STEAM TURBINE

INSTRUCTIONS

GEK-46488

420.66

TRIP & MONITORING UNIT

GENERAL

The Trip and Monitoring Unit (T&M) is a part of the Turbine Protective System, and consists of logic circuits located in the EHC cabinet, and pushbuttons, indicating lights, and meters on the Control Panel and on the System Monitoring Panel of the EHC Cabinet.

The principal function of the Trip and Monitoring Unit is to receive signals corresponding to various undesirable or dangerous turbine-generator operating conditions, perform suitable logic operations on these signals, and relay them as tripping signals to either or both the Mechanical Trip Solenoid Valve (MTSV) or the Electrical Trip Solenoid Valve (ETSV). These valves are independently capable of tripping the Emergency Trip System (ETS) which trips the turbine; in most cases both of these valves operate and provide redundancy at this level.

The Trip and Monitoring Unit provides display signals for Protective System status, signals for annunciation and First Hit Detection of tripping or other abnormal conditions, signals for control functions by other EHC units, and signals for customer use.

DESIGN

A. FUNDAMENTAL TRIP CIRCUITS

Figure 1 shows an elementary diagram of the trip circuits. Here and elsewhere in the Trip & Monitoring Unit, relays and circuits are often arranged in a two-out-of-three logic scheme. This improves by many orders of magnitude the reliability of both failure modes. A standard two-out-of-three relay arrangement is shown in Figure 2.

The Trip and Monitoring Unit has two fundamental trip circuits, the 125V Trip Bus and the 24V Trip Circuit.

The 125V Trip Bus trips the MTSV directly by energizing its solenoid, while the 24V Trip Circuit trips the ETSV directly by de-energizing its two solenoids.

When activated, the 125V Trip Bus trips the 24V Trip Circuit, resulting in an indirect trip of the ETSV. (Crosstrip action.) In some cases of 24V Trip Circuit activation, depending on the cause, the 24V Trip Circuit trips the 125V Trip Bus, resulting in an indirect trip of the MTSV. (Crosstrip action.)

Each trip signal, through its individual trip circuit, energizes one of the two fundamental trip circuits. In general, signals external to the EHC cabinet energize the 125V Trip Bus, while signals internal to the EHC cabinet energize the 24V Trip Circuit. In some cases, a trip signal energizes both fundamental trip circuits; this in conjunction with the crosstrips provides the redundancy mentioned previously.

Each of the two trip circuits is electrically latched a short time interval (typically 30 msec) after a trip of the circuit. The 125V Trip Bus has an additional "hydraulic" latch circuit that is established when the following conditions are met:

a. The ETS is tripped (as detected by two pressure switches)

b. The Mechanical Trip Valve is tripped (as detected by a pressure switch).

c. The Generator Circuit Breaker is open.

The four TRIP VALVES indicating lights ("MECHANICAL RESET," "MECHANICAL TRIPPED", "ELECTRICAL RESET", and "ELECTRICAL TRIPPED"), located on the Control Panel, provide indication of the status of these devices, as detected by pressure and limit switches.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

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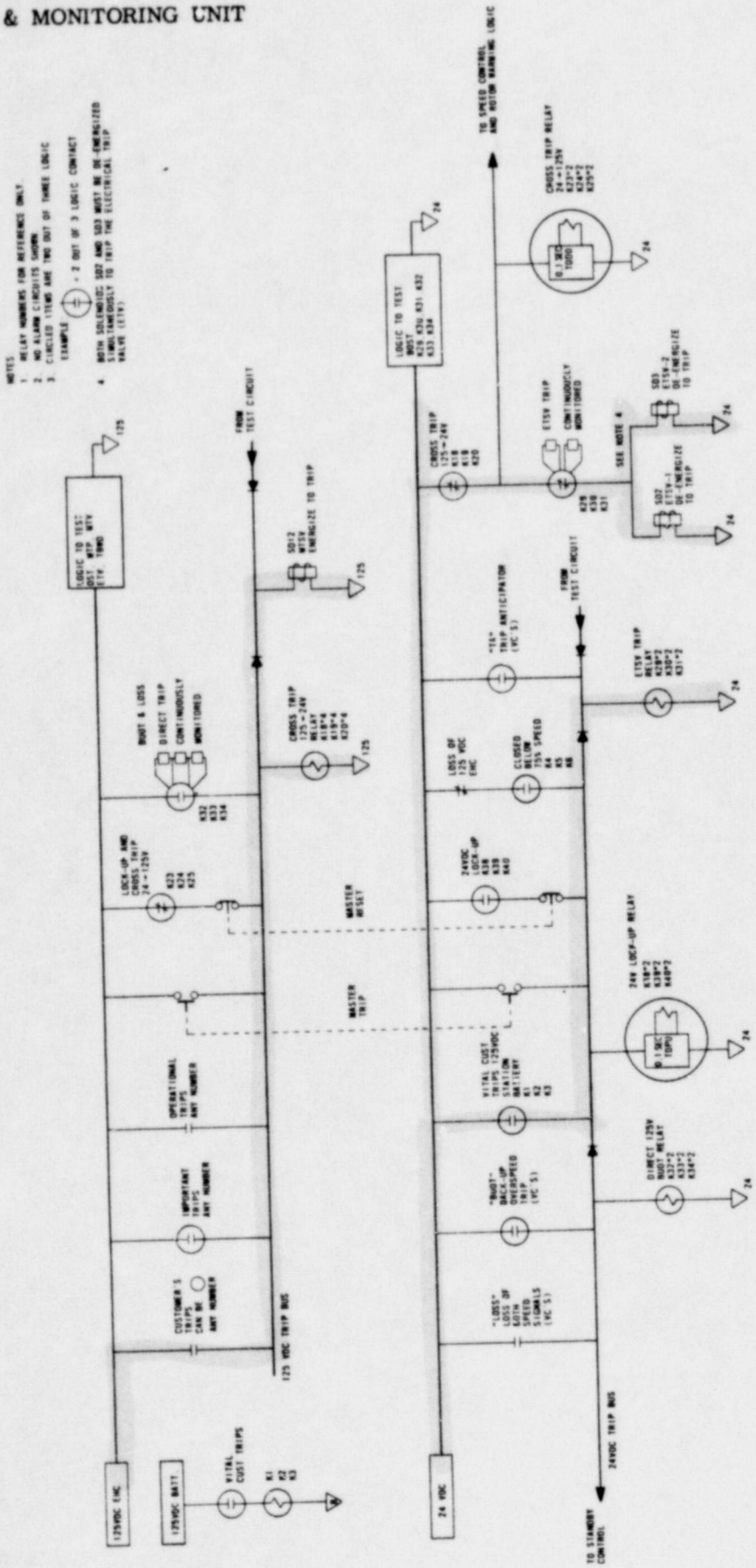
NOTES
1 RELAY NUMBERS FOR REFERENCE ONLY
2 NO ALARM CIRCUITS SHOWN
3 CIRCLED ITEMS ARE TWO OUT OF THREE LOGIC
EXAMPLE - 2 OUT OF 3 LOGIC CONTACT
4 BOTH SOLENOIDS SD2 AND SD3 MUST BE DE-ENERGIZED SIMULTANEOUSLY TO TRIP THE ELECTRICAL TRIP VALVE (ETV)
TO SPEED CONTROL AND MOTOR WARMING LOGIC
CROSS TRIP RELAY
LOGIC TO TEST
FROM TEST CIRCUIT
ETSV TRIP CONTINUOUSLY MONITORED
SEE NOTE 4
SD3 ETSV-2 DE-ENERGIZE TO TRIP
SD2 ETSV-1 DE-ENERGIZE TO TRIP
SD2 WTSV ENERGIZE TO TRIP
LOGIC TO TEST
"TSS" TRIP ANTICIPATION (VC 5)
ETSV TRIP RELAY
BOOT & LOSS DIRECT TRIP CONTINUOUSLY MONITORED
CROSS TRIP 125-24V RELAY
LOSS OF 125 VDC (VC
CLOSED BELOW 755 SPEED
LOCK-UP AND CROSS TRIP 24-125V
24VDC LOCK-UP
MASTER RESET
MASTER TRIP
24V LOCK-UP RELAY
OPERATIONAL TRIPS ANY NUMBER
VITAL CUST TRIPS 125VDC BATTERY
IMPORTANT TRIPS ANY NUMBER
"BOOT" BACK-UP OVERSPEED TRIP (VC 5)
DIRECT 125V BOOT RELAY
CUSTOMER'S TRIPS CAN BE ANY NUMBER
"LOSS" OF LOCAL SPEED SIGNALS (VC 5)
125 VDC TRIP BUS
24VDC TRIP BUS
125VDC EMC
125VDC BATT
VITAL CUST TRIPS
24 VDC
TO STANDBY CONTROL

Figure 1

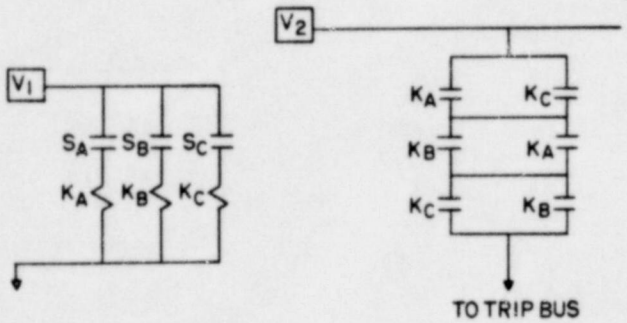

Figure 2

The individual trip circuits are described in the following sections B and C. These circuits are connected to the 125V Trip Bus or the 24V Trip Circuit through diodes, providing isolation between circuits and permitting each signal to be used for purposes other than tripping. They provide inputs to the First Hit Detection Circuit (FH), the Electrical Malfunction Circuit (EM), and Plant Communications (PC). FH and EM are parts of the T&M and are described in sections F and G. Unless otherwise stated, the signals to PC are relayed to the Customer through isolation relays for optional annunciation or other uses.

The two fundamental trip circuits have the following auxiliary outputs:

1. 24V applied when the 125 Trip Bus is energized, to Speed Control Unit.

2. 24V applied when the 125 Trip Bus is energized, or the 24V Trip Circuit is energized and latched, to:

   a. Standby Control Unit.

   b. Flow Control Unit. (In turbines with slave valves)

   c. Plant Communications.

3. 24V removed when the 125 Trip Bus is energized, to Plant Communications.

4. 24V removed when the 125 Trip Bus is energized, or when the circuit breaker is open, the ETS tripped, and no Trip Anticipator Action has taken place, to:

   a. Speed Control Unit.

   b. Load Control Unit.

The circuits accomplishing the functions described in sections A, B, C, and D are located on 125V/24V TRIP SYSTEM circuit board unless otherwise stated.

B. 125V TRIP SIGNALS

1. CUSTOMER TRIP

The Customer can provide a parallel combination of any number of contacts, corresponding to any undesirable conditions of his choice. Closure of any one of these contacts energizes the 125V Trip Bus and, in addition, provides a signal to FH and PC. The customer has the option of providing a two-out-of-three logic circuit instead of a single contact for some of the tripping conditions.

2. LOSS OF STATOR COOLANT TRIP

This trip is initiated by a contact closure in the Generator protection system. An input is provided to FH and PC.

3. LOW SHAFT PUMP DISCHARGE PRESSURE TRIP

When the stated condition occurs, three pressure switches using the two-out-of-three logic arrangement provide a switching signal to T&M. The trip circuit is armed only when the speed of the turbine exceeds 75% of rated; this is accomplished with a second two-out-of-three logic contact chain, in series with the first. These contacts belong to three T&M relays which are energized independently by signals from Auxiliary Speed Sensor Unit. This is an example of two-out-of-three logic encompassing more than one level of devices. Each path consists of a Speed Sensor, a Frequency to Voltage Converter, a Voltage Comparator, and a relay. During this trip, an input is provided to FH and PC.

4. TURBINE SUPERVISORY INSTRUMENTS (TSI) TRIP (HIGH VIBRATION)

This trip is initiated by a contact closure in the Turbine Supervisory Instruments System. An input is provided to FH and PC. The Customer may choose not to connect this trip; however, it is recommended by General Electric that the trip be connected.

5. HIGH EXHAUST HOOD TEMPERATURE TRIP

This trip protects the last stage of the turbine from damage due to overheating. There is one thermostat contact for each hood; all contacts are connected in parallel. An input is provided to FH and PC.

6. LOW HYDRAULIC PRESSURE TRIP

This protects the turbine against operation under abnormally low hydraulic pressure. Three pressure switches are used with their contacts connected in a two-out-of-three arrangement. An input is provided to FH and PC, and an auxiliary relay is energized during this trip. Its function is to turn off the "HYDRAULIC FLUID PRESSURE" indicating light on the Control Panel when the hydraulic pressure is low.

7. REMOTE OPERATION TRIP

(Applicable to turbines equipped with the Remote Operation option). A tripping signal from PC permits tripping the Turbine through remote operation. During this trip an input is provided to FH and PC.

8. MOISTURE SEPARATOR HIGH LEVEL TRIP

(Applicable only to Nuclear Turbines with Moisture Separators supplied by General Electric).

In each separator three "high level trip" devices have their contacts connected in a two-out-of-three arrangement. All of these two-out-of-three contact chains (one for each separator) are connected in parallel and energize through timers (with 10 seconds pick-up delay) three relays. A "high level" signal must remain for more than 10 seconds to cause a trip and this prevents spurious trips due to level transients. When a trip occurs, an input is provided to FH and PC.

9. LOW BEARING OIL PRESSURE TRIP

Three pressure switches are used with contacts connected in two-out-of-three logic. An input is provided to FH and PC.

10. VACUUM TRIP

This trip protects the turbine against damage from high exhaust hood pressure (or low vacuum).

There are three vacuum switches on each hood, with their contacts connected in a two-out-of-three arrangement. These two-out-of-three contact chains are connected in parallel, and energize the 125V Trip Bus.

An input is provided to FH and PC, and an auxiliary relay is energized during this trip. Its function is to light the "VACUUM TRIPPED" indicating light during this trip and the "VACUUM RESET" when the vacuum is normal.

11. THRUST BEARING WEAR DETECTOR (TBWD) TRIP & TEST CIRCUIT

The TBWD provides two trip signals, designated LOWER and UPPER, each corresponding to one of the two thrust plates.

Excessive wear of one thrust plate activates two pressure switches set at different levels of pressure, which correspond to different shaft displacements, the first representing an alarm level, and the second a trip.

The pressure switch contacts are connected in series, constituting a two-out-of-two logic arrangement. A third series contact, belonging to a relay, permits the trip line to be opened for the testing of the TBWD.

Three high impedance meter-relays are connected across the three contacts, monitoring the contact states. If there is sufficient wear to activate only the first pressure switch, or if the pressure switch contact fails in the closed mode, the respective "WEAR" lamp on the System Monitoring Panel will light, and an input will be provided to EM and PC.

If there is wear exceeding the setpoints of both pressure switches, in addition to the above a trip will occur, the respective "TRIP" lamp on the System Monitoring Panel will light, and an input to FH and PC will be provided.

If the second pressure switch contact fails in the closed mode, the "TRIP" lamp will light but no trip will occur.

Each channel, LOWER and UPPER, can be tested by depressing and holding the respective "TEST" pushbutton, located on the Control Panel. The following events occur in sequence:

a. The trip circuit is interrupted

b. The respective "TRIP OPEN" lamp on the Control Panel lights and an input is provided to PC

c. The respective TBWD Solenoid Valve is energized, simulating a thrust plate wear

d. The two pressure switches are depressurized and their two contacts close

e. The respective "TEST OK" on the Control Panel lamp lights.

When the "TEST" pushbutton is released, the Solenoid Valve is de-energized, the contacts of the pressure switches open, and only after this has occurred will the trip circuit reclose and the test be completed. During the test the "WEAR" and "TRIP" lamps do not light.

Associated with the TBWD are two analog circuit boards of the Trip & Monitoring Unit. One is the TBWD POSITION INDICATOR DRIVER, which is a 400 HZ oscillator used to excite the Linear Voltage Differential Transformer (LVDT) mounted on the TBWD. The second is the TBWD POSITION INDICATOR, that demodulates the LVDT output and provides a DC signal for the TBWD position meter located on the control panel. This system provides an analog indication of the exact position of the turbine shaft.

For additional information see THRUST BEARING WEAR DETECTOR in Volume I of the Instruction Book.

12. MASTER TRIP BUTTON – 125V TRIP

A contact of the Master Trip Button on the Control Panel energizes the 125V Trip Bus, and provides an input to FH and PC.

As a customer option, two Master Trip Buttons may exist, with their contacts in series. Both must be simultaneously depressed to cause a trip.

13. 24V TO 125V CROSSTRIP

This Crosstrip occurs during a Loss of Both Speed Signals Trip or a Backup Overspeed Trip, as described in Section C.

During this Crosstrip an input is provided to FH and PC.

14. 125V TRIP BUS LATCH

This circuit, in addition to the function implied by its name, trips the 125V Trip Bus on loss of 24V power. In either case, an input is provided to FH and PC.

15. MECHANICAL OVERSPEED TRIP & MANUAL HANDLE TRIP

Both of these trips act directly on the Mechanical-Hydraulic Trip System, and not the Trip and Monitoring.

However, after the trip has occurred and the Generator circuit breaker has opened, the hydraulic latch circuit energizes the 125V Trip Bus which in turn trips the 24V Trip Circuit.

C. 24V TRIP SIGNALS

The principal components of the 24V Trip Circuit are:

a. **Three Trip relays** with contacts connected in a two-out-of-three logic arrangement that de-energize the ETSV Solenoids. The contacts are monitored by two meter-relays, connected in a way adapted to the particular nature (de-energize-to-trip) of the ETSV trip.

b. Three Latch timer-relay pairs with contacts connected in a two-out-of-three logic that latch themselves and the Trip relays.

c. **Three Crosstrip relays** with contacts connected in a two-out-of-three logic arrangement that energize the 125V Trip Bus. The contacts are monitored by three meter-relays connected across them.

The individual 24V Trip Signals are the following:

1. LOSS OF BOTH SPEED SIGNALS TRIP

This trip occurs when both speed signals are lost while the Turbine is not in the Standby Control mode. When both of these conditions are met, the Speed Control Unit provides to Trip & Monitoring a switching signal which energizes the Trip, Latch and Crosstrip relays, and provides a signal to FH.

2. BACKUP OVERSPEED TRIP (BOST)

The Backup Overspeed Trip Circuit provides protection against turbine overspeed as follows:

a. Normal Mode - Set to trip the turbine at approximately 1/2% above the Mechanical Overspeed Trip Setting.

When no tests are being conducted, it provides redundant overspeed protection. (Speed Control provides the first line of protection and Mechanical Overspeed Trip Device the second).

During Mechanical Overspeed Trip Test or Piston Trip Test it provides the second line of protection.

b. Standby Mode - Set to trip the turbine at 105% of rated speed, and provides the first line of protection.

When the speed setting of the BOST is exceeded, the Auxiliary Speed Sensor unit (where most of the BOST circuitry is located) provides to the Trip & Monitoring Unit three independent switching signals which energize the Trip, the Latch and the Crosstrip relays. Three auxiliary relays are also energized, providing a two-out-of-three input to FH.

The Trip & Monitoring Unit contains logic for testing each of the three BOST channels separately at rated speed. This logic is located on BOST TEST circuit board. Depressing one of the three test pushbuttons on the Control Panel ("NO. 1", "NO. 2", or "NO. 3") applies a switching signal to the Auxiliary Speed Unit lowering the BOST setting of the respective channel to about 99% of rated speed. This path is activated, and energizes the respective Trip, Latch and Crosstrip relays. No actual trip occurs, but the meter-relays which monitor the Trip and Crosstrip relay contacts cause the lighting of the "125 VOLT DC" and "24 VOLT DC" lamps (Upper and lower half of the test button). The lamps light via magnetically latched relays, and in order to be turned off, the adjacent "RESET" button or alternately, the Master Reset button, must be depressed.

An "ACTUAL 105% TRIP OF BOST OFF LINE" button on the Control Panel reduces the BOST reference to 105% of rated when the Generator Circuit Breaker is open. If both this button and the "OVERSPEED" test pushbutton are simultaneously depressed and held, the Turbine will overspeed and trip by BOST action.

3. MASTER TRIP BUTTON - 24V TRIP

A contact of the Master Trip Button (or a series combination of two contacts if two buttons exist) energizes the Trip and the Latch relays, and provides an input to FH and PC. Although the Crosstrip relays are not energized, a 125V Trip occurs through a separate contact of the Master Trip Button.

4. CUSTOMER TRIPS OPERATED WITH STATION BATTERY

The customer can provide switching signals, powered by the station battery, representing any number of undesirable conditions of his choice. The signals enter the Trip and Monitoring Unit through three relays located on CUSTOMER TRIP STATION BATTERY circuit board. These relays are connected in a two-out-of-three logic. Thus, each undesirable condition must energize all three relays. These relays energize the Trip and Latch relays of the 24V Trip Circuit, but not the Crosstrip relays. It is recommended that the Customer provide the 125V EHC Trip as well as the Station Battery Trip for the same undesirable conditions, to trip both fundamental trip circuits. In this case, the 125V Trip Bus will also be energized.

An input to FH and PC during this trip is provided.

5. LOSS OF 125V POWER TRIP

This trip is armed when the speed of the turbine is below 75% of rated. When the 125V EHC power is lost, a relay contact closes and providing the above condition is met, energizes the Trip and Latch relays. The Crosstrip relays are not energized: with the 125V power lost, a 125V trip is impossible.

When 125V power is lost, an input is provided to FH and two to PC. The second input to PC is a command to go to the Manual operating mode.

6. TRIP ANTICIPATOR ACTION

The Trip Anticipator (TA) is used on turbines having a low inertia-to-power ratio to reconcile the following two opposing requirements:

a. The second line-of-defense against overspeed must operate at a speed low enough to keep the maximum speed below 120% of rated speed should the first line-of-defense fail to operate properly.

b. A latching trip must occur at a speed high enough so that if the first line-of-defense operates properly during an overspeed, there is no unnecessary trip.

This is accomplished by separating the function of fast valve closure, which is delegated to TA and is set low enough to satisfy (a), from the function of latching this closure, which is left with the Mechanical Overspeed Trip device, and set high enough to satisfy (b).

The TA consists of three independent channels, located in the Auxiliary Speed Sensor Unit. When the turbine speed exceeds the TA reference (which is load-dependent and in the upper load region is lower than the peek speed reached in a load rejection with normal Speed Control function), the TA energizes the three Trip relays of the 24V Trip Circuit and depressurizes the ETS. This action is not a trip because it is not latched, and is automatically cleared when and if the speed drops below the TA reference without having exceeded the Mechanical Overspeed Trip setting.

During TA action an input is provided to FH and PC; also the hydraulic latch line is interrupted.

7. ELECTRICAL TRIP TESTING SIGNAL

This signal energizes the trip relays, but not the Latch and the Crosstrip relays. The Electrical Trip Testing is described in section E.

8. LOSS OF 24V POWER TRIP

This trip does not activate the 24V Trip Circuit, but de-energizes the two ETSV solenoids and the 125V Trip Bus latch timer-relay pairs. It causes both 24V and 125V trips.

9. 125V TO 24V CROSSTRIP

This trip does not activate the 24V Trip Circuit, but de-energizes the two ETSV solenoids. It causes 24V trip. The same contacts de-energize three timer-relay pairs and cause the latching of the 125V trip.

D. MASTER RESET CIRCUIT

Reset of the Trip and Monitoring System and ETS is initiated by depressing the Master "RESET" button on the Control Panel. In turbines equipped with Remote Operation option, a reset signal may be given through PC.

All trip signals must have been cleared for the reset to be successful.

The following actions take place during the reset process:

a. The electrical latching circuits of the 125V Trip Bus and the 24V Trip Circuit unlatch. This immediately resets the 24V Trip Circuit, but not the 125V Trip Bus, the MTSV, or the ETSV, which remain latched by the hydraulic latching circuit.

b. The Oil Reset Solenoid Valve is energized, operating the reset mechanism, and resetting the Mechanical Trip Valve. This opens the hydraulic latching circuit, which in turn resets the 125V Trip Bus, the MTSV, and the ETSV. The Oil Reset Solenoid Valve remains energized for about 5 seconds, no matter whether the Master Reset Button is released quickly or slowly.

The Master Reset Button should be released when the "HYDRAULIC FLUID PRESSURE" lamp lights.

E. TRIP TEST CIRCUITS

The Mechanical Trip test and the Electrical Trip test circuits permit the following tests during normal operation at rated speed and any load, without tripping the turbine:

1. MECHANICAL OVERSPEED TRIP TEST (OIL TEST)

During this test the following events occur in sequence:

a. The Mechanical Lockout Solenoid Valve is energized, locking out the Mechanical Trip System.

b. The Oil Trip Solenoid Valve is energized, tripping the Mechanical Overspeed Trip, and causing the Mechanical Trip System to trip.

c. The Oil Trip Solenoid Valve is de-energized.

d. The Oil Reset Solenoid Valve is energized, resetting the Mechanical Trip System.

e. The Mechanical Lockout Solenoid Valve is de-energized.

f. The Oil Reset Solenoid Valve is de-energized.

2. MECHANICAL TRIP PISTON TEST

During this test the following events occur in sequence:

a. The Mechanical Lockout Solenoid Valve is energized locking out the Mechanical Trip System.

b. The MTSV is energized, activating the Trip Piston and tripping the Mechanical Trip System.

c. The MTSV is de-energized.

d. The Oil Reset Solenoid Valve is energized, resetting the Mechanical Trip System.

e. The Mechanical Lockout Solenoid Valve is de-energized.

f. The Oil Reset Solenoid Valve is de-energized.

3. ELECTRICAL TRIP TEST

During this test the following events occur in sequence:

a. The Electrical Lockout Solenoid Valve is energized, locking out the Electrical Trip System.

b. The Electrical Trip Solenoid Valves are de-energized, tripping the Electrical Trip System.

c. The Electrical Trip Solenoid Valves are energized, resetting the Electrical Trip System.

d. The Electrical Lockout Solenoid Valve is de-energized.

Each test is initiated by depressing the proper "START" pushbutton and holding it in until Lockout has occurred. The sequence of each step is followed automatically; each step takes place only after the previous step was successful as acknowledged by operation of pressure and limit switches. Also, sufficient time intervals between the steps are allowed to permit the damping of pressure transients.

In case a malfunction occurs, the test sequence stops before completion. Depressing the proper "STOP GO NORMAL" pushbutton will reset the test circuits back to normal. The same pushbutton can be used in case the operator decides to interrupt the test before completion.

For turbines equipped with Remote Operation option, the three tests can be initiated and a "STOP GO NORMAL" action can be provided by four remote signals through PC.

The sequence of events during these tests can be observed from the Control Panel through a number of indicating lights. Information about the status of the various components (RESETTING, LOCKED OUT, etc.) is also provided to PC for Customer use.

If Tests 1 or 2 are unsuccessful, an input is provided to PC, a "TEST MALFUNCTION" lamp on the Control Panel lights, and, depending on the component that failed, one of a number of lamps on the Mechanical Trip Test Malfunction section of the Monitoring Panel lights. If Test 3 is unsuccessful, another input is provided to PC and another "TEST MALFUNCTION" lamp on the Control Panel lights.

During the oil test or the piston test, the Electrical Trip Valve provides protection to the turbine. During the electrical trip test, the Mechanical Trip System provides protection to the turbine. The test circuits are interlocked so that only one test can be performed at a time.

The circuits that accomplish the above functions are located on the MECHANICAL/ ELECTRICAL TRIP TEST circuit board.

The Trip and Monitoring Unit contains also logic for testing the TBWD Trip circuit, described in Section B-11 and the BOST circuit, described in Section C-2.

F. FIRST HIT DETECTION CIRCUIT

The First Hit Detection circuit provides an indication of the cause for a trip by lighting appropriate indicating lights on the First Hit section of the System Monitoring Panel.

The circuit receives input signals from three groups of circuits:

a. Electrical Tripping Circuits

b. Front Standard Tripping Circuits

c. Non-Tripping Circuits

Each input corresponds to a latching relay. The first signal received in each group at the time of a trip energizes the corresponding relay which identifies the input by means of an indicating light. The relay also disconnects the common of all relays of its group so that subsequent signals received do not energize the corresponding relays.

The sequence in which the three signals (first signal of each group) are received is identified by a sequence logic circuit. For this purpose

there are two lights for each group, labeled "HIT 1" and "HIT 2".

Resetting of the Trip System does not erase the First Hit information. To reset the First Hit circuit the two Reset buttons on the Monitoring Panel must be simultaneously depressed, after the Trip System has been reset.

The logic for the above function is located on the FIRST HIT DETECTION circuit board.

G. ELECTRICAL MALFUNCTION INDICATION CIRCUIT

This circuit receives signals representing a number of abnormal, non-tripping conditions of the EHC, and provides indication by means of lights located on the Electrical Malfunction section of the Monitoring Panel, as well as signals for optional use by the customer. The circuit provides the following lamps and signals, all of which remain lit after the removal of the inputs by means of magnetically latching relays corresponding to the inputs:

a. Individual lights for identification of the inputs.

b. Two common lights and a switching signal labeled "SYSTEM FAULT".

c. Two common lights and a switching signal labeled "ELECTRICAL MALFUNCTION".

A & b can be cleared only after all inputs have been removed, while c can be cleared either before or after input removal. This last function is accomplished by means of a relay which is momentarily energized by capacitor charging currents and activates a magnetically latching relay.

Two reset buttons on the Monitoring Panel, when simultaneously depressed, clear this circuit.

The logic for the above functions is located on the ELECTRICAL MALFUNCTION circuit board.

H. LAMP TEST CIRCUIT

Depressing the "LAMP TEST" pushbuttons on the Control Panel and the System Monitoring Panel, energizes the respective group of indicating lights, as a check for burned-out bulbs.

This is accomplished through a number of relays located on the LAMP TEST circuit board.

TESTING

The following tests of the Trip and Monitoring and the Protective System must be performed at the specified intervals:

A. MECHANICAL OVERSPEED TRIP TEST (OIL TEST)

1. Frequency of Testing

   a. Weekly (just after testing the Backup Overspeed Trip - Test D)

   b. Each startup

2. Turbine Operation Status

   a. NORMAL mode of operation. (Exception: If necessary this test can be performed in the STANDBY mode; permissible only if the Power/Load Unbalance circuit is operative).

   b. Turbine at rated speed.

3. Test Initiation and Successful Test Sequence

   a. Observe that "NORMAL", "MECHANICAL OVERSPEED RESET", "TRIP PISTON RESET" lights are ON, and all other lights in this group are OFF.

   b. Depress and hold "START MECHANICAL OVERSPEED TRIP TEST" pushbutton.

   c. Observe that the pushbutton light comes ON, then "NORMAL" goes OFF, "LOCKED OUT" comes ON.

   d. Release pushbutton.

   e. Observe that:

      1. The "MECHANICAL OVERSPEED RESET" light goes OFF, and the "MECHANICAL OVERSPEED TRIPPED" light comes ON.

      2. The "RESETTING" light comes ON.

      3. The "MECHANICAL OVERSPEED TRIPPED" light goes OFF and "MECHANICAL OVERSPEED RESET" light comes ON.

      4. The "LOCKED OUT" and "START MECH O/S TRIP TEST" light goes OFF and "NORMAL" light comes ON.

      5. The "RESETTING" light goes OFF.

4. Action following an unsuccessful test

Deviation from the above indicates an unsuccessful test. Usually the test will stop at an intermediate point, and the "TEST MALFUNCTION" light will come ON.

Follow the instructions in the GEK "Periodic Test Summary". After unloading the turbine and opening the generator breaker record event sequence. Record indications on the EHC Cabinet Mechanical Trip Test Malfunction Panel, and any other abnormal conditions. Shutdown to correct the problem.

B. MECHANICAL TRIP PISTON TEST

1. Frequency of testing

a. Weekly

b. Each start-up

2. Turbine Operation Status

a. NORMAL mode operation (Exceptions: If necessary this test can be performed in the STANDBY mode; permissible only if the Power Load Unbalance circuit is operative).

b. Turbine at rated speed.

3. Test Initiation and successful test sequence

a. Observe that the "NORMAL", MECHANICAL OVERSPEED RESET", "TRIP PISTON RESET" lights are ON, and all other lights in this group are OFF.

b. Depress and hold the "START MECHANICAL TRIP PISTON TEST" pushbutton.

c. Observe that the pushbutton light comes ON, then the "NORMAL" goes OFF, and "LOCKED OUT" comes ON.

d. Release the pushbutton.

e. Observe that:

1. "TRIP PISTON RESET" and "MECHANICAL OVERSPEED RESET" go OFF, and the "TRIP PISTON TRIPPED" and "MECHANICAL OVERSPEED TRIPPED" come ON.

2. "RESETTING" light comes ON.

3. "TRIP PISTON TRIPPED" and "MECHANICAL OVERSPEED TRIPPED" goes OFF and their complements come ON.

4. "LOCKOUT" and "START MECHANICAL TRIP PISTON TEST" go OFF and "NORMAL" comes ON.

5. "RESETTING" light goes OFF.

4. Action Following an unsuccessful test

Same as in A4.

If Test B is unsuccessful, and tests A, C, and D (performed immediately prior to or after B) are successful, unloading and shutdown of the Turbine may be postponed for up to one week.

C. ELECTRICAL TRIP TEST

1. Frequency of testing

a. Weekly

b. Each start-up

2. Turbine Operation Status

a. NORMAL or STANDBY mode operation

b. Turbine at rated speed

3. Test initiation and successful test sequence

a. Observe that the "NORMAL" and "RESET" lights are ON and all other lights in this group are OFF.

b. Depress and hold the "START TEST" pushbutton

c. Observe that the "NORMAL" light goes off and "LOCKED OUT" light comes on.

d. Release the pushbutton.

e. Observe that:

1. The "RESET" light goes off and the "TRIPPED" light comes on.

2. The "TRIPPED" light goes off and the "RESET" light comes on.

3. The "LOCKED OUT" light goes off and the "NORMAL" comes on.

4. Action following an unsuccessful test

Same as in A4

If Test C is unsuccessful, and if tests A, B, and D (performed immediately prior to or

after C) are successful, unloading and shutdown of the Turbine may be postponed for up to one week.

D. BACKUP OVERSPEED TRIP TEST

1. Frequency of Testing

a. Weekly (prior to testing the Mechanical Overspeed Trip - Test A)

b. Prior to or immediately after transferring to STANDBY.

c. Each start-up.

2. Turbine Operation Status

a. NORMAL or STANDBY mode of operation. (It is preferable to perform this test while in the NORMAL mode).

b. Turbine at rated speed.

3. Test initiation and successful test sequence

a. Depress and hold the "NO. 1" pushbutton.

b. Observe that the "125 VOLT DC" and "24 VOLT DC" lamps (upper and lower halves of pushbutton) light.

c. Release the pushbutton. The two lamps shall remain lit.

d. Depress the "RESET" pushbutton. The lamps shall go out.

e. Repeat a, b, c, and d with "NO. 2" and "NO. 3" pushbuttons.

4. Action following an unsuccessful test

Record observations including indications of meter-relays on the System Monitoring Panel.

a. If in STANDBY mode and more than one test is unsuccessful, unload immediately following the instructions in Periodic Test Summary and shutdown before trouble-shooting.

b. If in STANDBY mode and only one test is unsuccessful unload as soon as possible (within 24 hours) following the instructions in Periodic Test Summary and shutdown before trouble-shooting.

c. If in NORMAL mode and one of the tests is unsuccessful, do not proceed to the next (if any) BOST test, since this may trip the turbine. Trouble shooting can be done on-line by replacing components of the BOST circuit that failed. After normal operation has been restored, proceed to the next (if any) test. The turbine may be kept operating at any load for up to one week with defective BOST circuits. During this period transfer to STANDBY and tests A, B, and C are prohibited.

E. THRUST BEARING WEAR DETECTOR TEST

This weekly on-line test is described in "Thrust Bearing Wear Detector Testing" in Volume 1.

The electrical sequence of the testing is described under the DESIGN, Section B-11 of these instructions.

F. ACTUAL OVERSPEED TEST

1. Frequency of testing

Every six to twelve months.

2. Turbine Operation Status

a. Turbine at rated speed.

b. Circuit breaker open.

c. Rotor hot.

3. Test initiation and successful test sequence

a. Select the "FAST" Starting Rate.

b. Depress and hold the "OVERSPEED TEST" pushbutton.

c. Observe that the "SPEED INCREASING" lamp lights.

d. At 50 RPM below rated trip speed select the "MEDIUM" Starting Rate.

e. Observe that the turbine trips at rated trip speed, plus or minus trip speed tolerance. TRIP VALVES "MECHANICAL TRIPPED" and "ELECTRICAL TRIPPED" lamps light. "CLOSE VALVES" Speed Set lamp lights. Record the trip speed.

f. Release the "OVERSPEED TEST" pushbutton.

g. Allow the Turbine to slow down to rated speed or less.

h. Reset the Turbine.

i. Perform the complete test twice more to check repeatability.

4. Action following an unsuccessful test

If the Turbine failed to trip, or the trip speed is not within tolerances, shut down and correct the problem before synchronizing the turbine to the system.

G. ACTUAL 105% TRIP OF BOST OFF-LINE

1. Frequency of testing

Six to twelve months.

2. Turbine Operating Status

a. Turbine at rated speed

b. Circuit breaker open

c. Rotor hot

d. The BOST Test (Test D) was just performed and was successful.

3. Test Initiation and successful test sequence

a. Select the "FAST" Starting Rate

b. Simultaneously depress and hold the "ACTUAL 105% TRIP OF BOST OFF-LINE" and "OVERSPEED TEST" pushbuttons. Observe that the "SPEED INCREASING" lamp lights.

c. Observe that at 105% of rated speed, the turbine trips by BOST action. Trip Valves "MECHANICAL TRIPPED" and "ELECTRICAL TRIPPED" lamps light. "CLOSE VALVES" Speed Set lamp lights. On the First Hit Detection part of the Monitoring Panel, the "BACKUP OVERSPEED TRIP" lamp lights.

d. Release "OVERSPEED TEST" and "105% TRIP OF BOST OFF-LINE" pushbuttons.

e. Allow the Turbine to slow down to rated speed or less.

f. Reset the Turbine.

4. Action following an unsuccessful test

If the Turbine failed to Trip by BOST action at 105% of rated speed, shut-down and correct the problem before synchronizing the turbine to the system.

H. ACTUAL TRIP ANTICIPATOR ACTION TEST

(applicable to units equipped with the Trip Anticipator feature)

1. Frequency of testing

Six to twelve months.

2. Turbine Operation Status

a. Turbine at rated speed

b. Circuit breaker open

c. Rotor hot

d. NORMAL mode of operation

3. Test initiation and successful test sequence

a. Select the "SLOW" Starting Rate

b. (For Fossil Turbines equipped with Full Arc & Partial Arc Admission Modes): Momentarily depress the "HOLD" Admission Mode Pushbutton and manually transfer to Partial Arc mode by slowly rotating the Admission Mode Potentiometer in the EHC Cabinet.

c. Increase the Load Set to 100% of rated load. The speed of the Turbine will gradually increase until 105% or rated speed is reached (5% Regulation is assumed).

d. Wait 3 to 5 minutes after the Turbine stops accelerating.

e. Select the "FAST" Starting Rate.

f. Depress and hold the "OVERSPEED TEST" pushbutton. The Turbine will accelerate.

g. At the speed equal to the Trip Anticipator setting, indicated in the "Field Line-Up Diagram" of the Turbine, TA action must occur. Observe that on the First Hit Detection part of the Monitoring Panel the "TRIP ANTICIPATOR ACTION" and "ELECTRICAL TRIP SOLENOID" lamps light.

h. Release the "OVERSPEED TEST" pushbutton. Observe that the turbine speed returns to 105% of rated.

i. Decrease the Load Set to the no-load flow point. Observe that the turbine returns to rated speed.

j. Momentarily depress the "TRANSFER FULL ARC" pushbutton. Observe that a transfer to FA takes place.

4. Action following an unsuccessful test

If Trip Anticipator Action failed to occur, shut down and correct the problem before synchronizing the turbine to the system.