REFERENCE: SO123-VI-1.0.1 Page 1 of 1

EDITORIAL CORRECTION(S) (EC)

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Issuance Date 1-10-03 EC No. 2-1 (b)(6)

1. Document No. SO23-V-2.9 (b)(6) Revision No. 2

Document Title Emergency Diesel Generator Engine Monitoring Program (EDGEMP)

Document Author/Originator (b)(6) ME
PRINT OR TYPE NAME PAX ORGANIZATION

Remarks (Optional) Revise references (AR 020200052)

2. Check appropriate box: ☒ Entire document attached ☐ Affected page(s) attached

Superseded/Incorporated EC(s)/TCN(s) None *(Not applicable for single use TCNs)*
NUMBER (IF NONE, SO STATE)

STOP

TECHNICAL CHANGES ARE NOT ALLOWED (e.g., changes to numerical data, setpoints, or acceptance criteria, implementing NRC commitments, changing levels of approval). For technical changes (or a combination of technical changes and editorial corrections) use the revision (SO123-VI-1) or TCN (SO123-VI-1.0.1) process.

CAUTION To be used for EDITORIAL CORRECTIONS (ECs) ONLY; ensure document corrections are covered by item(s) listed in 3, below. ECs DO NOT change the intent of a document and DO NOT require 50.59 review.

3. Allowed types of Editorial Corrections are:

- Updating a specified tool to an equivalent or better substitute.
- Correcting obvious equipment identifier or location errors (e.g., correcting 2TSH-8960 to 2TSH-8961 when the procedure section was obviously written for 2TSH-8961; an approved document modifies annunciator window phrasing, etc.).
- Correcting misnumbered steps/sections (paragraph numbering) or step references (referencing one step to another step).
- Correcting spelling, punctuation, and typographical errors. (Do NOT change numerical data, setpoints, or acceptance criteria, use the revision [SO123-VI-1] or TCN [SO123-VI-1.0.1] process.)
- Dividing large multiple action steps into several smaller steps which accomplish the same goal.
- Updating names, phone numbers, document format, procedure numbers, distribution lists, or references.
- Updating personnel titles (without changing the level of approval).
- Clarifying wording in a step to enhance understanding (changing the meaning/result of the step is NOT allowed).
- Clarifying existing procedural direction via a NOTE or additional information [including ACTION statement(s) or changing the meaning/result of step(s) is NOT allowed].
- Updating obsolete material codes (verified in an approved document or MOSAIC/MMS).
- Reordering steps out of sequence. For example:
  6.1 Install cover.
  6.2 Use RTV to seal cover.
  Obviously the RTV should be applied to the cover before installing the cover.

4. **REVIEWED AND APPROVED BY:** (b)(6) DATE: 1/3/03
COGNIZANT SUPERVISOR

5. EC work-in-progress record and cognizant supervisor approval entered in computer system.

PERFORMED BY: (b)(6) 1/8/03
NUCLEAR PROCEDURES GROUP (NPG)/DESIGNEE DATE

SCE PF(123) 111, Rev. 5 10/01

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EMERGENCY DIESEL GENERATOR ENGINE MONITORING PROGRAM (EDGEMP)

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EMERGENCY DIESEL GENERATOR ENGINE MONITORING PROGRAM (EDGEMP)

NOTE: The below reflects terminology used in this procedure and the equivalent. The equivalent reflects Nuclear Organization terminology until a reorganization takes place as a result of change management and is implemented in the Topical Report/Topical Quality Assurance Manual (TQAM):

Maintenance Engineering = Technical

1.0 OBJECTIVES

1.1 The EDGEMP is a tool intended to assist in the planning of maintenance activities, to improve availability, and reduce unnecessary maintenance. The EDGEMP is independent of any Technical Specification or Licensee Controlled Specification Limiting Condition of Operability, Action Statement, Surveillance Requirement or Program. As a result EDG Operability requirements and Maintenance Rule evaluations are not affected. Engine analysis is a subjective tool that relies upon engineering judgement and is not intended for use in operability determinations where objective criteria is required.

1.2 Define an integrated Emergency Diesel Generator Engine Monitoring Program (EDGEMP).

1.2.1 Define the roles and responsibilities for implementing the EDGEMP program.

1.2.2 Define the parameters to be monitored.

1.2.3 Define the frequencies of data collection.

1.2.4 Define the trends to be maintained.

1.2.5 Provide the bases for each parameter to be monitored as it relates to engine condition and maintenance recommendations.

1.3 Provide direction for obtaining engine data using the Recip-Trap 9240 Engine analyzer.

1.4 Provide direction for generating an Engine Combustion Report.

2.0 REFERENCES

2.1 Procedures

2.1.1 SO23-I-8.69, "Emergency Diesel Generator and Engine Inspection"

2.1.2 SO23-I-8.76, "Emergency Diesel Generator Overhaul"

2.1.3 SO23-3-3.23, "Diesel Generator Monthly and Semi-Annual Testing"

2.1.4 SO23-3-3.23.1, "Diesel Generator Refueling Interval Tests"

2.1.5 SO23-2-13, "Diesel Generator Operation"

2.1.6 SO123-V-14, "Oil Sampling and Analysis Program"

2.1.7 SO123-III-6.6, "Diesel Fuel Oil Testing Program"

2.1.8 SO123-III-2, "Closed Cooling Water System Chemistry Control Program"

2.2 Other

2.2.1 "Predictive Maintenance with Diesel-Trap," Beta Monitors & Controls, Int, Inc., Houston, TX

2.2.2 "Recip-Trap 9240," Users Guide, Dynalco Controls,

2.2.3 Vendor Manual, SO23-403-12-302, Diesel Engine EMD Model 645-E4 Replacement Parts Catalog

2.2.4 Vender Manual, SO23-403-12-2551-1, 645-E4 Turbo Charged Engine Maintenance Manual

2.2.5 EPRI TR-107135, "Diesel Engine Analysis Guide"

2.2.6 OP(123) 3-1, "Work Authorization Record (WAR)"

3.0 PREREQUISITES

3.1 Before using this document, verify the revision and any issued TCNs and/or ECs (Editorial Corrections) are current by using one of the following methods:

3.1.1 Access the Nuclear Document Management System (NDMS) (preferred method).

3.1.2 Check it against a Corporate Documentation Management-SONGS (CDM-SONGS) controlled copy and any issued TCNs/ECs.

3.1.3 Contact CDM-SONGS by telephone or through counter inquiry.

3.1.4 Obtain a user-controlled copy of this procedure from CDM-SONGS or NDMS.

3.2 Equipment List

3.2.1 RT9240 Analyzer with communication cable and charger

3.2.2 DC aquaprobe for engines with DC transducer cable

3.2.3 Vibration accelerometer with channel lock pliers and cable.

3.2.4 Ultrasonic transducer with cable

3.2.5 Laser tachometer or SKF optical eye with tripod and cable

3.2.6 BETA-LINK transmitter or TM5D Trigger Module with marker cable

3.2.7 Timing light

3.2.8 Beta-Link battery charger

3.2.9 Spare analyzer batteries and charger

3.2.10 Reflective Tape

3.2.11 Allen wrench for analyzer front panel

3.2.12 5/8" open end socket wrench

3.2.13 1 3/8" open end wrench (short handle)

D/I water

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3.3 Engine Analyzer Checks

3.3.1 Check instrument calibration tags to insure the RT9240 and transducers have valid calibration dates. (b)(6)

3.3.2 Check the Recip-Trap battery at least one day in advance of expected analysis run. The RT9240 should read at least 15.2 V with the charger disconnected.

NOTES: (1) The RT9240 displays the current battery level from the Main Menu on the graphics screen.

(2) The RT9240 internal batteries should always be charging when it is not in use.

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NOTES: (3) When the RT9240 is not expected to be used for more than one week, turn off the main power switch behind the front panel.

3.3 Verify correct engine route is loaded into the RT9240. (b)(6)

3.4 Prior to running the engine for analyzer data collection conduct a tailboard with Operations to ensure personnel are familiar with the work to be performed.

3.5 This procedure is intended to be used as guidance for the collection of data.

4.0 PRECAUTIONS

4.1 Take extreme caution when working on operating equipment. The majority of engine data is taken on rotating machinery.

4.2 Avoid wearing loose garments and restrict movement of loose items.

4.3 Exhaust gases and test valves are extremely hot. Proper safety equipment should be worn including double ear protection, leather safety gloves and glasses.

5.0 CHECKLIST(S)

5.1 None.

6.0 PROCEDURE

NOTE: The steps in this procedure may be performed in any order as indicated by the Engineer.

6.1 Roles and Responsibilities

6.1.1 MAINTENANCE ENGINEERING

.1 Manager, Maintenance Engineering, is responsible for:

.1.1 Ensuring resources are available for EDGEMP implementation and maintenance.

.1.2 The implementation and maintenance of the Oil Sampling and Analysis Program (Reference 2.1.6),

.2 Supervisor, Auxiliary Process, is responsible for:

.2.1 Assigning responsible Engineer for EDGEMP implementation and provide other non-proceduralized diesel engine analysis services, as requested; and

.2.2 Provide review and approval of engine analysis data, trends and required actions.

.3 Engineer, is responsible for the collection of engine analysis data, maintain records, and provide interpretation of EDGEMP data and trends to provide maintenance recommendations.

6.1.2 CHEMISTRY

.1 Manager, Chemistry, is responsible for the Diesel Fuel Oil Testing Program (Reference 2.1.7), and the Closed Cooling Water System Chemistry Control Program (Reference 2.1.8).

6.2 Start the Recip-Trap Software Program

6.2.1 Turn on the computer. (b)(6) 10/5/10 (Step 3.5)

6.2.2 From the Windows 95 start up screen, double click the RT WIN icon. The main menu of the Recip-Trap software displays.

6.2.3 Check the current computer date. If date is incorrect change to current date (Reference 2.2.2).

6.3 Loading and Running the Recip-Trap

6.3.1 With the Recip-Trap turned off, connect it to the computer at COM1 port.

6.3.2 Turn on the Recip-Trap after the connection is complete.

NOTES:

(1) A route is a pre-established computer listing of the test points that will be collected during the engine analysis. The routes are set up on a Emergency Diesel generator specific basis (i.e., 2G002, 2G003, etc.). Each EDG route is then divided into engine #1 and engine #2. Each engine route consists of an RPM data point followed by cylinder pressure vibration and ultrasonic data. (See Reference 2.2.2 on how to set up a route.)

(2) Individual test points may be loaded into the Trap in lieu of an entire route as required. The test point(s) are loaded in the same manner as a route.

(3) The computer will search for the Trap then load all the route test points into the Trap.

6.3.3 Select "load" from the menu bar and then choose the route by selecting the appropriate engine from the list.

6.4 Engine and Marker Signal Setup

6.4.1 Record repetitive maintenance order number on Engine Analysis Record, Attachment 1.

CAUTION The following steps can be completed only after the diesel engine has been cleared to prevent it from starting.

6.4.2 If the TDC pointer has been moved, complete steps 6.4.2.1 through 6.4.2.3, otherwise go to step 6.4.3.

NOTE: One piece of reflective tape is used for each engine to reduce timing error associated with crankshaft twisting.

N/A 6.4.2.1 If required, request Maintenance to verify/adjust the position of the flywheel pointer for TDC in accordance with SO23-I-8.69.

N/A 6.4.2.2 Request Maintenance to handbar the diesel generator so that engine number 1(2), cylinder number 1, is at top dead center (TDC) as indicated by the flywheel pointer.

N/A 6.4.2.3 On the exposed part of the engine coupling to generator shaft, on the left side (as viewed from flywheel end) of engine number 1(2), attach a piece of reflective tape at the horizontal or "nine O'clock" position. The reflective tape should be as close to the engine as possible and still allow the laser tachometer to illuminate the tape.

6.4.3 Install laser tachometer onto tripod and set into position so that the light beam illuminates the reflective tape.

6.5 Engine Analyzer Setup

6.5.1 Prepare the marker signal to the analyzer.

1 Connect laser tachometer to the TM5D trigger module at the B&C connection marked "Marker Input."

2 Connect the 75-foot cable, labeled "75' Marker Cable (26343)" to the TM5D trigger module at the connector labeled "Marker/Encoder Input."

3 Connect the other end of the 75-foot marker cable to the engine analyzer at the port labeled "MARKER/CHARGER."

6.5.2 Prepare the pressure transducer by connecting the cable Labeled "Aqua Probe" Cable (26397) to the Aqua Probe pressure transducer.

1 Fill Aqua Probe with Demineralized Water.

6.5.3 Prepare the vibration pickup by connecting the Accelerometer (100mV/g) to channel lock pliers and the cable labeled "Trap to Accel/AE xder (26383)" to the accelerometer.

6.5.4 Prepare the ultrasound pickup by connecting the ULT-200 to the Armoured AE cable (26387).

6.6 Engine Analysis Data Collection

NOTE: Engine analysis data is to be taken after engine lube oil and exhaust temperatures have stabilized with the EDG at surveillance load and 900 RPM. Engine data is collected in accordance with the preprogrammed route loaded into the Trap in step 6.3. For any engine all data collection is completed prior to collecting any data for the next engine.

6.6.1 Insure all Kiene valve dust caps are finger tight. If not, loosen dust cap with open end wrench (1 3/8") while holding valve body in place with another open end wrench to prevent valve body from rotating.

6.6.2 Record on the Engine Analysis Record, Attachment 1, the following information.

- Date 10/5/10
- EDG Equipment ID S22420MG003
- NRMO # 80539039

(b)(6)
10/5/10

6.6.3 Operations to start and load engine.

6.6.4 Verify timing marker

CAUTION This step is performed near moving flywheel. Do **NOT** reach over flywheel cowling.

Engine 2 Engine 1

.1 Turn on Laser Tach and line up the laser to illuminate the reflective tape for the engine to be analyzed. The Laser Tach should read approximately 900 RPM.

.2 Turn on the Trap and connect the timing light to the Trap connection labeled "MARKER OUTPUT."

.3 Activate the timing light and direct it at the engine timing pointer to determine if the marker is indicating at TDC of cylinder number 1. Record any deviations from 0 deg TDC on the engine analysis record sheet.

MCA key strokes

.4 With the test point indicating RPM on the front of the trap. Press the "Trap" button to record engine RPM in the analyzer

.5 After the engine speed is "Trapped" the analyzer will provide a prompt indicating the cylinder #, and type of variable (EPH pressure, VT4 vibration, ULT ultrasonic vibration) to be collected.

Wait for Eng to Be Loaded to 100%

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6.7 Collecting Engine Cylinder Pressure Data

100%

NOTES: (1) The cylinder number and data type "EPH" should be displayed on the Trap front panel as a prompt for pressure data collection.

(2) Before collecting cylinder pressure data, the transducer needs to be zeroed out. Zeroing has to be performed only one time during any diesel generator test.

Loosen it a little make sure it's not seizing.

(3) Ensure that the Aquaprobe has water whenever it is attached to the engine.

CAUTION The Kiene valves and combustion gases are very hot and will cause serious burns. Do **NOT** operate the Kiene valves or touch the pressure transuder without adequate protection.

Foil load 13:20

Ø 6.7.1 Connect the Aqua probe cable to the Trap using the input connection labeled "Ch 1."

Ø 6.7.2 Zeroing pressure transducer

Ø .1 At the first cylinder on the route, remove the dust cap and open Kiene valve with the 5/8" wrench to briefly expel carbon and exhaust byproducts.

START Time U2 1513

Ø .2 Warm the transducer by placing it on the Kiene valve (finger tight only) with the cooling water bottle in the upright position.

Ø .3 Open the Kiene valve and allow a few minutes for the transducer to warm up.

Ø .4 Close the Kiene valve and remove the transducer. (b)(6)

Ø .5 When the transducer is reading atmospheric pressure (zero), press the TRAP button to zero the transducer.

Ø 6.7.3 - Connect the [illegible] cable to the [illegible] connector labeled [illegible] (4)

(b)(6) 10/4/10 Added per Step 3.5

6.7.3 Cylinder Pressure Data collection

.1 Prior to data collection at each cylinder, clear out Kiene valve by removing dust cap and momentarily opening the valve to blow out any carbon that could foul the pressure transducer.

.2 Connect the Aquaprobe transducer to the Kiene valve and open the valve at the cylinder indicated on the Trap.

NOTE: The Trap starts to collect firing pressure data.

.3 Press the "START" button. This removes any previously collected data and starts data collection and statistical averaging.

.4 Verify pressure data (PFP and Phasing) is reasonable by viewing statistics on front panel and flip up screen.

NOTES: (1) The phasing is correct if the highest point of the P-T curve is on the left-hand side of the screen.

(2) Phasing only needs to be done on the first cylinder.

N/A N/A .5 If the highest point is elsewhere on the screen, ~~press the 360-degree shift button~~ on the TM5 Trigger Module. Recheck strobe MCA 6.6.3

.6 After the Analyzer has collected more than 100 samples as indicated on the front panel, press the TRAP button to capture the data.

.7 Close the Kiene valve.

.8 Remove the Aquaprobe pressure transducer.

.9 Install dust cap finger tight.

.10 Verify closed the Kiene valve.

6.7.3.11 Mark N/A for engine not tested.

13.9 Lowest

20 Cylinder Engine (front)

PERFORMED BY INITIAL	LEFT BANK	RIGHT BANK	PERFORMED BY INITIAL
(b)(6)	L1 11	R1	(b)(6)
	L2 12	R2	
	L3 13	R3	
	L4 14	R4	
	L5 15	R5	
	L6 16	R6	
	L7 17	R7	
	L8 18	R8	
	L9 19	R9	
	L10 20	R10	

Left Bank closed **VERIFIED BY:** (b)(6)

Right Bank closed **VERIFIED BY:**

16 Cylinder Engine (front)

PERFORMED BY INITIAL	LEFT BANK	RIGHT BANK	PERFORMED BY INITIAL
(b)(6)	L1 9	R1	(b)(6)
	L2 10	R2	
	L3 11	R3	
	L4 12	R4	
	L5 13	R5	
	L6 14	R6	
	L7 15	R7	
	L8 16	R8	

Left Bank closed **VERIFIED BY:**

Right Bank closed **VERIFIED BY:** (b)(6)

6.7.3.12 Repeat steps 6.7.3.1 through 6.7.3.7 for each cylinder to be tested.

6.8 Collecting Engine Vibration Data

NOTE: The cylinder number and data type "VT4" should be displayed on the Trap front panel as a prompt for vibration data collection.

6.8.1 Connect vibration pickup cable to the Analyzer through the connection labeled CH1.

6.8.2 Verify the Analyzer is prompting for a Cylinder and a vibration (VT4) data type.

6.8.3 Clamp the channel locks onto the Cylinder Kiene valve so the vibration pickup is in an axial position relative to the Kiene valve.

NOTE: Steady vibration patterns should start to appear on the screen in less than one minute.

6.8.4 Verify proper phasing on the flip up screen and press the 360 deg shift button on the Beta Link or TM5D as required (once per engine). (b) 10/5/10 removed per step 3.5

6.8.5 Verify the number of periods is greater than 100 and press the TRAP button to store the vibration data for that cylinder. 12 (b)(6) 10/5/10 changed per step 3.5

6.8.6 Repeat steps 6.8.1 through 6.8.5 for the remaining cylinders to be tested.

6.8.7 Disconnect the accelerometer cable from the Analyzer.

N/A

6.9 Collecting Engine Ultrasonic Vibration Data

Completed per Step 6.7.3

NOTE: The cylinder number and data type "ULT" should be displayed on the Trap front panel as a prompt for ultrasonic data collection.

6.9.1 Attach the Ultrasonic transducer cable to the analyzer through input labeled "CH1."

6.9.2 Press the rubber tip of the ultrasonic microphone against the ~~Engine near the Kiene valve~~ End of Pressure Transducer. Be sure to form a tight seal with the engine surface.

NOTE: Steady vibration patterns should start to appear on the screen in less than one minute.

6.9.3 Wait for a steady vibration pattern to appear on the flip up screen and then press the Trap button.

6.9.4 Repeat steps 6.9.1 through 6.9.3 for the remaining cylinders to be tested.

6.10 Downloading Collected Data to Computer

6.10.1 Verify the Trap is off prior to making computer connections.

6.10.2 Connect the Trap to the computer COM1 port using the computer cable.

6.10.3 Turn on the Trap.

6.10.4 From the Recip-Trap software program area explorer screen choose the dump function.

6.10.5 From the Dump Trap menu choose the appropriate function to download the data into the computer and process the data.

NOTES: (1) The software retains the dumped data in memory until a new set of data is dumped into the computer.

(2) Downloading takes 20-30 minutes.

6.10.6 Process the data for that date and backup the data to ensure the data is not inadvertently lost.

6.11 Documentation Completion

6.11.1 Complete an engine analysis record (Attachment 1) for each EDG engine analysis test run.

6.11.2 Review combustion data and graphs for trends and make annotations of any anomalous or unusual trends using the guideline of Reference 2.2.5. Any anomalous or unusual trends shall be documented in the AR system for resolution. The analysis shall be reviewed and approved by the cognizant supervisor.

6.11.3 Print a hard copy of the Engine Combustion Report.

6.11.4 Attach a current lube oil analysis report to the Engine Analysis Record.

6.11.5 Attach a graph of vital fuel oil trend parameters to the Engine Analysis Record.

6.11.6 Attach a graph of jacket cooling water chemistry parameters to the Engine Analysis Record.

7.0 RECORDS

7.1 Original procedure to be submitted to CDM.

7.2 The completed Engine Analysis Record shall be attached to the Engine Combustion Report and retained by Maintenance Engineering.

ENGINE ANALYSIS RECORD

Diesel Generator Equipment ID S22420MG003

NRMO # 8028539034

(b)(6)

Date of Test Run 10/5/10

Ambient Temp 62°F

Time of initial full load (4.45 to 4.7 MW) 1320

Time Data Collection began 1320

TDC verification - Record the indicated TDC using timing light:

Engine #1 353.0 Deg

Engine #2 69.0 Deg

Exhaust Temperatures - from pyrometer indication mounted on engine skid.

Engine Number 1		Engine Number 2	
Pyrometer	Exhaust Temp	Pyrometer	Exhaust Temp
1R	870	1R	830
2R	830	2R	850
3R	890	3R	870
4R	890	4R	840
5R	890	5R	880
6R	880	6R	840
7R	860	7R	840
8R	890	8R	860
9L	825	9R	860
10L	830	10R	860
11L	890	11L	880
12L	910	12L	870
13L	880	13L	860
14L	870	14L	870
15L	900	15L	910
16L	870	16L	860
		17L	880
		18L	860
		19L	890
		20L	870

Attach the completed form to the combustion report.