modified start procedures are not used, the time, voltage, and frequency tolerances of SR 3.8.1.7 must be met.] --- Verify each DG starts from standby conditions and achieves steady state voltage ≥ [3740] V and ≤ [4580] V, and frequency ≥ [58.8] Hz and ≤ [61.2] Hz.	As specified in Table 3.8.1-1

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.1.7	------------------NOTE------------------ All DG starts may be preceded by an engine prelube period. -- Verify each DG starts from standby condition and achieves in ≤ [10] seconds, voltage ≥ [3740] V and ≤ [4580] V, and frequency ≥ [58.8] Hz and ≤ [61.2] Hz.	184 days
SR 3.8.1.8	------------------NOTES------------------ 1. This Surveillance shall not be performed in MODE 1 or 2. 2. Credit may be taken for unplanned events that satisfy this SR. -- Verify [automatic [and] manual] transfer of AC power sources from the normal offsite circuit to each alternate [required] offsite circuit.	[18 months]

(continued)

Table 3.8.1-1 (page 1 of 1)
Diesel Generator Test Schedule

NUMBER OF FAILURES IN LAST 25 VALID TESTS[a]	FREQUENCY
≤ 3	31 days
≥ 4	7 days[b] (but no less than 24 hours)

(a) Criteria for determining number of failures and valid tests shall be in accordance with Regulatory Position C.2.1 of Regulatory Guide 1.9, Revision 3, where the number of tests and failures is determined on a per DG basis.

(b) This test frequency shall be maintained until seven consecutive failure free starts from standby conditions and load and run tests have been performed. This is consistent with Regulatory Position [ ], of Regulatory Guide 1.9, Revision 3. If, subsequent to the 7 failure free tests, 1 or more additional failures occur, such that there are again 4 or more failures in the last 25 tests, the testing interval shall again be reduced as noted above and maintained until 7 consecutive failure free tests have been performed.

Note: If Revision 3 of Regulatory Guide 1.9 is not approved, the above table will be modified to be consistent with the existing version of Regulatory Guide 1.108, GL 84-15, or other approved version.

ENCLOSURE 2 TO TXX-94118

NUREG-1366, IMPROVEMENTS TO TECHNICAL SPECIFICATIONS
SURVEILLANCE REQUIREMENTS
DECEMBER 1992
PAGES 16 AND 53 THROUGH 59

water hammer could not occur), operators and health physicists who must climb ladders to the top of a tank farm must be dressed in protective clothing because the tank farm is a radiation area.

At another PWR, the surveillance on the containment area high radiation monitor requires that a heavy (because of shielding) high-level source be lowered to the monitor.

The current industry effort on advanced reactor designs should include a study of how all required surveillance testing will be performed in order to (1) minimize the possibility of a transient caused by testing, (2) minimize the burden on plant personnel who will have to perform these tests, and (3) minimize the radiation exposure received by people in performing the required testing.

3.10 Surveillance Testing and Power Reductions

Some surveillance tests in both PWRs and BWRs require power reductions in order to prevent a transient that can trip the reactor. In a PWR, a power reduction is necessary for stroking turbine valves. In a BWR, there are three tests that typically require a reduction in power: MSIV testing, control rod movement testing, and turbine valve stroking. Therefore, another incentive for eliminating unnecessary testing is the increase in capacity factor if such testing were done at a reduced frequency.

3.11 Surveillance Testing and Equipment Wear

Equipment is sometimes operated in a different way for surveillance testing than the way it would be used performing its design function. A simple example is an injection pump which, when tested, recirculates water back to a tank through a line that is smaller in diameter than the normal injection line, thus making the pump operate off its best efficiency point which degrades the pump. discussed in more detail later.

Electrical and electronic equipment wears or breaks fro unplugging and removing equipment from cabinets f testing or from lifting leads and using jumpers.

The use of valves for isolation or flowpath change caus leaks around the valve packing and other valve or val actuator problems.

The testing of an emergency diesel generator in its eme gency mode induces thermal stresses and causes oth problems which are discussed later in this report.

Thus, the importance of the test must be balanced again considerations of wear on equipment as well as on oth considerations.

3.12 Surveillance Testing on a Staggered Test Basis

Staggered testing is the scheduling of tests for the subsy tems or trains of a system in which the surveillance te interval is divided into a subinterval for each subsystem o train.

The advantage to testing on a staggered test basi a the chances of a common-mode failure and equipmen unavailability are reduced. A staggered test basis can hav disadvantages.

One resident inspector stated that, at his plant, this typ of testing requires additional licensed operators and over time for operators. It also requires more individu entries into protection cabinets which causes schedulin problems for licensees and may increase the chance of reactor trip. It can also extend the time required to pe form surveillance tests by requiring initial setup time f test equipment to be repeated for each test rather th setting up just once.

10 ELECTRIC POWER

10.1 Emergency Diesel Generator Surveillance Requirements (PWR, BWR)

Corresponding to their importance to safety, emergency diesel generators (EDGs) have the most detailed Technical Specifications surveillance requirements of any piece of mechanical or electrical equipment in a nuclear power plant. Surveillance requirements for EDGs are currently based on Regulatory Guides 1.108 and 1.9.

The safety function of the diesel generators is to supply ac electrical power to plant safety systems whenever the preferred ac power supply is unavailable. Through surveillance requirements, the ability of the EDGs to meet their load and timing requirements is tested and the quality of the fuel and the availability of the fuel supply are monitored.

As part of the resolution of Unresolved Safety Issue (USI) A-44, "Station Blackout," the NRC staff has prepared Regulatory Guide (RG) 1.155 to provide guidance on EDG reliability levels. RG 1.155 also specifies that the reliable operation of onsite emergency ac power sources should be ensured by a program designed to maintain and monitor the reliability level of each power source over time to ensure that the selected reliability levels are being achieved.

Generic Safety Issue (GSI) B-56, "Diesel Reliability," was established to develop guidelines for an EDG reliability program. In addition to these efforts, the Office of Nuclear Regulatory Research (RES) is conducting the Nuclear Plant Aging Research (NPAR) Program, which is intended to resolve technical safety issues related to the aging degradation of equipment important to reactor safety. An important part of this program is the study of the aging of emergency diesel generators.

The results of these programs were reviewed as part of this study to determine how these programs will affect surveillance requirements for EDGs in the Technical Specifications.

The current performance requirements are stringent. The EDG must start on any of several signals (e.g., manual actuation, safety injection, or loss of normal power to an emergency bus), increase to rated speed in a short time (e.g., 10 seconds), and pick up its emergency load in blocks at programmed times (load sequencing). These times are relatively short and are set by the requirements of the large-break loss-of-coolant accident (LOCA).

Research done by NRC and the industry has shown that some of the assumptions in the analysis of the LOCA, required by 10 CFR 50.46 and Appendix K to 10 CFR Part 50, are very conservative. In addition to the conservative nature of the regulations, other conservatisms have been included in the vendors' LOCA models. SECY-83-472 provides a method to eliminate those conservatisms not specifically required by the regulations.

Under the sponsorship of the Electric Power Research Institute (EPRI), calculations were performed, using the methods given in SECY-83-472, that show margin is available to the criteria of 10 CFR 50.46 that could be used to extend the EDG start and load times. Studies done for a typical four-loop Westinghouse PWR (NSAC-130) show that the diesel start and load time could be increased to 45 seconds from 10 seconds. The 45-second start time is limited by environmental qualification considerations of equipment in containment. The calculated peak cladding temperature was below 2200°F.

A similar calculation for a typical BWR 4 showed that the diesel generator start and load time could increase to 118 seconds (NSAC-96), and still be within acceptable limits.

However, for the purpose of evaluating the effects of surveillance testing, start and load times should be addressed separately.

A fast start (i.e., start and acceleration to synchronous speed at full fuel rack position) has the potential to accelerate the degradation of the diesel generator if conducted without the benefit of a prelube period. However, prelubricating diesel generators is now common practice, and any remaining negative effects of fast starts are minimal. Nevertheless, fast starts can be eliminated on some diesel generators by changing the governor configuration, but only at the cost of reducing diesel generator reliability, by eliminating a redundant overspeed protection feature, that is, the backup mechanical governor. In this case, the gain associated with slow starts does not offset the loss of the backup overspeed protection.

Fast loading (i.e., zero to full load in 120 seconds or less) during surveillance testing is, on the other hand, the most significant cause of accelerated degradation of diesel generators. It can cause rapid piston ring and cylinder liner wear (up to 40 times greater than normal wear) and should be eliminated in favor of loading in accordance with the manufacturer's recommendations, except for the 18-month loss of offsite power (LOOP) test. Manufacturers' recommendations for diesel generator loading can be 30 minutes or more to reach full load.

In an actual emergency, loads will be sequenced onto a diesel generator in approximately 60 seconds. This

constitutes fast loading of the diesel generator regardless of whether the sequencing started at 10 seconds or at either 45 or 118 seconds (as suggested by the studies referenced above) after the diesel generator starts. Hence, design changes for slower diesel generator starting and acceleration would not significantly reduce the degradation of diesel generators which is inherent with rapid loading that is necessary to meet safety analysis requirements.

The NRC staff recommends that all testing of the diesel generators, with the exception of the LOOP tests which are performed with and without an ESF signal once each refueling, be performed by gradual loading in accordance with the manufacturer's recommendations.

EDG tests were typically started with the EDG initially at ambient conditions with no prelubrication or warmup time. Generic Letter (GL) 84-15 changed this, stating that "[l]icensees are encouraged to submit changes to their Technical Specification[s] to accomplish a reduction in the number of [cold] fast starts." A typical technical specification was included in GL 84-15 which required a start from ambient conditions every 184 days rather than every month.

Some nonstandard Technical Specifications require that, with an inoperable EDG, not only the remaining operable diesel generator(s) must be tested at a higher frequency than normally required but, in addition, other emergency equipment such as the emergency core cooling system (ECCS), safety-related cooling water pumps (e.g., service water), and other power supplies also must be demonstrated operable. This testing must commence "immediately" upon discovering that a diesel generator is inoperable.

Some nonstandard Technical Specifications also require that if a train or subsystem of certain safety systems other than the diesel generators (for example, a low-head safety-injection pump of the ECCS) is declared inoperable, not only the other train of the particular system but also other equipment of the emergency core cooling systems and the diesel generators must be tested. Thus, a failed train in one safety system can cause a great deal of testing of apparently unrelated systems. This type of testing is called "alternate testing."

An example of this in matrix form is shown in Table 10.1 (from a letter from Vermont Yankee Nuclear Power Corp., July 15, 1988 [Capstick, 1988]) which is based on the Vermont Yankee Technical Specifications.

By a letter dated December 7, 1987 (Murphy, 198 , the licensee for Vermont Yankee submitted a request to revise this surveillance/alternate testing requirement. The NRC staff reviewed this proposed change to the Technical Specifications and requested a more quantitative analysis than had been originally supplied. In response to this request, the Vermont Yankee N ar Power Corp. submitted an analysis dated July 15, 1988 (Capstick, 1988), using reliability methods. The NRC staff is reviewing that submittal.

The analysis quantified the unavailabilities of the systems when required to perform their intended function upon demand, both with and without alternate testing. Two systems were chosen for detailed analysis: the core spray system and the diesel generators.

The pros and cons of testing were quantified, that is, (1) the decreased potential for an undetected failure due to the alternate testing and (2) the increased unavailability due to (a) the alternate testing and (b) repair of demand-related and test-related failures. Other disadvantages to alternate testing which were not quantified in this study are:

(1) reduced reliability due to equipment degradation from excessive testing

(2) potential for unnecessary shutdowns that result in plant transients and challenges to safety systems

(3) potential for plant transients initiated during surveillance tests

(4) diversion of operating personnel time and attention

(5) increased radiation exposure to operating personnel

The analysis showed that, for the core spray system, alternate testing (which is required daily by the Vermont Yankee Technical Specifications) produced unavailabilities at least a factor of 4 greater than monthly testing. For the diesel generators, this factor was about 3.

Considering this analysis and similar conclusions in NUREG-1024, the staff recommends that alternate testing requirements be deleted from the Technical Specifications for all plants so that the failure of a train or subsystem of a safety-related system other than an emergency diesel generator would not require testing of the diesel generators or any other equipment.

Table 10.1 Alternate testing requirements

Inoperable subsystem	Operation inoperable components (days)	Standby liquid control	Core spray	LPCI subsystems	Diesel generators	Containment cooling	RHR service water	Service water	Alternate cooling tower	ADS	RCIC	HPCI	Standby gas treatment
Standby liquid control	7	I/D											
Core spray	7		I/D	I	I								
LPCI pump	7		I	I/D[a]	I	I							
LPCI subsystem	7		I/D	I/D	I/D	I/D							
Diesel generators	7		I/D	I/D	I/D	I/D							
Containment cooling	30					I/D							
RHRSW pump	30						I/D						
RHR service water	7				I/D		I/D						
Service water	15							I/D	I/D				
Alternate cooling tower	7			I/D			I/D	I/D					
ADS	7											I	
RCIC	7											I/D	
HPCI	7		I	I						I/D	I/D		
Standby gas treatment	7												I/D
UPS[b]													

Note: I–Immediate; D–Daily
a–Redundant component only
b–See LPCI subsystem, core spray, and diesel generator alternate testing requirements.

The NRC staff recommends that the requirements to test the remaining diesel generator(s) when one diesel generator is inoperable due to any cause other than preplanned preventive maintenance or testing be limited to those situations where the cause for inoperability has not been conclusively demonstrated to preclude the potential for a common mode failure. However, when such testing is required, it should be performed within 8 hours of having determined that the diesel generator is inoperable.

The NPAR Program found that regulatory surveillance requirements are not the only contributor to EDG degradation. NUREG/CR-4590, Volume 1, identified four categories of stressors that contributed to emergency diesel generator aging: vibration, inferior quality of components, adverse environment, and human error.

The NPAR Program did not specify the fraction of problems found with emergency diesel generators which are due to testing. A study done for EPRI (NP-4264, Vol. 2) looked specifically at failures of emergency diesel generators that result from surveillance testing. The data for this study consist of LERs from January 1979 through early 1983, a period of just over 4 years. Note that this period preceded the issuance of Generic Letter 84-15 so that, hopefully, the situation now would be somewhat better. A total of 585 failures of 136 diesel generators were found. Of these 585 failures, 70 (12%) were determined to be related to surveillance testing. The components that had the highest numbers of surveillance-test-related problems were: turbocharger, power assembly and bearings, starting system, cooling system, lube oil system, governor and exciter, and regulator. However, no specific failures were widespread enough to be considered generic. Generic failures with diesel generators have occurred in the past, but solutions to these problems are available and, in most cases, have been implemented.

Emergency diesel generator testing appears to be an area that would benefit from a reliability-based testing program (as discussed in Section 3.8 of this report). The NRC staff is evaluating reliability-centered concepts for the resolution of GI B-56 that may further reduce unnecessary testing. NUREG/CR-5078 describes an approach to a reliability-based testing program for emergency diesel generators. As part of this reliability-based approach, a detailed root-cause analysis procedure and a good preventive maintenance program (also reliability based) should be included. Detailed monitoring and trending are important to assure good performance.

Diesel generator surveillance requirements could also be improved in another area.

The Standard Technical Specifications contain a requirement to operate each emergency diesel generator for 24 hours. During the first 2 hours, the diesel is to operate with its 2-hour-rated load and for the last 22 hours it is to operate at its continuous-rated load. The Standard Technical Specifications require that, within 5 minutes after completing this 24-hour test, the emergency buses must be deenergized and loads shed with a subsequent fast start and full load acceptance.

Duke Power Co., by letter dated February 15, 1988, on the Catawba Units 1 and 2 dockets (Tucker, 1988) proposed to separate the 24-hour test from the 5-minute test. The NRC staff approved Duke's proposal in a letter to Duke dated July 28, 1988 (Jabbour, 1988).

The reason for requesting this change is that separating these two required tests gives plant operators added flexibility and prevents critical path complications during the outages.

Duke stated that it has been necessary to shut down the diesel generator faster than recommended by the diesel generator shutdown procedure in order to perform the hot restart test within 5 minutes of the 24-hour test run. Another problem with performing these tests in quick succession is their potential for causing critical path complications and delays during an outage. Engineered safety features (ESF) actuation testing is performed at the beginning of refueling outages. Block tagouts are d[illegible]d until completion of ESF testing. As a result of the testing sequence currently dictated by Technical Specifications, a minimum of 48 hours of critical path time is spent each refueling outage running the two diesel generators. By revising the surveillance requirements as requested, the two 24-hour runs could be completed later in the outage or at some other convenient time.

Duke proposed to substitute a diesel generator run at continuous-rated load for 1 hour or until the operating temperature had stabilized, followed within 5 minutes by a diesel engine start. To ensure that operating temperatures have stabilized, the NRC staff concludes that 2 hours is a more appropriate time limit.

The hot-restart test is performed to verify that the diesel generator does not have, in any way, impaired performance following operation at full load or equilibrium temperature.

Failure to restart when hot, or extended delay in restarting, is typically only experienced with small forced-air-cooled diesel engines which, upon being tripped undergo a temperature rise transient. The large diesel generators are typically water cooled and do not experience any significant temperature rise transients during operation or after shutdown. In addition, diesel generators are normally maintained at hot standby conditions (heated cooling water and lubricating oil).

The NRC staff, therefore recommends that other utilities be permitted to change their Technical Specifications to separate the 24-hour test and the hot-startup test if they propose doing so.

Findings

- EDGs are very important to safety.
- EDGs are tested too often because:
  (1) Technical Specifications at some plants require testing if other safety-related equipment is inoperable.
  (2) Technical Specifications at some plants require not just one start to verify operability but starts "immediately," or within 1 hour, and every 8 hours thereafter.
- Studies show that testing too frequently is counter-productive to safety in terms of equipment availability.
- Rapid loading is a major cause of diesel generator degradation.
- There is no safety reason for performing a startup of a diesel within 5 minutes of the 24-hour test run as is required by Technical Specifications.

Recommendations

- When an EDG itself is inoperable (not including a support system or independently testable component), the other EDG(s) should be tested only once (not every 8 hours) and within 8 hours unless the absence of any potential common-mode failure can be demonstrated.
- EDGs should be loaded in accordance with the vendor recommendations for all test purposes other than the refueling outage LOOP tests.
- The hot-start test following the 24-hour EDG test should be a simple EDG start test. If the hot-start test is not performed within the required 5 minutes following the 24-hour EDG test, it should not be necessary to repeat the 24-hour EDG test. The only requirement should be that the hot-start test is performed within 5 minutes of operating the diesel generator at its continuous rating for 2 hours or until operating temperatures have stabilized.
- Delete the requirement for alternative testing that requires testing of EDGs and other unrelated systems not associated with an inoperable train or subsystem (other than an inoperable EDG).

10.2 Battery Surveillance Requirements (PWR, BWR)

Industry guidance for testing large lead storage batteries of the kind used in nuclear power plants is found in Standard 450–1980 of the Institute of Electrical and Electronics Engineers (IEEE). Regulatory Guide 1.129, Revision 1 (February 1978) endorses an earlier version of this standard (IEEE 450–1975). The Standard Technical Specifications follow this standard to some extent but are more conservative in some requirements and less conservative in others. Table 10.2 compares IEEE 450–1980 with the Westinghouse Standard Technical Specifications, Version 4A.

Note that IEEE 450–1980 requires more visual inspections of the condition of the batteries (e.g., cleanliness, evidence of corrosion, cracks and leakage of electrolyte) than the Westinghouse Standard Technical Specifications (STS). On the other hand, the Westinghouse STS are more conservative with respect to the frequency of measurements of battery charger output, pilot cell conditions, and total terminal battery voltage. (The Westinghouse STS require these every 7 days while IEEE 450–1980 requires these surveillances only monthly.)

It is apparent from this comparison that the Westinghouse STS are most concerned with measurements of the operability of the batteries and not as concerned with mechanisms that degrade the batteries.

Perhaps the most significant surveillance not included in the Westinghouse STS is the surveillance for ambient room temperature. IEEE 450–1980 requires a monthly surveillance. The Westinghouse STS do not. The Westinghouse STS do require a quarterly surveillance of electrolyte temperature in a representative number of cells, but the requirement is that the temperature be greater than a minimum value, an operability requirement. There is no maximum temperature specified.

A limit on maximum ambient temperature would protect the batteries from degradation mechanisms.

NUREG/CR-4457, which studied the aging of Class 1E batteries for the NPAR Program, states that "thermal stresses, whether caused by internal sources. . .or by the room temperature, are probably the most detrimental with respect to accelerating the aging of batteries." As an example, the report cites a major battery manufacturer as stating that an increase in ambient temperature from 77°F to 95°F reduces the life of the battery by 50%.

Table 10.2 Comparison of requirements of IEEE Standard 450-1980 with requirements of Westinghouse STS

Requirement	IEEE 450-1980	Westinghouse STS
1. General appearance and cleanliness of battery and battery area	M	-
2. Evidence of corrosion on terminals or connectors.	M	Q
3. Cracks in cells and leakage of electrolyte	M	-
4. Individual cell condition	Y	R
5. Tightness of bolted connections	Y	R
6. Integrity of battery rack	Y	R
7. Condition of ventilation equipment	M	-
9. Electrolyte levels, each cell	M	Q
10. Ambient temperature	M	-
11. Voltage, specific gravity, each cell	Q	Q
12. Electrolyte temperature, representative cells	Q	Q
13. Total terminal battery voltage	Q	Every 7 days
14. Pilot cell electrolyte level	See item 9	Every 7 days
15. Float voltage	M	Every 7 days
16. Specific gravity	M	Every 7 days
17. Electrolyte temperature	M	-

Note: M = monthly, Q = quarterly, Y = yearly, R = not to exceed 18 months.

The NRC staff therefore recommends a study of the need for a maximum (and minimum) allowable ambient temperature for batteries.

There are other important phenomena discussed in NUREG/CR-4457 that are not covered by either the Standard Technical Specifications or IEEE 450-1980. These are the seismic vulnerability of the batteries and excessive harmonic fluctuations in the battery charger voltage, called ac "ripple."

According to NUREG/CR-4457, excessive harmonic fluctuations in voltage from the battery charger cause stresses at the battery plate similar to overcharging, accelerate corrosion, and produce excessive internal temperatures. The NRC Office of Nuclear Regulatory Research should continue to study these to determine if this situation is really a problem at nuclear power plants.

The seismic event is the design-basis event for the mechanical integrity of batteries. Seismic vulnerability is caused by physical degradation of the structure of the battery. There are no good tests to detect this aging, but IEEE Standard 535-1986 requires that batteries that have been aged to their end-of-life service be given a pre-seismic capacity test, a capacity test during a simulated seismic test, and a post-seismic test. IEEE 535-1986 also requires seismic qualification of the battery rack. Therefore, batteries tested to IEEE 535-1986 should be acceptably qualified for seismic events, recognizing that this is not a Technical Specifications issue and seismic testing should not appear in the Technical Specifications.

The Standard Technical Specifications require several surveillances more often than called for by IEEE 450-1980. These are the electrolyte level, float voltage, specific gravity of the pilot cell (Category A items of Table 4.8.2), and the total terminal battery voltage. Several of the PWR licensees identified these as burdensome surveillance intervals. However, as shown in Table 10.3 (taken from NUREG/CR-4457), some of the most common causes of battery failure are associated with items covered by these surveillances. Note that the leading cause of battery inoperability is low specific gravity. Insufficient charge and low electrolyte levels are also significant causes of battery failure.

Table 10.3 Battery failure events reported in LERs

Failure cause	No.	%
Low specific gravity	67	27
Personnel (operation, maintenance, testing)	52	21
Insufficient charge	27	11
Defective/weak cells	22	9
Low electrolyte solution level	14	6
Faulty connections	13	5
Defective procedures	11	4
Charger malfunction	9	4
Design, fabrication, construction	8	3
High electrolyte solution level	8	3
Unknown causes	5	2
Corrosion	4	2
Short circuit	4	2
Normal wear/natural end of life	3	1
Extreme environment	1	< 1
Total	248	100

Source: NUREG/CR-4457.

Note also that testing (grouped together with operation and maintenance) is the second largest contributor to battery failures. However, these 7-day surveillances should not be significant contributors to testing failures.

In addition, one utility representative told the NRC staff during a site visit that in addition to the Technical Specifications requirement, it was company policy to do these checks every 7 days.

The NRC staff therefore recommends that the battery surveillance requirements remain as they are.

As noted earlier, many factors specified in IEEE 450-1980 are important for degradation of batteries that are not covered by Technical Specifications. This is probably appropriate, if the purpose of the Technical Specifications is limited to operability concerns. However, the staff recommends that these factors be included in any preventive maintenance program.

Findings

- Operability surveillances of batteries required by Technical Specifications are performed more often than the industry standard recommends.
- There is no Technical Specifications requirement for monitoring or controlling battery room temperature.
- Seismic qualification is an important consideration for Class 1E batteries and battery racks. All Class 1E batteries and battery racks should be qualified to IEEE Standard 535-1986. This is not a Technical Specifications issue.
- Alternating current (ac) ripple from battery chargers may be a degradation concern.

Recommendation

- The NRC should consider the above findings and determine whether any additional action is warranted.

ENCLOSURE 3 TO TXX-94118

GENERIC LETTER 84-15,
PROPOSED STAFF ACTIONS TO IMPROVE AND
MAINTAIN DIESEL GENERATOR RELIABILITY
(PAGES 1, 2 AND ENCLOSURE 1)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

July 2, 1984

TO ALL LICENSEES OF OPERATING REACTORS, APPLICANTS FOR AN OPERATING LICENSE, AND HOLDERS OF CONSTRUCTION PERMITS

Gentlemen:

SUBJECT: PROPOSED STAFF ACTIONS TO IMPROVE AND MAINTAIN DIESEL GENERATOR RELIABILITY (Generic Letter 84-15)

As part of the proposed technical evaluation of Unresolved Safety Issue (USI) A-44, Station Blackout, the staff is considering new requirements that would reduce the risk of core damage from station blackout events. The reliability of diesel generators has been identified as being one of the main factors affecting the risk from station blackout. Thus, attaining and maintaining high reliability of diesel generators is a necessary input to the resolution of USI A-44.

Plants licensed since 1978 have been required to meet the reliability goals of Regulatory Guide 1.108 for their diesel generators. However, the staff has determined that many operating plants do not have reliability goals in place for their diesel generators. Considering the critical role diesel generators play in mitigating various transients and postulated events following a loss of offsite power, the staff has determined that there is an important need to assure that the reliability of diesel generators at operating plants is maintained at an acceptable level. The staff has determined that the risk from station blackout is such that early actions to improve diesel generator reliability would have a significant safety benefit. Toward this objective, we have developed the following approach to assess and enhance, where necessary the reliability of diesel generators at all operating plants.

The items covered by this letter fall into the following three areas:

1. Reduction in Number of Cold Fast Start Surveillance Tests for Diesel Generators

   This item is directed towards reducing the number of cold fast start surveillance tests for diesel generators which the staff has determined results in premature diesel engine degradation. The details relating to this subject are provided in Enclosure 1. Licensees are requested to describe their current programs to avoid cold fast start surveillance testing or their intended actions to reduce cold fast start surveillance testing for diesel generators.

2. Diesel Generator Reliability Data

   This item requests licensees to furnish the current reliability of each diesel generator at their plant(s), based on surveillance test data. Licensees are requested to provide the information requested in Enclosure 2.

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3. Diesel Generator Reliability

Licensees are requested to describe their program, if any, for attaining and maintaining a reliability goal for their diesel generators. An example of a performance Technical Specification to support a desired diesel generator reliability goal has been provided by the staff in Enclosure 3. Licensees are requested to comment on, and compare their existing program or any proposed program with the example performance specification.

Accordingly, pursuant to 10 CFR 50.54(f), operating reactor licensees are requested to furnish, under oath or affirmation, no later than 90 days from the date of this letter, the information requested in Items 1 through 3 above. Applicants for operating licenses and holders of construction permits are not required to respond.

Licensees may request an extension of time for submittals of the required information. Such a request must set forth a proposed schedule and justification for the delay. Such a request shall be directed to the Director, Division of Licensing, NRR. Any such request must be submitted no later than 45 days from the date of this letter.

This request for information has been approved by the Office of Management and Budget under Clearance Number 3150-0011, which expires April 30, 1985.

Sincerely,

Darrell G. Eisenhut, Director
Division of Licensing

Enclosures:
1. Reduction in Number of Cold Fast Starts for Diesel Generators
2. Diesel Generator Reliability Data
3. Diesel Generator Reliability

ENCLOSURE 1

REDUCTION IN NUMBER OF COLD FAST START
SURVEILLANCE TESTS FOR DIESEL GENERATORS

Fast Start Testing

The staff has for sometime had under review and assessment methods of diesel generator testing. The staff has determined that many licensees use a method of testing which does not take into consideration those manufacturer recommended preparatory actions such as prelubrication of all moving parts and warmup procedures which are necessary to reduce engine wear, extend life and improve availability. The existing Standard Technical Specifications require fast starts from ambient conditions for all surveillance testing which in many engine designs and operating practices subject the diesel engine to undue wear and stress on engine parts. Concerns were expressed by ACRS regarding the imposition of severe mechanical stress and wear on the diesel engine due to frequent cold fast starts. Nuclear Industry related groups (INPO and American Nuclear Insurer) have also expressed concern based on operating experience that cold fast start testing results in incremental degradation of diesel engines and that, if proper procedures covering warmup prelubrication, loading/unloading etc., were taken, an improvement in reliability and availability would be gained. Similar views have been identified by the nuclear power industry and the regulatory authority in Sweden. The authority in Sweden has taken corrective actions to reduce the frequency of fast starts.

It is the staff's technical judgement that an overall improvement in diesel engine reliability and availability can be gained by performing diesel generator starts for surveillance testing using engine prelube and other manufacturer recommended procedures to reduce engine stress and wear. The staff has also determined that the demonstration of a fast start test capability for emergency diesel generators from ambient conditions cannot be totally eliminated because the design basis for the plant, i.e., large LOCA coincident with loss of offsite power, requires such a capability.

In view of the above, the staff has concluded that the frequency of fast start tests from ambient conditions of diesel generators should be reduced. An example of an acceptable Technical Specification to accomplish this goal is provided in the attachment to this enclosure. Licensees are requested to describe their current programs to avoid cold fast starts or their intended action to reduce the number of cold fast start surveillance tests from ambient conditions for diesel generators. Licensees are encouraged to submit changes to their Technical Specification to accomplish a reduction in the number of such fast starts.

Other Testing

Also, the staff is concerned regarding a number of additional diesel generator tests that are currently being required by Technical Specifications for some of the earlier licensed operating plants. For example, when subsystems of the emergency core cooling system on some plants are declared inoperable, the diesel generators are required to be tested. The staff has concluded that excessive testing results in degradation of diesel engines. In order to make those few plants consistent with the majority of the plants, it is the staff's position that the requirements for testing diesel generators while emergency core cooling equipment is inoperable, be deleted from the Technical Specifications for such plants. The affected licensees are encouraged to propose Technical Specifications to make such changes.

ATTACHMENT TO ENCLOSURE 1

TYPICAL TECHNICAL SPECIFICATION

SURVEILLANCE REQUIREMENTS

4.8.1.1.1 Each of the above required independent circuits between the offsite transmission network and the onsite Class 1E distribution system shall be:

a. Determined OPERABLE at least once per 7 days by verifying correct breaker alignment, indicated power availability, and

b. Demonstrated OPERABLE at least once per 18 months during shutdown by transferring (manually and automatically) unit power supply from the normal circuit to the alternate circuit.

4.8.1.1.2 Each diesel generator shall be demonstrated OPERABLE:

a. In accordance with the frequency specified in Table 4.8-1 on a STAGGERED TEST BASIS by:

1. Verifying the fuel level in the day and engine-mounted fuel tank,

2. Verifying the fuel level in the fuel storage tank,

3. Verifying the fuel transfer pump starts and transfers fuel from the storage system to the day and engine-mounted tank,

4. Verifying the diesel starts from ambient condition and accelerates to at least (900) rpm in less than or equal to 10 seconds.* The generator voltage and frequency shall be (4160) ± (420) volts and (60) ± (1.2) Hz within (10)* seconds after the start signal. The diesel generator shall be started for this test by using one of the following signals:

   a) Manual

   b) Simulated loss of offsite power by itself.

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*The diesel generator start (10 sec) from ambient conditions shall be performed at least once per 184 days in these surveillance tests. All other engine starts for the purpose of this surveillance testing may be preceded by an engine prelube period and/or other warmup procedures recommended by the manufacturer so that mechanical stress and wear on the diesel engine is minimized.

NOTE: Bars in the margin show changes made to the Standard Technical Specifications.

SURVEILLANCE REQUIREMENTS (Continued)

c) Simulated loss of offsite power in conjunction with an ESF actuation test signal.

d) An ESF actuation test signal by itself.

5. Verifying the generator is synchronized, loaded to greater than or equal to (continuous rating) in less than or equal to ( ) seconds,* and operates with a load greater than or equal to (continuous rating) for at least 60 minutes,

6. Verifying the diesel generator is aligned to provide standby power to the associated emergency busses.

b. At least once per 31 days and after each operation of the diesel where the period of operation was greater than or equal to 1 hour by checking for and removing accumulated water from the day and engine-mounted fuel tanks.

c. At least once per 92 days and from new fuel oil prior to additional to the storage tanks by verifying that a sample obtained in accordance with ASTM-D270-1975 has a water and sediment content of less than or equal to .05 volume percent and a kinematic viscosity @ 40°C of greater than or equal to 1.9 but less than or equal to 4.1 when tested in accordance with ASTM-D975-77, and an impurity level of less than 2 mg. of insolubles per 100 ml. when tested in accordance with ASTM-D-2274-70.

d. At least once per 18 months, during shutdown by:

1. Subjecting the diesel to an inspection in accordance with procedures prepared in conjunction with its manufacturer's recommendations for this class of standby service.

2. Verifying the generator capability to reject a load of greater than or equal to (largest single emergency load) kw while maintaining voltage at (4160) ± (420) volts and frequency at (60) ± (1.2) Hz (less than or equal to 75% of the difference between nominal speed and the overspeed trip setpoint, or 15% above nominal whichever is less).

3. Verifying the generator capability to reject a load of (continuous rating) kw without tripping. The generator voltage shall not exceed (4784) volts during and following the load rejection.

*See footnote on previous page

ENCLOSURE 4 TO TXX-94118

SAFETY EVALUATIONS, INSPECTION REQUIREMENTS
FOR TDI, DIESEL GENERATORS (TAC NO. M85325)
MARCH 17, 1994
PAGES 1, 2, SER 1, 6, 7, 9, 10 AND 11

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

MAR 17 1994

Mr. R. C. Day
Duke Engineering & Services, Inc.
TDI Diesel Generators Owners' Group
Clearinghouse
230 South Tryon Street
P. O. Box 1004
Charlotte, North Carolina 28201-1004

Dear Mr. Day:

SUBJECT: SAFETY EVALUATION, INSPECTION REQUIREMENTS FOR TRANSAMERICA DELAVAL, INC. DIESEL GENERATORS (TAC NO. M85325)

The Transamerica Delaval (TDI) diesel generators Owners' Group (Owners' Group) submitted proposals on November 30, 1992 (Reference 1 in the enclosed Safety Evaluation) and December 7, 1993 (Reference 2), recommending removal of licensing conditions imposed as part of a technical resolution to address concerns regarding the reliability of the TDI emergency diesel generators (EDGs) following the crankshaft failure at Shoreham in August 1983. The technical resolution involved implementation of Phase I and Phase II programs as identified in NUREG-1216 (Reference 3). The Phase I program focused on the resolution of known engine component problems that had potential generic implications, while the Phase II program focused on the design review of a large set of important engine components to ensure their adequacy from a manufacturing standpoint as well as operational performance. At that time, the staff concluded that these components merited special emphasis in the area of load restrictions and/or maintenance and surveillance. The 16 major components which were identified included connecting rods, crankshafts, cylinder blocks, cylinder heads, piston skirts, and turbochargers. Engine load restrictions were addressed in the plant Technical Specifications, license conditions, engine operating procedures and operator training, as appropriate, for five of these components. The most critical periodic maintenance/surveillance actions for these components were incorporated as license conditions.

On the basis of substantial operational data and inspection results the Owners' Group provided information in References 2 and 3 to demonstrate that the special concerns of NUREG-1216 are no longer warranted. The Owners' Group stated that the TDI EDGs should be treated on a par with other EDGs within the nuclear industry and subjected to the same standard regulations, without the special requirements of NUREG-1216. In addition, the Owners' Group stated that this action will improve availability of the engines for service, especially during outages, while maintaining current reliability levels.

The NRC staff and its consultants at Pacific Northwest Laboratories (PNL) have completed a review of the operational data and inspection results contained in the Owners' Group submittal reports relative to the individual components. In addition, independent opinions were obtained from three leading diesel engine experts regarding these inspection requirements.

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On the basis of its review, the staff has concluded that there is adequate justification for removing the present component-based licensing conditions. The staff's evaluation of the Owners' Group's submittal reports is in the attached safety evaluation (SE).

It is intended that the attached SE be referenced by affected licensees in proposals for changes to facility licenses to the extent specified and under the limitations delineated in the licensee submittals and the associated NRC evaluation. The evaluation defines the basis for the approval of the reports and is applicable to the eight Owners' Group licensees: Texas Utilities for Comanche Peak; Entergy Operations for Grand Gulf; Duke Power for Catawba; Carolina Power for Shearon Harris; Georgia Power for Vogtle; Cleveland Electric Illuminating for Perry; Grand Gulf Utilities for River Bend; and Tennessee Valley Authority for Bellefonte.

In accordance with procedures established in NUREG-0390, the TDI Owners' Group is requested to publish approved versions of the Owners Group reports as generic topical reports within three months of receipt of this staff approval. The accepted version should incorporate this approval letter and the enclosed evaluation between the title page and the abstract. The approved version shall include an -A (designating approved) following the report identification symbol.

The staff does not intend to repeat its review of the approved matters described in the approved generic topical reports when the reports appear as references in license applications except to assure that the material presented is applicable to the specific plant involved. The staff's approval applies only to the matters described in the reports.

Should the staff's criteria or regulations change so that the staff's conclusions as to the acceptability of the reports are invalidated, the Owners' Group and/or the licensees referencing the reports will be expected to revise and resubmit their respective documentation, or submit justification for the continued effective applicability of the reports without revisions of their respective documentation.

Sincerely,

James A. Norberg

James A. Norberg, Chief
Mechanical Engineering Branch
Division of Engineering
Office of Nuclear Reactor Regulation

Enclosure:
Safety Evaluation

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION OPERABILITY AND RELIABILITY REVIEW OF EMERGENCY DIESEL GENERATORS MANUFACTURED BY TRANSAMERICA DELAVAL, INC.

I. INTRODUCTION

During the 1970s, many utilities ordered diesel generators from Transamerica Delaval, Inc. (TDI) for installation at nuclear plants in the United States. The first of these engines to become operational in nuclear service were those at San Onofre Unit 1 in 1977. However, nuclear plant operating experience with TDI emergency diesel generators (EDGs) remained very limited until preoperational test programs were started at Shoreham and Grand Gulf Unit 1 in the early 1980s.

Concerns about the reliability of large-bore, medium-speed diesel generators manufactured by TDI for application at domestic nuclear plants were first prompted by a crankshaft failure at Shoreham in August 1983. However, a broad pattern of deficiencies in critical engine components subsequently became evident at Shoreham and at other nuclear and non-nuclear facilities employing TDI diesel generators. These deficiencies stemmed from inadequacies in design, manufacture, and quality assurance/quality control by TDI.

In response to these problems, 11 (now 8) U.S. nuclear utility owners[1] formed a TDI Diesel Generator Owners' Group to address operational and regulatory issues relative to diesel generator sets used for standby emergency power. On March 2, 1984, the Owners' Group submitted a proposed program ("TDI Owners' Group Program Plan") to the NRC that was intended to provide an in-depth assessment of the adequacy of the respective utilities' TDI engines to perform their safety-related function through a combination of design reviews, quality revalidations, engine tests, and component inspections.

The Owners' Group program addressed three major elements concerning the manufacture, inspection, and operation of TDI diesel engines:

(1) Phase I: Resolution of known generic engine component problems to serve as a basis for licensing plants during the period before completion of Phase II of the Owners' Group program.

(2) Phase II: A Design Review/Quality Revalidation (DR/QR), of a large set of important engine components to ensure that their design and manufacture, including specifications, quality control and quality assurance, and operational surveillance and maintenance, are adequate.

(3) Expanded engine tests and inspections as needed to support Phase I and II programs.

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[1] Carolina Power and Light Co. (Shearon Harris), Cleveland Electric Illuminating Co. (Perry), Duke Power Co. (Catawba), Georgia Power Co. (Vogtle), Gulf States Utilities (River Bend), Entergy Operations, Inc. (Grand Gulf Units 1 & 2), TVA (Bellefonte), Texas Utilities (Comanche Peak).

proposes to use this generic diesel management program in lieu of the current maintenance/surveillance requirements.

On the basis of the substantial operational experience of the TDI EDGs accumulated since 1985 and the inspection results of the EDG components, the Owners' Group has provided information in its submittal reports of November 30, 1992, and December 7, 1993 (References 2 and 3) to demonstrate that the special concerns of NUREG-1216 are no longer warranted. The Owners' Group has recommended removing the license conditions related to EDG component inspections involving teardowns and surveillance requirements.

The Owners' Group has analyzed the need for engine overhauls in accordance with the current DR/QR requirements. Their analysis and conclusions are based on an understanding of the historical concerns for each component affected by the overhaul and the results of extensive inspections performed by the licensees who make up the TDI Owners' Group. The information in its submittal reports includes component description, component identification number per the DR/QR Appendix II, "Preventive Maintenance (PM) Task Description," the manufacturer's replacement/overhaul recommendations, the number of engine hours run between inspections or cumulative engine hours, number of engine starts, inspection findings, and the percentage of all components in service covered by the inspections. The results of the inspections compiled by the Owners' Group in its submittal reports (References 2 and 3) indicate that most teardowns have shown little or no wear on internal engine components. However, with continuing operation, it is possible that problems could occur with specific components which could require inspection or overhaul of affected components. The Owners' Group is proposing that such actions be determined on a case-by-case basis, and that inspections or overhauls be performed so that engine reliability and availability are maximized. The Owners' Group contends that the primary purpose of EDG 10-year teardown inspections is to document the condition of the specific components, not to replace components, since most components being inspected show little or no wear. However, as a matter of good maintenance practice, these components are generally replaced after a teardown inspection, regardless of condition. These teardowns can result in reassembly errors or entry of foreign materials resulting in increased wear or decreased engine reliability.

The Owners' Group believes that an overhaul will be needed during the life of these engines as they are currently operated. However, due to the limited number of run hours and the availability of periods to perform major teardowns the licensees need the flexibility to determine when an overhaul is required and how an overhaul is conducted.

The Owners' Group contends that some of the early concerns with EDG components were caused by the deleterious effects of the fast starts and loading of EDGs in nuclear service. The Owners' Group notes that the life expectancy of most engine components in commercial service, which are not subject to fast starts, is far greater than the estimated life of EDG components in nuclear service based on early data.

All licensees have the authority to delete fast-start and loading requirements on the basis of Generic Letter (GL) 84-15, and are committed to doing so.

However, some licensees have not taken this step for a number of reasons. First, many engines have control systems which will not allow a slow start. The necessary changes in such control systems are currently being implemented. Second, some of the TDI licensees want to consolidate all changes for a particular technical specification (TS) to lessen the impact on the licensee and the NRC workload resulting from a TS change request. The staff is currently preparing a GL addressing the requirements for accelerated testing of emergency diesels. Most licensees are waiting for this GL to be issued before requesting a change to their TSs which would include a request for the deletion of the fast starts. Once the slow start option is implemented and accelerated testing is eliminated, engines at nuclear plants will be operated similarly to those in commercial service, and the expected life of components in engines at nuclear plants should compare favorably with commercial engine components. The data from engines in nuclear service which have implemented the slow-start option supports this contention. Since the manufacturer's recommendations for commercial operation of TDI/EDG components prior to overhaul indicate that there are substantial safety margins available, appropriate changes can be made in M/S requirements based on realistic estimates of component life expectancy, and flexibility can be achieved in the frequency of performing teardown inspections.

The Owners' Group, in its submittal reports, has also discussed the need for flexibility in scheduling teardown inspections from the standpoint of shutdown risk management (SRM). According to the Owners' Group, the "available windows" of outage time of sufficient length to allow engine teardowns and/or overhauls are being shortened because of SRM requirements. The "available window" during which a diesel can be removed from service for maintenance depends on a number of factors, including plant design, availability of alternate power sources, fuel handling schemes, and other operational, maintenance, or inspection requirements. These factors cause the "available window" to vary from outage to outage. Typically, the "available window" is between 10 and 21 days; however, SRM programs have compressed this "window" by as much as 20%. As a result of this shortening of "available windows," all plants need maximum flexibility in scheduling EDG maintenance activities (i.e., schedule major diesel work during times when longer "windows" are available without impacting overall outage length). Time-directed teardowns/overhauls do not allow this flexibility. The Owners' Group is proposing a generic diesel management program which combines predictive maintenance, surveillance, and inspection. The Owners' Group contends that with this program, considerable flexibility can be achieved in the frequency of performing teardowns and/or overhauls without sacrificing engine reliability.

Typical components that are inspected or replaced or both during an engine overhaul are turbochargers, main bearing caps/studs, cylinder blocks, connecting rods/bearings/bushings, cylinder heads, push rods, lower cylinder liner seals, base assemblies, crank shafts, cylinder liners, pistons/rings, fuel injection tubing, and rocker arm capscrews/drive studs. Problems with these components resulting from the intrusive inspections could certainly limit or preclude the engine's acceptable power output. Disassembly of these components can result in the accidental introduction of dirt and other foreign materials that may harm the engine. In addition, these components are

* Because specific surveillances/inspections were imposed by regulation to ensure that acceptable engine conditions were being maintained, the inspection results should not identify unacceptable findings.

* The Owners' Group should have an alternative diesel management program with elements that are judged by the regulatory staff to be reasonably and equally effective compared to current license requirements in maintaining diesel reliability.

* The underlying source or technical basis for the proposed regulatory change should be justified by authorities and expertise equal to that which determined the current regulatory requirements.

As discussed in the following paragraphs, all five criteria have been satisfied. The current TDI engine reliability was found to be equal to or better than the industry average. In the period between January 1990 and December 1992, the median reliability of TDI diesels was found to be 0.9906. This is about 1% better than the nuclear industry average, and well above NRC's highest goal of 0.975.

Specific surveillances/inspections were imposed by NRC regulations to ensure that acceptable TDI engine conditions were being maintained. A review of the operational database and the inspection results for the key components, as discussed in Appendix A, show no unacceptable findings. In fact, most inspections did not uncover any signs of wear or degradation that need to be addressed.

NRC-sponsored research (Reference 8) has indicated the potentially negative consequences of intrusive inspections on components and engine reliability as a result of current practices. In a study of failures related to aging, a failure curve, sometimes called the "bathtub" curve, correlates the change in failure rate with age. The beginning segment of the curve represents a "wear-in" portion, with a higher failure rate associated with many pieces of new equipment. Once the machinery is broken in, the failure rate is at its lowest and remains constant for a period of time. As the machinery wears and reaches the end of its lifetime, the failure rate increases. The challenge is to determine the time scale for these regions for each piece of equipment. On the basis of these studies, it is generally believed that the diesel engine's reliability is considerably lower during the "wear-in" period, and some engines may be on the lower end of the acceptable range of reliability, during the "wear-in" period of operation.

Some of the early concerns with EDG components were due to the deleterious effects of fast start and loading of EDGs in nuclear service. Component life expectancy in commercial TDI engines which are not subject to fast starts is far greater than life expectancy for TDI engine components in nuclear service. Although the fast-start requirements have been relaxed on the basis of GL 84-15, not all licensees have implemented the changes in the EDG control system to permit slow starts. All members of the Owners' Group are committed to implementing these changes in the near future. The staff is also addressing the issues related to accelerated testing in a generic letter to be issued shortly. Once the slow start option has been implemented and accelerated

- Because specific surveillances/inspections were imposed by regulation to ensure that acceptable engine conditions were being maintained, the inspection results should not identify unacceptable findings.

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testing has been eliminated, nuclear service engine operation will more closely match that of engines in commercial service and the expected component life for TDI engines in nuclear service should compare favorably with commercial engine component life. The data from engines in nuclear service which have implemented the slow-start option supports this contention. A review of the manufacturer's recommendations for commercial operation of TDI/EDG components before overhaul indicates that there are substantial safety margins available for most components in nuclear service. The staff concurs with the Owners' Group recommendation that by combining predictive maintenance, surveillance, and inspections, as in the proposed generic diesel management program, considerable flexibility can be achieved in the frequency of performing engine teardowns and/or overhauls without sacrificing engine reliability.

The Owners' Group contends that the "available windows" of outage time of sufficient length to allow engine teardowns and/or overhauls are being shortened due to SRM requirements. As a result of this shortening of available windows, all plants need maximum flexibility in scheduling EDG maintenance activities. The adoption of a predictive maintenance program for EDGs as proposed, in lieu of the current time-directed teardown/overhaul requirements would give the licensee this flexibility without jeopardizing engine reliability.

The Owners' Group has requested the removal of inspection requirements from the license conditions. The Owners' Group proposes to continue appropriate inspections; however, scope, inspection schedules, and especially the amount of intrusive inspections involving disassembly would be changed to maximize EDG availability and reliability. Inspections would be planned to respond to monitoring and trending results and where other maintenance activities make the component accessible, such as in response to failures of nearby components or where monitoring is indicating an end of component life conditions. The Owners' Group will continue appropriate inspections, especially those not involving engine disassembly. Inspections will be defined and included as part of a well-managed engine program currently under preparation. Elements of correct engine management have been reported previously to the NRC and industry (References 8 and 9). Key features of an EDG management program, acceptable to the staff (see Appendix C of this safety evaluation) have been discussed and provided to the Owners' Group. The Owners' Group agrees that each member would adopt the group's proposed generic management program, resolution, or mitigating actions, and that all actions are intended to be acceptable to the manufacturer.

Finally, the underlying source or technical basis for the proposed regulatory change is equal in expertise to that which was responsible for recommending the current regulatory requirements. The TDI Owners' Group, with support from the manufacturer, was instrumental in preparing the technical basis for the original regulatory conditions in NUREG-1216.

V. OVERALL CONCLUSIONS

The staff, with assistance from its consultants and recognized diesel engine experts, concluded that the regulatory requirements on TDI engines may be

reconsidered at this time. This conclusion is based on a review of the current reliability data of the TDI engines, the Owners' Group inspections of the last several years, and the opinion of experts who have experience in the design and operation of large diesel engines. The staff believes that the TDI Owners' Group, like any other owners group, must address the unique maintenance needs for its specific engine to keep the reliability factor acceptable. With a current median reliability of 0.9906, the TDI Owners' Group, and its individual owners, seem to fully understand the maintenance needs of this engine. The staff further believes that there is sufficient information in the Owners' Group submittal reports to conclude that TDI engine operation at authorized loads is acceptable under normal NRC regulatory oversight procedures for EDGs. The staff and its consultants, in their review of the TDI submittal reports and the operational database, did not uncover any new concerns or issues. Individual reports from recognized experts endorse many of the TDI engine management practices, inspections, or precautions. The Owners' Group intends to incorporate most of the inspections and precautions from the current M/S requirements in its generic diesel management program and appropriately supplement these inspections with alternate condition monitoring procedures. All members of the Owners' Group are committed to implement this diesel management program.

The key features of a maintenance program which the staff finds acceptable are delineated in Appendix C of this safety evaluation. The staff has reviewed the preliminary version of the diesel management program, which the Owners' Group is proposing in lieu of the current M/S requirements. The staff finds the principal elements of this program acceptable. The proposed maintenance program is in conformance with the requirements in Regulatory Guide 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," dated June 1993, which endorses NUMARC 93-01 dated May 1993, "Industry Guide for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants."

Accordingly, the staff has concluded that the license conditions related to the periodic M/S program (see Appendix D of this safety evaluation) for certain components (see Appendix E of this safety evaluation) which were imposed on the licensees based on the recommendations in NUREG-1216, be removed at this time. Therefore, the detailed steps of the preventive M/S programs will not be subject to NRC staff review and approval. However, the staff believes that future revisions of the M/S program would be subject to the provisions of 10 CFR 50.59 (Code of Federal Regulations) in view of the importance of the M/S program in ensuring the operability and reliability of the engines. The staff will require that the owners of each plant commit to the current M/S program in the interim period preceding the implementation of the generic diesel management program currently under development in association and agreement with the manufacturer. The transition from the current M/S program to the generic diesel management program could be accomplished under the provisions of 10 CFR 50.59. The TS requirements of subjecting the diesel to an inspection in accordance with procedures prepared in conjunction with its manufacturer's recommendations for the class of standby service would continue to remain in effect, similar to the TS requirements on other EDG manufacturers.