INFORMATION SYSTEMS LABORATORIES

Emergency Diesel Generator Failure Review 1999 - 2001

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Introduction

This report documents the review of emergency diesel generator (EDG) failures that occurred during the period of January 1, 1999, through December 31, 2001. The failure review was performed to:

- Confirm the baseline reliability values contained in the Mitigation System Performance Index (MSPI) guidance (Nuclear Energy Institute (NEI) 99-02, "Regulatory Assessment Performance Indicator Guideline," Revision 6, October 2009),
- Support the changes in the MSPI EDG failure definitions, and
- Assess the impact on the EDG baseline failure rates that results from including the fuel oil transfer pumps (FOTPs) and related controls within the EDG component boundary.

MSPI Baseline Data

NEI 99-02 provides guidance for the data and calculations used to support the MSPI program.. Included in this guidance are the identification and definition for three modes of EDG failures: Failure to Start, Failure to Load/Run and Failure to Run. Each of these failure modes has an associated baseline reliability value that is used in the MSPI formulation to determine the change in a simplified core damage frequency evaluation resulting from differences in unavailability and unreliability relative to these baseline values.

The baseline values used by the MSPI program are shown in Table 8 of NEI 99-02. These values were developed by Idaho National Laboratory (INL) and can be traced to a paper titled, "Historical perspective on failure rates for US commercial reactor components," [1] dated December 19, 2002, written by Steve Eide (formerly of INL) for *Reliability Engineering & System Safety*. The failure data used in the paper were derived from the Equipment Performance and Information Exchange (EPIX) database contained within Institute of Nuclear Power Operations' (INPO's) Consolidated Data Entry System (CDE).

The reported failure rates shown in Eide's paper were based on failures that occurred during the period of 1999 to 2001. Regrettably, the source data (i.e., specific failure records and success data) used for these failure rates are not available. This lack of data makes it difficult to determine the effect of changes to the scope and definitions of EDG failures on the baseline values. Therefore, a key objective of this current report is to identify and document the EDG failures that are used in the baseline failure rate calculation.

MSPI EDG Failure Definitions

A proposal to revise the EDG failure definitions is documented in Frequently Asked Question (FAQ) 11-08 (available in NRC's Agencywide Documents Access and Management System (ADAMS) at Accession No. ML111450134). Key differences between the current definitions used in NEI 99-02 Revision 6 and the proposed definitions are:

[1] Reliability Engineering and System Safety Volume 80, Issue 2, May 2003, Pages 123-132

- Changes to the transition point between a start and load/run failure where start failure exposure ends when the EDG output breaker receives a signal to close as opposed to the previous requirement where a successful start required reaching rated speed and voltage.
- Changes to the load/run failure definition from the failure to successfully load sequence and run/operate for one hour to the failure to run for one hour after breaker has received a signal to close.
- Clarification of run failure to not require the EDG to be fully loaded and the inclusion of the failure of a FOTP if the pump's failure results in the failure of the EDG to be able to run for 24 hours.

The impact of the treatment of the first run hour was also identified as a potential issue to be resolved in conjunction with the proposed changes in failure definitions[2]. The current practice defined in NEI 99-02, Revision 6, is to include the first hour in the calculation for the EDG run failure rate while failures during this first hour are included in the load/run failure rate.

The primary objective of the failure definition changes is to sharpen the transition points between the three failure modes. A key objective of this report is to determine whether the EDG failure rates reported in NEI 99-02, Table 8, remain valid given the revised failure definitions. The report also addresses the impact of changing the treatment of the first run hour.

Fuel Oil Transfer Pumps

FOTPs are often used in EDG fuel systems to transfer fuel from storage tanks to a local day tank. As part of the current MSPI formulation, FOTPs are not considered to be a monitored component for reliability monitoring within the MSPI Emergency AC performance indicator. An objective of this failure review is to assess the impact of including the FOTPs within the scope of the EDG baseline reliability data.

Approach

This section addresses the approach used to collect and review selected EDG failures and associated success data. In order to meet the stated objectives, all EDG failures that occurred at U.S. commercial nuclear power plants during the MSPI industry baseline period were identified and reviewed. Each failure was assessed as to whether it placed an EDG in a condition to not meet its safety function consistent with the modeling of EDGs in a typical probabilistic risk assessment (PRA). Those failures resulting in the loss of the EDG safety function were considered to be MSPI failures. The failure data identification and review process is described in the *Failure Data* Section below. The associated start demands, load/run demands and run hours, referred to as "success data," were also determined for the same period and for the same set of EDGs. The development of these data is described in the *Success*

[2] FAQ 11-06, MSPI EDG Run Hour reporting, ADAMS Accession Number: ML 110980021, and posted as FAQ 480 on http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/faqs_by_id.pdf)

Data Section below. The resulting failure and success data were used to calculate the failure rates contained within this document, and these rates were then compared against the NEI 99-02 Table 8 values. The assessment of the failure definition changes was accomplished by comparing the failure record categorization between that coded by the industry with the coding determined by this current review. Failures associated with the FOTPs were explicitly identified, and a sensitivity analysis was performed to determine the impact of including these failures within the boundary of the EDGs. A sensitivity analysis was also performed to determine the impact of excluding the first run hour from the run failure rate.

Failure Data

In order to reconstitute the original data and to perform a broad review of the failures that could be candidate contributors to the failure rate for the baseline period, a review was performed using the same data source (EPIX) and the same period (January 1, 1999 through December 31 2001) as that of Steve Eide's original review. Specifically, a copy of the EPIX data source containing data through the 1st quarter of 2010 was used for the review.

To ensure the identification of all applicable records, the scope of review included failure records associated with the EDG systems having a discovery date between January 1, 1999 and December 31, 2001. The Energy Industry Identification System (EIIS) Codes DC, DE and EK were used to identify the EDG-related records because other searchable fields contained plant-specific names and system designators that limited automatic searches. Some non-applicable records were identified and excluded because this approach yielded some records not associated with the EDGs.

Each failure was reviewed against the MSPI failure definitions and categorized by failure mode and cause. Table 1 provides the list of cause categories used in this report.

Table 1
Cause Categories

Failure Cause Category	Description
AAC	The screening process identified 65 failures associated with non-safety-related emergency diesel generators. These failures were coded as "AAC" for Alternate AC power. These failures are not further discussed in this report.
Air Start	Failures related to the air start function.
Breaker	Failures related to breaker operation internal to the breaker.
Control	Failures related to EDG start, load, speed or voltage control. Excludes failures of the output breaker and sequencer failures.
Coolant	Failures associated with water leakage, cooling water valve problems and silting.
Engine	Failures directly related to the mechanical operation of the EDG.

Fuel (Other than transfer)	Failures related to the fuel system including leakage and contamination. Excludes failures associated with the transfer of fuel from storage tanks to day tanks.
Fuel Transfer	Failures of the fuel transfer system including the fuel oil transfer pumps.
Generator	Failures associated with generator operation including field flash and generator excitation. Excludes voltage control, which is address under "Control."
Lube Oil	Failures related to the lube oil system including lube oil pump failures and system leakage failures.
Not Applicable	The failure identification process identified 43 failures of components not related to the EDGs or Alternate AC power. These were all coded as "Not Applicable." These failures are not further discussed in this report.
Operator Error	EDG failures directly caused by operator actions.
Sequencer	Failures related to the sequencing of loads.
Unknown	Failures with an unknown cause.
Ventilation	Failures associated with the ventilation system.

The failures are summarized in Appendix A.

Success Data

The success data used for the calculation of the EDG failure rates were obtained from CDE. The collected data include EDG start and load-run demands and run hours needed to calculate the applicable failure rates for each failure mode. Much of the data are based on licensee estimates with a limited amount of actual performance data. In several cases there were multiple entries of success data reflecting updates of data since the initiation of the MSPI. In all cases, the success data used were those closest in calendar time to the 1999 – 2001 baseline period.

For the failure to run, the impact of including the first load run hour in the total run hours was investigated by calculating the run failure rate with and without the inclusion of the first run hour. This impact was estimated by equating each load/run demand to a run hour.

The success data are listed in Appendix B.

Data Quality

The identified MSPI failures and their associated failure modes are highly dependent on the CDE failure and success data because the assignment of these failure codes was performed using only the available information contained within CDE. Many records contained limited or incomplete information about the operational condition of the EDG at the time of the failure (e.g., EDG loaded, output breaker closed,

etc.) and the timing when the failure occurred (e.g., run time following breaker closure). Many records also lacked a complete narrative assessment of the failure's impact. These limitations required the application of considerable judgment by the reviewers of these data and are a source of uncertainty in both the identification of MSPI failures and the assignment of their failure modes.

A review of the initial failure identification and mode assignment was performed by members of the NEI Reactor Oversight Process Task Force. This industry review was done only for the identified MSPI failures and did not include the identification process or a review of the screened failure records. Their review found the classifications to be generally appropriate but identified several failure records that were judged not to be EDG MSPI failures and several where there was a significant possibility that the reported condition did not represent a failure. In response to the review comments, six of the seven failures assessed as not representing a failure were reclassified. The remaining failure, Failure ID 26533, was maintained because it addressed the failure of an FOTP and is included in the proposed revision to the EDG run failure definition. Of the 13 additional failures identified as questionable by the NEI task force members, 5 were removed from the MSPI baseline failures. Table 2 provides a summary of the disposition of each of the 13 failures.

Table 2
NEI Failure Recommendations and NRC/ISL Final Disposition

Number	Failure ID	Description	NEI Task Force Comment	NRC/ISL Disposition
1	2683	With the EDG loaded, the lube oil pump relief valve cycled open and closed, below its 130# setpoint. The lube oil pressure was approximately 85#.	Identified as questionable.	The failure report states that a degraded lube oil pump required replacement and includes no assessment as to whether the EDG would have perform its safety function. This failure is maintained.
2	3099	A fuel oil leak at the fuel oil isolation valve occurred while the DG was being shutdown.	Leak during shutdown cycle. Need more information to determine the potential impact during an emergency demand.	The failure record states that "a fuel oil leak developed and rapidly grew in size, requiring declaring the DG unavailable at 03:00." This failure is maintained.

Number	Failure ID	Description	NEI Task Force Comment	NRC/ISL Disposition
3	6481	Burning odor and smoke came from an EDG control Panel during a surveillance run. The EDG was manually shutdown. A linear reactor in the generator exciter controls was found to be completely functional, except that there was evidence of a grounded overheated location.	Degraded operation, but no failure occurred. Evaluate actual impact.	Failure was coded by licensee as a run failure based on the belief that failure was imminent. This failure is maintained.
4	13786	EDG voltage went to 2KV after starting, then hesitated prior to reaching 4KV as required. Time to reach 4KV exceeded required 10 seconds. The problem was in the field flash circuitry.	The only impact was a slow start time. This should not be counted as a failure.	As the EDG did perform its safety function consistent with that required for a typical PRA and was only delayed for 5 - 6 seconds, this failure has been removed from the MSPI baseline failures.
5	15174	Service Water leak on elbow on heat exchanger tube side bent elbow was found corroded.	This minor condition needs further evaluation to determine the impact, but it would not result in a start failure.	As the leak was characterized as minor and the failure was coded by the licensee as not impacting the EDG, this failure has been removed from the MSPI baseline failures.
6	15228	EDG was recently rebuilt due to extensive damage. During it break-in runs engine had to be shutdown due to high d/p across lube oil strainer indicative of bearing failure. Bearing failure heating caused damage to multiple other components.	Post Maintenance run?	Licensee coded this failure as unavailable, not failed. Therefore, it is assumed that bearing failure is the result of maintenance as failure was discovered during post maintenance testing. This failure has been removed from the MSPI baseline failures.

Number	Failure ID	Description	NEI Task Force Comment	NRC/ISL Disposition
7	15635	Unstable governor output caused DG to hunt and swing during unloaded, loading and unloading operations. The cause was determined to be multifold, including soldered joint connections and HVAC air flow interaction.	See Failure ID 15636. Two independent failures on the same day.	A review of the two failure records (15635 and 15636) confirms that both failures did occur on the same day and were independent. The second failure was associated with exciter diodes and believed to be caused by a voltage transient (independent of the governor maintenance). This failure is maintained.
8	15636	EDG tripped on overspeed due to failed exciter diodes. The failed diodes prevented voltage from developing after field flash was applied.	See Failure ID 15635. Two independent failures on the same day.	See Failure ID 15636. This failure is maintained.
9	16235	Rust scale blocking air start pressure control valves in the air start system caused a failed start attempt on the EDG.	Did this affect both air start subsystems? Are there two subsystems on this DG?	The failure record does indicate that there are two air start systems. It states that "Following the failed start, Operations closed DA31, open DA45, and reset the 86-2 lockout via the pushbutton on C3616. Nothing abnormal was noted in the DA45 side start." This failure has been removed from the MSPI baseline failures.
10	17428	EDG annunciators for "Crankcase Pressure HI" and "DG Auto Start Locked Out" came in, in response to work being performed on the room ventilation dampers. When an HVAC damper failed shut, it caused a vacuum in the room, which actuated the crankcase pressure switch trip.	There was no failed component within the component boundary.	The failure record states that the EDG was in standby and would not have started during the brief interval that the crankcase pressure switch was activated. As this event is the result of maintenance of the ventilation system with EDG performing as designed, the failure has been removed from the MSPI baseline failures.

Number	Failure ID	Description	NEI Task Force Comment	NRC/ISL Disposition
11	20392	EDG failed to respond to voltage regulator manual control during loaded operation. VAR loading dropped without adjustment and would not respond to control board signal adjustment.	Is this a duplicate of Failure ID 20393?	These two failures (20392 and 20393) have different discovery dates. Evidence is insufficient to combine the records. This failure is maintained.
12	20393	EDG failed to respond to voltage regulator manual control during loaded operation. VAR loading dropped without adjustment and would not respond to control board signal adjustment.	Voltage regulator is not used in manual control during emergency start.	The failure record provides no indication as to cause of failing to reach rated voltage. This failure is maintained.
13	20404	EDG experienced spurious annunciation of oil pressure, low water pressure, and overspeed after successful completion of test. A faulted LWD relay was most likely the cause.	Annunciated Failure?	The failure record contains Insufficient information to remove. The licensee coded the failure as erratic output (MSPI-S). This failure is maintained.

Results

A total of 383 functional failure reports from CDE related to emergency and alternative AC power generation were identified and reviewed. Of these failures, 275 were identified as failures related to the EDGs. The remaining 108 screened records were related to alternative AC power sources or other non-EDG related components. Of the 275 failures associated with the EDGs, 137 were assessed as being MSPI failures. In addition, the success data (start demands, load run hours and run hours) were estimated for the 222 EDGs included within the scope of CDE. The results of this review are summarized below:

Table 3
EDG Failure Comparison

Type	Total	Start	Load Run	Run
Number of Failures (including FOTPs)	137	75	42	20
Number of Failures (excluding FOTPs)	135	75	42	18
Success Data		13,772 demands	11,843 demands	26,170 hours
Average (Demands/Hours) per EDG per year		62 demands	53 demands	118 hours
Maximum Likelihood Failure Rate (including FOTPs)		5.45E-03	3.55E-03	7.64E-04
Maximum Likelihood Failure Rate (Excluding FOTPs)		5.45E-03	3.55E-03	6.88E-04
NEI 99-02 Revision 6 Table 8 Values		5.00E-03	3.00E-03	8.00E-04

EDG Run Hour Sensitivity Results

Table 4 summaries the impact of including the first load-run hour in the failure to run calculation. It shows that the exclusion of this hour results in a failure rate value consistent with NEI 99-02, Table 8.

Table 4
EDG Run Hour Sensitivity

Type	Run Including first hour	Run Excluding first hour
Number of Failures (including FOTPs)	20	20
Number of Failures (excluding FOTPs)	18	18
Success Data	38,013 hours	26,170 hours
Average per EDG per year	171 hours	118 hours
Maximum Likelihood Failure Rate (including FOTPs)	5.26E-04	7.64E-04
Maximum Likelihood Failure Rate (Excluding FOTPs)	4.74E-04	6.88E-04

Failure Categories

Table 5 provides a breakdown of the major causes of EDG failures for the 137 identified failures.

Table 5
MSPI Failure Cause Categories (with FOTP failures)

Failure Cause Category	Total	Total MSPI Failures	Failure to Start	Failure to Load Run	Failure to Run	Total MSPI Failure Percentage
Air Start	28	5	5	0	0	4%
Breaker	14	11	2	8	1	8%
Control	89	55	38	14	3	39%
Coolant	21	13	6	4	3	10%
Engine	27	18	7	8	3	13%
Fuel (Other than transfer)	12	7	4	1	2	5%
Fuel Transfer	8	2	0	0	2	1%
Generator	14	10	5	3	2	8%
Lube Oil	21	13	6	3	4	9%
Operator Error	6	1	1	0	0	1%
Sequencer	19	0	0	0	0	0%
Unknown	4	2	1	1	0	1%
Ventilation	12	0	0	0	0	0%
TOTAL	**275**	**137**	**75**	**42**	**20**	**100%**

Conclusions

Baseline Failure Rate Data

This failure data review found that the failure rates contained within NEI 99-02, Table 8 are generally consistent with the data reviewed for this report.

The report did note that failure-to-run is sensitive to whether the run hours include the first hour. This sensitivity is not unexpected because an EDG is often run for a short duration. Based on the information in Table 3, the average run duration per start is less than three hours when both load/run and run hours are considered ((118 hours + 53 load-demands)/62 starts). Although MSPI treats load/run as a demand, it is, by definition, addressing the first hour of EDG operation following breaker closure and is used in this report to estimate the initial run time. If one removes these load/run hours, the estimated average run duration per start is 1/3 less, a substantial reduction. The exclusion of this initial hour from the run failure rate results in a failure rate increase from 5.3E-4 to 7.6E-4 per hour and results in a failure rate that is consistent with NEI 99-02, Table 8.

Failure Definition Changes

Although the review of the baseline failure data identified many differences between the failure modes determined during the review and those indicated by the failure record, it did not appear that the differences were driven by the proposed changes in the EDG failure mode definitions. Table 6 summarizes the noted differences:

Table 6
Failure Determination Differences

Type	Failures determined by this NRC/ISL review	Industry Total	Industry Failure to Start	Industry Failure to Load/Run	Industry Failure to Run	Industry EDG Unaffected
Failure to Start	75	100	66	3	0	6
Failure to Load/Run	42	15	26	12	3	1
Failure to Run	20	11	8	0	8	4
Total	**137**	**126**	**100**	**15**	**11**	**11**

The baseline failure records developed by industry for this time period predate the implementation of the MSPI program and, as such, do not explicitly code the failure records as MSPI failures. Therefore, Table 6 was developed by reviewing the failure mode codes contained within CDE for those failure records identified as MSPI EDG failures by this current review. This comparison approach allows only the assessment of failures that appear to be under-reported and/or miss-categorized, and does not allow for the assessment of whether the review documented in this report failed to identify any MSPI failures.

The first row of Table 6 addresses the failure to start. It shows 75 start failures of the 137 MSPI failures identified during this review. The column titled “Industry Total” shows the total number of failure to starts coded by industry for the same 137 MSPI failures. The fact that 100 is greater than 75 indicates that 25 failures were coded by this review as one of the other two failure modes. The remaining columns show the treatment of the 75 failures by industry. Of the 75 failure to starts, the industry coded 66 as start failures, 3 as load/run failures, 0 as run failures and 6 were identified as having not impact on the EDG. The other rows are similarly formatted.

Given this framework, a total of 11 failures were identified by industry as not being EDG failures. Although it is possible that with additional information some or all of these failures may be found to

have not impacted the EDG's safety function, a conclusion of EDG success could not be made based on the available information.

For the records considered to be both failures by this review and the industry, a comparison of failure mode categorization notes significant differences. There are 86 failures (66 start failures + 12 run/load failures + 8 run failures) of the 137 identified MSPI failures that are categorized as having the same failure mode by this review and industry. Excluding the 11 failures coded as not impacting the EDGs, the resulting differences in failure modes is 40 failures including 26 load/run failures identified as start failures by the industry. Of these 26 failures, most appear to be unaffected by the failure definition used. For example, seven of these failures were associated with the EDG output breaker. The failure of the breaker to close is included as part of the load/run failure definition in both versions. However, six of the 27 failures are related to voltage control issues and may have been identified as start failures due to the inclusion of the requirement for achieving required speed and voltage in the current failure to start definition.

Two of the identified failure to run events are associated with the inclusion of the FOTPs and are clearly the result of the proposed change in the failure definition.

Therefore, with the exception of the voltage-related and fuel oil transfer pump failures representing approximately 20% of the mismatched failures, the failure mode differences appear to be driven by other factors.

Fuel Oil Transfer Pumps

The failure review found eight failure reports related to the fuel oil transfer system. Of these eight reports, two were found to be failures to run. The six failures that were evaluated as not impacting the EDGs include:

- 3 events - Day tank level switch out of tolerance (Potentially 3 duplicate records as they occurred at the same plant and involved the same component)
- 2 events – FOTP failed to stop and overflowed the day tank. Pump was manually terminated.
- 1 event – Diesel FOTP cycled intermittently. Appears that fuel flow to day tank was adequate.

The two fuel oil transfer failures included in the failure rate calculation include:

- Gross leakage of the fuel oil transfer valve discharge relief valve such that the pump would not pump to the day tank.
- Malfunction of the FOTP

The inclusion of the FOTPs within the baseline data has minimal impact on the baseline failure rates and provides a resulting failure rate more consistent with NEI 99-02, Table 8.

Appendix A

1999 – 2001 Failures

1999 - 2001 EDG Failures

Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
	137	**75**	**42**	**20**		**190**	**157**	**18**	**15**	**SUBTOTALS**				
245	None	0	0	0	3/27/1999	R	0	0	1	Engine	Cylinder leakage appears to be maintenance related as failure occurred on first STP following maintenance	Unknown	Unknown	
309	None	0	0	0	11/25/1999	R	0	0	1	Operator Error	Load level too low as operator did not step through procedure quick enough	EDG tripped on reverse power while shutting down from test run	Procedure revised	
310	None	0	0	0	3/26/2000	R	0	0	1	Operator Error	Tripped on reverse power 86B during SOP-38.0. Insufficient caution for shutdown with minimal load - Procedural inadequacy	EDG tripped on reverse power	Unknown	
343	S	1	0	0	9/12/2000	S	1	0	0	Control	Auto start light was not illuminated. Blown fuse causing auto voltage circuitry to be inoperable	EDG declared inoperable	Light socket and fuse replaced	
604	None	0	0	0	11/13/1999	None	0	0	0	Sequencer	Sequencer Relay HFA Relay 68G4 did not have acceptable continuity	Unknown - declared a FF	Unknown	
621	None	0	0	0	1/17/2000	S	1	0	0	Control	Would not respond to repeated attempts to raise load. Load was at 3.5 MW. Pot had dead spot on pot winding	Condition cleared with no further operator action. Pot later found to have dead spot on winding	Replaced pot	Recommended by NEI review to be removed as a failure as this failure assoicated with the POT would not impact an emergency demand.
809	R	0	0	1	7/1/1999	R	0	0	1	Lube Oil	LO pressure degraded to approximately 33psi (from 75 psi) from a combination of failed bolting and cracked bracket (stub shaft bushing assembly). Discovered as part of the post maintenance testing. A non-manatory May 1972 maintenance bulletin to retrofit with a new design bracket in order to increase strength had not been implemented. Upgrade likely to have been planned in conjunction with turbo charger upgrades at a later date. Failure does not appear to be directly related to the maintenance actions.	EDG was shut down	Unknown	
944	S	1	0	0	1/28/1999	S	1	0	0	Lube Oil	LO AMOT (cast iron) valve flanges were torqued such that the valve body cracked approximately 20 days after the maintenance was performed. Crack resulted in loss of LO.	EDG declared inoperable	Valve replaced and procedure revised	
945	S	1	0	0	1/29/1999	L	0	1	0	Control	Tachometer driven gear coupling tang broke. The tang connects the tachometer shaft to the bevel driven gear. In addition, the bevel drive gear had broken teeth. The bevel drive gear is attached to the governor power take off shaft. The tachometer drive shaft was bent. Failure investigation concluded that the gear mesh engagement was inadequately spaced. This caused excessive forces to be experienced by the tachometer driven gear and shaft. It was also determined that mesh adjustment could be achieved by varying the thickness of the bearing retainer cover gasket, which corrected the problem.	During Manual Slow Speed Start - this failure had little impact on engine operation. Local Panel Tachometer readout was erratic and reading between 0 and 200 RPM, even though the engine was being loaded at 900 RPM. At less than 200 RPM indicated, the standby keep warm engine systems automatically operated. Note: Had the Tachometer malfunctioned during an Auto-Start, the engine would have failed to run.	An undamaged Tachometer Assembly was installed, and the bearing retainer cover gasket thickness was altered to achieve the desired driven gear engagement.	On an actual LOOP, this Tachometer malfunction would have resulted in a failure to start. A slow start bypasses this input.
1006	None	0	0	0	6/11/1999	None	0	0	0	AAC	AACG tripped during a surveillance test due to failure of the speed sensor. The speed sensor signal provides trip logic to the PLC.	EDG tripped	Speed sensor was replaced	Screened as this is a alternative AC generator.
1014	None	0	0	0	9/23/2000	S	1	0	0	Control	Local Regulator Control Lockout Relay malfunctioned such that the Differential Lockout Relay was not bypassed, when taken to "Local." This prevented the Manual control of the voltage regulator, which went to 5kV.	This malfunction would not have prevented automatic operation of the EDG because it is normally aligned in the "Remote" Voltage Regulator position. This condition was identified during a surveillance of the overspeed trip test, which requires the Voltage Regulator to be taken to Local.	The Local Regulator Lockout Relay was replaced and procedures initiated to exercise the contacts periodically.	

1999 - 2001 EDG Failures

Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
1050	None	0	0	0	2/28/2001	L	0	1	0	Control	EDG A was undergoing its monthly surveillance test by paralleling and loading it onto the grid. The Voltage regulator malfunctioned in Speed Droop mode of operation. This caused an underexcited EDG condition. Attempts to control VARS were unsuccessful and the EDG was subsequently unloaded and secured.	The EDG could not be paralleled to the bus while the Voltage Regulator was in Speed Droop mode. The EDG would have automatically provided emergency power to a de-energized bus such as in the case of a LOOP. However, in order to terminate a LOOP, the EDG would have to be taken to Speed Droop in order to transfer load to the offsite source of power. This function would not be available.	The Voltage Regulator was replaced and tested.	EDG will not parallel with an energized source
1180	None	0	0	0	7/11/1999	S	1	0	0	Coolant	Diesel Engine radiator hose broke and leaked all the coolant from the engine.	The Diesel Engine may have run long enough to perform its intended function to provide starting motive force for the SBO Gas Turbine Generator. Therefore, minimal impact was experienced by the radiator hose failure.	The radiator hose was replaced.	
1195	None	0	0	0	1/7/2009	None	0	0	0	AAC	Gas Turbine Generator # 1 failed to start during cold weather testing to prove reliability. Cause was determined to be fuel flow too low due to valve throat diameter.	Gas Turbine was unavailable until ambient temperature rose.	Larger fuel valve was installed.	
1196	None	0	0	0	1/5/2000	S	1	0	0	Air Start	Air dryer found to have a hole rusted through its accumulator section.	EDG 1B was inoperable, although may have been able to start because the air pressure with the compressor running was > 85 psig. Note: The compressor may not be built to accommodate continuous operation.	The defective accumulator was replaced.	
1203	None	0	0	0	2/18/2000	None	0	0	0	AAC	Cooldown Lockout Alarm came in due to an loose RTD wire. This prevented the start of the Gas Turbine Generator.	This failure would have prevented the start of the SBO Gas Turbine Generator.	RTD terminal was tightened and tested.	
1221	None	0	0	0	11/17/2000	None	0	0	0	AAC	Lube Oil Header Temperature RTD Alarm came in due to an loose RTD wire. This prevented the start of the Gas Turbine Generator.	This failure would have prevented the start of the SBO Gas Turbine Generator.	RTD terminal was tightened and tested.	
1239	None	0	0	0	4/25/2001	None	0	0	0	AAC	Malfunctioning Lube Oil Pressure Switch caused erroneous trip input.	Gas Turbine was unavailable until Pressure Switch was replaced.	Replaced Pressure Switch with correct part.	
1300	None	0	0	0	4/6/1999	None	0	0	0	AAC	13.8kV Gas Turbine #2 Output Breaker to Unit 2 failed to close when taken to Close, because it was not fully racked up. This condition was caused by a failed limit switch on the breaker. The damage occurred when racking the breaker up and down for maintenance.	The #2 Gas Turbine was not available for service until the breaker limit switch was repaired.	The operations and maintenance personnel were trained on the event to prevent recurrence. The training and included how to properly adjust the limit switch such that the roller securely fits into the vee notch.	
1425	None	0	0	0	4/14/1999	S	1	0	0	Fuel (Other than transfer)	A drawstring from a spray shield got lodged between fuel pump 8R metering rod and the fuel pump housing. This prevented the rack from going to No-Fuel position when the engine was unloaded.	The EDG ran as expected loaded, but did not go to no-fuel position when shutdown. Although this event did not prevent the engine from raising load, it held the rack open at 50% fuel position. This could have prevented paralleling the engine with offsite power.	All the spray shield drawstrings with removed to prevent further interference.	
1463	R	0	0	1	4/22/2000	R	0	0	1	Fuel (Other than transfer)	Failure of fuel supply line from engine header to the jerk pump (high pressure fuel injection pump) suction	EDG secured via emergency stop	Replace fuel supply hose, inlet elbow and fuel injection pump	
1566	None	0	0	0	1/19/1999	L	0	1	0	Coolant	EDG tripped during loading due to high temperature trip at 198F.	EDG was shut down and declared inoperable.	Adjusted cooling water valve position	Recommended by NEI review to be removed as a failure as this trip is a non-emergency trip that is bypassed during an emergency demand.

1999 - 2001 EDG Failures

Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
1568	None	0	0	0	2/18/1999	S	1	0	0	Engine	EDG tripped on high crankcase pressure trip due to the crankcase pressure trip switch being out of calibration.	EDG tripped from unloaded condition.	Crankcase pressure trip switch was calibrated.	Recommended by NEI review to be removed as a failure as this trip is a non-emergency trip that is bypassed during an emergency demand.
1580	None	0	0	0	6/29/1999	S	1	0	0	Engine	Turbo Air Assist compressor unloader malfunctioned, consequently the compressor would not load.	EDG may have not loaded as required on auto start. Operator nudged unloader and the compressor subsequently loaded. Assumption that turbo boost compressed air is required in order for EDG to start within its required time.	Replaced Unloader with new unit	Likely would not start in rated time -- but would start
1587	None	0	0	0	9/21/1999	None	0	0	0	AAC	Fuel Oil Pumps 2L, 6R, 6L, and 1R leaking fuel excessively such that the engine needed to be secured. Gaskets were not sealed correctly due to relaxation.	SBO EDG was unavailable.	Replaced gasket/tightened fittings	Screened as it is a SBO DG
1589	None	0	0	0	12/13/1999	S	1	0	0	Air Start	EDG M2 Air Start Motor failed to start the EDG in the required time constraints.	EDG may have not loaded as required on auto start. Operator nudged unloader and the compressor subsequently loaded. Assumption that turbo boost compressed air is required in order for EDG to start within its required time.	Replaced M2 Air Start Motor	Believe that the engine would have started without operator intervention
1618	None	0	0	0	5/24/2000	None	0	0	0	Engine	EDG Cooling Fan Drive Gear Box had excess free play, which prompted dismantling and rebuilding.	EDG was unaffected	Rebuilt Drive Gear	
1619	None	0	0	0	5/30/2000	S	1	0	0	Control	"C" Phase Ammeter wiring was historically wired using the wrong gauge wire. Consequently, after a period of time, it broke.	Indication Only was lost	Rewired Ammeter, checked others, and opposite train EDG	
1622	None	0	0	0	8/3/2000	None	0	0	0	AAC	Air Start Motor pinion gear was misaligned with the EDG ring gear causing severe damage	SBO EDG was unavailable.	Repair damaged ring gear and air start motor	Screened as it is a SBO DG
1781	L	0	1	0	2/5/1999	S	1	0	0	Engine	Engine #2 caused the load inbalance by producing 4.6 MW instead of 4.0 MW which Engine #1 was producing. The #2 Engine Fuel Rack Limiter Jack vibrated out of position and required readjustment.	EDG was unavailable	Readjusted and locked down Fuel Rack Jack	
1802	None	0	0	0	5/6/1999	None	0	0	0	AAC	Smoke issued from under the exhaust heat shield of the 0C1 engine when tested. The smoke came from a loose Temperature Element in the exhaust system, which fell out. The engine was secured	EDG was unavailable	Temperature Element was replaced	Screened as it is a SBO DG
1828	S	1	0	0	9/13/1999	S	1	0	0	Control	Operator were unable to control generator output frequency due to Generator Load Sharing and Speed Control Module	EDG was unavailable	The speed control module was replaced, calibrated, and tested	
1956	None	0	0	0	3/8/2000	None	0	0	0	AAC	OC SBO EDG tripped 58 minutes into loaded run due to Cylinder #14 Temperature Element producing a false high temperature system. Failed RTD was cause.	EDG was unavailable	Faulty Temperature Element was replaced	Screened as it is a SBO DG
1987	None	0	0	0	5/10/2000	None	0	0	0	Fuel (Other than transfer)	Engine oil sump was overfilled due to a problem with the insertion of the dipstick. This caused foaming during a test run. The foam caused a low level trip of the EDG within 5 minutes of loaded operation.	EDG was unavailable	Oil level was adjusted	Recommended by NEI review to be removed as a failure as this trip is a non-emergency trip that is bypassed during an emergency demand.
1995	None	0	0	0	4/9/2000	S	1	0	0	Control	1A EDG Output Breaker test failed. Instead of closing in 2 seconds upon reciept of signal, it closed in 245.7 seconds. The fault was traced to the Bus Load Shed Verification Relay.	This failure would not have prevented the 1A EDG from loading Bus 11, but it would have delayed it.	Relay time delay was found to have drifted. EDG taken out of service and relay recalibrated	
1996	None	0	0	0	6/3/2000	None	0	0	0	AAC	Operator changing burnt out light bulb experienced sparks and a short circuit which blew Fuse FUP1A. The "Loss of 125VDC" alarm came in.	DC Power to the SBO EDG was lost, rendering engine unavailable	Light socket and fuse replaced	Screened as it is a SBO DG

1999 - 2001 EDG Failures

Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
2059	L	0	1	0	4/16/2001	S	1	0	0	Control	EDG Radiator Fans were not running with the engine loaded, due to numerous electrical malfunctions including starting relay.	Rendered EDG unavailable	Wiring re-attached to Relay and breaker overcurrent trip settings raised	
2161	None	0	0	0	4/12/1999	S	1	0	0	Control	2A EDG Output Breaker test failed. Instead of closing in 2 seconds upon reciept of signal, it closed in 84. The fault was traced to the Bus Load Shed Verification Relay.	This failure would not have prevented the 2A EDG from loading Bus 21, but it would have delayed it.	Relay time delay was found to have debris in it. EDG taken out of service and relay cleaned and recalibrated	Delayed closure - plant would likely have been protected for all events except large break LOCA
2313	None	0	0	0	7/16/2000	None	0	0	0	Lube Oil	2A EDG had a Lube Oil Cooler leak at a sensing line. It was prudent to secure the engine.	This failure would not have prevented 2A EDG from loading and running.	Engine was secured and oil leak repaired	
2374	None	0	0	0	8/16/2001	None	0	0	0	Control	"2A DG POT VOLT FREQ LO" alarm came in and could not be cleared during test. Engine had to be secured for repair.	After MOT repair it was determined that EDG 2A would have still have been available	Engine was secured and MOT repaired	Believe that on a real event that the EDG would not have been secured.
2453	L	0	1	0	8/31/1999	S	1	0	0	Breaker	The root cause of the diesel generator output breaker tripping was an improper over-current trip set point for the Ampector (solid state trip device) of the breaker. Post trip testing revealed the over-current trip set point for 23 EDG was 3200 amps vs 6000 as intended. This improper setting was caused by the difficulty of setting the Ampector low in its high amp, coarse setting span.	EDG was unavailable during a test demand	Circuit breaker Amptector was recalibrated	
2464	None	0	0	0	9/11/1999	None	0	0	0	AAC	Gas Turbine Generator Starting Diesel failed to start on demand. Diesel air start motor malfunctioned.	Gas Turbine unavailable	starting motor replaced	
2465	None	0	0	0	7/8/1999	None	0	0	0	AAC	Gas Turbine Generator Starting Diesel failed to start due to high jacket water temperature. HVAC Louvers failed to open as required.	Gas Turbine unavailable	Louver motors repaired	
2466	None	0	0	0	7/20/1999	None	0	0	0	AAC	Gas Turbine tripped due to operator error in shifting fuel oil supplies	Gas Turbine unavailable	Valve labelling enhanced	
2467	None	0	0	0	7/16/1999	None	0	0	0	AAC	Tripped on "Combustor #1 Temp Trip" shortly after receiving the teermperature alarm. Alarm was not valid and was found to be due to a loose wire.	Gas Turbine unavailable	Loose wire repaired	
2468	None	0	0	0	7/23/1999	None	0	0	0	AAC	Gas Turbine tripped several times while attempting to start. Investigation identified that Turbine vibration probe #2 wires were detached.	Gas Turbine unavailable	Vibration Probe replaced	
2469	None	0	0	0	7/27/1999	None	0	0	0	AAC	GT2 tripped on high vibration. On restart attempt, however, it tripped on overspeed trip pressure low. Further, a fire started due to a loose bearing cover.	Gas Turbine unavailable	Leak was repaired	
2470	None	0	0	0	7/30/1999	None	0	0	0	AAC	GT2 tripped on high vibration.	Gas Turbine unavailable	Vibration caused by lack of thermal insulation which was replaced	
2474	None	0	0	0	9/13/1999	None	0	0	0	AAC	Gas Turbine turning gear damaged due to lubricating oil sediments. Sediments also found in reduction gears.	Gas Turbine unavailable	Turning gear repaired and new lube oil used	
2475	None	0	0	0	8/24/1999	None	0	0	0	AAC	Gas Turbine 3 Black Start Diesel lube oil check valve to the main reservoir had backflow. This caused insufficient flow in the Diesel Engine if engine is not prelubed prior to starting. The Diesel would have tripped if demanded to start.	Gas Turbine unavailable	Governor logic altered to allow starting with lower lube oil pressure	
2476	None	0	0	0	7/2/1999	None	0	0	0	AAC	GT-3 tripped on sart-up with the Lube Oil Pump breaker opened. The cause of the trip was high current due to high Summer time temperatures and additional loads.	Gas Turbine unavailable	Breaker was replaced with one rated for higher current	
2485	None	0	0	0	12/14/1999	None	0	0	0	AAC	Turning gear failed during test which prevented run of Gas Turbine. Turning gear motor had a blown fuse	Gas Turbine unavailable	Fuse replaced	
2488	None	0	0	0	10/13/1999	None	0	0	0	AAC	Start Air receiver Solenoid Operated Drain Valve malfunctioned. One quart of water found in Receiver.	None	SOV replaced	
2489	None	0	0	0	1/9/2000	None	0	0	0	AAC	GT-1 Air Receiver automatic blowdown valve stuck open, causing low air pressure. Instrument Air Pressure Low alarm was annunciating.	Gas Turbine was unavailable	Air Receiver drain valve was replaced	

1999 - 2001 EDG Failures

Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
2490	None	0	0	0	11/19/1999	None	0	0	0	AAC	GT3 Blackstart Diesel voltage regulator failed. Generator failed to provide power to GT1 and GT2.	GT1 and GT2 were unavailable, which limits availability of SBO power	The Blackstart Diesel motor was rewound and re-installed.	
2491	None	0	0	0	3/10/2000	None	0	0	0	AAC	GT3 Blackstart Diesel was found tripped due to generator stator windings shorting to the armature. Although the generator tripped, the Engine ran until it ran out of fuel because the power supply to the fuel pump was the output of the Generator.	GT3 wouldn't have been available under SBO conditions	The Blackstart Diesel Generator was rewound and re-installed.	
2644	L	0	1	0	1/10/1999	S	1	0	0	Fuel (Other than transfer)	EDG did not load as required due to failure of Fuel Oil Booster Pump losing its prime. The cause was determined to be improper pump and piping configuration, which caused air in-leakage through the pump seal.	EDG was unavailable for power production	Booster pump piping modifications are being evaluated for installation	
2654	S	1	0	0	6/20/1999	S	1	0	0	Engine	EDG had a cracked Cylinder Head which leaked noticeably during unloaded operation. Leak prevented engine from running in its normal parameters and was shutdown.	EDG was unavailable for power production	Cracked cylinder was replaced	
2673	S	1	0	0	10/6/1999	S	1	0	0	Generator	EDG did not load as required due to a shorted diode resulting in loss of generator excitation. The shorted diode in the jacket water pressure permissive is an input into breaker 72-302 field flashing/excitation breaker logic.	EDG was unavailable for power production	The diode was replaced	
2683	R	0	0	1	6/24/1999	S	1	0	0	Lube Oil	With the EDG loaded the Lube Oil Pump P-212B, Relief Valve cycled open and closed, below its 130# setpoint. The Lube Oil Pressure was approximately 85#.	EDG was unavailable for power production	Lube Oil Pump and Relief Valve was replaced	
2706	None	0	0	0	4/4/2000	S	1	0	0	Operator Error	Error in removing Diesel Generator Output Brkr, 152-107, to the 4kV ESF Bus, caused breaker to close and motorize the generator. This caused the Reactor to Trip.	Operations recovered the plant and restored stability to the EDG.	Operations recovered the plant and upgraded procedures and training for 4kV Brkr operations	Maintenance activity - screened
2916	None	0	0	0	2/16/1999	None	0	0	0	Air Start	DG3 starting air compressor intercooler had through wall air leak at the mechanical connection between the high and low pressure heads.	Minimal. Although this rendered Air Start System inoperable until air start headers were cross tied to ensure starting air available to #3 EDG, air start cylinders were charged.	Replaced Air Compressor	
2955	L	0	1	0	5/23/1999	L	0	1	0	Control	DG would not load to greater than 1500 kW instead of the desired 3000 kW. EGA Motor Operated Pot was determined to be malfunctioning.	DG was taken out of service for repair. DG would have been able to pick up Full Load in a LOOP, however may not been able to parallel to restore buses when off-site power returned. A LOOP concurrent with a LOCA may challenge the 1500kW limit.	DG Motor operated POT was repaired	
2961	None	0	0	0	6/9/1999	S	1	0	0	Control	Control Room manual start switch failed	EDG would not start on manual demand from the Control Room.	Control Switch repaired	Screened as it appears that the automatic start function was available and would have functioned.
2989	None	0	0	0	8/22/1999	None	0	0	0	Air Start	Diesel starting air compressor had a leaking intercooer between the first and second stage.	The iar leak did not exceed the capacity of the compressor and the air receiver pressure was maintained.	Control Switch repaired	Screened as it appears that the automatic start function was available and would have functioned.
2996	None	0	0	0	9/7/1999	None	0	0	0	Air Start	DG2 starting air compressor intercooler had leak at the soldered connection between the high pressure outlet and the header.	Minimal. The air start cylinders were charged.	Repaired leak	
2999	None	0	0	0	9/29/1999	None	0	0	0	Air Start	DG1 starting air compressor high pressure RV was found lifted and the compressor running.	Minimal. The air start cylinders were charged.	Replaced Relief Valve	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
3005	None	0	0	0	11/14/1999	None	0	0	0	Control	During the performance of 97-AABT1, it was discovered that the 2-E3-AI4-86DB relay was bound up and would not trip. This relay provides protection of the generator against reverse power (32D), an external fault condition (51V), and a loss of excitation (40).	This relay provides protection of the generator against reverse power, an external fault condition, and a loss of excitation. It was found in the reset position. Hence, it would not have prohibited EDG-3 from performing itsdesign function. However, this failed relay exposed the EDG to damage on the occurrence of these events.	Replaced Relay	Not applicable to a real demand.
3047	R	0	0	1	3/3/2000	R	0	0	1	Generator	DG 2 Tripped while supplying power to Bus E-2, due to a failure of the Excitation Transformer.	DG was unavailable	Excitation Transformer was replaced	
3071	None	0	0	0	4/12/2000	None	0	0	0	Lube Oil	DG 4 Aux Lube Oil Pump Brkr was found tripped during operator rounds with the DG secured (standby).	DG was unaffected	Pump motor was tested and found satisfactory. The breaker was replaced.	
3090	None	0	0	0	9/27/2000	None	0	0	0	Air Start	Start Air Compressor had leak on Intercooler leak due to high pressure resulting from failure of compressor suction valves.	Minimal. The air start cylinders were charged.	Air Compressor was replaced	
3099	R	0	0	1	10/17/2000	None	0	0	0	Fuel (Other than transfer)	A Fuel Oil Leak at the fuel oil isolation valve occurred while the DG was being shutdown.	DG became unavailable	1/4" Close nipple was replaced	
3100	None	0	0	0	10/22/2000	None	0	0	0	Air Start	Start Air Compressor had leak on Intercooler leak due to high pressure resulting from failure of compressor suction valves.	Minimal. The air start cylinders were charged.	Air Compressor was replaced	
3103	None	0	0	0	11/27/2000	None	0	0	0	Lube Oil	DG 1 was being secured from a run when it was noticed that the Aux LO Pump was not running normally. At this point in DG operations, the Aux LO Pump should have been supplying pressure. The pump Coupling was damaged.	None	Pump coupling was repaired	
3152	None	0	0	0	3/25/2001	None	0	0	0	Air Start	2-DSA-DG3-CMP-1, Air Start Compressor Brkr was found in the Tripped Condition	None	Motor was placed back in service after meggering and testing	
3590	None	0	0	0	8/23/1999	None	0	0	0	Ventilation	EDG Room Exhaust Fan HVE-17 tripped its breaker, due to faulted motor windings.	EDG B was unavailable	Motor was rewound	Problem associated with a high room temperature after a period of EDG operation.
3948	None	0	0	0	5/19/1999	None	0	0	0	AAC	Fan Trips on Start due to slow Damper Response.	Unknown	Damper was lubricated	Screened as this is an alternative AC DG - Fan is a room cooling fan that would have impacted the DG once the room heats up.
3949	None	0	0	0	5/21/1999	None	0	0	0	AAC	Fans E-85 A-SB and E-85 B-SB will not stay running. Trouble alarm comes in sporadically.	Unknown	Damper was lubricated	Screened as this is an alternative AC DG - Fan is a room cooling fan that would have impacted the DG once the room heats up.
3982	U	0	0	0	11/4/1999	S	1	0	0	Control	Oxidized Motor Operated Potentiometer in the Governor caused the Generator Frequency to drift. This caused the Frequency to stabilize outside of the required 10 Seconds.	EDG B was Inoperable however it would have loaded the ESF bus in the event of LOOP when the Governor is in Isochronous Mode.	Testing cleaned the Potentiometer which functioned normally subsequently.	
4226	S	1	0	0	1/13/2000	S	1	0	0	Control	Loose lead terminal on Governor caused unexpected Frequency Swings when 1A DG was running unloaded.	DG was unavailable	Trouble shooting activities identified the loose governor terminal lead, which was tightened.	
4253	None	0	0	0	2/16/2000	None	0	0	0	Not Applicable	Not EDG related	Not EDG related	Not EDG related	
4374	None	0	0	0	3/15/1999	None	0	0	0	Not Applicable	Not a DG. This is an Emergency Light			
4555	S	1	0	0	2/5/1999	S	1	0	0	Control	DG trouble alarm came in while engine was running unloaded. This alarm can be caused by multiple conditions, many of which were locally in alarm. Additionally, the engine speed spiked for a short time. The cause for all the alarms were from a Power Supply Failure in a control panel.	Failed Power Supply caused 1B DG to be inoperable and unavailable.	Power Supply was replaced with a functioning one	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
4655	None	0	0	0	10/5/2000	None	0	0	0	Sequencer	The ESF Sequencer failed to properly sequence the 1A Component Cooling Pump within the surveillance acceptable time of 19.5 to 20.5 seconds. The pump started at 17.4 seconds. This caused other ESF equipment to fail due to the time differential required after the Component Cooling Pump start. The cause may have been relay contacts with a high resistance and a malfunctioning ESF Timer.	The ESF relay contacts were cleaned, and the timer was replaced.	The ESF relay contacts were cleaned, and the timer was replaced.	Screened as related to Sequencer
5062	S	1	0	0	4/12/2000	S	1	0	0	Control	EDG speed oscillated while unloaded. The fuel rack was moving as demanded by the governor. The Governor Solenoid was found to be open-circuited during trouble shooting.	EDG was inoperable and unavailable	Governor was repaired	
5066	None	0	0	0	4/29/2000	None	0	0	0	AAC	U2 SBO DG tripped due to high room tempertures because a room HVAC damper failed to operate. The high temperature caused a loss of control power to the engine. Damper operator was Hydramotor type. Engine was being run for a 24 hour endurance run.	SBO EDG was unavailable 14 hours into the 24 hour test.	Hydramotor was serviced and damper tested	Screened as it's a SBO DG
5145	None	0	0	0	11/26/2000	None	0	0	0	Not Applicable	U2 SBO UPS Inverter failed due to overheating. The overheating was caused by lack of ventilation in that area.	Unknown	Modification planned for increased ventilation to Inverter	
5277	R	0	0	1	3/9/2000	S	1	0	0	Control	EDG electrical output drifted downward while paralleled, due to a governor problem. Missing fasteners caused the Governor Motor to vibrate and change its demand signal downward during 24 hour endurance test.	EDG was inoperable and might not have completed its mission time	Fasteners were installed on the governor housing	
5278	S	1	0	0	3/11/2000	S	1	0	0	Unknown	EDG failed the hot restart test after and endurance run with full load reject. Trouble shooting did not identify a cause.	Engine did not restart to power the ECCS system as required	Trouble shooting activities did not identify a cause. Engine was successfully retested.	
5322	S	1	0	0	6/2/1999	S	1	0	0	Coolant	EDG Jacket Water Cooling system partially drained due to leaking Heat Exchanger Tubes.	Engine would not have run loaded for greater than an hour.	Heat Exchanger tubes repaired	
5324	None	0	0	0	7/4/1999	None	0	0	0	Not Applicable	Not DG related - Circuit Breaker to Non Safety MCC Trip			Circuit breaker failure did not affect EDG
6069	S	1	0	0	7/20/1999	S	1	0	0	Air Start	The air start motr failed to turn over indicating a potential problem with the solenoid	Failure to start	Investigate and repair - no other action stated	
6070	None	0	0	0	6/25/1999	None	0	0	0	AAC	U1 SBO DG tripped on overspeed during testing.	Failure to start	Repaired Overpeed condition	SBO Diesel
6215	None	0	0	0	1/28/2000	None	0	0	0	Ventilation	The EDG Ventilation Control Switch was found in the "Alternate" Feed position instead of the "Normal" Position.	None	Placed switch to "Normal"	
6444	L	0	1	0	10/21/1999	R	0	0	1	Generator	Burning odor came from EDG 12 Control Panel after the completion of a surveillance run. Linear Reactor 1 and the Current Potential Transformer in the Generator Exciter controls, were found to be completely functional, except that there was evidence of a grounded overheated location.	Failure report states that the EDG was manually unloaded and manually shutdown at the end of the surveillance test. Conservatively assumed that the Engine would have failed to Load.	Replaced with new components	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
6481	L	0	1	0	5/6/2000	R	0	0	1	Generator	Burning odor and smoke came from EDG 14 Control Panel during a surveillance run. EDG 14 was manually shutdown. Linear Reactor 1 in the Generator Exciter controls, were found to be completely functional, except that there was evidence of a grounded overheated location.	EDG was secured to burnging order	Replaced with new components	
6482	None	0	0	0	5/6/2000	S	1	0	0	Engine	EDG was found with Fuel Rack disconnected from the Governor Actuator. Further, when the Fuel Rack was reconnected, it was found that it would not have been able to achieve full load position.	Limited EDG load to 2750kw during testing.	Reconnected and adjusted governor fuel rack linkage	Maintenance activity - screened
6540	R	0	0	1	3/21/2001	R	0	0	1	Generator	EDG 14 Generator Outboard Bearing failed due to lack of lubrication 11 hours into its 24 hour endurance run.	EDG was unavailable after 11 hours of loaded run	Bearing was replaced and oil sightglass was calibrated.	
6696	L	0	1	0	7/16/1999	L	0	1	0	Control	EDG-2 Voltage Regulator failed which caused the trip of 2DF Emergency Bus. The Voltage Regulator failure caused the Bus offsite feeder to trip open, and erratic EDG voltage caused the operator to manually open the EDG output breaker on to that bus. EDG voltage ultimately went to zero, which instananeously caused the Offsite Power Feeder Breaker to trip on overcurrent.	EDG energized 2DF Emergency Bus but operator force to trip the EDG due to voltage swings.	Voltage Regulator was repaired	
6698	None	0	0	0	12/20/1999	None	0	0	0	Not Applicable	A DC Bus Trouble Alarm for Battery 2-1 Charger came in. The Bus voltage was found to be at 120V. The AC input breaker to the 2-1 Battery Charger was found opened by accident.	Unknown for EDG availability because there may have been enough voltage to start a EDG associated with that DC Bus.	Breaker was closed	This is not a EDG issue. It was determined that the Battery voltage was 120V. If this DC bus provided control power and field flashing to a EDG, there would be enough voltage present to start the diesel. There is not enough information to
6799	None	0	0	0	5/26/1999	None	0	0	0	Not Applicable	Loss of Emergency Power to 1A Pressurizer Heater Group due to problem with its breaker indication.	This is not an EDG Issue	Breaker Repaired	Not an EDG Issue
6803	L	0	1	0	11/16/1999	S	1	0	0	Engine	D/G Tripped on OverCurrent while loading for Operations Testing. Problems were identified in Fuel Rack Linkages	This is a Failure to Load because the Test was secured prior to one hour of loaded operation.	Fuel Rack Linkages were replaced	
6834	None	0	0	0	7/26/2000	None	0	0	0	Not Applicable	An unexpected trip of Breaker cused loss of power to transformer 1LXI causing loss of blackout power to some loads, not related to EDG.	None - not a EDG	None - Not a EDG	Not an EDG Issue
6842	L	0	1	0	2/6/2001	L	0	1	0	Lube Oil	DG tripped on Lo-Lo Lube Oil Pressure due to instrument slow response. The instrument line had sludge buildup restricting flow. The actual lube oil pressure was always above the trip setpoint.	DG tripped during manual loading	Oil Pressure Instrument Line was flushed	
6846	R	0	0	1	11/10/2000	None	0	0	0	Control	Smoke came from 1B D/G Control Panel during a test run. The D/G was carrying the emergency bus without being paralleled. The Voltage Regulator 3 Phase Power Potential Transformer was faulted.	1B D/G was secured from its loaded run, however it is unknown if it was tripped in less than 1 hour.	Replaced Voltage Regulator	
6965	L	0	1	0	2/7/2000	R	0	0	1	Breaker	DG Output Breaker Closing Coil malfunctioned such that it would not close when testing DG.	DG was inoperable since the Breaker was last closed on 2/7/00 (22 Days). The Breaker Failure prevented the DG from Loading.	Repaired Closing Coil.	
6972	None	0	0	0	5/10/2000	None	0	0	0	Sequencer	DG 2A Sequencer was found Locked in the Reset position and would not actuate on a safety signal.	This is a Sequencer problem where it would prevent the sequenced loading of equipment after D/G Breaker Closure	The D/G 2A Load Sequencer Timer was replaced with a new design	This is a Sequencer issue

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
7055	None	0	0	0	1/28/1999	None	0	0	0	AAC	The SSF D/G Output Breaker tripped while carrying 700kW of load during paralleled testing. A failed Exciter Diode caused on Overcurrent condition across the Breaker which tripped it.	The Breaker tripped after one hour of loaded operation, however the SSF DG is not Safety-Related.	The Exciter Diode was replaced	The SSF DG supports Safe Shutdown in accordance with Appendix "R"
7061	L	0	1	0	10/2/1999	S	1	0	0	Engine	DG experienced high exhaust temperatures on number 4 Left Cylinder accompanied by noise. Hydraulic cylinder required replacing. Subsequent testing resulted in replacing Exhaust Valve Insert, which was fractured.	DG was shutdown after being loaded for 15 minutes.	Cylinder was rebuilt	
7079	None	0	0	0	11/26/2000	None	0	0	0	AAC	The SSF DG Alarm "600 V System Ground" annunciated. The DG was found with Radiator empty. The Ground alarm indicated high fluid level in the DG Room Sump Area.	SSF DG was unavailable	Holes in the Jacket Water Heater Body and Cooling System were repaired.	The SSF DG supports Safe Shutdown in accordance with Appendix "R"
7217	None	0	0	0	1/10/2000	None	0	0	0	Not Applicable	Hydroelectric Generator Breaker failed	Hydroelectric Generator was unavailable.	Breaker Repaired	This is a Hydroelectric Dam
7240	None	0	0	0	6/8/1999	None	0	0	0	Not Applicable	"Battery Charger Trouble" and "DC Volts Low" Alarms annunciated for the SSF system. Loose lugs caused erratic float voltages to occur.	SSF Standby Battery Charger has no effect on Emergency Diesel Generators	Terminal Lugs repaired	SSF supports Safe Shutdown in accordance with Appendix "R"
7242	None	0	0	0	7/12/1999	None	0	0	0	Not Applicable	SSF Battery Charger Amps dropped to 0 while output voltage dropped to 120V. Soon after, the Charger output returned to normal.	SSF Standby Battery Charger has no effect on Emergency Diesel Generators	None	SSF supports Safe Shutdown in accordance with Appendix "R"
7257	None	0	0	0	8/20/2000	None	0	0	0	Not Applicable	DC Low Voltage Alarm Annunciated in the SSF. Trouble shooting activities determined the problems.	None	Repaired battery cells with low specific gravity.	
7258	None	0	0	0	10/5/1999	None	0	0	0	AAC	Combustion Turbine problem	None	None	
7275	None	0	0	0	6/26/2000	None	0	0	0	Not Applicable	Hydroelectric Generator Breaker failed	Unavailable	Repair Breaker	Hydroelectric Generator
7279	None	0	0	0	1/14/2000	None	0	0	0	Not Applicable	Hydroelectric Generator Breaker failed	Unavailable	Repair Breaker	Hydroelectric Generator
7286	None	0	0	0	9/13/1999	None	0	0	0	Not Applicable	Breaker Failed Offsite Power Supply	Unavailable	Repair Breaker	Offsite Power Supply
7287	None	0	0	0	9/22/1999	None	0	0	0	Not Applicable	Hydroelectric Generator Breaker failed	Unavailable	Repair Breaker	Hydroelectric Generator
7289	None	0	0	0	2/3/2000	None	0	0	0	Not Applicable	Hydroelectric Generator Breaker failed	Unavailable	Repair Breaker	Hydroelectric Generator
7588	None	0	0	0	9/1/1999	S	1	0	0	Coolant	EGDG-1B had a leak that developed in the Jacket Coolant line, during a 2 hour loaded run.	None because the leakage was stopped while the engine was in operation.	Replaced clamp on jacket water line. Clamp was tightened while the engine was loaded.	The test appeared to be completed with the leakage present. This is not a failure to start because the Loaded Run was completed successfully.
7629	None	0	0	0	1/5/2000	S	1	0	0	Engine	Radiator Fan Clutch was hot enough to burn the paint off the Clutch Housing. Condition exists when engine is run in Slow Speed at less than 500 RPM for an extended time. Slow Speed starting is a practice used to minimize wear on engines during testing, however, it raises the wear on the Clutch.	None. The test was completed satisfactorilly. The engine would have run and loaded normally if it were in fast speed or automatic operation modes.	Operations with engine less than 500 RPM was precluded by procedure	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
7695	S	1	0	0	8/30/1999	S	1	0	0	Control	The B Battery Ground that was detected coincidentally with the loaded test run of EGDG-1B was localized to an Amphenol Connector on the DG Governor. Amphenol connector started to smoke when energized.	DG Test was suspended apparently prior to loading generator.	Connections were repaired	
7718	S	1	0	0	7/5/2001	S	1	0	0	Fuel (Other than transfer)	EDG failure due to loss of Fuel Oil Header Prime.	EDG would did not start and would not have been available.	Cause of Fuel Prime loss was identified and corrected.	
7834	None	0	0	0	9/16/1999	L	0	1	0	Control	EDG 1A failed to start in the 10 second time limit as required. It started however, in 10.4 seconds and was declared Out of Service. Troubleshooting activities concluded that the Woodward Governor needed replacement.	None. Slow Start would not have affected LOOP Mitigation.	Replace Governor with new model.	
7846	None	0	0	0	6/29/2000	S	1	0	0	Unknown	EDG 1A failed to reach 60 Hz within the required 10 second time limit. It started however, in 10.29 and 10.59 seconds and was declared Out of Service.	None.	Unknown	
7876	S	1	0	0	5/22/2001	S	1	0	0	Coolant	EDG developed a serious radiator leak requiring immediate shutdown.	EDG was shutdown and deemed unavailable.	Radiator repaired	
7877	L	0	1	0	6/11/2001	S	1	0	0	Coolant	EDG developed a serious radiator leak requiring immediate shutdown.	EDG was unavailable less than 1 hour into the loaded run	Radiator repaired	Report states that the Engine was Unloaded and Stopped
7884	S	1	0	0	7/2/2001	S	1	0	0	Air Start	Air Start System Air Flasks Check Valve was leaking such that starting air pressure could not be maintained above the required limit.	EDG would not have been able to start if demanded.	Check valve was repaired	
8010	S	1	0	0	7/20/2000	S	1	0	0	Control	A failed Rectifier Diode prevented the EDG Voltage and Frequency to stabilize while attempting to parallel the Generator on the Safety Bus.	EDG 2B would not have been able to provide reliable power to the Emergency Bus	Diode was replaced	
8136	R	0	0	1	2/26/2000	R	0	0	1	Control	The ITD Time delay relay associated with the EDG governor failed causing a reverse power lockout and subsequent idling of the EDG.	EDG would not have remained loaded.	ITD Coil was failure tested and replaced	Assumed that the EDG was loaded for greater than minutes prior to opening.
8153	S	1	0	0	8/16/2000	S	1	0	0	Control	EDG Speed Control failed to control RPM from a Normal Start demand. Further, the EDG failed to Stop from the Control Room Push Button. The electronic section of the Governor had failed and defaulted to the mechanical section of the Governor.	EDG failed to start within normal parameters.	Capacitors and other electronic components were replaced.	
8212	None	0	0	0	7/28/1999	None	0	0	0	Breaker	Failure of Breaker during testing did not affect EDG operation	None	Breaker Repaired	
8214	S	1	0	0	10/24/1999	S	1	0	0	Fuel (Other than transfer)	EDG Trouble Alarm annunciated for "EDG Not Ready for Emergency Start" and other similar conditions. Fuse Holders were found to be loose and non-conductive. This affected the DC Fuel Oil Pump.	Engine may not have started reliably	Fuse Clip holders replaced	
8399	R	0	0	1	1/29/2000	R	0	0	1	Engine	EDG was manually tripped during Maintenance run due to #4L Link Pin Bushing damage which caused physical damage and vibrations. Engine ran for greater than 1 hour.	Engine would not have run loaded for for continued operation.	Link Pins and bearing supports repaired	This condition was unrelated to the planned maintenance on the EDG.
8416	R	0	0	1	3/23/2001	R	0	0	1	Lube Oil	An Oil Leak on the Turbocharger Lube Oil Piping required that EDG 2B be shutdown prior to the completion of the 24 hour run.	Engine was secured after being loaded for greater than 1 hour.	Leak was repaired	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
8422	None	0	0	0	4/26/2001	S	1	0	0	Generator	A malfunction of the Field Flashing circuit caused the DG start time to Voltage and Frequency to be delayed to 13 to 15 seconds beyond the normal 11.4 seconds. DG was undergoing Post Rework Functional Test Run at the time.	Engine was not able to be loaded. Had there been a LOOP demand, the breaker would have closed in and the sequencer actuated the loads appropriately.	Field flashing circuit repaired	
8453	S	1	0	0	1/17/1999	None	0	0	0	Control	"L.O. Temp Hi/Lo, Jacket Temp Hi/Lo Crankcase Press Hi/Lo" Alarm annunciated because the Lube Oil and Jacket Coolant Pumps were not running as required. Although the Breaker Door Handle/Switch indicated that the Breaker for these Loads were not tripped, the breaker was found to be tripped.	Engine may not have started reliably	Breaker door was repaired	
8508	None	0	0	0	1/18/1999	None	0	0	0	Ventilation	DG Room Louver and Room Fan Switches were found in Off Position.	Had DG been required to run, the room temperature would have most likely caused the DG to trip after 1 hour of loaded operation, however the most conservative temperature of 95 F could overheat the room in as little as 19 minutes.	Switches were taken to correct position and placards placed as operator aids.	If outside air temperature was 95 F, then the engine could trip in as little as 19 minutes, however, it would most likely last for at least 2 hours.
8535	S	1	0	0	8/21/1999	S	1	0	0	Control	"L.O. Temp Hi/Lo, Jacket Temp Hi/Lo Crankcase Press Hi/Lo" Alarm annunciated because the Standby Lube Oil Pump and Heater were not running as required. Pump and Heater was restarted locally and alarm cleared.	Engine may not have started reliably	Pump and Heater was restarted locally	
8999	None	0	0	0	6/13/1999	None	0	0	0	AAC	SBO Diesel Cooling Water Supply Isolation Valve would not open as required to admit cooling water.	Engine may not have started reliably	Valve operator was repaired.	SBO Diesel
9098	S	1	0	0	5/5/2001	S	1	0	0	Lube Oil	"LOW LUBE OIL TEMPERATURE" Alarm annunciated because the LO Standby Pump was found not running as required. The pump tripped on high motor current because it was mechanically bound	Engine may not have started reliably	Standby LO Pump was rebuilt	
9216	None	0	0	0	4/18/1999	None	0	0	0	Not Applicable	Manual Initiation Section Feeder Breaker ACB04 tripped and Division III DG closed and energized the bus.	This is not a Diesel Generator Malfunction, the DG functioned as designed.	None	This is not a EDG Issue.
9220	S	1	0	0	7/14/1999	S	1	0	0	Control	Tachometer failed to indicate Div 1 D/G speed change when starting engine.	This condition would have prevented the DG from starting and loading.	Power Supplies for the Tachometer was replaced.	
9276	L	0	1	0	2/8/2001	None	0	0	0	Engine	The DIV II DG Tripped during a loaded run due to a fault. The Air Inlet valve inadvertently closed causing the engine to trip.	DG Tripped less than one hour after synchronising to the bus	Air Inlet Valve and Actuator repaired	
9387	None	0	0	0	4/16/1999	None	0	0	0	AAC	TSC D/G Radiator Fan Failed during attempt to start engine.	Engine would not have been able to run without the radiator.	Radiatiator Fan repaired	This is a TSC DG, not a Safety Related DG
9411	None	0	0	0	4/10/1999	None	0	0	0	Sequencer	Loss of Sequencer Power Supply rendered it inoperable	Sequencer would not have been available to sequence the loads onto the bus	Replaced Power Supply	This is a Sequencer issue
9416	None	0	0	0	9/2/1999	None	0	0	0	AAC	BOP DG tripped while attempting to start because of operator error. Operator overranged the voltage regulator	BOP DG would have to be re-started	Operator Training	BOP Generator is not a Safety Related DG

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
9434	None	0	0	0	7/29/1999	None	0	0	0	Sequencer	Failed to operate on Demand	Sequencer would not have been available to sequence the loads onto the bus	Unknown	This is a Sequencer issue
9439	None	0	0	0	2/15/2000	None	0	0	0	AAC	TSC DG Failed to start due to Low Battery Voltage	Capability to start and generate electrical power was lost	Batteries replaced	This is a TSC DG, not a Safety Related DG
9454	None	0	0	0	3/13/2000	None	0	0	0	AAC	TSC DG Differential Lockout Relay discovered Tripped with engine secured.	TSC Diesel would not have been available until Breaker Trip was reset	Trouble shooting and reset was successful	This is a TSC DG, not a Safety Related DG
9465	None	0	0	0	4/17/2000	None	0	0	0	AAC	BOP DG Output Brkr failed to close due to a blown fuse in the breaker control power circuit	BOP DG would have not been able to provide power to the BOP bus	Fuse was replaced	BOP Generator is not a Safety Related DG
9498	None	0	0	0	8/14/2000	S	1	0	0	Lube Oil	Lube Oil sampling concluded that was Fuel Oil contamination from leaky injectors.	Engine would have sustained damage after 2 days of loaded run.	Replaced all fuel injectors	This is a TSC DG, not a Safety Related DG
9684	S	1	0	0	3/4/1999	S	1	0	0	Lube Oil	STBY DG 21 Lube Oil Circ Pump did not Auto Start Following Surveillance Testing.	Condition could have affected the next start, however the condition was identified	Replaced starting relay	
9715	None	0	0	0	10/19/1999	None	0	0	0	AAC	SBDG Voltage Regulator failed causing output breaker.	SBDG was loaded for under one hour.	Voltage Regulator was repaired	
9740	None	0	0	0	5/15/2000	None	0	0	0	AAC	TSC DG failed to start due to Control Power Supply Capacitor failure.	Engine wouldn't start	Capacitors and other electronic components were replaced.	TSC Engine
9753	None	0	0	0	5/15/2000	None	0	0	0	AAC	TSC DG failed to start due to loss of Control Power Supply because a battery terminal cable was loose.	Engine wouldn't start	Battery cable tightened	TSC Engine
9759	None	0	0	0	7/3/2000	None	0	0	0	AAC	BOP DG Output Brkr Tripped open immediately after closing due to loose Trip Latch that rotated freely on its shaft.	BOP DG was unavailable for loaded operation	Set screw on Trip Shaft to Trip Paddle tightened	BOP Generator is not a Safety Related DG
9766	None	0	0	0	10/28/2000	None	0	0	0	AAC	BOP DG Output Brkr Tripped open because Closing Solenoid was Sticking. The DG was loaded briefly	BOP DG was unavailable for loaded operation	Closing Coil Solenoid was replaced	BOP Generator is not a Safety Related DG
9767	None	0	0	0	10/23/2000	None	0	0	0	AAC	BOP DG Radiator Overflowed causing Hi-Temperature Trip. Leakage was from Cylinder Freeze Seals and Jacket Water Heaters.	Engine tripped from Loaded condition in less than 1 hour. Engine was not readily available for restart	Leak was repaired	BOP Generator is not a Safety Related DG
9861	None	0	0	0	4/25/1999	None	0	0	0	Sequencer	Load Shedding Relay for Bus 1A3 failed its Continuity Check during Surveillance Testing.	Although this is not a DG malfunction, it would have prevented automatic Breaker operation to energize Bus 1A3 in case of a LOOP. This malfunction is associated with sequencer operation.	Load Shedding Relay contacts were cleaned.	Load Shedding Relay is not a DG Malfunction - sequencer problem
9891	None	0	0	0	8/7/1999	None	0	0	0	Fuel Transfer	EDG Day Tank level switch for Fuel Oil Transfer Pump failed a surveillance where it should have pumped fuel. Instead of the pump filling the Day Tank to 55", it stopped running at 50". The tolerance is + or - 3".	None. This is not a DG malfunction as the Day Tank had adequate level to run the DG.	Level Switch was calibrated.	
9911	None	0	0	0	8/7/1999	None	0	0	0	Fuel Transfer	EDG Day Tank level switch for Fuel Oil Transfer Pump failed a surveillance where it should have pumped fuel. Instead of the pump filling the Day Tank to 55", it stopped running at 50". The tolerance is + or - 3".	None. This is not a DG malfunction as the Day Tank had adequate level to run the DG.	Level Switch was calibrated.	
9930	None	0	0	0	7/8/1999	None	0	0	0	Fuel Transfer	EDG Day Tank level switch for Fuel Oil Transfer Pump failed a surveillance where it should have pumped fuel. Instead of the pump filling the Day Tank to 55", it stopped running at 50". The tolerance is + or - 3".	None. This is not a DG malfunction as the Day Tank had adequate level to run the DG.	Level Switch was calibrated.	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
10217	None	0	0	0	2/26/2001	S	1	0	0	Air Start	AB2 DG Starting Air Compressor 2nd Stage RV was stuck open, causing the Air Start Receivers to blow down to 216# instead of 226#. The pressure was maintained because the Air Start Compressors were cross-connected.	None. The minimum required Air Start Receiver pressure is 200#.	Relief Valve was replaced and Compressor 2 was placed in service	Had no effect on DG availability.
10537	None	0	0	0	3/13/2001	None	0	0	0	Air Start	Air Receiver Safety Valve 2-SV-78-AB2 leaking allowing pressure to go to 220#. Normal operating pressure range is 220-240#. "DG2AB Compressor Air Receiver Pressure Low" Alarm annunciator in the control room.	None. The backup Air Receiver was intact and maintaining full pressure and the affected air receiver still had normal operational pressure	Relief Valve was replaced.	Had no effect on DG availability.
10543	None	0	0	0	4/18/2001	S	1	0	0	Air Start	Air Start Compressor Safety Valve 2-SV-81-CD2 failed open. Air Compressor became unavailable.	CD EDG was not available because it is not certain whether there alternative compressed air sources were available. Likely alternate air available - assumed to be no impact.	Relief Valve was replaced.	
10920	None	0	0	0	8/9/1999	None	0	0	0	Fuel (Other than transfer)	A Fuel Oil leak on DG1B sprayed fuel into the Engine Crankcase where it diluted the Lube Oil to greater than 5.7%. This is over the specification allowed for continued operation.	The licensee determined that DG1B would have been available for 7 day continuous operation and beyond.	Fuel Oil Leak repaired, oil replaced	
11004	S	1	0	0	2/12/1999	S	1	0	0	Generator	A loose diode on Div III Generator Exciter was found during inspection.	Generator may have been unavailable to provide power to the bus	Diode was re-torqued to proper specifications	
11010	S	1	0	0	1/26/1999	None	0	0	0	Control	Three Relays were found outside their time delay range specifications. The Relays were Field Flash, Cranking Timer, and Jog Delay.	Engine may not have started reliably	Time delays for the relays were calibrated	
11022	S	1	0	0	3/7/1999	S	1	0	0	Air Start	DG failed to start when 2 out of 3 Air Start Motors failed to engage when demanded. Problem with Air Start Solenoids prevented Air Start Motors from Engaging as required.	DG tripped after the 10 second time delay logic determined that engine was not running	Air Start Solenoids for the Air Start Motors were replaced	
11035	None	0	0	0	4/20/1999	None	0	0	0	Breaker	DG 1A Circuit Brkr failed to Close in response to it's handswitch position when clearing a Tag Out. It is unknown what the Circuit Breaker Load was. Brkr is a Molded Case breaker	Unknown	Breaker was replaced	
11086	None	0	0	0	10/26/1999	None	0	0	0	Control	A Portion of DG 1C Hi-Temperature Shutdown Switch Sealing material was missing. There was no leakage. Condition was identified during routine Switch Calibration.	None. There was no leakage associated with the missing portion of the sealant around the stem of the Temperature Switch. Further, The Hi-Temperature Trip is bypassed on LOCA.	Switch was re-sealed.	
11130	None	0	0	0	2/28/2000	S	1	0	0	Operator Error	Div 3 DG 1C was paralleled to its associated bus Out of Phase due to a failed Synchscope and operator error	DG 1C Output Brkr Tripped after closing and engine removed from service to check for damage. Severe damage resulted from the Out of Phase operations. Operator error associated with test activity, not consider a failure.	Replaced Generator, Turbocharger, and Synchscope	
11184	None	0	0	0	8/31/2000	S	1	0	0	Control	DG 1C Fire Protection Panel Test resulted in Failure of Revolving Light to stop when Reset was Pressed.	None. Engine would not have been affected by this malfunction	Replaced Relay in Fire Protection Panel	
11584	None	0	0	0	1/12/1999	S	1	0	0	Coolant	EG 1A Service Water Bypass around A EDG Heat Exchanger Outlet Valve. Leak was characterized as a pinhole leak	EG 1A is inoperable but would have been available	Repaired leak	This leak had no effect on EG 1A availability. There could have been some seismic degradation which would required analysis

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
11631	None	0	0	0	1/4/2000	None	0	0	0	AAC	Failed Battery in SBO DG UPS caused SBO DG unavailability. Condition identified during routine check of system.	SBO DG unavailable	Replaced failed battery	SBO Diesel
11632	None	0	0	0	6/12/2000	None	0	0	0	AAC	SBO DG Enclosure Air Conditioning unit found to have a failed 24 VDC transformer that prevented the Temperature Control Function of the HVAC unit	SBO DG was unaffected because alarm function allowed compensatory actions to be taken.	Replaced transformer	SBO Diesel
11639	None	0	0	0	10/24/2000	None	0	0	0	AAC	SBO Computer Trouble Alarm annunciated, indicated that SBO DG was unavailable.	SBO DG unavailable	Repaired cause of Computer Trouble Alarm	SBO Diesel
11789	None	0	0	0	7/6/1999	None	0	0	0	Ventilation	EDG 103 Rollup Door would not function to Close as demanded by the local pushbutton station. The door was opened beyond the limit permitted by Security, which rendered it inoperable. Due to the room temperature, DG room ventilation fans started, which placed too much force against the Roll Up doors to allow movement.	None. Operator secured fan and closed the Roll Up Door. There was no impact.	Signs describing operation of Roll Up Doors with ventilation configuration were placed.	TS Action Statements were applicable for 2-3 Minutes
11796	S	1	0	0	9/18/1999	S	1	0	0	Generator	Bad Fuse connections caused EDG 103 Voltage Regulator to excite the Generator to only 3100 Volts instead of the 4100 Volts required.	EDG 103 was unavailable to provide power to its associated bus as required.	Fuses and Fuse Holders were replaced	
12174	None	0	0	0	2/8/2000	None	0	0	0	Not Applicable	None. This Breaker Failure is applicable only to the RHR Pump related to the Load Shed Logic	None for EDG	Repaired Aux Switch	This condition was unrelated to the EDG
12175	None	0	0	0	1/25/2000	None	0	0	0	Sequencer	Undervoltage Relay for Switch Gear 101 did not reset during testing.	None for EDG, the failure affects Sequencer operation	Replaced Relay	This is a Sequencer issue
12180	None	0	0	0	2/23/2000	None	0	0	0	Sequencer	Div 1 Emergency Switchgear Test Light failed to identify that Undervoltage Relay was functioning correctly.	None for EDG, the failure affects Sequencer operation	Replaced Relay	This is a Sequencer issue
12187	L	0	1	0	3/15/2000	S	1	0	0	Control	Div 1 DG was started for test when Voltage went to over 5kV instead of 4kV. A mispositioned Potential Transformer Fuse Carriage was discovered that caused the anomaly. The DG was tripped which resulted in a Dead Bus on SW101. Breaker was closed in on the bus.	DG was unavailable	Repaired PT assembly	
12408	None	0	0	0	6/21/1999	None	0	0	0	Control	DG-TI-3150, D Cylinder and Exhaust Temperature TI was out of calibration as determined by routine PM. There was no change in indication with manually input variable signal.	None. Although EDG may rely on this TI as trip input, it appears that the temperature was failed below trip setpoint.	Replaced TI Assembly	There is no mention that the instrument output failed high or above trip setpoint, therefore the DG would not have tripped on this condition.
12544	None	0	0	0	4/16/1999	None	0	0	0	Not Applicable	Portable Diesel Oil Pump Operability Test failed because the gas tank was empty and the carburator needle valve was closed.	None. This is not a DG malfunction as the Day Tank had adequate level to run the DG.	Filled gas tank and realigned needle valve	This is not an installed Fuel Oil Pump and does not affect EDG operation.
12652	R	0	0	1	11/25/1999	R	0	0	1	Coolant	DG tripped on High Crankcase Pressure during test run. Coolant leaking into the Crankcase through failed Lube Oil Cooler Welds vaporized causing high pressure.	Engine tripped from Loaded condition in greater than 1 hour. Engine was not readily available for restart	Lube Oil Cooler weld leaks repaired and coolant evacuated from crankcase	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
12653	None	0	0	0	12/22/1999	None	0	0	0	AAC	Return to service test run Non-Safeguards DG tripped on Reverse Current due to a dirty Rheostat Motor. Diesel tripped on Reverse Current.	DG Tripped less than one hour after synchronising to the bus	Rheostat motor was cleaned and loose wiring repaired	This is not a Safety-Related DG
12700	S	1	0	0	11/18/1999	S	1	0	0	Engine	DG Surveillance Test aborted due to increase in Crankcase Pressure. The Crankcase Breather had a flow restriction and the Oil Level in the Sump was higher than normal. Both conditions contributed to high pressure.	DG was unavailable until corrective actions taken. DG was not loaded at the time.	Crankcase Breather Tube cleaned and oil level adjusted	
12701	None	0	0	0	10/10/1999	S	1	0	0	Control	D6 DG failed to start and load within 60 Seconds as required. A loose connection on the Digital Reference Unit Load was found.	The DRUL Circuit does not affect Isochronous Operation, therefore, the DG would have Functioned during a LOOP or LOCA with LOOP	Loose wiring tightened.	
12704	S	1	0	0	3/13/2000	S	1	0	0	Control	DG Failed to respond to Raise/Lower voltage demand from Volt Reg Norm/Stby Sel Switch. This caused to Voltage Regulator to fail as-is.	The Normal Voltage Controller was unavailable and it is unknown how this would affect Isochronous Operation	Control Switch Replaced	Assumed that the DG would not have been able to power bus
12705	L	0	1	0	5/26/2000	L	0	1	0	Control	EDG Tripped after reaching rated speed and voltage due to a failed Circuit Board that falsely input a fuel rack differential trip.	DG Tripped less than 1 hour of loaded run. EDG was unavailable to provide emergency power	Circuit Board was replaced	
12707	S	1	0	0	10/29/2000	S	1	0	0	Control	EDG Conditioner Display failed while Engine in Standby. Discovered condition through normal plant rounds	DG was inoperable and would not function to provide power	Conditioner repaired	
12918	R	0	0	1	11/15/2000	None	0	0	0	Coolant	DG Engine Driven Jacket Water Pump Seal leak discovered during manual engine barring. Leak was minor, however engine was declared inoperable	DG would have been able to start, load, and run for several hours	Seal was replaced	Since engine would have run loaded for greater than 1 hour, run failure mode has been assumed.
13186	None	0	0	0	6/17/1999	None	0	0	0	Operator Error	Incorrect Test Equipment connected to 2C DG while engine was being tested. Test Equipment had an output that caused unexpected starting of Room Exhaust Fan	None. When maintenance and testing was complete, Engine was restored to service	Proper Test equipment procured	
13327	None	0	0	0	3/10/2001	None	0	0	0	Sequencer	E3 DG had an electrical Jumper left control circuits that caused the B ESW Pump to start inadvertently. The jumper was supposed to have been removed in a subsequent procedure step. Engine was not in operation	None. The EG was in test at the time. The failure was similar to a Sequencer Issue.	Test Jumper removed from circuit.	Similar to a Sequencer Issue
13720	None	0	0	0	1/21/2000	None	0	0	0	Sequencer	SEC Testing resulted in a Failed Automatic Test Insertion module. This is similar to a Sequencer Failure	DG may not have started with failure present. This is similar to a Sequencer Malfunction where the DG is unaffected	A malfunctioning relay was replaced	Similar to a Sequencer Issue
13786	None	0	0	0	2/27/1999	None	0	0	0	Generator	EDG voltage went to 2kV after starting, then hesitated prior to reaching 4kV as required. Time to reach 4kV exceeded required 10 seconds. The problem was in the Field Flash Circuitry.	EDG was unavailable for power production	Trouble shooting and repair was performed on the Voltage Regulator.	Recommended by NEI review to be removed as a failure.
13807	L	0	1	0	9/10/1999	S	1	0	0	Breaker	52HG10 4kV Brkr to MCC 1G, 125 VDC control switch and red light lamp socket, found broken during operator round.	Would prevent EDG Breaker from closing on Bus. Also, if a seismic event had shorted out the lamp socket, it could have caused a loss of power to MCC 1G.	Replaced Lamp Socket, Control Switch, and Fuse	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
13811	None	0	0	0	2/28/2000	None	0	0	0	Not Applicable	DEG3 failed to start when demanded during Test. A jumper installed in accordance with procedure should have supplied voltage to the DEG staring relay, however, there was no voltage present at the designated points. The points were on the Auto/Manual Selector Switch. It was later determined that the switch was configured correctly, however the Test was incorrect.	None. The Start Procedure was incorrect. The EDG would have performed as designed after the test when restored	The Test was corrected to reflect configuration	
13904	R	0	0	1	10/12/1999	S	1	0	0	Breaker	DG Output Breaker opened on Overcurrent during Loaded Test Run. Breaker opened 22 hours into 24 hour test run due to voltage regulator transformer becoming Grounded.	DG 2-1 failed Loaded Run Test	Transformer Replaced	
13919	None	0	0	0	6/17/1999	None	0	0	0	Not Applicable	Control Room Appendix R Lighting Battery failed test	None. This is not a DG malfunction	Power Supply was replaced with a functioning one	This is not related to DG Equipment
14089	L	0	1	0	12/31/1998	L	0	1	0	Control	EDG Tripped on Overcurrent during routine Testing, from a loaded run. The Voltage Regulator was malfunctioning.	EDG tripped in less than one hour and was not available.	Voltage Regulator was repaired	
14095	None	0	0	0	1/13/1999	None	0	0	0	AAC	App R DG 15 AMP Feeder Breaker to EDG Auxiliaries Tripped open. Trouble Alarm annunciated this condition to the Control Room.	App R DG waas not available during the time the breaker was tripped	Breaker reset	
14110	None	0	0	0	8/25/1999	None	0	0	0	Fuel (Other than transfer)	EDG Monthly Fuel Oil Sample showed that the Storage Tank had 5 inches of water and there was evidence of Microbiological Growth.	None. EDG and Day Tank was unaffected	Tank cleaning and coated	
14116	S	1	0	0	5/19/1999	S	1	0	0	Lube Oil	EDG had a Lube Oil Leak at the Heat Exchanger Gasket	EDG was unavailable to run until leak was repaired	Leak Repaired	
14118	None	0	0	0	5/12/1999	None	0	0	0	AAC	App R DG Upper Air Start Motor Failed. Engine started however due to the Lower Air Start Motor functioning.	None. Engine started successfully on one Air Start Motor	Bendix Drive repaired	This is an Appendix R Engine
14120	None	0	0	0	6/13/1999	None	0	0	0	AAC	App R DG Tripped from Full Load due to High Jacket Water Temperature during test. Radiator Cooling Fan Motor failed	App R DG was not available until Fan Motor replaced. Engine ran for under 1 hour loaded	Replaced Fan Motor for Radiator	This is an Appendix R Engine
14121	None	0	0	0	6/17/1999	None	0	0	0	AAC	App R DG Lube Oil Heaters were found de-energized due to a loose wire.	App R DG was not affected	Repaired Heater	This is an Appendix R Engine
14125	None	0	0	0	9/15/1999	None	0	0	0	Control	33 EDG "Start Defeated" Alarm Annunciated due to a failed relay.	DG function was not lost	Replaced Relay	Engine remained in Auto
14156	S	1	0	0	4/18/2000	None	0	0	0	Engine	EDG Test Run was cut short due to a large Oil Leak at Cylinder 7R. The Engine was emergency shutdown.	DG Function was lost until it was repaired	Leak Repaired	
14169	S	1	0	0	8/6/2000	None	0	0	0	Lube Oil	EDG Pre-Lube Pump was found in the OFF position and Lube Oil and Jacket Water Temps were Low out of Specification. This was due to a blown fuse in the Feeder Breaker	EDG may have started however it is not certain	Fuse replaced	
14540	S	1	0	0	2/23/2001	S	1	0	0	Control	EDG could not be raised to full speed. Mechanical Governor needed adjustment.	Engine did not reach full speed and was not able to be loaded	Mechanical Governor required adjustment	
14756	L	0	1	0	3/6/2000	S	1	0	0	Coolant	DG Intercooler Temperatures rose out of specification due to TCV Disk Separated from Valve Stem.	Engine had to be shutdown	Repaired TCV	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
15174	None	0	0	0	3/17/1999	None	0	0	0	Coolant	Service Water Leak on elbow on Heat Exchanger Tube Side Vent Elbow. Pipe was found corroded.	DG was unavailable for operation	Minor through-wall leak. Repaired Leak	Recommended by NEI review to be removed as a failure.
15175	None	0	0	0	3/29/1999	None	0	0	0	Sequencer	Part of D/G test to cycle UAT Breaker Failed. Breaker did not open as demanded due to loose Posts on back of K85 Relay.	None. DG functioned as required. This was not the DG Output Breaker	Repaired Relay.	This is similar to a Sequencer Issue
15179	None	0	0	0	3/30/1999	None	0	0	0	Sequencer	EDG Output Breaker did not Close during Surveillance Testing because UAT Brkr to the Emergency Bus Failed to Open as required to satisfy EDG Brkr Logic. UAT Relay K85 Failed to function as required.	None. DG functioned as required. This was not the DG Output Breaker. This would have resulted in a emergency EDG failure to load.	Repaired Relay.	This is similar to a Sequencer Issue
15199	None	0	0	0	10/8/1999	None	0	0	0	Air Start	Air Start line Check Valves are weeping air past its seat	None. Leakage was slight	Replaced checkvalves	Engine did not fail to start
15209	None	0	0	0	4/30/1999	None	0	0	0	Air Start	DG-V72A Compressor Discharge Relief Valve leaks continuously.	None. This failure affected AC 2A only. The air start system has multiple air compressors	Replaced RV	Air Start system was in standby when this condition was discovered
15227	S	1	0	0	11/1/2000	S	1	0	0	Engine	DG had to be shutdown due to High Crank Case Exhaust Pressure and Vibrations. In addition, smoke was reported in DG-1B building.	EDG was not loaded at the time of the trip	Engine had to be extensively rebuilt.	Engine was not available for start.
15228	None	0	0	0	12/1/2000	S	1	0	0	Engine	DG was recently rebuilt due to extensive damage. During its break-in runs engine had to be shutdown due to high d/p across lube oil strainer indicative of bearing failure.Bearing failure heating caused damage to multiple other components.	Engine was loaded for less than 1 hour when the damage occurred. Engine required complete rebuild.	Engine Rebuild.	Recommended by NEI review to be removed as a failure. Engine was not available for run but appears to be related to a maintenance activity and was identified during a post maintenance test.
15441	L	0	1	0	6/8/1999	S	1	0	0	Breaker	DG Output Breaker to 14 Bus Failed to Close. Breaker Trip Bar Misalignment prevented breaker operations. Breaker Frame had loose screws in C Phase Arc Chute	Breaker Failure prevented DG from loading bus. This is a Load Failure because the breaker was demanded to close but did not not close.	Breaker Rebuild	
15633	S	1	0	0	1/10/2001	L	0	1	0	Control	EDG failed to Develop Voltage after coming to rated speed during testing. Two shorted Diodes in the Rectifier Bridge	Although the engine started, the generator was unavailable to provide electrical power.	Rectifier Diodes were replaced	Failed to develop voltage therefore this is a Start Failure. The breaker never closed in on the Bus
15634	S	1	0	0	12/21/2000	S	1	0	0	Control	Unstable Governor output caused DG to hunt and swing during unloading from load. Additionally, the DG experienced oscillations in load and speed during loaded operation and during unloaded operation	EDG was not available for loaded operation greater than one hour nor was it stable during unloaded operation therefore this is a failure to start	Governor modified	There were several run attempts that caused the DG load to oscillate prior to one our of loaded run.
15635	S	1	0	0	12/21/2000	S	1	0	0	Control	Unstable Governor output caused DG to hunt and swing during unloaded, loading, and unloading operations. The cause was determined to be multifold including soldered joint connections and HVAC air flow interaction.	EDG was not reliably available to start.	Governor and HVAC system modified.	
15636	S	1	0	0	12/21/2000	S	1	0	0	Generator	EDG tripped on overspeed due to failed exciter diodes. The failed diodes prevented voltage from developing after field flash was applied.	EDG was not available to start.	Diodes were replaced.	
15973	S	1	0	0	1/12/1999	S	1	0	0	Control	EDG Feeder Breaker Current Transformer (CT) epoxy insulation liquified due to a known process.	EDG was taken out of service until CT was replaced	Replaced CT with a liquification resistant epoxy	EDG was assumed to be inoperable until CT repair was completed
15988	None	0	0	0	9/9/1999	R	0	0	1	Generator	Div 3 DG was emergency shutdown after sparks and smoke came from Generator during 24 hour endurance run.	Div 3 EDG was unavailable for loaded run.	Cause of Generator failure repaired	HPCS Diesel Generator - screened
16038	S	1	0	0	2/19/2001	S	1	0	0	Engine	Div I EDG Turbocharger Cooling Water Crack leaking and worsening as 24 hour run commenced.	Assumed that EDG was not loaded when failure necessitated engine shutdown	Leak Repaired	
16039	S	1	0	0	2/21/2001	S	1	0	0	Fuel (Other than transfer)	Div 1 EDG Fuel Injector Plug developed a Fuel Leak. The leak was caused by an Injector Plug that became loosened.	EDG was immediately shutdown and taken out of service.	Leak Repaired	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
16048	S	1	0	0	5/17/2001	S	1	0	0	Coolant	Div 2 EDG Jacket Water Level was intentionally lowered. Later, the Low Jacket Water Tank Level Alarm annunciated. A crack was found in the Drain Valve Yoke Nut which caused the valve to leak through.	EDG was declared inoperable and removed from Standby. This failure would have prevented EDG from Starting.	Leak Repaired	
16141	S	1	0	0	1/10/1999	S	1	0	0	Operator Error	EDG Control Power was inadvertently tagged out.	EDG was unavailable to start and run manually or automatically.	AC control power was restored	
16168	None	0	0	0	10/27/1999	S	1	0	0	Air Start	Air Start Motor failed to start EDG, which automatically shutdown during a start attempt, on Start Failure Lockout.	Although the Opposite Side Air Start Motor subsequently started the EDG, this engine was declared out of service. EDG was unavailable for starting	Air Start Motor was replaced	Recommended by NEI review to be removed as the failure was assoicated with one of two start headers. The second air start was available but isolated for the test.
16235	None	0	0	0	4/12/2001	S	1	0	0	Air Start	Rust scale blocking Air Start Pressure Control Valves in the Air Start System caused a failed start attempt on the EDG.	EDG was unavailable to start and run manually or automatically.	Strainers were installed in the system and procedures to clean them were adopted	Recommended by NEI review to be removed as the failure appears to be assoicated with one of two start headers.
16238	None	0	0	0	6/2/2001	None	0	0	0	Ventilation	EDG 1 Supply Fan Inlet Damper failed in the Closed Position resulting in the EDG being declared Inoperable	EDG 2 was unavailable to start and run manually or automatically.	Replaced damper hydramotor	EDG room Supply fans were used to lower Room Temperature without EDG in operation. It is doubtful that the EDG would have been able to Load without the Damper in operation. Ventilation system is OOS based on MSPI scoping document.
16435	None	0	0	0	9/18/1999	None	0	0	0	Sequencer	Sequencer Failed Test	EDG was not available to start.	Replaced Optical Isolater on Sequencer.	This is a Sequencer issue
16689	S	1	0	0	8/18/2000	S	1	0	0	Control	EDG Tripped on Voltage Spike. Ground Relay Tripped due to a poor connection of the Potential Transformer primary side through a loose knife switch.	EDG was not available to start.	Replaced and tightened PT Stabs and Knife Switch connections	EDG did not achieve rated speed and voltage prior to engine trip
16691	S	1	0	0	10/13/2000	S	1	0	0	Control	DG tripped due to a voltage spike when the K1 Relay contacts failed. DG A Normal Voltage Regulator swapped to Standby Voltage Regulator while engine was being started.	EDG was not available to start. EDG was being tested subsequent to maintenance to replace the SCRs	Replaced K1 Contactors	
16815	S	1	0	0	9/25/1999	S	1	0	0	Air Start	EDG declared inoperable based on Air Starting System Pressure <165psi. The Right Bank Air Dryer Relief Valve was relieving continuously bringing the air pressure to 150 psig. The Left Bank Compressor was inoperable for a motor replacement.	EDG was not available to start.	The Right Bank Air Dryer was manually by-passed and isolated. This restored starting air pressure but did not cause the EDG from being declared Operable.	This Starting Air System failure rendered the EDG unable to start.
16817	S	1	0	0	11/7/1999	S	1	0	0	Control	EDG Control Power Ground occurred on the +48 VDC Bus preventing it to achieve 900 RPM during fast speed start. EDG was shutdown immediately thereafter. Troubleshooting found that the Field Flash Relay and Field Flash Cutout Relay needed replacement.	EDG failed to start within normal parameters.	The Field Flash and Cutout Relays were replaced.	
16821	S	1	0	0	3/10/2000	S	1	0	0	Control	EDG Governor failed to bring speed up to rated Frequency during testing and prior to loading. After loading with the low frequency, the normal Bus Feeder Breaker Tripped. The breaker tripped prior to 1 hour of loaded operation.	The licensee decided to continue the test with the low frequency condition. After they loaded the engine the normal bus feeder breaker tripped due to EDG load swings. This condition is a Failure to Start because the rated Frequency was not satisfactorilly achieved.	Governor was repaired.	INL evaluated this as a Run Failure. This is a Start Failure because although the licensee Loaded the EDG with the faulted Governor, causing a subsequent transient, the EDG did not meet start criteria.
16836	None	0	0	0	1/28/2001	None	0	0	0	Control	3B EDG Governor Failed to control Speed due to a loose Lock Nut which had vibrated off of speed adjuster. This caused the mechanical governor to lock up near the upper limit.	The Speed controller failure does not affect the EDG's ability to load the bus from a LOOP. Therefore, this failure is not a Start Failure.	Lock Nut on Governor Speed Motor repaired	This Failure did not affect the EDG's ability to start and load the Bus from a LOOP, however, it would preclude the ability to Parallel with Offsite Power when it is restored. This would necessitate the need for a Dead Bus restoration post LOOP

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
17391	S	1	0	0	3/1/1999	S	1	0	0	Control	DG failed to maintain Frequency during the 18 Month Surveillance due to a bad Governor Resistor.	DG failed to load	All DG Governors at Watts Bar have been replaced to those that do not require this component.	One sentence description. The frequency swings implies that the EDG is not paralled
17428	None	0	0	0	9/8/1999	None	0	0	0	Ventilation	EDG Annunciators for "Crankcase Pressure HI" and DG Auto Start Locked Out" came in, in response to work being performed on the Room Ventilation Dampers. When an HVAC Damper failed shut, it caused a vacuum in the room, which actuated the Crankcase Pressure Switch Trip	The EDG was in Standby at the time of the lockout. The lockout prevented the EDG from starting if a demand signal came in. Therefore, the EDG would not have been able to start, load, and run if demanded.	HVAC equipment was repaired	This issue is related to room ventilation, the engine would not be able to perform its mission to to the vacuum in room.
17488	None	0	0	0	6/28/2000	None	0	0	0	Ventilation	EDG Failed performance test because Room HVAC Exhaust Fans found inoperable. The HVAC fans were not properly reset at the conclusion of a Fire Detector Test as required.	EDG is assumed to have started, but was not able to be loaded and run	HVAC Relay was reset.	Room ventilation issue.
17508	L	0	1	0	5/16/2001	S	1	0	0	Breaker	EDG Spring Charging Motor was installed incorrectly which caused the breaker to remain Closed when its Hand Switch was taken to Trip Position, during a test. A new style Spring Charging Motor should have had a spacer installed, about which no vendor instructions were provided.	EDG would not have been available to load if a demand signal was present. This condition is considered a Start Failure because the Breaker would malfunction.	Installed Breaker Spring Charging Motors correctly	This is a Load Failure because it is not assured that the Breaker would close in on the Bus
17612	None	0	0	0	10/20/1999	S	1	0	0	Control	Approximately 18 hours while at Full Load, EDG B Load output increased with no operator action. Further, the Load failed to be controlled with operator intervention due to a Governor Malfunction. The governor malfunction was only in the Speed Droop Side and not with the Isochronous portion of the governor	Trouble shooting efforts showed that If the EDG was running in Isochronous mode, there would have been no output swings. Therefore, there is no failure with this engine	Governor Speed Droop was adjusted so that when the EDG is paralleled to the grid, the governor would be more responsive to voltage swings on the grid	
17670	None	0	0	0	8/9/2000	None	0	0	0	Not Applicable	A Fire Door was found to be inoperable between two ESF Switchgear Rooms	None of EDG operations	Locksmith fixed door latch	This event is not EDG related
17671	S	1	0	0	8/29/2000	S	1	0	0	Control	EDG tripped on Volts/Hertz at the time the Generator was being Unloaded and the Breaker opened. This caused a Breaker Lockout. The 5B Relay was found to be defective. This relay malfunction would have prevented future EDG Starts	The EDG would have not been available to Start	5B Relay was replaced	This event would prevent DG subsequent starts. This relay failure would not have prevented the EDG from continuing to run.
17678	L	0	1	0	12/20/2000	L	0	1	0	Control	EDG Tripped during manual loading. When the EDG was synchronized, it immediately accepted 4MW and tripped when the operator attempted to reduce load. The UPR in the Governor was determined to have high resistance in the contacts	This is a Load Failure because the EDG was loaded when it tripped.	The Governor was subsequently modified	
17706	None	0	0	0	1/17/2001	S	1	0	0	Control	EDG did not reach rated speed or voltage during Maintenance Run Start. The engine tripped on Volts/Hertz due to an out of adjusted Motor Operated Potentiometer.	EDG was out of service for maintenance	Adjusted MOP Settings	Not considered to be a failure as it is assumed that the potentiometer was out of adjusted due to maintenance.
18032	None	0	0	0	2/19/2000	None	0	0	0	Not Applicable	Spillway DG failed batter caused engine start failure	Spillway DG is not Safey Related Engine	Replaced Battery	Not a safety related EDG
18067	S	1	0	0	4/4/2000	S	1	0	0	Engine	EDG failed to Start on LOOP to its associated bus. A piston was found hydraulically locked and filled with oil.	EDG Failed to start on valid demand signal	None specified	
18072	None	0	0	0	7/11/2000	None	0	0	0	Not Applicable	4C HVAC Chiller Outlet Isolation valve failed to open on signal.	Chiller was out of service	Replaced Solenoid	Not a EDG Failure
18074	None	0	0	0	6/22/2000	None	0	0	0	Not Applicable	EDG Trouble Alarm annunciated because Brkr 1-EE-BKR-1J1-1-G2 had tripped and MCC 1J1-A became De-Energized. The cause of the De-Energized MCC was that a Load, 1-HV-F-22C Motor in the HVAC System, failed and drew large amount of current. A breaker problem caused the entire MCC that feeds power to the 1J EDG to become De-Energized.	This condition would have prevented the DG from starting and loading.	Replaced the HVAC Motor	Protective tripping failed to prevent the lost of MCC which resulted in failure of the EDG. NEI review recommended removal of this failure as the failed component is outside the EDG boundary.

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
18075	None	0	0	0	6/22/2000	S	1	0	0	Control	EDG 1J Trouble Alarm annunciated because Brkr 1-EE-BKR-1J1-1-G2 had tripped and MCC 1J1-A became De-Energized. The cause of the De-Energized MCC was that a Load, 1-HV-F-22C Motor in the HVAC System, failed and drew large amount of current. A breaker problem caused the entire MCC that feeds power to the 1J EDG to become De-Energized.	This condition would have prevented the DG from starting and loading.	Replaced the HVAC Motor	Appears to be a duplicate of 18075.
18118	None	0	0	0	1/10/2001	None	0	0	0	Not Applicable	Axial Tilt Rod Deviation Alarm annunciated due to a drifting IRPI. This condition was caused by a failed SOLA transformer	This is not a Diesel Generator Malfunction	Replaced SOLA Transformer	
18132	None	0	0	0	4/19/2001	None	0	0	0	Not Applicable	Battery Cell found reading low.	Voltage was out of specification low for this Cell, however this condition did not cause an EDG failure	Replaced Cell	
18134	None	0	0	0	5/12/2001	None	0	0	0	Not Applicable	2B Screen Wash Pump circuit breaker Control Transformer had a short circuit. Circuit Breaker Failed.	This is not a Diesel Generator Malfunction	Replaced Breaker and transformer	
18285	None	0	0	0	6/3/1999	None	0	0	0	Not Applicable	Battery Cells found reading low.	Resistance was out of specification high for several Cells, however this condition did not cause an EDG failure	Replaced Cells	
18292	None	0	0	0	9/3/1999	None	0	0	0	Ventilation	2-HV-F-40B Room Fan was found running with its discharge Damper closed. Damper Failure of the Auxiliary contactor within the 480v power supply	This failure did not affected EDG operation	Replaced contactor	This failure is assumed to not affect EDG operability, it is not an EDG Room Ventilation Fan
18321	None	0	0	0	1/16/2000	None	0	0	0	Not Applicable	4A HVAC Chiller Outlet Isolation valve failed to open on signal.	Chiller was out of service	Replaced Thermal Overload	Not a EDG Failure
18395	None	0	0	0	5/27/2001	None	0	0	0	Ventilation	Breaker for 2-HV-F-40B Room Fan was found Tripped an hour after starting a Test. A and B Phase wiring was found loose	This failure did not affected EDG operation	Rewired Breaker	This failure is assumed to not affect EDG operability, it is not an EDG Room Ventilation Fan
18665	None	0	0	0	4/9/1999	None	0	0	0	AAC	SBO Engine "Low Starting Pressure" alarm annunciated with both air compressors running. Air was coming out of the Air Dryer Drain Traps which were not isolable.	SBO Engine was not available to start	New drain traps were installed	This is a SBO engine
18688	None	0	0	0	7/18/1999	S	1	0	0	Air Start	"#3 EDG Trouble" Alarm annunciated due to low air pressure alarm. Air Compressor 3-EG-C-1 would not start even though the air pressure at the Pressure Switch was below 165 psig. At the time, the Air Bottle Pressure was greater at 165 psig, just above the limit required for ensuring a EDG start. The Pressure Switch was found to be defective.	Although EDG would have been unavailable to start if the Starting Air Header Pressure was slightly under 165 psig, the Engine was administratively declared inoperable.	Air Pressure Switch was replaced	Conservativley, this event has been evaluated as not a failure, even though the EDG was declared Inoperable.
18696	None	0	0	0	7/21/1999	None	0	0	0	Air Start	#1 Compressor for all EDGs experienced Motor Contactor Chatter each time the compressor shuts off, due to faulty control circuitry. In one instance the associated compressor breaker, tripped on TOL.	EDG 3 was not declared inoperable because system air pressure was high enough to permit required EDG starts.	Contactors replaced and logic modified	The event was is evaluated as no failure because the Air Start System Pressure was adequate to start the EDG
18697	None	0	0	0	7/30/1999	S	1	0	0	Air Start	#2 Air Compressor Failed to start during its Test. Pressure tap location was unsuitable for use with recently changed pressure switches.	EDG 1 was not declared inoperable because system air pressure was high enough to permit required EDG starts.	Location of the Pressure Taps will be modified so that they would work with the new style pressure switches.	
18699	None	0	0	0	8/9/1999	S	1	0	0	Air Start	#1 Air Compressor for EDG 3, would not start. The TOL at the MCC was actuated because the Pressure Switch sensitivity was too high for the Air Compressor Impulses. This caused the TOL to trip the Air Compressor Breaker	EDG 3 was not declared inoperable because system air pressure was high enough to permit required EDG starts.	Location of the Pressure Taps will be modified so that they would work with the new style pressure switches.	
18716	None	0	0	0	12/6/1999	None	0	0	0	AAC	SBO DG Failed maintenance test due to over loading. A factory defect was responsible for the failure	SBO DG was unavailable	Cause of problem was corrected	SBO Diesel

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
18730	None	0	0	0	4/15/2000	None	0	0	0	Control	A Failed resistor caused the EDG Battery Charger output to go to 147 VDC and 28 Amps, which is greater than specifications.	For this event it is assumed that the Battery Charger is necessary for the long term operation of the EDG. The event does not describe the function of the Battery therefore it is conservatively assumed that it is used for Control Power. The EDG would start as required with the battery charger failure, however, it would not continue to Run as the battery charger is unavailable.	Resistor in the Battery Charger was replaced	
18750	S	1	0	0	8/22/2000	S	1	0	0	Control	EDG found running with Mechanical Overspeed Lever in the Actuated Position during Surveillance Test. Breaker was also found tripped open.	EDG would not have been able to start and carry load if required.	Overspeed Trip assembly was repaired	
18788	None	0	0	0	2/2/2001	None	0	0	0	AAC	Valve on Discharge of "B" Compressor for the SBO DG Air Start System came apart during operation and damaged compressor.	None because the SBO DG Air Start System was still capable of starting DG	Comperessor rebuilt	SBO Diesel
18799	None	0	0	0	5/22/2001	None	0	0	0	AAC	SBO DG Air Compressor #1 Breaker was found tripped open. "C" Phase Termination found loose.	None because the SBO DG Air Start System was still capable of starting DG	Breaker Rewired	SBO Diesel
19195	S	1	0	0	7/24/1999	S	1	0	0	Air Start	EDG Air Start System Flexible Hose Split, causing Air Receivers to lose pressure. "Starting Air Pressure Low" Alarm annunciated.	EDG was unavailable to start.	Hoses were replaced	Air Receivers lost air pressure during this event.
19198	S	1	0	0	11/11/1999	S	1	0	0	Breaker	EDG Output Breaker failed to Open at conclusion of Surveillance Test. Breaker had to be opened Locally. Problems occurred in Switch Wiring.	This event is conservatively evaluated as a Start Failure because it is not apparent whether the Breaker Wiring Problem would have allowed Breaker to Close as required.	Switch Rewired	Unclear as to whether this breaker would close in future demands. Assumed to be a failure to start.
19314	S	1	0	0	3/16/1999	S	1	0	0	Generator	EDG failed to Flash the Generator field during Surveillance Test Auto-Start. Control Power fuses were found to be blown.	EDG experienced a Start Failure because it could not provide power to its associated bus.	Fuses Replaced	
19363	None	0	0	0	6/16/1999	None	0	0	0	Sequencer	Bistable discovered with voltage high out of specification prior to failing. Bistable condition was found during PM activities on that Sequencer.	This is a Sequencer problem where it would prevent the sequenced loading of equipment after D/G Breaker Closure	Sequencer Power Supplies replaced	Sequencer Issue
19364	None	0	0	0	6/16/1999	None	0	0	0	Sequencer	Sequencer DC and AC power supplies degraded such that AC ripple was bleeding through the DC side. Condition was found during PM activities on the Sequencer	This is a Sequencer problem where it would prevent the sequenced loading of equipment after D/G Breaker Closure	Sequencer Power Supplies replaced	Sequencer Issue
19386	R	0	0	1	2/11/2000	None	0	0	0	Coolant	EDG Jacket Water Pump Mechanical Seal was discovered to be degraded and leaking during Preventive Maintenance Activities. Subsequent analysis determined that the Engine would not be able meet its 7 day Run requirement.	Engine would have not met its 7 day Run Time, therefore this is a Run Failure	Seal was replaced	Licensee determined that the Leakage would have exceeded the makeup capacity of the Jacket Water Head Tank
19387	S	1	0	0	6/7/2000	S	1	0	0	Lube Oil	Diesel Lube Oil Keep Warm Pump tripped during standby operation. It was found to have a Failed Outboard Bearing during Troubleshooting Activities, due to improper grease. A Bearing Sleeve was found to block the grease path to the bearing internals.	This event is conservatively evaluated as a Start Failure because it is not apparent whether the loss of Lube Oil Prelube would have prevented the engine to start successfully.	Bearing was re-fit with a proper Rotor Sleeve that would allow grease passage to the bearing internals.	Fairbanks Morse engines typically use Lube Oil Pressure to avoid a start failure. The engine also requires initial oil pressure to protect the most remote bearings from damage during start.
19505	S	1	0	0	8/11/2000	S	1	0	0	Engine	EDG had excessive Wrist Pin Bearing Wear as found by vendor recommended routine Lube Oil Analysis.	This event is conservatively evaluated as a Start Failure because bad wrist pin bearings could have affected engine starting.	Engine was rebuilt.	
19815	S	1	0	0	6/1/2001	S	1	0	0	Control	EDG failed to start during testing due to failed UV initiation Relay. Relay and its contacts were in a degraded condition.	This event is a Start Failure	Relays were replaced	
19816	None	0	0	0	6/20/2001	S	1	0	0	Air Start	DG 2 Air Start System pressure boundary found degraded but not leaking. Air Start System degradation was identified through UT examination.	None because the EDG Air Start System was still capable of starting DG	Corroded fittings were replaced	
19918	None	0	0	0	1/21/1999	None	0	0	0	AAC	TSC DG Starting Motor Battery did not function to start TSC DG during Test	TSC Diesel would not have been available	Batteries replaced	TSC Engine

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
19940	None	0	0	0	2/22/1999	None	0	0	0	AAC	TSC DG Radiator leaking while engine was running for test. Engine ran for 1.5 hours before failure occurred. Piece of metal from roof damaged some radiator tubes.	TSC Diesel would not have been available to Run	Tubes repaired	TSC Engine
20019	L	0	1	0	3/15/2001	S	1	0	0	Breaker	DG was being shutdown from a Surveillance run. DG output breaker was taken to Open, however, "Bus 6 from D/G B breaker 1-603 Closed" alarm was annunciating. This alarm should have cleared when the breaker was open. It was found that Breaker linkage was disconnected such that the breaker was no longer operable.	This event was conservatively evaluated as a Start Failure because the disconnected linkage could have prevented closure of the breaker.	Breaker Linkage Cotter Pins needed to be replaced and bent correctly.	
20027	None	0	0	0	7/25/2001	S	1	0	0	Breaker	Breaker for KHU-1 was modified incorrectly such that it would not operate as required to bring power from the Hydro Unit to the Emergency Buses. An Inertia paddle was replaced on the Breaker and its function was restored.	The Hydro Unit was not available and is considered a Start Failure	The Breaker was repaired	This is a Hydroelectric Dam
20031	L	0	1	0	4/10/2001	L	0	1	0	Control	During Test, EDG failed to develop Voltage, however, its Output Breaker Closed as expected. This caused a LOOP on the associated bus, which caused the EDG to run without Cooling Water for 10 minutes prior to shutting down the EDG. The K1 Relay failed to Open to allow the Generator to build up voltage.	As the EDG failed to develop the propoer voltage, it is assumed to be a start failure.	The K1 Relay was repaired. The EDG was checked for damage.	
20062	None	0	0	0	7/25/2001	S	1	0	0	Control	23 EDG Failed to Start during a Post Maintenance Test. A new Governor Servo Motor was not vented properly.	Servo Motor issued result EDG failure to reach rated RPM and voltage. Servo failure rated to maintenance being performed - Screened.	Governor Booster was replaced	
20127	L	0	1	0	10/29/2000	S	1	0	0	Control	EDG Voltage and VARS were unable to be controlled upon connecting the generator to its associated Bus. Failure attributed to malfunctioning Auto Voltage Regulator Circuit Board.	This is a Load Failure because the EDG was loaded when it was shutdown	Auto Voltage Circuit Board was replaced	
20143	None	0	0	0	8/29/2001	None	0	0	0	Not Applicable	Keowee U2 Field Breaker would not close when demanded	Keowee was unavailable	Repaired Breaker	This is a Hydroelectric Dam
20225	L	0	1	0	8/7/2001	S	1	0	0	Breaker	DG Breaker to Bus 17 failed to Close during Test due to excess play in Breaker Mechanism.	This is a Start Failure	Repaired Breaker	
20235	None	0	0	0	4/6/2001	None	0	0	0	AAC	13.8 kV related Alarms annunciated in the Control Room beacause Feeder 13W93 was deenergized.	Offsite Power Sources needed to be verified from different Line	Restored Feeder	This is a Gas Turbine
20236	None	0	0	0	7/10/2001	S	1	0	0	Fuel Transfer	EDG 1B Fuel Oil Day Tank "Hi" and "Hi Hi" Alarms annunciated with Fuel Oil Transfer Pump running. Before the FOTP was manually secured, the Day Tank overflowed approximately 80-100 Gals. The Level Control Switch malfunctioned. EDG 1B was in Standby at the time and was unaffected	Oil Leaked into the Room Sump Trench which is designed to handle Day Tank Overflows. The EDG was unaffected.	Level Switch was calibrated.	Engine could have started and performed its function in presence of fuel in the trench
20244	None	0	0	0	7/25/2001	S	1	0	0	Fuel Transfer	Fuel Oil Transfer Pump failed to automatically stop when the Day Tank Level switch, Hi Level Limit was reached. Operator manually shut pump down before tank overflowed.	EDG 1B was unaffected. The Day Tank had adequate level to support EDG Operations in the short term. The Fuel Oil Day Tank was able to be filled if required.	Level Switch was calibrated.	
20257	None	0	0	0	4/10/2001	None	0	0	0	Not Applicable	System Operator performed Switching Station Breaker Manipulations that rendered one of the Required Offsite Sources Inoperable to Cooper, without warning Plant Personnel.	LCO 3.8.1.A for one offsite circuit inoperable Entered.	System Operator restored Line to operability.	This event is not EDG related
20392	L	0	1	0	8/8/2001	S	1	0	0	Control	EDG failed to respond to Voltage Regulator Manual Control during Loaded Operation. VAR loading dropped without adjustment and would not respond to Control Board signal adjustment.	This event is a Load Failure because the Voltage Regulator failed while paralelled.	Unknown	This event was assumed to have occurred prior to one hour of loaded operation

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
20393	L	0	1	0	8/13/2001	S	1	0	0	Control	EDG failed to respond to Voltage Regulator Manual Control during Loaded Operation. VAR loading dropped without adjustment and would not respond to Control Board signal adjustment.	This event is a Load Failure because the Voltage Regulator failed while paralelled.	Unknown	This event was assumed to have occurred prior to one hour of loaded operation
20404	S	1	0	0	8/8/2001	S	1	0	0	Control	EDG experienced spurious annunciation for Oil Pressure, Low Water Pressure, and Overspeed after generator after successful completion of test. A faulted LWD Relay was most likely the cause.	A relay failed. It is assumed that the annunciation is tied with actuation of the trips, therefore EDG unavailable when the faulted relay occurred. The EDG would have been unavailable for Starting after this event.	Relays were replaced	This is assumed to be a failure during Unloading.
20440	S	1	0	0	5/9/2001	S	1	0	0	Control	EDG failed to develop Voltage due to malfunction in the K1 Relay.	This is a failure to Start because the generator was not able to energize the bus	K1 relay was replaced	
20441	S	1	0	0	8/1/2001	S	1	0	0	Control	EDG failed to stabilize its Frequency output while running unloaded during a test.	This is a Start Failure	Governor was repaired	
20522	L	0	1	0	10/8/2001	L	0	1	0	Coolant	EDG was Loaded when a Trouble Alarm annunciated that was caused by lowering Jacket Water Head Tank Level. A Leak from the Jacket Water Pump Seal was found. The Engine ran for 42 minutes of its one hour run.	This is a Load Failure because the EDG would not have completed one hour of Loaded Operation.	Mechanical Seal was replaced	
20541	None	0	0	0	9/30/2001	None	0	0	0	Coolant	EDG 1 Jacket Water Temperature Control Valve Failed Open near the end of a Test Run. This caused a rapid rise in Oil and JW Temperatures. Operator intervention included taking manual control of the Temperature Control valve to reduce temperature to near normal operating limits.	The licensee's analysis determined that if operator actions to control temperture had not been taken, the higher temperatures experienced by the Jacket Water and the Lube Oil would still have been able to support the completion of the EDG Safety Function. Therefore, there is no failure associated with this event.	Temperature Control Valve was repaired.	
20564	None	0	0	0	12/13/2001	None	0	0	0	Control	EDG 23 developed Load Swings while being tested under load, due to a loose wire on the Motor Operated Potentiometer. The test was aborted to perform trouble shooting activities.	Trouble shooting efforts showed that If the EDG was running in Isochronous mode, there would have been no output swings. Therefore, there is no failure with this engine	MOP wire was re-landed and tightened	
20565	None	0	0	0	4/23/2001	S	1	0	0	Engine	EDG 1 inspection showed unexpected wear on Wrist Pins. Wrist Pins were found to have failed due to inadequate lubrication.	None. The inspection detected the condition before it failed to start, load, or run	Engine was rebuilt.	
20578	S	1	0	0	4/26/2000	S	1	0	0	Fuel (Other than transfer)	EDG failed to start following repairs to the Fuel Oil Filter System. Fuel Oil Sediment stirred up in the Fuel Oil Tank prevented the successful start. The sediment was stirred up from Maintenance Activities.	EDG was unavailable to start and run manually or automatically.	Sediment was removed from components and cleaned. Evaluated as indirectly related to the maintenance activity and therefore considered a failure.	
20582	None	0	0	0	8/26/2001	None	0	0	0	Fuel (Other than transfer)	EDG 1 DC Fuel Oil Backup Pump did not Start as expected during a Engine Run. The EDG did start normally via the Shaft Driven Pump, however. A Relay Contact for the DC Pump was determined to have a hair across the mechanism, preventing its movement. Foreign material was subsequently removed.	None - EDG started normally with no Alarms received. DC Pump is a back up pump only.	FME procedures reviewed.	
20776	None	0	0	0	6/14/2001	S	1	0	0	Lube Oil	EDG B Auxiliary Lube Oil Pump Keep Warm Pump became mechanical bound and failed. The pump rebuilt prior to this failure and may have been re-assembled incorrectly.	None. The Pump circulate's Lube Oil through a heater and filter in order to maintain cleanliness and temperature. Loss of this function would not render the EDG unavailable.	Pump Rebuilt	
20856	None	0	0	0	10/3/2000	None	0	0	0	Sequencer	Safety Related Load failed to Load Shed in response to a signal from the Load Shed Relay due to a breaker problem.	Breaker Failure could have prevented EDG from carrying Bus Load.	Breaker Rebuilt	This is a Sequencer issue
20867	None	0	0	0	7/10/2001	None	0	0	0	Ventilation	Fire Dampers for EDG 1/2 C and D Room Air Intake Plenums were found in Closed position with the Blowoff Clip from the Fire Damper Operator Disconnected. This condition rendered Room Ventilation unavailable because the dampers were blocked off.	Both C and D EDGs would Start and Load for approximately 30 minutes prior to tripping due to high room temperature at the time and current temperature of the date of discovery.	Fire Damper Inspections were revised and Blowoff Clips modified.	This is a Room HVAC Issue.

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
20878	None	0	0	0	11/29/2000	None	0	0	0	Sequencer	B Train Sequencer Logic would not have functioned as required because Inspection Activities found that power supplies were degraded.	Sequencer would not have been available to sequence the loads onto the bus	Sequencer Power Supplies replaced	Sequencer Issue
20969	None	0	0	0	9/17/2001	S	1	0	0	Generator	EDG 2AB failed the restart Test and didn't achieve rated Voltage in less then 10 seconds. It did achieve voltage in slightly over 10 seconds however. The cause was dirty Contacts in the Field Flash Relay.	None. The Generator start was delayed by 3.58 seconds and is not significant.	Field flashing circuit repaired	Field Flash occurred in 13.58 seconds instead of 10 seconds.
20995	None	0	0	0	3/22/2001	S	1	0	0	Control	BOP DG Voltage varied between 450 and 500 Volts. Manual Voltage Control was not effective in adjusting voltage. Potentiometer was found to be degraded.	BOP DG was unavailable for loaded operation	Voltage Regulator was repaired	BOP Generator is not a Safety Related DG
21008	None	0	0	0	8/29/2001	S	1	0	0	Coolant	Essential Service Water Flows were degraded due to Silting. This affected 2AB and 2CD DGs.	Unit 1 and Unit 2 EDGs were unavailable to start and run due to lack of ESW Flow.	DG Heat Exchangers were flushed and flow restored to required rates	This is a ESW Issue and is screened
21168	None	0	0	0	8/6/2001	None	0	0	0	AAC	BOP DG Output Breaker did not close. Further, the breakder did not rack out for trouble shooting. Breaker was found with mechanical linkages disconnected.	BOP DG was unavailable for loaded operation	Breaker was repaired	BOP Generator is not a Safety Related DG
21305	R	0	0	1	10/8/2001	S	1	0	0	Engine	DG Monthly Test was terminated after 1.5 hours of loaded operation because of noise coming from a cylinder and high exhaust temperature. Engine was found to have failed exhaust valve seat inserts.	EDG did not run because it was unable to carry full load after 1 hour.	Engine was rebuilt.	
21317	S	1	0	0	10/21/2001	S	1	0	0	Control	DG Control Power to its logic circuitry was lost during testing. Engine may have not been running at the time, however, it was being prepared for an operations test. Failure occurred when an operator changed a lamp, which shorted inside the lamp receptacle. This in turn caused a control power Fuse to blow.	DG became unavailable and had to be secured. Further, this failure affected the ability for restart, until the control power was restored and components reset.	Short was cleared, fuses replaced, and components were reset.	It is assumed that DG4 was being prepared for an Operations Run when the Fuse Blew.
21322	L	0	1	0	12/13/2001	S	1	0	0	Generator	Although, DG connected to its bus in the required time during an Operations Test, it immediately lost voltage. This failure occured during the ESF Bus during LOOP with ESF Test. The DG did not develop rated Voltage as desired during its starting cycle. A failed Exciter was identified.	DG was unavailable to Load and Run.	Exciter repaired	
21357	None	0	0	0	8/11/2001	None	0	0	0	Sequencer	With EDG 13 removed from service, a Sequencer Malfunction occurred and caused a LOOP on the associated Bus.	Bus E1C was de-energized. The EDG was tagged out of service at this time and was not failed.	Sequencer Power Supplies replaced	Sequencer Issue
21374	L	0	1	0	7/31/2001	S	1	0	0	Control	During Operations Test of EDG A, the Voltage dipped 2 minutes and 30 seconds after Breaker Closure. A failure on the Voltage Regulator was identified.	The engine was secured for repair. EDG A would not have been able to Load.	Voltage Regulator was repaired	
21400	None	0	0	0	12/7/2000	None	0	0	0	AAC	SBO DG Air Compressor would not stop when Receiver reached normal pressure. The SBO DG Computer System failed to stop the Compressor.	None	Computer repaired	SBO Diesel
21581	S	1	0	0	10/17/2001	S	1	0	0	Control	EDG failed to start on Test Signal simulating UV and SI. The EDG went through 3 cranking cycles without a successful start. This left the 1H Emergency Bus de-energized. The EDG's Governor Load Limit was found to be mispositioned. There were further complications with the EDG.	The EDG failed to Start.	The governor was adjusted and a jacket water leak was repaired.	
21616	L	0	1	0	9/16/2001	S	1	0	0	Breaker	25H3 Breaker to 2H Emergency Bus from EDG failed to close while attempting to parallel. An internal Breaker Failure prevented Closure.	The breaker would not have been able to be closed as required to load the EDG. Therefore, this is a Load Failure.	The Breaker, Synch Switch, and Control Switch was replaced.	
21693	L	0	1	0	7/9/2001	S	1	0	0	Engine	EDG shut down from Testing due to Exhauast Leaks. A failed exhaust gasket blew out of the manifold and prevented Turbocharger Operation. This condition rendered the EDG inoperable.	EDG was not available to load	Repaired Exhaust Leaks	

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Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
21695	S	1	0	0	10/20/2001	S	1	0	0	Coolant	EDG "Lube Oil Reservoir" Alarm annunciated shortly after it was started for a test. Oil was observed coming from the Vent on the Reservoir and water was visible in the Sightglass. Engine was shutdown. Water was leaking into the Lube Oil Reservoir from a Jacket Water Leak. This occurred prior to paralleling the EDG with the Bus.	EDG was not available for Starting because the EDG Output Breaker was not yet closed.	Repaired Leak	
21745	None	0	0	0	8/17/2001	None	0	0	0	Coolant	Jacket Water Heater became electrically shorted and needed replacement. Heater Circuit became de-energized while EDG was in Standby with the Temperature above 85F.	None - Jacket Water Temperature was always above 85F	Jacket Water Heater Replaced.	
21775	None	0	0	0	5/26/2001	None	0	0	0	Lube Oil	3EC EDG Lube Oil standby circulating keepwarm pump coupling failed.	None - The function of the Circulating Oil Pumps is to supply warmed oil to the Turbocharger and Engine while shutdown to minimize wear during starts.	Pump Rebuilt	
21781	None	0	0	0	10/15/2001	None	0	0	0	Not Applicable	Main Generator failure	None-Main Generator		This is not EDG - Main Generator
21782	S	1	0	0	12/26/2001	S	1	0	0	Breaker	EDG Output Breaker Closing Spring not Charged causing the EDG to be inoperable.	EDG was unavailable for subsequent load. Closing Springs should automatically Charge when breaker is racked up. EDG would Start but not Load.	Breaker Repaired	With Breaker Closing Spring not charged, EDG can NOT carry the bus.
21870	None	0	0	0	7/3/2001	None	0	0	0	Engine	Turbo Charger Hose Leak while running	EDG failed to Load	Repair Hose	This is not a Safety-Related DG
21877	None	0	0	0	4/20/2001	None	0	0	0	Air Start	EDG 33 Air Start Motor ran longer than expected during Test Run. Swagelok Fitting was found sheared off to the Air Start Motor. Additionally, the Air Pressure was higher than expected due to a Regulator problem.	Although the EDG started as required, the failure may have prevented further starts. This condition did not affect the West Air Header	Starting Air problems repaired.	
21879	None	0	0	0	5/4/2001	None	0	0	0	AAC	Appendix R Diesel failed when flames were coming out of its Head Petcock.Engine was secured in 10 minutes after starting.	Engine did not Load	Repaired	Not a safety related EDG
21881	None	0	0	0	5/12/2001	None	0	0	0	Unknown	32 EDG undergoing maintenance activities was manually tripped under full control of the operators.	None - EDG was out of service for related Maintenance	None - Maintenance Activities were in progress	Shutdown was precautionary
21894	None	0	0	0	6/15/2001	None	0	0	0	Lube Oil	33 DG Pre Lube Pump was not running in Standby.MCC 39 feeder to EDG Auxiliaries was deengergized. EDG was declared inoperable and secured from standby because it under 120 F. Subsequently the EDG was run, to bring temperature up and was declared operable.	None- EDG would have started and run.	MCC fuses were replaced.	
21912	L	0	1	0	10/16/2001	L	0	1	0	Control	Speed Switch failed on EDG Start which caused its tripping on Reverse Power. The EDG was loaded for a short period of time prior to the tirp.	Failure to Load.	Speed Switches were replaced	
21943	None	0	0	0	12/4/2000	S	1	0	0	Control	EDG 1-3 failed to stabilize Voltage in less than 13 seconds as requied. Instead it stabilized in 13.58 seconds. The Motor Operated Potentiometer was adjusted and the engine passed criteria.	None- EDG would have started and run.	MOP was adjusted	
21949	None	0	0	0	7/3/2001	None	0	0	0	AAC	Appendix R DG jacket water heater was energized while engine was being drained for maintenance.	None - DG was in Maintenance	None	Appears to be a duplicate of 18075.
22001	S	1	0	0	6/21/2001	S	1	0	0	Control	EDG Speed Switch was found with loose screws while EDG was in Standby. When touched, the Overspeed Trip, locked out the Engine which became unavailable for Starting.	Engine was unable to Start	Speed Switch was repaired	
22150	None	0	0	0	9/12/2001	None	0	0	0	Not Applicable	Lighting UPS Ballast failed	None	Replaced Ballast	Not a EDG Failure
22158	None	0	0	0	2/19/2001	S	1	0	0	Control	EDG 1-2 failed to reach 900 RPM in 10 Seconds during Operations Test. Fuel system and Governor needed adjustment.	None - Engine was only 0.162 Seconds out of specification	Adjusted Fuel Component Settings.	
22249	None	0	0	0	4/5/2001	None	0	0	0	Not Applicable	Control Room Lighting UPS Inverter Blower B1 not running.	None	None	Not DG Related

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22309	None	0	0	0	10/12/2001	S	1	0	0	Control	EDG A SW Bypass Valve failed to close when handswitch was taken to Close. This caused to EDG to be declared Inoperable.	None - This condition would not preclude DG Start, Load, or Run	Handswitch repaired	Requirement for SW Separation is Administrative and had no effect on ability of EDG to start
22325	None	0	0	0	11/15/2000	S	1	0	0	Fuel Transfer	DFOTP1 Diesel Fuel Oil Transfer Pump 0-1 was selected to ON in order to recirculate the tank for sampling. Pump began to cycle on and off intermittently. High Resistance was found across Relay 49-1H-65.	None - FOTP ran steadily with operator intervention. Intermittent operation did not appear to be enough to prevent adequate fuel supply.	Contactors Cleaned on Relay 49-1H-65	
22363	None	0	0	0	6/29/2001	None	0	0	0	Not Applicable	CR Battery Lighting UPS failed to power lighting for the full 4 hours as required.	None	NA	Not DG Related
22557	None	0	0	0	9/22/2001	None	0	0	0	Not Applicable	AC Supply Breaker to 1-IV Battery Charger Tripped just after placing Charger in service.	None	NA	Not DG Related
22561	L	0	1	0	10/17/2001	S	1	0	0	Engine	EDG experienced Water/Oil Mixture coming out of Crankcase Air Box Drain during a Test Run. The Test was halted. A failed Plug was found on Cylinder #19.	This is a Failure to Load because the Test was secured prior to one hour of loaded operation.	Plug on Cylinder 19 was replaced	
22568	None	0	0	1	9/26/2001	S	1	0	0	Fuel Transfer	Fuel Oil Transfer Pump Discharge RV leaking grossly, so that pump would not pump fuel oil to the U2 "H" EDG day tank. Pump was able to pump with operator intervention by manipulating the relief valve.	None - FOTP ran steadily with operator intervention	Pump Rebuilt	
22573	S	1	0	0	11/17/2001	S	1	0	0	Control	EDG failed to start during Testing due to failed START Relay 1. STR 1 did not allow Air Start Solenoid to Energize.	This is a Start Failure	STR1 was replaced.	
22583	L	0	1	0	10/17/2001	S	1	0	0	Engine	EDG had to be shutdown during loaded testing due to noise coming from the Scavenging Air System. Test was aborted prior to one hour of loaded operation. Fuel Rack was also found to be hunting.	This is a Load Failure	Found several mechanical problems and repaired	
22619	None	0	0	0	9/19/2001	S	1	0	0	Air Start	EDG B failed to start on one Air Start System Train. SOV DG-23B malfunctioned. EDG B started successfully on the opposite Air Start System Train.	None- EDG would have started and run on the opposite Starting Air System Train.	Replaced SOV DG-23B	
22824	None	0	0	0	9/25/2001	None	0	0	0	Not Applicable	DEG-0-1032 Check Valve for the DG Fuel XFR Pump Vault Floor Drain Check Valve was inspected and found to be on the closed position, however, it was stuck in the closed direction due to buildup of deposits.	Drain Check Valve prevents room flooding and does not affect EDG operation, therefore, the is No Failure	Valve was cleaned	
23557	L	0	1	0	12/11/2001	S	1	0	0	Lube Oil	EDG loaded but needed to be shutdown due to a Governor Oil Leak	EDG failed to Load	Oil Leak was repaired	This is a Failure to Load
23659	None	0	0	0	12/11/2001	None	0	0	0	Ventilation	EDG D1 Room Ventilation Failed to Start during EDG Surveillance Test. Operators locally started fans which ran successfully. The 14X/D1 relay was replaced.	Had operators not intervened, the room temperature may have risen to where the EDG would trip on temperature related causes.	Relay was replaced	This is a HVAC issue
23691	None	0	0	0	11/14/2001	S	1	0	0	Control	EDG Voltage Regulator was damaged by Test Equipment improperly hooked up electronically. This shorted a power supply to a Voltage Regulator circuit.	EDG was out of service for several days thereafter, for repairs.	Repaired faulted electrical components	Maintenance-related failure. The test equipment caused the EDG to be unavailable for several days
23699	L	0	1	0	11/28/2001	L	0	1	0	Unknown	EDG tripped due to High Crankcase Pressure during Monthly Test. EDG was Loaded for Less than one hour.	This is a Failure to Load because the Test was secured prior to one hour of loaded operation.	Cause of the Crankcase pressure was repaired after extensive troubleshooting.	
24086	None	0	0	0	8/23/2001	None	0	0	0	AAC	Conowingo Dam Breaker to SBO Bus Tripped.	None - not a EDG	SBO SWGR Repaired	Not a safety related EDG
24139	S	1	0	0	10/30/2001	L	0	1	0	Coolant	EDG Tripped on Low Jacket Cooling Water Pressure, during Testing. Cause was valve mispositioning error. The JW Cooling Headtank isolation Valve was closed and should have been open.	This is a Start Failure as the EDG was not yet Paralleled to the Bus. The licensee stated that no power was lost.	Conducted investigation to the cause of the Valve Mispositioning Event	
24322	None	0	0	0	9/7/2001	None	0	0	0	Not Applicable	This event describes the shared response to RIS 2000-24 between NMP and Fitzpatrick Offsite Power and Grid Reliabilities studies.	None - not a EDG	None	
24573	None	0	0	0	7/26/1999	S	1	0	0	Control	Control Panel Module failed to annunciate a EDG Trouble Alarm in the Control Room in response to Local Panel Alarm "Lo Air Pressure" TEST.	None - Alarm Function Only. The Alarm Test did not render the EDG unavailable.	Repaired Module	

1999 - 2001 EDG Failures

Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
24576	None	0	0	0	7/26/2000	S	1	0	0	Control	Control Panel Module failed to annunciate a EDG Trouble Alarm in the Control Room in response to Local Panel Alarm "Lo Air Pressure" TEST.	None - Alarm Function Only. The Alarm Test did not render the EDG unavailable.	Repaired Module	
24659	L	0	1	0	12/26/2001	L	0	1	0	Lube Oil	0EDG Locked Out on Low Lube Oil Pressure even though adequate oil pressure existed. Tubing was inadequate to transmit the pressure to Pressure Switch.	EDG failed to Load	Installed Larger Tubing	
24702	S	1	0	0	12/11/2001	S	1	0	0	Control	Malfunctioning Speed Switch caused Overspeed Trip Signal with EDG in Standby.	This is a Start Failure	Replaced Speed Switch	
24766	None	0	0	0	5/22/2001	None	0	0	0	Not Applicable	Breaker Tripped from voltage fluctuation do to a Lightning Strike.	None - not a EDG	None - Not a EDG	
24787	None	0	0	0	12/23/1999	S	1	0	0	Control	Local Panel did not Alarm Test Correctly. This is Alarm Function only	None - Did not cause a EDG Failure	Repaired Panel	
24788	None	0	0	0	3/9/2000	S	1	0	0	Control	Local Panel did not Alarm Test Correctly. This is Alarm Function only	None - Did not cause a EDG Failure	Repaired Panel	
24789	None	0	0	0	7/5/2000	S	1	0	0	Control	Local Panel did not Alarm Test Correctly. This is Alarm Function only	None - Did not cause a EDG Failure	Repaired Panel	
24790	None	0	0	0	8/19/2001	S	1	0	0	Control	Local Panel did not Alarm Test Correctly. This is Alarm Function only	None - Did not cause a EDG Failure	Repaired Panel	
25440	None	0	0	0	10/13/2000	None	0	0	0	Not Applicable	Misoperation of electrical bus line ups caused inadvertent ESF Actuation and Auto Start of Component Cooling Water Pump 1-1	None- Did not cause a EDG Failure	Stabilized plant and secured from errant Line Up.	
25617	None	0	0	0	11/26/2001	None	0	0	0	Not Applicable	RCP 1A Overcurrent Relays found out of tolerance.	None - Did not cause a EDG Failure	Calibrated Overcurrent Relays	
25871	None	0	0	0	6/26/2000	None	0	0	0	Not Applicable	Alternate Sources of Offsite AC were not available to be controlled from the Control Room, as designed. Instead, the Transmission Control Center had control of the breakers due to misunderstanding of responsiblities.	None - Did not cause a EDG Failure	Revised TCC procedures	
26533	R	0	0	1	5/1/2001	S	1	0	0	Fuel Transfer	EDG Fuel Oil Day Tank Level was Low, during EDG Endurance Run. Fuel Oil Transfer Pump malfunctioned causing Low level in Day Tank. Pump had a Failed RV.	EDG would not have been able to Run over one hour of loaded operation with the Failed Transfer Pump	FOTP was repaired.	Day Tank Level was dropping 4" per hour. Day Tank had 25" in it when test started. EDG would not have been able to run for greater than 4 hours. NEI review recommended removal of this failure. As new guidance for the inclusion of thie FOTP would count this failure, the failure is retained.
26561	None	0	0	0	12/5/1999	None	0	0	0	Lube Oil	OC DG Prelube Pump Breaker was found open and its indication not illuminated. The cause of this was a blown fuse in the Breaker Control Power Circuit.	None - Prelube Pump Loss did not affect the EDG Availability.	Short Circuit was traced to lamp socket	Prelube Pump is used for Slow Speed start - OC DG is an alternate AC diesel.
27306	L	0	1	0	4/15/2000	S	1	0	0	Control	While Operating EDG For Surveillance Testing an acrid burning odor coming from the EDO control panel was detected. The Linear Reactor in the Exciter circuit was found grounded. Although this did not cause any operation problems, the degraded condition of the Reactor caused operations to shut down the engine.	This is a Load Failure because the engine was shutdown in less than one hour of loaded operation.	Repaired Linear Reactor	
27924	L	0	1	0	6/2/2000	L	0	1	0	Coolant	EDG Tripped on Low Jacket Coolant Pressure in the first 20 minutes of loaded run. The test was an endurance run. A failed Jacket Water Coolant pump seal was identified	Engine was unavailable for Loading and Running	Replaced JW Cooling Pump	
28504	R	0	0	1	10/31/2000	S	1	0	0	Lube Oil	EDG surveillance run had to be terminated after several hours of operation due to high Lube Oil Strainer Differential Pressure. Unusual amounts of Lube Oil Debris were identified due to engine cylinder and piston wear in excess of what was expected.	Engine would not have been available for Running. This is assumed because of the Piston and Cylinder damage, not the Lube Oil Strainer DP.	Unknown	Assumed that Operators could swap Lube Oil Strainers during Engine Run. In this case, EDG could run longer.
29130	S	1	0	0	8/8/2001	None	0	0	0	Control	EDG started for no apparent reason. There was an problem in the Control Relay Panel.	Assuming that the failure affected the Start Logic, this event is conservatively evaluated as a Start Failure	Unknown	Assuming that this event is a Start Failure due to lack of detailed information and that it affected the Starting Logic.

1999 - 2001 EDG Failures

Failure ID	Recommended EDG Failure Mode	Start	Load	Run	Discovery Date	Industry Code	Start	Load	Run	Category	Failure Description	Impact	Corrective Action	Comment
31883	None	0	0	0	8/31/2001	None	0	0	0	Sequencer	UV Bistable found with degraded Deadband.	None - Bistable although degraded, was able to function.	Bistable replaced.	Sequencer Issue
34546	L	0	1	0	12/14/1999	S	1	0	0	Engine	Prior to Running, EDG was found with a broken Bearing Bullseye Oil Detector. Test was post-poned until after maintenance.	This would have prevented the EDG from operating for an extended period. Therefore, this is conservatively identified as a Load Failure	Bullseye was repaired	
34548	None	0	0	0	8/12/1999	None	0	0	0	Ventilation	EDG 2A-A had a failed Room HVAC Damper Link which would have caused unavailability. The Fire Protection CO2 Thermal Link failed causing closure of the Damper.	This condition could have caused room temperature to rise to tripping point IF EDG were in operation. Because there is no alarm on the closed fire damper, this event is conservatively identified as Start Failure.	Link Replaced	This event is screend as it is an HVAC event.
34586	S	1	0	0	11/13/2001	S	1	0	0	Control	EDG failed to start from Local Control. The Time Delay relays were found with tight tolerances incompatible with actual engine performance requirements.	Start Failure	Time delays for the relays were calibrated	
37226	S	1	0	0	11/14/2000	None	0	0	0	Coolant	EDG Jacket Water Leaked into Lube Oil. Leakage was from the Lube Oil Ht Exchanger Floating Packing Head Connection. Significant amount of water was found in Lube Oil. This condition was identified during routine Maintenance.	Significant Damage could have ocurred if EDG was ran. This is a start faiure.	Heat Exchanger was rebuilt.	It is assumed that the Maintenance Activities were unrelated to repairing the Heat Exchanger.
37310	R	0	0	1	5/9/2001	S	1	0	0	Engine	DG was prematurely shutdown due to increasing crankcase pressure prior to it reaching the trip set-point. Causes of the hi-crankcase pressure include a change in Fuel Oil type and Lube Oil Problems.	The DG would not have been able to Run. It is assumed that the DG ran loaded for greater than 1 hour.	Investigation inconclusive	

Appendix B

EDG Success Data

EDG Success Data

DeviceID	Test Start Demands	Operation Start Demands	Total Start Demands	Avg Starts / Month	Test Load Demands	Operation Load Demands	Total Load Demands	Avg Load Run / Start	Test Run Hours	Operation Run Hours	Total Run Hours	Run - Load Run Hours	Comments
28468	42	4	46	1.3	61	4	65	1.5	153.45	7.61	161.06	96.06	Actual
92	38	5	43	1.2	59	5	64	1.6	193.31	8.26	201.57	137.57	Actual
30727	60		60	1.7	50		50	0.8	124.01		124.01	74.01	Actual
54598	51		51	1.4	44		44	0.9	109.52		109.52	65.52	Actual
64497	46		46	1.3	44		44	1.0	69		69	25	Actual
64832	49		49	1.4	46		46	0.9	72		72	26	Actual
70252	47	2	49	1.4	45	1	46	1.0	70.5	20	90.5	44.5	Actual
71036	43		43	1.2	41		41	1.0	64.5		64.5	23.5	Actual
75429	36	22	58	1.6	42	24	66	1.2	148.71	96.82	245.53	179.53	No Load Run data recorded for 1999 - 2001. Used 200301 - 200512,
75430	37.43	32	69.43	1.9	44	26	70	1.2	121.22	121.16	242.38	172.38	No Load Run data recorded for 1999 - 2001. Used 200301 - 200512,
103913	47.47	30	77.47	2.2	43	24	67	0.9	143.46	123.68	267.14	200.14	No Load Run data recorded for 1999 - 2001. Used 200301 - 200512,
103804	62.64	28	90.64	2.5	43	18	61	0.7	102.11	134.58	236.69	175.69	Actual
124217	56		56	1.6	46		46	0.8	95		95	49	Estimated per 36 months - effective 200201
920861	53		53	1.5	45		45	0.8	88.4		88.4	43.4	Estimated per 36 months - effective 200201
124306	57		57	1.6	44		44	0.8	94.6		94.6	50.6	Estimated per 36 months - effective 200201
124307	54		54	1.5	46		46	0.9	118.7		118.7	72.7	Estimated per 36 months - effective 200201
129113	52		52	1.4	46		46	0.9	95.2		95.2	49.2	Estimated per 36 months - effective 200201
129112	52		52	1.4	45		45	0.9	92.8		92.8	47.8	Estimated per 36 months - effective 200201
129115	60		60	1.7	51		51	0.9	117.1		117.1	66.1	Estimated per 36 months - effective 200201
129117	56	1	57	1.6	48	1	49	0.9	122.7	0.63	123.33	74.33	Estimated per 36 months - effective 200201
138701	40.5	8	48.5	1.3	37.5	2	39.5	0.9	256.5	21.6	278.1	238.6	Estimated per 24 months - effective 200101
138703	40.5	8	48.5	1.3	27.5	2	29.5	0.7	256.5	10.1	266.6	237.1	Estimated per 24 months - effective 200101
138705	40.5	8	48.5	1.3	27.5		27.5	0.7	256.5	13.42	269.92	242.42	Estimated per 24 months - effective 200101
138707	40.5	8	48.5	1.3	27.5		27.5	0.7	256.5	14.02	270.52	243.02	Estimated per 24 months - effective 200101
144445	72		72	2.0	60		60	0.8	216		216	156	Estimated per 12 months - effective 199701
144447	72		72	2.0	60		60	0.8	216		216	156	Estimated per 12 months - effective 199701
149279	72		72	2.0	60		60	0.8	216		216	156	Estimated per 12 months - effective 199701
149281	72		72	2.0	60		60	0.8	216		216	156	Estimated per 12 months - effective 199701
154071	66		66	1.8	66		66	1.0	66		66	0	Estimated per 18 months - effective 200301
154072	76		76	2.1	76		76	1.0	76		76	0	Estimated per 18 months - effective 200301
159750	74		74	2.1	51		51	0.7	92		92	41	Actual
159126	52		52	1.4	49		49	0.9	80.2		80.2	31.2	Actual
163626	55		55	1.5	44		44	0.8	93.7		93.7	49.7	Actual
163078	54		54	1.5	48		48	0.9	101.8		101.8	53.8	Actual
166779	46		46	1.3	46		46	1.0	214.3		214.3	168.3	Actual
166780	47		47	1.3	42		42	0.9	192.5		192.5	150.5	Actual
173053	49		49	1.4	47		47	1.0	160.6		160.6	113.6	Actual
172652	67		67	1.9	59		59	0.9	231.3		231.3	172.3	Actual
178388	51	1	52	1.4	42	1	43	0.8	169.44	8.6	178.04	135.04	Estimated per 24 months - effective 200301
178752	52.5	1	53.5	1.5	42	1	43	0.8	214.35	9.3	223.65	180.65	Estimated per 24 months - effective 200301
185770	44		44	1.2	43		43	1.0	137.63		137.63	94.63	Estimated per 36 months - effective 200301
185526	44		44	1.2	44		44	1.0	41.4		41.4	-2.6	Estimated per 36 months - effective 200301
191043	76		76	2.1	70		70	0.9	206		206	136	Estimated per 18 months - effective 200301
190618	72		72	2.0	70		70	1.0	200		200	130	Estimated per 18 months - effective 200301
196783	72	1	73	2.0	70	1	71	1.0	194	7.35	201.35	130.35	Estimated per 18 months - effective 200301
197074	68		68	1.9	66		66	1.0	184		184	118	Estimated per 18 months - effective 200301
250005	63.6		63.6	1.8	58.8		58.8	0.9	276.4		276.4	217.6	Load-run estimated per 30 months - effective 200301, run estimated per 20 months -effective 199703
246629	52.8	1	53.8	1.5	48		48	0.9	267.1		267.1	219.1	Load-run estimated per 30 months - effective 200301, run estimated per 20 months -effective 199703
262755	42	3	45	1.3	43	2	45	1.0	158.45	7.5	165.95	120.95	Actual
262756	47	4	51	1.4	42	4	46	0.9	160.3	1	161.3	115.3	Actual
269404	49	11	60	1.7	39	1	40	0.8	99.13	5.35	104.48	64.48	Actual
268257	45	17	62	1.7	41	3	44	0.9	94.85	8.39	103.24	59.24	Actual
272113	54.8	6	60.8	1.7	42.3	1	43.3	0.8	87.7	37.28	124.98	81.68	Estimated per 23 months - effective 200207
272071	120	3	123	3.4	56	1	57	0.5	296.44	39.06	335.5	278.5	Based on 9 months (199901,04,,07)

EDG Success Data

DeviceID	Test Start Demands	Operation Start Demands	Total Start Demands	Avg Starts / Month	Test Load Demands	Operation Load Demands	Total Load Demands	Avg Load Run / Start	Test Run Hours	Operation Run Hours	Total Run Hours	Run - Load Run Hours	Comments
272072	132	4	136	3.8	68	1	69	0.5	251.68	41.12	292.8	223.8	Based on 9 months (199901,04,,07)
276584	52	3	55	1.5	40		40	0.8	65.68	4.07	69.75	29.75	Based on 9 months (199901,04,,07)
276585	92.57	3	95.57	2.7	48		48	0.5	162.9	6.02	168.92	120.92	Estimated per 21 months - effective 200301
276858	85.7	3	88.7	2.5	53.1		53.1	0.6	176.6	8.14	184.74	131.64	Estimated per 21 months - effective 200301
201637	44		44	1.2	40		40	0.9	104		104	64	Estimate per 18 months - effective 200101
201638	44	2	46	1.3	40	4	44	0.9	104	4.28	108.28	64.28	Estimate per 18 months - effective 200101
202801	44		44	1.2	40		40	0.9	104		104	64	Estimate per 18 months - effective 200101
202802	44	1	45	1.3	40	1	41	0.9	104	2.05	106.05	65.05	Estimate per 18 months - effective 200101
281254	115.2	2	117.2	3.3	115.2		115.2	1.0	411.3	5.6	416.9	301.7	Estimated per 20 months - effective 199703. Start demands assumed equal to load runs
281253	48.6		48.6	1.4	48.6		48.6	1.0	171.7		171.7	123.1	Estimated per 20 months - effective 199703. Start demands assumed equal to load runs
285123	54	1	55	1.5	54		54	1.0	80	2.53	82.53	28.53	Estimated per 18 months - effective 199705. Start demands assumed equal to load runs
292556	48.75	10	58.75	1.6	42	10	52	0.9	101.41	10	111.41	59.41	Estimated per 48 months - effective 200201. Run data actual.
293925	52.5	10	62.5	1.7	42	10	52	0.8	101.55	10.2	111.75	59.75	Estimated per 48 months - effective 200201. Run data actual.
373820	55		55	1.5	45		45	0.8	111.68		111.68	66.68	Actual
373380	49		49	1.4	44		44	0.9	103.83		103.83	59.83	Actual
373369	57		57	1.6	44		44	0.8	108.57		108.57	64.57	Actual
378663	57		57	1.6	53		53	0.9	103.19		103.19	50.19	Actual
378777	47		47	1.3	49		49	1.0	110.93		110.93	61.93	Actual
294268	97		97	2.7	70		70	0.7	155		155	85	Actual
294265	89		89	2.5	59		59	0.7	151		151	92	Actual
294266	104		104	2.9	58		58	0.6	138		138	80	Actual
299053	81		81	2.3	58		58	0.7	140		140	82	Actual
305131	60	3	63	1.8	59	3	62	1.0	196.15	5.9	202.05	140.05	Actual
305200	62	1	63	1.8	51	1	52	0.8	176.92	3.2	180.12	128.12	Actual
305133	55		55	1.5	54		54	1.0	177.46		177.46	123.46	Actual
305202	62		62	1.7	57		57	0.9	205		205	148	Actual
315455	70	1	71	2.0	45	1	46	0.6	136.4	0.5	136.9	90.9	Actual
315392	82	1	83	2.3	43	1	44	0.5	121.1	0.7	121.8	77.8	Actual
323887	84		84	2.3	49		49	0.6	236.4		236.4	187.4	Actual
324067	80		80	2.2	49		49	0.6	168.09		168.09	119.09	Actual
713103	48	7	55	1.5	48	7	55	1.0	240	39.3	279.3	224.3	Estimated per 18 months - effective 200101
713379	48	9	57	1.6	48	9	57	1.0	240	11.4	251.4	194.4	Estimated per 18 months - effective 200101
384243	54		54	1.5	52		52	1.0	285.14		285.14	233.14	Estimated per 18 months - effective 199707
384680	52		52	1.4	52		52	1.0	193.44		193.44	141.44	Estimated per 18 months - effective 199707
384249	46		46	1.3	46		46	1.0	177.72		177.72	131.72	Estimated per 18 months - effective 199707
384251	48		48	1.3	46		46	1.0	140.42		140.42	94.42	Estimated per 18 months - effective 199707
390338	51	24	75	2.1	51	18	69	1.0	111	37.91	148.91	79.91	Estimated per 24 months - effective 200301
390359	60	35	95	2.6	60	33	93	1.0	90	22.25	112.25	19.25	Estimated per 24 months - effective 199807
390342	45	35	80	2.2	45	32	77	1.0	108	25.2	133.2	56.2	Estimated per 24 months - effective 199807
394357	46		46	1.3	42		42	0.9	80.09		80.09	38.09	Actual
394359	50		50	1.4	43		43	0.9	80.47		80.47	37.47	Actual
394291	53		53	1.5	44		44	0.8	79.16		79.16	35.16	Actual
309388	89		89	2.5	101		101	1.1	95.51		95.51	-5.49	Estimated per 26 months - effective 200301
309446	89		89	2.5	101		101	1.1	97.21		97.21	-3.79	Estimated per 26 months - effective 200301
309390	89		89	2.5	104		104	1.2	101.47		101.47	-2.53	Estimated per 26 months - effective 200301
309392	97		97	2.7	104		104	1.1	109.08		109.08	5.08	Estimated per 26 months - effective 200301
399159	51		51	1.4	43		43	0.8	232.02		232.02	189.02	Actual
399176	54		54	1.5	41		41	0.8	249.56		249.56	208.56	Actual
402984	68	1	69	1.9	52	2	54	0.8	137.69	22.02	159.71	105.71	Actual
402986	61		61	1.7	41		41	0.7	127.35		127.35	86.35	Actual
408836	67		67	1.9	52		52	0.8	146.71		146.71	94.71	Actual
413910	30		30	0.8	49.5		49.5	1.7	53.25		53.25	3.75	Estimated per 24 months - effective 199611. Startt demand were shown as 2 per 24 months. This appears to be an error as more recent data shows monthly testing. Assumed 20 per 24 months.

EDG Success Data

DeviceID	Test Start Demands	Operation Start Demands	Total Start Demands	Avg Starts / Month	Test Load Demands	Operation Load Demands	Total Load Demands	Avg Load Run / Start	Test Run Hours	Operation Run Hours	Total Run Hours	Run - Load Run Hours	Comments
414093	30		30	0.8	49.5		49.5	1.7	53.25		53.25	3.75	Estimated per 24 months - effective 199611. Startt demand were shown as 2 per 24 months. This appears to be an error as more recent data shows monthly testing. Assumed 20 per 24 months.
414094	30		30	0.8	49.5		49.5	1.7	53.25		53.25	3.75	Estimated per 24 months - effective 199611. Startt demand were shown as 2 per 24 months. This appears to be an error as more recent data shows monthly testing. Assumed 20 per 24 months.
413911	30		30	0.8	49.5		49.5	1.7	53.25		53.25	3.75	Estimated per 24 months - effective 199611. Startt demand were shown as 2 per 24 months. This appears to be an error as more recent data shows monthly testing. Assumed 20 per 24 months.
420673	30		30	0.8	49.5		49.5	1.7	53.25		53.25	3.75	Estimated per 24 months - effective 199611. Startt demand were shown as 2 per 24 months. This appears to be an error as more recent data shows monthly testing. Assumed 20 per 24 months.
420941	30		30	0.8	49.5		49.5	1.7	53.25		53.25	3.75	Estimated per 24 months - effective 199611. Startt demand were shown as 2 per 24 months. This appears to be an error as more recent data shows monthly testing. Assumed 20 per 24 months.
420943	30		30	0.8	49.5		49.5	1.7	53.25		53.25	3.75	Estimated per 24 months - effective 199611. Startt demand were shown as 2 per 24 months. This appears to be an error as more recent data shows monthly testing. Assumed 20 per 24 months.
420945	30		30	0.8	49.5		49.5	1.7	53.25		53.25	3.75	Estimated per 24 months - effective 199611. Startt demand were shown as 2 per 24 months. This appears to be an error as more recent data shows monthly testing. Assumed 20 per 24 months.
426106	78		78	2.2	49		49	0.6	206.9		206.9	157.9	Actual
425897	83		83	2.3	56		56	0.7	193.9		193.9	137.9	Actual
431267	70		70	1.9	46		46	0.7	214.5		214.5	168.5	Actual
431268	76		76	2.1	49		49	0.6	222.6		222.6	173.6	Actual
440377	30	1	31	0.9	45		45	1.5	185.4		185.4	140.4	Actual
440379	25		25	0.7	41		41	1.6	194.06		194.06	153.06	Actual
444272	10		10	0.3	50		50	5.0	142.94		142.94	92.94	Actual
444340	10		10	0.3	55		55	5.5	153.65		153.65	98.65	Actual
450139	45		45	1.3	42		42	0.9	80.88		80.88	38.88	Actual
449718	48		48	1.3	48		48	1.0	100.32		100.32	52.32	Actual
736429	56	1	57	1.6	51	1	52	0.9	261.5	35.48	296.98	244.98	No data recorded for 1999 - 2001. Used 200201 - 200412,
736430	59	1	60	1.7	57	1	58	1.0	277.53	39.17	316.7	258.7	No data recorded for 1999 - 2001. Used 200201 - 200412,
453530	44	1	45	1.3	40	1	41	0.9	52.11	9.16	61.27	20.27	Actual
453794	37	9	46	1.3	35	7	42	0.9	63.31	34.64	97.95	55.95	Actual
456878	43.9	11	54.9	1.5	37.9	2	39.9	0.9	176.8	9.77	186.57	146.67	Estimated per 20 months - effective 199610
456879	43.9	14	57.9	1.6	37.9	11	48.9	0.9	161.8	34.34	196.14	147.24	Estimated per 20 months - effective 199610
518352	44	1	45	1.3	44	1	45	1.0	122		122	77	Estimated per 18 months - effective 199701
511898	44	1	45	1.3	44	3	47	1.0	122	12.27	134.27	87.27	Estimated per 18 months - effective 199701
572985	44		44	1.2	44		44	1.0	122		122	78	Estimated per 18 months - effective 199701
534562	44		44	1.2	44		44	1.0	122		122	78	Estimated per 18 months - effective 199701
590380	119	1	120	3.3	97	1	98	0.8	131.8	3.4	135.2	37.2	Actual
590381	108		108	3.0	89		89	0.8	127.7		127.7	38.7	Actual
593097	60	12	72	2.0	60	5	65	1.0	300	450.56	750.56	685.56	Estimated per 18 months - effective 200101
593098	60	11	71	2.0	60	6	66	1.0	300	453.75	753.75	687.75	Estimated per 18 months - effective 200101

EDG Success Data

DeviceID	Test Start Demands	Operation Start Demands	Total Start Demands	Avg Starts / Month	Test Load Demands	Operation Load Demands	Total Load Demands	Avg Load Run / Start	Test Run Hours	Operation Run Hours	Total Run Hours	Run - Load Run Hours	Comments
596679	50	28	78	2.2	50	28	78	1.0	271.03	9.25	280.28	202.28	Estimated per 36 months - effective 200101
596680	49	23	72	2.0	49	23	72	1.0	262.83	8.8	271.63	199.63	Estimated per 36 months - effective 200101
603103	50	28	78	2.2	50	28	78	1.0	271.03	9.25	280.28	202.28	Estimated per 36 months - effective 200101
603104	49	23	72	2.0	49	23	72	1.0	262.83	8.8	271.63	199.63	Estimated per 36 months - effective 200101
610313	50	28	78	2.2	50	28	78	1.0	271.03	9.25	280.28	202.28	Estimated per 36 months - effective 200101
610315	49	23	72	2.0	49	23	72	1.0	262.83	8.8	271.63	199.63	Estimated per 36 months - effective 200101
615673	178.5	22	200.5	5.6	88.5	4	92.5	0.5	189	9.5	198.5	106	Estimated per 24 months - effective 200304
615674	178.5	14	192.5	5.3	88.5		88.5	0.5	189	1.66	190.66	102.16	Estimated per 24 months - effective 200304
615675	178.5	12	190.5	5.3	88.5	4	92.5	0.5	189	9	198	105.5	Estimated per 24 months - effective 200304
615676	178.5	10	188.5	5.2	88.5		88.5	0.5	189	2	191	102.5	Estimated per 24 months - effective 200304
626613	71		71	2.0	54		54	0.8	96.54		96.54	42.54	Actual
626615	77		77	2.1	62		62	0.8	83.34		83.34	21.34	Actual
632139	41	1	42	1.2	39	1	40	1.0	64.08	7.22	71.3	31.3	Actual
632109	43	1	44	1.2	39	1	40	0.9	62.1	8.53	70.63	30.63	Actual
635704	36	2	38	1.1	36	2	38	1.0	132.6		132.6	94.6	Estimated per 12 months - effective 200101
635653	36	2	38	1.1	36	2	38	1.0	103.5		103.5	65.5	Estimated per 12 months - effective 200101
635812	36	2	38	1.1	36	2	38	1.0	161.7		161.7	123.7	Estimated per 12 months - effective 200101
635811	36		36	1.0	36		36	1.0	225.9		225.9	189.9	Estimated per 12 months - effective 200101
641686	39		39	1.1	39		39	1.0	168.53		168.53	129.53	Actual
641679	35		35	1.0	35		35	1.0	160.73		160.73	125.73	Actual
645367	39	14	53	1.5	41	2	43	1.1	170.48	3	173.48	130.48	Actual
645606	50		50	1.4	45		45	0.9	233.24		233.24	188.24	Actual
648766	100.4	2	102.4	2.8	66.3	2	68.3	0.7	75.8	5.34	81.14	12.84	Estimated per 19 months - effective 199706
648777	132.6		132.6	3.7	36		36	0.3	43.6		43.6	7.6	Estimated per 19 months - effective 199706
653988	81.5	3	84.5	2.3	36	2.5	38.5	0.4	43.6	2.97	46.57	8.07	Estimated per 19 months - effective 199706
319512	40	2	42	1.2	40		40	1.0	40		40	0	Estimated per 18 months - effective 199701
319513	40		40	1.1	40		40	1.0	40		40	0	Estimated per 18 months - effective 199701
707056	103	1	104	2.9	80	1	81	0.8	240.75	1.03	241.78	160.78	Actual
656958	77		77	2.1	68		68	0.9	196.66		196.66	128.66	Actual
716627	72	2	74	2.1	51	2	53	0.7	152.4	3.07	155.47	102.47	Estimated per 36 months - effective 200201
716195	65	2	67	1.9	54	2	56	0.8	142.4	3	145.4	89.4	Estimated per 36 months - effective 200201
716626	75	2	77	2.1	55	2	57	0.7	136.3	2.97	139.27	82.27	Estimated per 36 months - effective 200201
720261	61	2	63	1.8	49	2	51	0.8	122.2	3.6	125.8	74.8	Estimated per 36 months - effective 200201
720262	63	2	65	1.8	51	2	53	0.8	139.5	2.73	142.23	89.23	Estimated per 36 months - effective 200201
720709	68	2	70	1.9	54	2	56	0.8	131.7	3.48	135.18	79.18	Estimated per 36 months - effective 200201
724718	62		62	1.7	60		60	1.0	150		150	90	Estimated per 36 months - effective 199801
724771	66		66	1.8	64		64	1.0	137		137	73	Estimated per 36 months - effective 199801
731388	59		59	1.6	57		57	1.0	135		135	78	Estimated per 36 months - effective 199801
731367	62		62	1.7	60		60	1.0	129		129	69	Estimated per 36 months - effective 199801
926916	53	4	57	1.6	42		42	0.8	136.8	17.5	154.3	112.3	Actual
926917	49	4	53	1.5	41		41	0.8	82.8	17.06	99.86	58.86	Actual
926922	58	4	62	1.7	42	2	44	0.7	108.62	15.32	123.94	79.94	Actual
926924	52	4	56	1.6	40		40	0.8	126.46	18.06	144.52	104.52	Actual
367900	52	3	55	1.5	50	2	52	1.0	239.6	4.47	244.07	192.07	Estimated per 36 months - effective 200201
367902	56	1	57	1.6	52	3	55	0.9	240.3	0.53	240.83	185.83	Estimated per 36 months - effective 200201
750279	51	7	58	1.6	51	11	62	1.0	568.8	15.3	584.1	522.1	Estimated per 18 months - effective 200304
749675	51	8	59	1.6	51	2	53	1.0	568.8	9.85	578.65	525.65	Estimated per 18 months - effective 200304
749676	51	8	59	1.6	51	7	58	1.0	568.8	21.95	590.75	532.75	Estimated per 18 months - effective 200304
756647	51.6	7	58.6	1.6	51.6	4	55.6	1.0	568.8	12.08	580.88	525.28	Estimated per 18 months - effective 200304
756108	51.6	4	55.6	1.5	51.6	1	52.6	1.0	568.8	4.8	573.6	521	Estimated per 18 months - effective 200304
756646	51.6	10	61.6	1.7	51.6	3	54.6	1.0	568.8	48.45	617.25	562.65	Estimated per 18 months - effective 200304
760785	60		60	1.7	48		48	0.8	139.6		139.6	91.6	Estimated per 18 months - effective 199801
760685	60		60	1.7	48		48	0.8	166.6		166.6	118.6	Estimated per 18 months - effective 199801
765968	60		60	1.7	48		48	0.8	139.6		139.6	91.6	Estimated per 18 months - effective 199801
765935	60		60	1.7	48		48	0.8	166.6		166.6	118.6	Estimated per 18 months - effective 199801
814319	58	1	59	1.6	48	1	49	0.8	148.94		148.94	99.94	Estimated per 18 months - effective 199701
820522	52	2	54	1.5	48	2	50	0.9	155.9		155.9	105.9	Estimated per 18 months - effective 199701
830214	56	1	57	1.6	48	1	49	0.9	184		184	135	Estimated per 18 months - effective 199701
865592	43		43	1.2	43		43	1.0	193.42		193.42	150.42	Starts appear to be underestimated. Changed to be consistent with load run

EDG Success Data

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865593	50		50	1.4	50		50	1.0	215.78		215.78	165.78	Starts appear to be underestimated. Changed to be consistent with load run
865544	50		50	1.4	50		50	1.0	199.72		199.72	149.72	Starts appear to be underestimated. Changed to be consistent with load run
865545	45		45	1.3	45		45	1.0	214.34		214.34	169.34	Starts appear to be underestimated. Changed to be consistent with load run
865594	61		61	1.7	61		61	1.0	256.08		256.08	195.08	Starts appear to be underestimated. Changed to be consistent with load run
868007	39	1	40	1.1	84	1	85	2.2	39	2.5	41.5	-43.5	Estimated per 24 months - 199911
868008	39	1	40	1.1	84	1	85	2.2	39	1.13	40.13	-44.87	Estimated per 24 months - 199911
871940	36	13	49	1.4	36		36	1.0	54	16	70	34	Estimated per 18 months - 199801
871775	36	10	46	1.3	36		36	1.0	54	7	61	25	Estimated per 18 months - 199801
875868	36	7	43	1.2	36		36	1.0	54	9.4	63.4	27.4	Estimated per 18 months - 199801
875869	36	17	53	1.5	36		36	1.0	54	8.6	62.6	26.6	Estimated per 18 months - 199801
769866	72		72	2.0	52		52	0.7	116.6		116.6	64.6	Estimated per 36 months - effective 200201
769940	52		52	1.4	46		46	0.9	112.4		112.4	66.4	Estimated per 36 months - effective 200201
878576	43		43	1.2	45		45	1.0	137.07		137.07	92.07	Start Demands estimated per 36 months - effective 200201. Other failure modes actual data
878423	58		58	1.6	44		44	0.8	132.1		132.1	88.1	Start Demands estimated per 36 months - effective 200201. Other failure modes actual data
883291	56		56	1.6	56		56	1.0	177.9		177.9	121.9	No data recorded for 1999 - 2001. Used 200301 - 200512,
882490	53		53	1.5	53		53	1.0	172.9		172.9	119.9	No data recorded for 1999 - 2001. Used 200301 - 200512,
887650	52		52	1.4	47		47	0.9	143.2		143.2	96.2	No data recorded for 1999 - 2001. Used 200301 - 200512,
887652	51		51	1.4	49		49	1.0	137.1		137.1	88.1	No data recorded for 1999 - 2001. Used 200301 - 200512,
892650	60		60	1.7	40		40	0.7	327.94	3.5	331.44	291.44	Actual
892685	55		55	1.5	42		42	0.8	307.06		307.06	265.06	Actual
898018	48		48	1.3	43.5		43.5	0.9	117		117	73.5	Estimated per 24 months - effective 200304
898020	48		48	1.3	43.5		43.5	0.9	117		117	73.5	Estimated per 24 months - effective 200304
898886	46.5		46.5	1.3	43.5		43.5	0.9	117		117	73.5	Estimated per 24 months - effective 200304
898885	46.5	1	47.5	1.3	43.5	1	44.5	0.9	117	8.57	125.57	81.07	Estimated per 24 months - effective 200304
903501	70		70	1.9	53		53	0.8	110.9		110.9	57.9	Actual
903397	58		58	1.6	46		46	0.8	121.8		121.8	75.8	Actual
TOTAL	**12977**	**795**	**13772**	**1.7**	**11319**	**525**	**11843**	**1.0**	**35607**	**2406**	**38013**	**26170**	
AVERAGE			**62**				**53**				**171**	**118**	Average per EDG for three years
FAILURES			**75**				**42**				**20**	**20**	
FAILURES			**75**				**42**				**18**	**18**	
Table 8 RATE			**5.00E-03**				**3.00E-03**				**8.00E-04**	**8.00E-04**	
MLE RATE			**5.45E-03**				**3.55E-03**				**5.26E-04**	**7.64E-04**	
MLE RATE			**5.45E-03**				**3.55E-03**				**4.74E-04**	**6.88E-04**	