Report

Malfunction Abatement Plan For One (1) Natural Gas-Fired Emergency Engine

Holland Energy Park
Holland Board of Public Works
Holland, Michigan

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1.0 INTRODUCTION

Holland Board of Public Works (BPW) received Permit to Install (PTI) No. 107-13E for the installation and operation of a natural gas-fired combined heat and power (CHP) plant, known as Holland Energy Park (HEP), located at East 5th Street and Fairbanks Avenue in Holland, Michigan. PTI No. 107-13E includes requirements to submit a Malfunction Abatement Plan (MAP) under Special Condition (SC) III.2 for HEP's natural gas-fired emergency engine, identified as EUNGENGINE, within 180 days of initial startup.

EUNGENGINE is a 1,000 kilowatt (kW) natural gas-fired emergency engine that is used to charge the batteries in the uninterruptible power supply (UPS) Battery System at HEP. EUNGENGINE is equipped with an oxidation catalyst to control emissions of carbon monoxide (CO) and volatile organic compounds (VOC).

1.1 Purpose of the Plan

Michigan Air Pollution Control Rule 911 requires, at the request of the Michigan Department of Environmental Quality (MDEQ), a source of an air contaminant to operate under a MAP. The purpose of a MAP is to document preventative measures of equipment malfunctions and/or failures that result in pollutant emissions above any applicable emission limitation, as well as procedures to detect and correct these incidents when they occur.

Sections 2.0 of this report details the MAP requirements. Sections 3.0 and 4.0 contain recordkeeping and reporting requirements. Sections 5.0 and 6.0 contain a list of plan revisions and referenced documents. Appendices A - C contain pertinent information related to this MAP, as obtained from the Caterpillar® (CAT) Systems Operation Testing and Adjusting manual, the HoltCAT – Diesel Engine Generator Manual, and the CAT Parts Manual listed in Section 6.0.

2.0 MALFUNCTION ABATEMENT PLAN

For the purposes of this MAP, a malfunction is defined as follows per Part 1 of the Michigan Air Pollution Control Rules:

> *Malfunction means any sudden, infrequent and not reasonably preventable failure of a source, process, process equipment, or air pollution control equipment to operate in a normal or usual manner. Failures that are caused in part by poor maintenance or careless operation are not malfunctions.*

During a malfunction of EUNGENGINE, BPW will follow the procedures in this plan for proper operation in order to minimize excess emissions. This MAP is intended to provide a roadmap to plant operations and outlines procedures for operation of EUNGENGINE during malfunction events. This plan will help ensure that:

- During malfunction events, BPW operates and maintains EUNGENGINE in a manner consistent with good air pollution control practices;
- BPW is prepared to correct malfunctions as soon as it is safe and practicable to do so, in order to minimize excess emissions of air pollutants; and
- BPW meets the recordkeeping and reporting requirements associated with periods of malfunction events (including documenting corrective action taken to restore malfunctioning process and air pollution control equipment to its usual manner of operation).

2.1 Malfunction Abatement Plan Requirements

Pursuant to Michigan Rule 911, a MAP must specify the following:

- A complete preventative maintenance program, including identification of the supervisory personnel responsible for overseeing the inspection, maintenance, and repair of air-cleaning devices, a description of the items or conditions that shall be inspected, the frequency of the inspections or repairs, and an identification of the major replacement parts that shall be maintained in inventory for quick replacement.
- An identification of the source and air-cleaning device operating variables that shall be monitored to detect a malfunction or failure, the normal operating range of these variables, and a description of the method of monitoring or surveillance procedures.
- A description of the corrective procedures or operational changes that shall be taken in the event of a malfunction or failure to achieve compliance with the applicable emission limits.

2.2 Preventative Maintenance Program

EUNGENGINE and any monitoring equipment must be operated by qualified individuals. The Maintenance Supervisor will be responsible for overseeing the inspection, maintenance, and repair of EUNGENGINE, and the on-going training of personnel in charge of operations and monitoring the equipment to ensure processes of EUNGENGINE are functioning properly.

The following items and/or their components will be inspected if and when there is a concern with their condition, and appropriate procedures will be followed as detailed throughout the CAT Systems Operation Testing and Adjusting manual (referenced in Section 6 of this MAP):

- Electronic Control System
- Ignition System

- Fuel System
- Air Inlet and Exhaust System
- Lubrication System
- Cooling System
- Cylinder Block
- Cylinder Liner Projection
- Flywheel and Housing
- Vibration Damper
- Air/Electric Starting System
- Electrical System

Additionally, there will be scheduled maintenance conducted on the engine at manufacturer recommended intervals. This is contained in Appendix A, as obtained from the HoltCAT – Diesel Engine Generator Manual (referenced in Section 6 of this MAP). Records of maintenance events, and date and time of occurrence will be properly documented.

A sample list of spare parts that will be kept in inventory for when repairs and maintenance on the engine is necessary is contained in Appendix B. The list is obtained from the HoltCAT – Diesel Engine Generator Manual. Additional information on maintenance parts can be found in the CAT Parts Manual (referenced in Section 6 of this MAP). Records of items shall be updated and maintained as necessary.

EUNGENGINE contains an Electronic Control Module (ECM) that controls the engine's functions, including monitoring and protection of engine operation. If an engine parameter surpasses an acceptable range, the ECM initiates a warning or a shutdown. The engine monitoring system monitors specific parameters, and the ECM will activate a warning if their associated trip points are reached. These are contained in Appendix C, as

detailed in the CAT Systems Operation Testing and Adjusting manual. Corrective action will be taken to bring the engine parameters back into their normal ranges (refer to the CAT Systems Operation Testing and Adjusting manual for more information).

The engine contains an oxidation catalyst for control of CO and VOC. The oxidation catalyst operates automatically and does not require any operator interaction, but will need to be replaced and/or cleaned as a preventative maintenance measure approximately every 5 years.

BPW will keep records of each malfunction in accordance with Section 3.0 of this document. Such records will be reported to Michigan Department of Environmental Quality (MDEQ) if they cause excess emissions, as specified in Section 4.0 of this document.

3.0 RECORDKEEPING REQUIREMENTS

Pursuant to PTI No. 107-13E for EUNGENGINE under SC III.2, BPW shall submit a MAP within 180 days of initial startup. The MAP shall address events that meet the characteristics of a malfunction and specify information contained in Michigan Rule 911. BPW will keep a current copy of the MAP onsite, and will maintain records of malfunction events in the plant log books. Records of the events shall be recorded including the time, date, probable cause(s), duration, affected equipment, emission estimates, and the corrective actions taken in response to the malfunction. All records shall be provided to the BPW's Environmental Department, which will be responsible for maintaining the records in accordance with BPW's records retention policy.

4.0 REPORTING REQUIREMENTS

This section covers various reporting requirements related to the MAP.

4.1 Michigan Air Pollution Control Rule 912

Michigan Rule 912 requires that a facility operate its source, process, or process equipment, to the extent that is reasonably possible, in a manner consistent with good air pollution control practices for minimizing emissions during periods of abnormal conditions, startup, shutdown, and malfunctions. A source, process, or process equipment that complies with all applicable emission standards and limitations during periods of abnormal conditions, startup, shutdown, and malfunction shall be presumed to have been operated in a manner consistent with good air pollution control practices for minimizing emissions.

PTI No. 107-13E contains emission limits for EUNGENGINE for oxides of nitrogen (NO_x), CO, particulate matter (PM, PM_{10}, $PM_{2.5}$), VOC and Greenhouse Gases (GHGs) (as carbon monoxide equivalent (CO_2e)) during normal operation. Pursuant to Rule 912, BPW shall provide notice of a malfunction that results in excess emissions of these pollutants.

BPW shall provide notice and a written report of a malfunction if it results in excess emissions above the emission limitations for EUNGENGINE for more than two (2) hours. The requirements for notices and written reports are as follows:

- The notices required shall be provided to MDEQ as soon as reasonably possible, but not later than two (2) business days after the discovery of the abnormal conditions or malfunction. Notice shall be by any reasonable means, including electronic, telephonic, or oral communication.
- Written reports, if required, must be submitted to MDEQ within 10 days after the abnormal conditions or malfunction has been corrected, or within 30 days of discovery of the abnormal condition or malfunction, whichever is first. The truth, accuracy, and completeness of the written reports shall be certified by a

responsible official in a manner consistent with the Clean Air Act. The written reports shall include all of the required information:

- The time and date, the probable causes or reasons for, and the duration of the abnormal conditions or malfunction.
- An identification of the source, process, or process equipment that experienced abnormal conditions or which malfunctioned and all other affected process or process equipment that have emissions in excess of an applicable requirement, including a description of the type and, where known or where it is reasonably possible to estimate, the quantity or magnitude of emissions in excess of applicable requirements.
- Information describing the measures taken and air pollution control practices followed to minimize emissions.
- For abnormal conditions and malfunctions, the report shall also include a summary of the actions taken to correct and to prevent a reoccurrence of the abnormal conditions or malfunction and the time taken to correct the malfunction.

5.0 PLAN REVISIONS

The MAP will be revised to address reasonable revision requests by MDEQ. Revisions may be requested if it is determined that the plan:

- Does not address a malfunction event that has occurred.
- Fails to provide operation of EUNGENGINE in a manner consistent with the general duty to minimize emissions during malfunction events.
- Inadequately addresses provisions for correcting malfunctioning process or emission control equipment.

Copies of the Written Plan

A current copy of the plan shall be sent to MDEQ. Another copy will kept on file by BPW (in paper or electronic form) for the life of EUNGENGINE.

Table 5-1. Revision History

Date Issued	Revision #	Revised by	Summary of Changes
4/12/17	0	Not Applicable	Original Version

6.0 REFERENCED DOCUMENTS

Table 6-1 contains a listing of referenced documents in this MAP and their locations. Copies of the documents can be provided to MDEQ upon request.

Table 6-1. Referenced Documents

Referenced Document	Location
CAT Systems Operation Testing and Adjusting Manual	Control Room or electronic
HoltCat – Diesel Engine Generator Manual	Control Room or electronic
CAT Parts Manual	Control Room or electronic
Plant Log Books	Hard copy log or electronic

APPENDIX A

GAS ENGINE MAINTENANCE SCHEDULE

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Gas Engine Maintenance Schedules

SMCS Code: 1000; 7500

This section contains maintenance schedules for commercial Caterpillar Gas Engines. For detailed descriptions of the maintenance procedures and for the most recent information, refer to the particular engine's Operation and Maintenance Manual.

Failure to adhere to proper maintenance intervals may result in the degradation of the engine's performance and/or in accelerated wear of the engine's components.

The maintenance schedules in this section are standard for industrial engines and for generator set engines. Because of individual applications, it is not possible to identify all of the factors which affect the maintenance schedules. Engines that are operating under severe conditions may need more frequent maintenance intervals. Consult your Caterpillar dealer about the maintenance that is needed for your specific engine.

Some optional attachments are listed in the maintenance schedules. If your engine is not equipped with an optional attachment, disregard the item.

G3500 Engines

Table 28

G3500 Turbocharged-Aftercooled Engine Maintenance Interval Schedule Dry Natural Gas Wellhead Gas								
Maintenance Procedure	**Maintenance Intervals and Service Hours**							
	Daily	**Every 250**	**Initial 1000**	**Every 1000**	**Every 2000**	**Every 4000**	**Every 8000**	**Every 24,000**
Clutch - Lubricate (1)	x							
Fluid levels - Check (2)	x							
Filter differential pressures - Check (3)	x							
Operation trends - Record	x							
Walk-around inspection	x							
Battery electrolyte level - Check		x						
Engine oil analysis - Obtain		x						

(continued)

(Table 28, contd)

G3500 Turbocharged-Aftercooled Engine Maintenance Interval Schedule Dry Natural Gas Wellhead Gas								
Maintenance Procedure	**Maintenance Intervals and Service Hours**							
	Daily	**Every 250**	**Initial 1000**	**Every 1000**	**Every 2000**	**Every 4000**	**Every 8000**	**Every 24,000**
Coolant SCA concentration - Check/Add			x		x			
Crankcase blowby - Record			x			x		
Cylinder pressure - Record			x			x		
Engine mounts - Check			x			x		
Speed sensor - Check			x		x			
Speed/timing sensor - Check			x		x			
Valve recession - Record			x			x		
Aftercooler condensation - Drain				x				
Air/fuel ratio - Check/Adjust				x				
Alternator and fan belts - Check/Adjust				x				
Crankcase breather - Check/Clean				x				
Engine - Clean				x				
Engine oil and filter - Replace (4)				x				
Exhaust piping - Check				x				
Gas pressure regulator - Check				x				
Hoses and clamps - Check/Replace				x				
Ignition timing - Check/Adjust				x				
Inlet air system - Check				x				
Radiator - Clean				x				
Spark plugs - Check/Adjust/ Replace				x				
Valve bridge, valve lash, rotators - Inspect				x				
Vibration damper - Check				x				
Actuator linkage - Check/Lubricate					x			
Air starting motor lubricator - Clean/Adjust						x		
Driven equipment alignment - Inspect						x		
Engine protective devices - Check						x		
Exhaust bypass - Inspect						x		
Starting motor - Check						x		

(continued)

(Table 28, contd)

G3500 Turbocharged-Aftercooled Engine Maintenance Interval Schedule Dry Natural Gas Wellhead Gas								
Maintenance Procedure	**Maintenance Intervals and Service Hours**							
	Daily	**Every 250**	**Initial 1000**	**Every 1000**	**Every 2000**	**Every 4000**	**Every 8000**	**Every 24,000**
Water pumps - Check						x		
Coolant analysis (Level II) - Obtain							x	
Turbocharger - Inspect							x	
Water/SCA type coolant - Replace (5)							x	
Water temperature regulators - Replace							x	
Glycol/SCA type coolant - Replace (6)								x

(1) Perform the maintenance that is described on the clutch's instruction plate.
(2) Check the levels of these fluids and add fluid, if necessary: engine oil, engine coolant, and air starting motor lubricator oil.
(3) Check the differential pressures and/or the service indicators of these filters and replace the filter elements, if necessary: engine oil filter, fuel filter, and inlet air cleaner. If the air cleaner has a dust collector, check the dust collector daily and clean the dust collector, if necessary. Air cleaner elements must be replaced every year.
(4) The interval for replacement of the engine oil can be adjusted according to the results of the oil analysis.
(5) The maximum interval for replacement of the water/SCA type of coolant is one year.
(6) The maximum interval for replacement of the glycol/SCA type of coolant is three years.

APPENDIX B

ENGINE SPARE PARTS LIST

Genset Model: G3516LE-1040 ekW, 480V, 60hz
Genset s/n: ZBA00893

Sample Spare Parts List

(Qty.)	Description
(3)	Lube filters
(2)	Air filters
(1)	Belts (set)
(4)	Thermostats
(4)	T-Stat gaskets seal kit
(23)	Lube Oil (5G container)
(16)	Spark Plugs
(1)	Voltage Regulator

APPENDIX C

ENGINE MONITORING SYSTEM

Engine Monitoring System

i04905475

Engine Monitoring System

SMCS Code: 1900; 1901

The Electronic Control Module (ECM) monitors the operating parameters of the engine. The ECM can initiate a warning or a shutdown if a specific engine parameter exceeds an acceptable range. Use the Caterpillar Electronic Technician (ET) to perform the following activities:

- Select the available responses.
- Program the level for monitoring.
- Program delay times for each response.

The default settings for the parameters are programmed at the factory. To accommodate unique applications and sites, the parameters may be reprogrammed with Cat ET. The screens of Cat ET provide guidance for the changing of trip points.

Note: Some of the parameters are protected by factory passwords. Other parameters can be changed with customer passwords.

Refer to the Troubleshooting Manual for the default settings and for instructions on the troubleshooting events.

Monitoring Parameters

"Low System Voltage"

The trip point for this parameter is set at the factory. The trip point cannot be changed. This parameter is always ON. This parameter cannot be turned off. If the system voltage decreases to the trip point, the ECM will generate a warning or a shutdown.

"High Engine Coolant Temperature"

The trip points for this parameter can be programmed by the customer. The shutdown response is always ON. The shutdown response cannot be turned off. If the engine coolant temperature exceeds the trip point, the ECM will generate a warning, an impending shutdown, or a shutdown.

"Low Engine Coolant Temperature"

The trip point for this parameter can be programmed by the customer. If the engine coolant temperature decreases to the trip point, the ECM will generate a warning.

"Engine Overspeed"

The trip point for this parameter is set at the factory. This parameter is always ON. This parameter cannot be turned off. If the engine speed exceeds the trip point, the ECM will activate an engine shutdown. For generator set engines, a typical trip point is 125 percent of the rated speed for the engine.

"High Engine Oil Temperature"

The trip point for a warning for this parameter can be programmed by the customer. The trip point for a shutdown is set at the factory. This parameter is always ON. This parameter cannot be turned off. If the engine oil temperature exceeds the trip point, the ECM will generate a warning or a shutdown.

"High Oil Filter Differential Pressure"

The trip point for a warning for this parameter can be programmed by the customer. The trip point for a shutdown is set at the factory. This parameter is always ON. This parameter cannot be turned off. If the engine oil filter differential pressure exceeds the trip point, the ECM will generate a warning or a shutdown.

"Low Oil Filter Differential Pressure"

The trip point for a warning for this parameter can be programmed by the customer. The trip point for a shutdown for this parameter is set at the factory. The warning is always on. The shutdown is configurable to OFF or ON. If the engine oil filter differential pressure decreases to the trip point, the ECM will generate a warning or a shutdown.

"High Fuel Temperature"

The trip point for this parameter can be programmed by the customer. If the fuel temperature exceeds the trip point, the ECM will generate a warning.

"Low Fuel Pressure"

The trip point for this parameter can be programmed by the customer. If the fuel pressure decreases to the trip point, the ECM will generate a warning.

"High Eng Oil to Eng Coolant Diff Temp"

The trip point for a warning for this parameter can be programmed by the customer. The trip point for a shutdown for this parameter is set at the factory. The shutdown response is always ON. The shutdown response cannot be turned off. If the differential temperature of the engine oil to the jacket water exceeds the trip point, the ECM will generate a warning or a shutdown.

"Low Gas Fuel Differential Pressure"

The trip point for this parameter can be programmed by the customer. If the fuel differential pressure decreases to the trip point, the ECM will generate a warning.

"High Gas Fuel Differential Pressure"

The trip point for this parameter can be programmed by the customer. If the fuel differential pressure exceeds the trip point, the ECM will generate a warning. This parameter is always on.

"High System Voltage"

The trip point for this parameter is set at the factory. The trip point cannot be changed. This parameter is always ON. This parameter cannot be turned off. If the system voltage exceeds the trip point, the ECM will generate a warning.

Trip Points of the Engine Load for High Inlet Air Temperature

The trip points for this parameter can be programmed by the customer. The shutdown response is always ON. The shutdown response cannot be turned off. This feature provides a trip point between high engine load and low engine load. The trip point is used for events that involve high inlet air temperature. The trip point for the events is based on the engine load. The possible responses of the system include warning, an impending shutdown, and shutdown.

"High Inlet Air Temperature at Low Engine Load"

The "Service/Configuration" screen of Cat ET defines the "High Inlet Air Temp Engine Load Set Point". The ECM can activate an event if the inlet air temperature exceeds the trip point during the low load operation that is defined.

"High Inlet Air Temperature at High Engine Load"

The "Service/Configuration" screen of Cat ET defines the "High Inlet Air Temp Engine Load Set Point". The ECM can activate an event if the inlet air temperature exceeds the trip point during the high load operation that is defined.

"High Fuel Pressure"

The trip point for this parameter can be programmed by the customer. The ECM will activate a warning if the fuel pressure exceeds the trip point.

Conditions for Parameters

Some of the programmable parameters are dependent on the status of an ECM output before the parameters are allowed to function. Some of the parameters are allowed to function after the crank terminate relay has been energized for more than 30 seconds. Other parameters are allowed to function after the output for the fuel control relay is energized. Some parameters are not dependent upon any conditions.

The conditions are designed to eliminate false events during start-up if the customer has programmed a delay time to zero.

A warning will not be activated if the trip point for a shutdown is programmed to activate before the trip point for a warning.

Default Settings of the Programmable Monitoring System

Table 7

Default Settings of the Programmable Monitoring System				
Parameter	**Severity**	**Delay in Seconds**	**Trip Point**	**Default State**
E073High Oil Filter Differential Pressure	(1)	10	117 kPa (17 psi)	Always On
	(3)		138 kPa (20 psi)	
E197High Engine Oil Temperature	(1)	20	102 °C (216 °F)	Always On
	(3)		104 °C (219 °F)	
E198Low Fuel Pressure	(1)	10	104 kPa (15 psi) (absolute pressure)	On
E199Low Engine Coolant Temperature	(1)	20	5 °C (41 °F)	On
E223High Fuel Temperature	(1)	20	60 °C (140 °F)	On
E267High Fuel Pressure	(1)	10	135 kPa (19.6 psi) (absolute pressure)	On
E337High Engine Oil to Engine Coolant Diff Temp	(1)	20	14° C (25° F)	Always On
	(3)		20 °C (36 °F)	
E361High Engine Coolant Temperature	(1)	20	109° C (228° F)	On
	(2)		111° C (232° F)	Off
	(3)		113° C (235° F)	Always On
E362Engine Overspeed	(3)	0	1550 rpm	Always On
E368High Inlet Air Temperature at Low Engine Load	(1)	20	75° C (167° F)	Always On
	(2)		100 °C (212 °F)	Off
	(3)		85 °C (185 °F)	On
E368High Inlet Air Temperature at High Engine Load	(1)	20	65° C (149° F)	On
	(2)		100 °C (212 °F)	Off
	(3)		75° C (167° F)	Always On
E666Low Oil Filter Differential Pressure	(1)	10	7 kPa (1 psi)	Always On
	(3)		7 kPa (1 psi)	
E864Low Gas Fuel Differential Pressure	(1)	10	5 kPa (0.7 psi)	On
E865High Gas Fuel Differential Pressure	(1)	10	35 kPa (5.1 psi)	Always On
E875Low System Voltage	(1)	20	20 VDC	On
	(3)	10	18 VDC	Always On
E876High System Voltage	(1)	20	34 VDC	On

Programmable Parameters of the Integrated Temperature Sensing Module

The Integrated Temperature Sensing Module (ITSM) monitors the temperatures of the cylinder exhaust ports, of the inlets of the turbocharger turbines and of the outlets of the turbocharger turbines.

If a temperature exceeds an acceptable range, the ITSM can initiate a "WARNING" or "SHUTDOWN". Both of the responses are available for all of the parameters. Use Cat ET to perform the following activities:

- Select the available responses.
- Program the level for monitoring.
- Program delay times for each response.

Note: To initiate the responses, the ITSM sends commands to the ECM via the Cat Data Link. If the connection between the ITSM and the ECM is not correct, the ITSM cannot initiate any response.

The default settings for the parameters are programmed at the factory. To accommodate unique applications and sites, the parameters may be reprogrammed with Cat ET. The screens of Cat ET provide guidance for changing trip points.

Table 8 lists default examples of the values for the parameters. However, the values may have changed. Use Cat ET to determine the programming for your engine. The items can be reprogrammed in order to accommodate the requirements of individual sites.

Use care when you program the trip points and the delay times. Ensure that the response of the ITSM is correct for the application. The monitoring system will accept any setting within the ranges.

If the trip point for a shutdown is lower than the trip point for a warning, the warning will not be activated.

Table 8

Default Settings for the Integrated Temperature Sensing Module

Parameter	Event Code	System Response	State	Trip Point	Delay in Seconds	Security Level Password	Range	Range of the Delay in Seconds
"High Exhaust Temperature"	E801 (1) through E820 (1)	Warning	On	655 °C	30	Customer	100 to 665 °C	1 to 60
	E801 (3) through E820 (3)	Shutdown		665 °C				
"Exhaust Port Temperature High Deviation"	E821 (1) through E840 (1)	Warning		50 °C	60		10 to 50 °C	1 to 60
	E821 (3) through E840 (3)	Shutdown		200 °C	10		100 to 200 °C	1 to 10
"Exhaust Port Temperature Low Deviation"	E841 (1) through E860 (1)	Warning		50 °C	60		10 to 50 °C	1 to 60
	E841 (3) through E860 (3)	Shutdown		200 °C	10		10 to 200 °C	1 to 10

(continued)

(Table 8, contd)

Default Settings for the Integrated Temperature Sensing Module								
Parameter	**Event Code**	**System Response**	**State**	**Trip Point**	**Delay in Seconds**	**Security Level Password**	**Range**	**Range of the Delay in Seconds**
"High Turbo Turbine Inlet Temperature"	E245 (1) E246 (1)	Warning		710 °C	30		100 to 710 °C	1 to 60
	E245 (3) E246 (3)	Shutdown		730 °C			100 to 730 °C	
"High Turbo Turbine Outlet Temperature"	E243 (1) E244 (1)	Warning		615 °C	60		100 to 625 °C	1 to 60
	E243 (3) E244 (3)	Shutdown		625 °C				

Separate timers are used in the ITSM for each response that is associated with a parameter. If a trip point is exceeded, the timer for that event is started.

For example, the warning for the "High Exhaust Temperature" (E801 (1)) can be set to 655 °C with a 30 second delay. The timer starts counting if the exhaust port temperature of the number 1 cylinder reaches 655 °C. If the temperature is not reduced to less than 655 °C within 30 seconds, the event becomes active and the event is logged.