

**Maryland Stadium Authority**  
**Hamburg Street Generating Plant**

**Generator Control System for Utility Peak Shaving**  
**To Oriole Park & Ravens Stadium**

**Operation Procedure**



S.O. # 01,02,03-27176, 01-27263  
W-3228 Part II

**ORIGINAL**

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## **System Overview**

This Operation Procedure covers the control of (1) 15kV, 1200A, 500MVA Metal-Clad Switchgear line-up and (2) 15kV, 1800KW Generators from the Peak Shaving Control Cabinets. It covers both the Automatic control by the Peak Shaving Programmable Logic Controller (PLC) and the Manual control (for emergency power to Ravens Stadium only) by a trained system operator.

The automatic controls allow the operator to select the peak shaving mode, the stadium to peak shave and the generators used to peak shave. The control parameters are entered into the touchscreen on the Peak Shaving Control Cabinet.

The manual controls allow manual synchronizing with the utility while the system components are controlled by the Peak Shaving PLC. The manual controls also allow two trained system operators to place a generator on the Emergency Switchgear from the Peak Shaving Control Cabinets and the Ravens Stadium Emergency Switchgear. Only (1) generator should be directed to the Emergency Switchgear.

The following drawings should be reviewed to familiarize the operator with the system prior to operation:

### Front View Drawings:

Hamburg Street Switchgear D-10161  
Peak Shaving Control Cabinets D-10203  
Emergency Control Cabinet D-10291  
Ravens Stadium Switchgear D-10240

### Schematic Diagram:

Hamburg Street Switchgear DW-11027  
Peak Shaving Control Cabinets DW-11049  
Emergency Control Cabinet DW-11099  
Ravens Stadium Switchgear DW-11065

### Wiring Diagram:

Hamburg Street Switchgear DW-11042  
Peak Shaving Control Cabinets DW-11050  
Emergency Control Cabinet DW-11100  
Ravens Stadium Switchgear DW-11066

### A. Initial System Set-up

The initial system set-up should be performed with the Switchgear Peak Shaving Mode Switch (43A/M) in the "Manual" mode and the PLC Fail relay picked-up by using the Breaker Control Switches (52CSR) at the Peak Shaving Control Cabinets.

The 15kV Vacuum Circuit Breakers should be in the following position:

<u>Circuit Breaker</u>	<u>Designation</u>	<u>Contacts</u>	<u>Position</u>
Generator G1 Ravens Bus	52-G1/R	open	connect
Generator G2 Ravens Bus	52-G2/R	open	connect
Generator G1 Orioles Bus	52-G1/O	open	connect
Generator G2 Orioles Bus	52-G2/O	open	connect
Hamburg St. Facility – Ravens Peak Shaving Breaker	52-HP/R	closed	connect
Hamburg St. Facility - Ravens Emergency Breaker	52-HEM	open	connect
Hamburg St. Facility - Orioles Peak Shaving Breaker	52-HP/O	closed	connect

The normal status of remote devices as stated in Specification section 16999 is as follows:

<u>Device</u>	<u>Designation</u>	<u>Contacts</u>	<u>Position</u>
Ravens Stadium Peak Shaving Breaker	52-RPS	closed	connect
Ravens Stadium Emergency Bus Incoming Breaker	52-RE1	closed	
Ravens Stadium Emergency Bus Life Safety Load Switch	89-RE2	closed	
Ravens Stadium Emergency Bus Non-Crucial Load Switch	89-RE3	closed	
Ravens Stadium Emergency Bus/Main Bus Tie Breaker	52-RE4	closed	
Oriole Park Peak Shaving Breaker	52-OPS	closed	connect

## **B. Local System Mode Switches**

This section describes the local system mode switches used on this project. The switch name on the schematic diagram is shown below with its location, a brief description of its function and positions available.

Also described below are the mode switches/pushbuttons incorporated into the 5" touchscreen on the Peak Shaving Control Cabinets. They define specific operating modes of the Hamburg Street Generators.

### **1. Hamburg Street 15kV Metal-Clad Switchgear Control Switches**

Breaker Control Switch (52CS - located on the front door of each breaker)

Operates the vacuum circuit breaker at the switchgear cubicle with the breaker in the test/drawn-out position only. The switch will allow the operator to trip the breaker while in the connect position. In the test position, all electrical interlocks & remote signals are defeated for maintenance operation.

Lockout Relay (86 - located on the front door of 52-HP/O, G1/R, G2/R & HP/R)

Trips and blocks closing of each circuit breaker (in both "Manual" and "Auto" modes) under specific fault conditions.

### **2. Hamburg Street Peak Shaving Control Cabinet Switches (discrete switches)**

Engine Speed Switch (15CS - located on the front door of unit #1&2)

Three-position switch that allows the system operator to raise or lower the generator's speed level. The switch has three positions, "Raise", "Off" and "Lower" with a spring return feature that keeps it in the "Off" position if it is not being operated. With the Switchgear Peak Shaving Mode Switch (43A/M) in "Manual", the Synchronizing Switch (SS) "On", and the 15kV generator vacuum circuit breakers open the "Raise" position raises the generator's speed level & the "Lower" position lowers the generator's speed level. In the "Off" position, the generator's speed level is unchanged.

Generator Voltage Switch (16CS - located on the front door of unit #1&2)

Three-position switch that allows the system operator to raise or lower the generator's voltage level. The switch has three positions, "Raise", "Off" and "Lower" with a spring return feature that keeps it in the "Off" position if it is not being operated. With the Switchgear Peak Shaving Mode Switch (43A/M) in "Manual", the Synchronizing Switch (SS) "On", and the 15kV generator vacuum circuit breakers open the "Raise" position raises the generator's voltage level &

the "Lower" position lowers the generator's voltage level. In the "Off" position, the generator's voltage level is unchanged.

Switchgear Peak Shaving Mode Control Switch (43A/M - located on the front door of unit #3)

The switch located on unit #3 defines the mode of operation of the Hamburg Street 15kV Metal-Clad Switchgear line-up under Peak Shaving Mode. The switch has two positions: "Auto" and "Manual". In the "Auto" mode, the system is operated by the Peak Shaving PLC located within the Peak Shaving Cabinet. It opens and closes the local vacuum circuit breakers at the Hamburg Street Generating Plant and controls the (2) generators. In the "Manual" mode, the Switchgear is controlled by a trained system operator at the Peak Shaving Control Cabinets. The Switchgear Emergency Mode Switch (43E) at the Emergency Control Cabinet has to be in "Auto" for the Peak Shaving PLC to operate breakers 52-G1/R, 52G2/R and 52-HEM from the Peak Shaving Cabinets.

*Note: If the PLC failure relay has dropped out (signifying a PLC processor failure), placing the switch in "Manual" will automatically trip breakers 52-G1/O, 52-G2/O and 52-HP/R.*

*Note: The Switchgear Peak Shaving Mode Switch and the Switchgear Emergency Mode Switch need to be in "Auto" for the Peak Shaving PLC to have full control of the Hamburg Street Switchgear and generators. Failure to do so may result in an interruption in the sequence of operation.*

PLC Mode Control Switch (43PLC - located on the front door of unit #3)

The switch located on unit #3 defines the mode of operation of the Peak Shaving Programmable Logic Controller (PLC). The switch has two positions: "Touchscreen" and "Computer". In the "Touchscreen" mode, the Peak Shaving PLC obtains its operating mode and parameters from the local touchscreen. In the "Computer" mode, the Peak Shaving PLC operating mode and parameters are defined by the server/client desktop computer (not provided at this time).

Synchronizing Mode Switch (43SM - one for each synchronizer) – **Keep in "Run"**

Determines the synchronizing mode of the Woodward SPM-A Generator automatic synchronizer. The switch has four positions: (1) Off (2) Run (3) Check and (4) Perm. The normal mode of this switch is the "Run" mode. It should be in this position at all times.

Off - Turns off the synchronizer.

Run - This is the normal state of the switch. It enables the synchronizer to synchronize the generator(s) to the utility bus. When they are in phase, it sends a signal to the PLC to close the 15kV vacuum circuit breaker it is paralleling across.

Check - Synchronizes the generator(s) to the utility bus but does not allow the PLC to close the 15kV vacuum circuit breaker it is paralleling across. (I.e. does not issue a breaker close command.)

Perm - In this mode, the synchronizer sends a signal to the PLC to close the 15kV vacuum circuit breaker if the generator(s) are in phase with the utility bus. (Frequency and voltage level of the generator matches the bus.) In this mode, the synchronizer does not change the speed or voltage level of the generator(s).

Breaker Control Switch (52CSR - one for each vacuum breaker)

Operates the vacuum circuit breakers at the 15kV Metal-Clad Switchgear line-up from the Peak Shaving Control Cabinets with the Switchgear Peak Shaving Mode Switch (43A/M) in the "Manual" mode. Open/Close operation is subject to all electrical interlocks within the close circuit with the breaker in the connect position. In the test/drawn-out position, the breaker control switches at the Peak Shaving Control Cabinets are defeated.

Acknowledge Pushbutton (ACK - located on the front door of unit #3)

Pushbutton that signals the annunciator that an alarm condition(s) has been acknowledged to silence the horn.

Emergency Stop Pushbutton (ESPB - located on the front door of unit # 1 & 2)

Pushbutton that signals its generator to stop without a cooldown cycle. The pushbutton also trips the lockout of that specific generator.

Lamp Test Switch (LT - located on the front door of unit #3)

Two position switch (On/Off) that allows the system operator to test all the lights on the Peak Shaving control cabinets and all the points on the annunciators.

Reset Pushbutton (RESET - located on the front door of unit #3)

Pushbutton that clears the annunciator and silences the ringback horn during the ringback cycle of the annunciator.

Synchronizing Switch (SS - located on the front door of unit#1&2)

Two-position switch that allows the system operator to manually synchronize the generators across the Oriole Park and Ravens Stadium generator breakers (G1/O, G2/O, G1/R and G2/R). The two positions are "Off" and "On". The switch has a handle that is removable in the "Off" position. The switch prevents multiple breakers with an alternate source of power on either side to be closed simultaneously. With the Switchgear Peak Shaving Mode Switch in "Manual", the synchronizing switch in the "On" position & the selected generator breakers open, allows the operator to manually adjust the speed and voltage of the generator and close its 15kV vacuum circuit breaker. In the "Off" position, all manual controls (speed & voltage adjust as well as manual closing of the circuit breaker through its breaker control switch) are disabled and the handle can be removed and taken to another synchronizing switch housing to manually operate its generator.

**3. Hamburg Street Peak Shaving Control Cabinet Switches (through the 5" touchscreen)**

Operation through the touchscreen involves entering the appropriate level password for specific control modes/setpoint changes (defined by others). The priority level assigned for the Automatic Modes are as follows:

<u>PRIORITY</u>	<u>MODE</u>	<u>MODE SWITCH</u>
1	Emergency Operation	Loss of Utility Contact from Multilin SR760 Relay at Ravens Stadium Emergency Switchgear
2	Automated Peak Shaving	Automated Peak Shave Selection on Peak Shaving Control Cabinet Touchscreen
3	System Test (No Load Test)	43T System Test Switch on Emergency Control Cabinet

**Automated Peak Shave - Sets Peak Shave Operating Mode**

Sets the peak shaving operating mode for the system. The operator must choose from two Peak Shaving Modes. The two modes are (1) Peak Shaving Import/Export Mode and (2) Base Load Parallel Operation Mode. Selecting either mode will take the operator through a series of mode selections/setpoints to determine the peak shaving direction (stadium) for each generator and power level from the generating system.

**Base Load Parallel Operation Mode**



Sets a base load Kilowatt output for the generator(s). In this mode, the KW value is set with no Import/Export control.

### **Engine Control Switch**

Determines the operating mode of each generator. The switch has four positions, "Off/Reset", "Stop/Cooldown", "Ravens" and "Orioles". In the "Off/Reset" position, the generator is taken off-line without a cooldown cycle and its circuit breaker opened. It also resets any internal generator faults in the Peak Shaving PLC after a fault shutdown. In the "Stop/Cooldown" mode, the generator is taken off-line and into a cooldown cycle that is controlled by the Peak Shaving PLC. It also trips open its generator breaker when the unloaded command from the AGLC is issued. In either the "Ravens" or "Orioles" position, the generators are assigned to the appropriate stadium for Peak Shaving control by the Peak Shaving PLC. This applies as long as the local generator control panel (EMCP II) switch is in "Auto".

*Note: A signal to commence Emergency Operation will take the single generator selected from the Emergency Control Cabinet, overriding the Engine Control Switch position and have the following action:*

*If the Generators are Peak Shaving Ravens Stadium: The selected generator will enter the Ravens Emergency Operation Mode while the remaining generator will go into cooldown. The Emergency PLC will signal the Peak Shaving PLC to trip 52-HP/R if the breaker is still closed. After the Ravens Stadium Emergency Switchgear transfers back to utility power, the selected generator will go into cooldown.*

*If the generators are Peak Shaving Oriole Park: The selected generator will go to the Ravens Emergency Operation Mode while Oriole Park Peak Shaving continues with the remaining generator. The Emergency PLC will signal the Peak Shaving PLC to trip 52-HP/R if the breaker is still closed and trip the selected generator's Oriole Park breaker in order to direct it to the Ravens Stadium bus.*

- If the selected generator was the only unit that was set to Peak Shave Oriole Park, it will go into the Emergency Operation Mode while the off-line unit will be started and continue the interrupted Oriole Park Peak Shaving operation. When the Ravens Stadium Emergency Switchgear transfers back to utility power, the selected generator will go into cooldown.*
- If both units were set to Peak Shave Oriole Park, the selected generator will enter the Emergency Operation Mode, its Oriole Park generator breaker will trip. The remaining unit will become the lead unit and continue Peak Shaving Oriole Park uninterrupted. After the Ravens Stadium Emergency Switchgear transfers back to utility power, the selected generator will become the lag unit and continue Peak Shaving Oriole Park.*

- *If the selected unit is off-line and not set to Peak Shave Oriole Park (while the remaining unit is set to Peak Shave Oriole Park), it will be started and taken to the Emergency Operation Mode. The remaining unit will continue Peak Shaving Oriole Park.*

*An engine/generator failure of the selected generator will cause the remaining generator to enter the Emergency Operation Mode.*

#### **Fail to Synchronize Reset Pushbutton**

Pushbutton that allows the system operator to reset the synchronizer to attempt another sync attempt. This will also reset the "Fail to Synchronize" and/or "Fail to Sync/Transfer" alarm on the master annunciator.

#### **Lead/Lag Generator Unit Selector Switch**

Switch that allows the operator to select a lead unit and a lag unit if both generators are directed to the same stadium (by the **Engine Control Switch**).

#### **Peak Shaving Import/Export Mode**

Sets the starting point for Peak Shaving in the Import/Export Mode. In this mode, the Kilowatt setpoint entered is the starting point for the generating system as well as the import value from the BGE utility feeder(s) that the system will try to maintain, up to the available connected capacity.

#### **Start/Stop Peak Shaving to Oriole Park**

Pushbuttons that signal the Peak Shaving PLC to start/stop the designated generators, synchronize & load them to Oriole Park. The generator(s) selected are determined by the setting of the **Engine Control Switch**.

#### **Start/Stop Peak Shaving to Ravens Stadium**

Pushbuttons that signal the Peak Shaving PLC to start/stop the designated generators, synchronize & load them to Ravens stadium. The generator(s) selected are determined by the setting of the **Engine Control Switch**.

## C. Automatic Controls (PLC Controlled)

### 1. Automated Peak Shaving Mode

#### (a) Initial Set-up

At each Generator:

- Place the Caterpillar Generator Controller in "Auto" if that generator is available for operation.

At the Peak Shaving Control Cabinets through the Touchscreen if controls are local or through the client/server computer if the controls are remote:

- Place each generator's **Engine Control Switch** in either "Ravens" or "Orioles" position.
- Assign a lead unit to a generator if both generators' **Engine Control Switches** are in either "Ravens" or "Orioles" position.

At the Peak Shaving Control Cabinets through the discrete switches:

- Place all Synchronizing Mode Switches (43SM) in the "Run" position.
- Place the PLC Mode Control Switch (43PLC) in either the "touchscreen" or "computer" position.
- Place the Switchgear Peak Shaving Mode Switch (43A/M) in the "Auto" position to enable the Peak Shaving PLC.

At the Emergency Control Cabinet through the discrete switches:

- Place the Switchgear Emergency Mode Switch (43E) in the "Auto" position to enable the Emergency PLC control and the Peak Shaving PLC control over the Ravens Stadium generator breakers and breaker 52-HEM.

#### (b) Import/Export Mode

(1) Import/Export Mode will allow the operator to start the generators selected to the stadium desired to lower the power draw by the stadium on its utility feeder. The Hamburg Street Generating Plant will try to maintain the desired KW power level imported from the utility feeder based on the power level chosen by the operator. The operator needs to determine the generators/stadium to Peak Shave and set a desired KW power level they want the generators to start Peak Shaving. The minimum setpoint allowable is 2950KW since the lead generator will go off-line when the Utility Import Level is 2300KW + 540KW for the initial/final generator

output during that mode + 110KW for any load swings. The generator(s) will parallel to the BGE utility feeder connecting the Hamburg Street Generating Plant to that stadium, and ramp the lead unit to a preset KW output of about 30% of a single generator. As load increases back to the starting KW setpoint, the generator(s) will switch to the Import/Export Mode. To stop peak shaving at any point, the operator must press the **Stop Peak Shaving pushbutton** to the selected stadium. When the Import/Export Mode is selected from the touchscreen, the following parameters must be entered:

- Generator G1 direction (**Engine Control Switch**)
- Generator G2 direction (**Engine Control Switch**)
- Lead/Lag Generator if both are selected to the same stadium
- Ravens Stadium Peak Shave Kilowatt start setpoint
- Oriole Park Peak Shave Kilowatt start setpoint

*The sequence below describes Peak Shaving to Ravens Stadium; Peak Shaving to Oriole Park or Peak Shaving to both Stadiums are identical.*

- a) Once the above conditions are entered, pressing the **Start Peak Shaving to Ravens Stadium pushbutton** will signal the Peak Shaving PLC to start the lead generator when the imported power from Ravens Stadium equals the Ravens Stadium Peak Shave Kilowatt start setpoint.
- b) The Peak Shaving PLC will pick-up the START relay for the lead generator.
- c) The generator control panel (EMCP II) will receive the start command and control the cranking/starting sequence of the lead generator.
- d) When the lead generator comes up to speed and voltage as determined by its 69/VOLT & 69/FREQ relays (voltage & frequency permissive) it will synchronize to the Ravens Stadium bus through its Woodward SPM-A synchronizer and its Ravens Stadium generator breaker will close. While the synchronizer is activated, the "Synchronizer On" window will illuminate on the generator annunciator.
- e) Once the generator breaker closes and parallels to the utility feeder the APTL to that utility will be activated. The generator will be ramped up (Internal Load Set feature on the APTL) to approximately 30% of its capacity at the pre-set ramp rate of 2 minutes. The ramp time is set per the Load Potentiometer on the APTL.
- f) After the generator has reached the Internal Load Set, the Peak Shaving PLC will hold the generator at that level until the Ravens Stadium Peak Shave Kilowatt start setpoint is again reached.
- g) When the imported power again reaches this setpoint, the APTL Import Level input (0 to +5VDC) from the Peak Shaving PLC will be

adjusted so that the APTL allows the system to import the desired KW.

*Note: 0VDC from the Peak Shaving PLC to the APTL Import Level input corresponds to 0KW import desired from the utility; +5VDC from the Peak Shaving PLC to the APTL Import Level input corresponds to the full scale KW import desired from the utility. The full scale KW is determined from the -5VDC to +5VDC APTL Watt transducer input from the Peak Shaving PLC. 0VDC corresponds to 0KW actually being imported (metered) from the utility and +5VDC corresponds to full scale KW actually being imported (metered) from the utility. If -10,000KW to 10,000KW is the full scale import level (-10,000KW = -5VDC; +10,000KW = +5VDC) from the Peak Shaving PLC to Watt transducer input, then +1.5VDC from the Peak Shaving PLC to the Import Level input will let the system import 3000KW from the utility. The minimum setting of 2950KW would correspond to +1.475VDC minimum output from the Peak Shaving PLC to the APTL Import level. The power (Kilowatt) being imported at any time is calculated from the KYZ pulse inputs from the BGE meters at each Stadium to the Hamburg Street Peak Shaving PLC.*

- h) When the power draw from the lead generator increases to 75% of its rating (1350KW) the lag unit (if available) will be brought on-line through the same steps as the lead unit, steps b) - d) above.

*Note: The power output of the generator system at any time is obtained from the APTL Load Level signal (+4mA to +20mA) to the Peak Shaving PLC. +4mA to +20mA corresponds to 0% to 100% output of the generator(s) connected.*

- i) When the lag generator breaker (if available) closes, its power output will ramp up and load share with the lead unit according to the ramp set on the generator AGLC.
- j) The APTL will keep the power imported from the utility at the Ravens Stadium Peak Shave Kilowatt start setpoint, increasing the output of the generators up to 100% output of the connected unit(s). The generator(s) will not run past 100% rating as set by the generator manufacturer. Power into Ravens Stadium exceeding the KW start setpoint plus 100% rating of the connected generator(s) will become the maximum peak power.
- k) As the stadium's imported power decreases the Peak Shaving PLC will take the lag unit (if available & on-line) off-line when its contribution falls to 600KW for a set time period (*set-point by others*).

- l) To take the lag unit off-line, the Peak Shaving PLC will activate the generator's AGLC unload feature. This will separate the lag unit's governor control system from the APTL and ramp its KW output down to a minimum value. When the AGLC unloaded command is sent to the Peak Shaving PLC, the lag unit's Ravens Stadium generator breaker will open and the unit will go into cooldown controlled by the PLC.
- m) The lead unit will carry the load in the Import/Export mode until its power decreases to 500KW for 5 minutes. After the time delay, the APTL will switch to the Internal Load Set mode and keep the lead unit's output at 30% (540KW).
- n) When the Ravens Stadium imported power falls to 2,300KW, the lead generator will come off-line according to step l) above for the lag unit.
- o) While armed to Peak Shave, should the imported power rise above the Ravens Stadium Peak Shave Kilowatt start setpoint for 5 minutes, the cycle would start again.
- p) If the **Stop Peak Shaving to Ravens Stadium pushbutton** is pressed at any point, the generator(s) designated to Ravens Stadium will come off-line per step l) above.
- q) If the **Engine Control Switch** for a generator designated to Peak Shave Ravens Stadium is changed to either another stadium or "Stop/Off-line" at any point, it will come off-line per step l) above. If the unit taken off-line is the lead unit and a lag unit is available, it will become the lead unit.
- r) If a generator fails to synchronize within an adjustable time delay (0-3 minutes) after the synchronizer has been activated, the Peak Shaving PLC will sound the "Fail to Synchronize" alarm from the generator's annunciator. It will simultaneously terminate the operation of the synchronizer and send the unit into cooldown. At this point, the system operator can press the **Fail to Synchronize Reset** pushbutton on the touchscreen to attempt another synchronization and cancel the cooldown. The system operator can also put the Switchgear Peak Shaving Mode Switch (43A/M) into "Manual" to turn on the manual synchronizing panel. The operator needs to press the **Fail to Synchronize Reset** pushbutton on the touchscreen while in "Manual" (to cancel the cooldown), manually synchronize the generator to the Ravens Stadium Bus and close its 15kV vacuum circuit breaker. *The system operator must place the 43A/M switches back into "Auto" after closing the breaker.*
- s) Should a utility power failure occur at Ravens Stadium Emergency Switchgear (Loss of Utility contact), the Emergency PLC will take control of the generator selected at the Emergency Control Cabinet. It will revert to the "Emergency Operation Mode - Loss of Utility Power at Ravens Stadium" sequence described in Part I (this sequence is Part

II) and logic described above. The power failure may cause the voltage and frequency relays on 52-HP/R to trip that breaker. If that should happen, the operator will have to come to the touchscreen and annunciator to reset the alarms & Peak Shaving PLC system and reclose the breaker manually.

- t) Should a utility power failure occur at Ravens Stadium and a Loss of Utility has not been sensed at Ravens Stadium Emergency Switchgear, the existing remote transfer switch may operate. The power failure may cause the voltage and frequency relays on 52-HP/R to trip that breaker. If that should happen, the operator will have to come to the touchscreen and annunciator to reset the alarms & Peak Shaving PLC system and reclose the breaker manually. The generators will shutdown according to their normal shutdown procedure with cooldown controlled by the PLC.
- u) Should a utility power failure occur at Oriole Park while peak shaving, the existing remote transfer switch will operate. The power failure may cause the voltage and frequency relays on 52-HP/O to trip that breaker. If that should happen, the operator will have to come to the touchscreen and annunciator to reset the alarms & Peak Shaving PLC system and reclose the breaker manually. The generators will shutdown according to their normal shutdown procedure with cooldown controlled by the PLC.

### **(c) Base Load Mode**

- (1) Base Load Mode will also allow the operator to start the generators selected to the stadium desired to lower the power draw by the Stadium on its utility feeder. The Hamburg Street Generating Plant will maintain the desired KW power level output from the generator(s), regardless of the imported power from the utility feeder. The operator needs to determine the generators/stadium to Peak Shave in this mode and set a desired KW power level output of the generators. The system will allow a setpoint from 50% up to 100% output as set by the generator manufacturer. The setpoint is a percentage (%) of the connected generators to the specific stadium, either of one unit or two units. (50% setpoint is either 50% of one unit or 50% of two units). The generator(s) will parallel to the BGE utility feeder connecting the Hamburg Street Generating Plant to that stadium, and ramp the unit(s) to the preset KW output. To stop peak shaving at any point, the operator must press the **Stop Peak Shaving pushbutton** to the selected stadium. When the Base Load Mode is selected from the touchscreen, the following parameters must be entered:

- Generator G1 direction (**Engine Control Switch**)
- Generator G2 direction (**Engine Control Switch**)

- Lead/Lag Generator if both are selected to the same stadium
- Ravens Stadium Base Load Kilowatt setpoint
- Oriole Park Base Load Kilowatt setpoint

*The sequence below describes Base Loading to Ravens Stadium; Base Loading to Oriole Park or Base Loading to both Stadiums are identical.*

- a) Once the above conditions are entered, pressing the **Start Peak Shaving to Ravens Stadium pushbutton** will signal the Peak Shaving PLC to start the generator(s) set for Ravens Stadium.
- b) The Peak Shaving PLC will pick-up the START relay for the selected generator(s).
- c) The generator control panel (EMCP II) will receive the start command and control the cranking/starting sequence.
- d) The first generator that comes up to speed and voltage as determined by its 69/VOLT & 69/FREQ relays (voltage & frequency permissive) will synchronize to the Ravens Stadium bus through its Woodward SPM-A synchronizer and its Ravens Stadium generator breaker will close. While the synchronizer is activated, the "Synchronizer On" window will illuminate on the generator annunciator.
- e) Once the generator breaker closes and parallels to the utility feeder the APTL to that utility will be activated. The generator will be ramped up to the External Load Set (+1VDC to +5VDC) on the APTL at the pre-set ramp rate of 2 minutes. The ramp time is set per the Load Potentiometer on the APTL.

*Note: The +1VDC to +5VDC External Load Set signal from the Peak Shaving PLC to the APTL is as follows: +1VDC from the Peak Shaving PLC to the APTL corresponds to 0% output desired from the generator(s); +5VDC from the Peak Shaving PLC to the APTL corresponds to 100% output desired from the generator(s). A minimum setting allowed of 50% output corresponds to +3VDC output from the Peak Shaving PLC.*

- f) If a second unit is available, it will be brought on-line per step d) above.
- g) When the second generator breaker (if available) closes, its power output will ramp up and load share with the first unit according to the ramp set on the generator AGLC.
- h) The APTL will keep the power output of the generators at the Base Load setpoint.
- i) A change in Base Load Kilowatt setpoint requires 2 minutes between setpoint changes for APTL ramping.



- j) To take a unit off-line, the Peak Shaving PLC will activate the generator's AGLC unload feature. This will separate the selected unit's governor control system from the APTL and ramp its KW output down to a minimum value. When the AGLC unloaded command is sent to the Peak Shaving PLC, the lag unit's Ravens Stadium generator breaker will open and the unit will go into cooldown controlled by the PLC.
- k) If the **Stop Peak Shaving to Ravens Stadium pushbutton** is pressed at any point, the generator(s) designated to Ravens Stadium will come off-line per step j) above.
- l) If the **Engine Control Switch** for a generator designated to Peak Shave Ravens Stadium is changed to either another stadium or "Stop/Off-line" at any point, it will come off-line per step j) above. If the unit taken off-line is the lead unit, then the lag unit will become the lead unit if available.
- m) If a generator fails to synchronize within an adjustable time delay (0-3 minutes) after the synchronizer has been activated, the Peak Shaving PLC will sound the "Fail to Synchronize" alarm from the generator's annunciator. It will simultaneously terminate the operation of the synchronizer and send the unit into cooldown. At this point, the system operator can press the **Fail to Synchronize Reset** pushbutton on the touchscreen to attempt another synchronization and cancel the cooldown. The system operator can also put the Switchgear Peak Shaving Mode Switch (43A/M) into "Manual" to turn on the manual synchronizing panel. The operator needs to press the **Fail to Synchronize Reset** pushbutton on the touchscreen while in "Manual" (to cancel the cooldown), manually synchronize the generator to the Ravens Stadium Bus and close its 15kV vacuum circuit breaker. *The system operator must place the 43A/M switches back into "Auto" after closing the breaker.*
- n) Should a utility power failure occur at Ravens Stadium Emergency Switchgear (Loss of Utility contact), the Emergency PLC will take control of the generator selected at the Emergency Control Cabinet. It will revert to the "Emergency Operation Mode - Loss of Utility Power at Ravens Stadium" sequence described in Part I (this sequence is Part II) and logic described above. The power failure may cause the voltage and frequency relays on 52-HP/R to trip that breaker. If that should happen, the operator will have to come to the touchscreen and annunciator to reset the alarms & Peak Shaving PLC system and reclose the breaker manually.
- o) Should a utility power failure occur at Ravens Stadium and a Loss of Utility has not been sensed at Ravens Stadium Emergency Switchgear, the existing remote transfer switch may operate. The power failure may cause the voltage and frequency relays on 52-HP/R to trip that

breaker. If that should happen, the operator will have to come to the touchscreen and annunciator to reset the alarms & Peak Shaving PLC system and reclose the breaker manually. The generators will shutdown according to their normal shutdown procedure with cooldown controlled by the PLC.

- p) Should a utility power failure occur at Oriole Park while peak shaving, the existing remote transfer switch will operate. The power failure may cause the voltage and frequency relays on 52-HP/O to trip that breaker. If that should happen, the operator will have to come to the touchscreen and annunciator to reset the alarms & Peak Shaving PLC system and reclose the breaker manually. The generators will shutdown according to their normal shutdown procedure with cooldown controlled by the PLC.

## **D. Manual Controls**

### **1. Manual Transfer of Emergency Switchgear to Generators**

#### **(a) Initial Set-up**

At the Ravens Stadium Emergency Switchgear:

- Place all the Ravens Stadium Local/Remote Mode Switches (43L/R) in the "Local" position to disable the Emergency PLC control.

At each Generator:

- Place the Caterpillar Generator Controller in "Run" if that generator is available for operation.

At the Peak Shaving Control Cabinets through the discrete switches:

- Place the Switchgear Peak Shaving Mode Switch (43A/M) in the "Manual" position to disable the Peak Shaving PLC control over the 15kV Switchgear.

At the Emergency Control Cabinet through the discrete switches:

- Place the Switchgear Emergency Mode Switch (43E) in the "Off" position to disable the Emergency PLC control and Peak Shaving PLC control over the 15kV Switchgear.

#### **(b) Placing Ravens Stadium Emergency Switchgear on the Hamburg Street Generators after a Loss of Utility**

- (1) Loss of Utility Power to Ravens Stadium Emergency Switchgear is determined by the "Loss of Utility Power @ Ravens Stadium" contact from the Multilin SR760 relay on 52-RE4.
  - a) Closure of this contact will automatically trip 52-RE4, separating the Ravens Stadium Emergency Switchgear from the utility feeder.
  - b) The operator must start the desired generator from the generator control panel (EMCP II). It will control the cranking/starting sequence of the generator.
  - c) The operator must open 52-HP/R if it is still closed at the Peak Shaving Control Cabinets through the breaker control switch (52CSR).
  - d) When 52-HP/R is opened, 52HEM can be closed through the breaker control switch. The interlocking in place will only allow 52HEM to

close when all the other breakers connected to Ravens Stadium Bus are open.

- e) Remote Ravens Stadium Emergency Bus Non-Crucial Load Switch 89-RE3 must also be opened prior to closing the generators onto the Emergency Feeder. The manual controls do not have provisions to open 89-RE3. This must be done at the Emergency Switchgear.
- f) Insert the synchronizing switch handle into the handle housing of the generator selected and turn to the "On" position.
- g) When the generator is up to speed and voltage as displayed on its Digital Power Meter (DPM), close its Ravens Stadium generator breaker with its breaker control switch. The generator's synchronization check relay at the Hamburg Street 15kV Metal-Clad Switchgear line-up will ensure breaker closure within acceptable limits.
- h) When the operator closes the generator breaker, it will supply power to Ravens Stadium Emergency Switchgear Bus Life Safety Load Switch 89-RE2.
- i) Remote Ravens Stadium Emergency Bus Non-Crucial Load Switch 89-RE3 can be closed after sufficient time delay for the generator to stabilize.
- j) A Hamburg Street Generator is now powering the Emergency Switchgear.

**(c) Placing Ravens Stadium Emergency Switchgear back on Utility Power - Open Transition**

- (1) Placing the Ravens Stadium Emergency Switchgear back on utility power is an open transition sequence.
  - a) At Hamburg Street, 52HEM must be tripped open from the Emergency Control Cabinets through the breaker control switch.
  - b) When 52-HEM is opened, the interlocking at Ravens Stadium Emergency Switchgear will allow the operator to close Emergency Bus/Main Bus Tie Breaker 52-RE4.
  - c) The Emergency Switchgear is now on utility power.
  - d) The generator breaker can be tripped open with its breaker control switch.
  - e) The generator should be kept running for cooldown, after which it can be shutdown from the generator control panel.
  - f) The controls should be placed back into the automatic mode to enable PLC control.

**(d) Loss of Communications/PLC Failure**

- (1) The control interlocking at both Ravens Stadium and Hamburg Street prevent manual paralleling of the Hamburg Street Generators with the utility at the Emergency Switchgear. The interlocking is accomplished through the PLC via the fiber optic communications. In case of a loss of communications/PLC failure the controls will function as follows:
- a) At Ravens Stadium, local closing of 52-RE4 will require 52-RE1 to be open. The PLC contact used for 52HEM indication in the close circuit will open on a PLC processor failure/loss of communications.
  - b) At Ravens Stadium, local closing of 52-RE1 will require 52-RE4 to be open. The PLC contact used for 52HEM indication in the close circuit will open on a PLC processor failure/loss of communications.
  - c) At Ravens Stadium, 52-RE1 will trip open if:
    - it is in the remote mode
    - 52-RE4 is closed
    - and a PLC processor fails or there is a loss of communicationsThis separates the Ravens Stadium Emergency Switchgear from the Emergency Feeder to force an open transition transfer between 52-RE1 (generator) and 52-RE4 (utility).
  - d) At Hamburg Street, a PLC processor failure will drop out the PLC failure relay. A processor failure will also cause an alarm on the touchscreen/computer and master annunciator.
  - e) At Hamburg Street, a loss of communications with the Ravens Stadium Distributed Input/Output PLC Rack will drop out the PLC failure relay and alarm on the touchscreen/computer and master annunciator.
  - f) At Hamburg Street, a PLC processor failure or loss of communications will automatically trip open 52-HP/R, 52-G1/O and 52-G2/O when the Switchgear Peak Shaving Control switch is placed in manual to force an open transition transfer between generators and utility and vice versa.

## **E. Electrical Interlocks**

There are inherent safeties (electrical interlocks) that come with Hamburg Street 15kV Metal-Clad Switchgear line-up and Ravens Emergency Switchgear line-up to prevent incorrect operation and protect the safety of equipment and personnel. The schematic diagrams should be referenced to familiarize the operator with the interlocks listed below.

### **1. Hamburg Street 15kV Metal-Clad Switchgear Line-up**

#### **(a) Generator Breaker 52-G1/O**

- 1) Interlocked so that 52-G1/O cannot close unless 52-G1/R is open

#### **(b) Generator Breaker 52-G1/R**

- 1) Interlocked so that 52-G1/R cannot close unless 52-G1/O is open

#### **(c) Generator Breaker 52-G2/O**

- 1) Interlocked so that 52-G2/O cannot close unless 52-G2/R is open

#### **(d) Generator Breaker 52-G2/R**

- 1) Interlocked so that 52-G2/R cannot close unless 52-G2/O is open

#### **(e) Peak Shaving Breaker 52-HP/O**

- 1) Interlocked so that 52-HP/O cannot close unless both 52-G1/O and 52-G2/O are open when in manual

#### **(f) Peak Shaving Breaker 52-HP/R**

- 1) Interlocked so that 52-HP/R cannot close unless 52-HEM is open and
- 2) Interlocked so that 52-HP/R cannot close in the manual mode unless 52-G1/R & 52-G2/R are both open

#### **(g) Emergency Breaker 52-HEM**

- 1) Interlocked so that 52-HEM cannot close unless 52-G1/R, 52-G2/R and 52-HP/R are all open and
- 2) Interlocked so that 52-HEM cannot close in the manual mode unless remote Ravens Breaker 52-RE4 is open

### **2. Ravens Stadium Emergency Switchgear Line-up**

#### **(a) Emergency Bus/Main Bus Tie Breaker 52-RE4**

- 1) Interlocked so that 52-RE4 cannot close manually unless either 52-HEM is open or 52-RE1 is open

**(b) Emergency Bus Incoming Breaker 52-RE1**

- 1) Interlocked so that 52-RE1 cannot close manually unless either 52-HEM is open or 52-RE4 is open

## **F. Annunciator Operation**

The Ronan Annunciation System along with the audible (adjustable) horns located on unit #3 of the Peak Shaving Control Cabinets help in notifying the system operators when a system problem is pending or has occurred. The system receives alarm/status information from the Peak Shaving PLC through the communication lines. Each Generator has an annunciator designed to notify the operator upon specific problems associated with that unit. There is also an annunciator located on unit #3 (with the horns) for general system alarms not pertaining to any specific generator. In addition to the alarms, each annunciator also has status indication windows that do not flash or sound the horn. The annunciation system is configurable for many types of alarm sequences, but will be configured for a Ringback sequence. Below is a description of the Ringback sequence. It should be used in conjunction with the flow chart for the Ringback annunciator logic sequence included below and also located in the Ronan X110 instruction manual.

### **1. Visual Alarm**

Each alarm condition is distinguished by a distinct flashing sequence:

- The alarm will cause the window to flash at an fast rate
- Once the alarm is acknowledged by pressing the "Ack" pushbutton, it will cause the alarm window to remain on without flashing
- Once the alarm has returned to normal (as determined by its field contact) its window will flash at a slow rate
- Pressing the "Reset" pushbutton after the alarm has been acknowledged in the normal state will cause that window to turn off
- If an alarm condition returns to the normal state prior to being acknowledged, it will cause that window to flash at a slow rate. The "Ack" pushbutton must be pressed twice and then the "Reset" pushbutton to clear the window

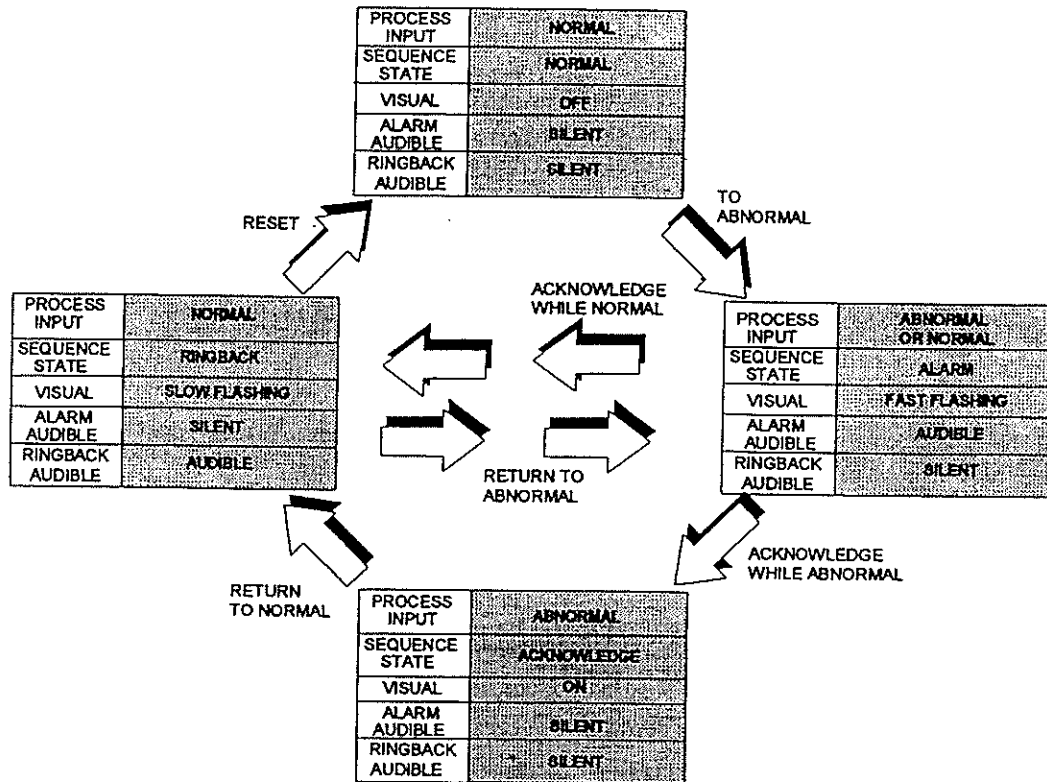
### **2. Audible Alarm**

- Each annunciator sounds a common alarm horn located on unit #3. Any alarm condition will sound the horn until manually acknowledged by pressing the "Ack" pushbutton. The pushbutton must be pressed for each alarm condition.
- After the alarm condition clears and returns to the normal state (as determined by the field contact), the ringback horn on unit #3 will sound to let the operator know the alarm has cleared



- If the alarm condition returns to the normal state prior to being acknowledged, it will sound until the "Ack" pushbutton is pressed twice and then the "Reset" pushbutton to silence the ringback horn

#### R - Ringback



Maryland Stadium Authority  
Hamburg Street Generating Plant

Generator Control System for Emergency Power to  
Ravens Stadium Emergency Switchgear

Operation Procedure



S.O. # 01,02,03-27176, 01-27263  
W-3228 Part 1

**ORIGINAL**

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## **System Overview**

This Operation Procedure covers the control of (1) 15kV, 1200A, 500MVA Metal-Clad Switchgear line-up, (1) 15kV, 1200A, 500MVA Metal-Clad/Metal-Enclosed Emergency Switchgear line-up and (2) 15kV, 1800KW Generators from the Emergency Control Cabinet. It covers the Automatic control by the Emergency Programmable Logic Controller (PLC) to place (1) 15kV Generator on-line and direct it to Ravens Stadium Emergency Switchgear "RE". The controls in place at the Emergency Control Cabinet will allow the selection of the generator to be placed on-line, as well as the method of retransfer from the generator back to utility power at the Emergency Switchgear. A method for running the selected generator unloaded for testing is also available.

The Emergency PLC is located in a cabinet next to the Emergency Control Cabinet. The following drawings should be reviewed to familiarize the operator with the system prior to operation:

### **Front View Drawings:**

Hamburg Street Switchgear D-10161  
Emergency Control Cabinet D-10291  
Ravens Stadium Switchgear D-10240

### **Schematic Diagram:**

Hamburg Street Switchgear DW-11027  
Emergency Control Cabinet DW-11099  
Ravens Stadium Switchgear DW-11065

### **Wiring Diagram:**

Hamburg Street Switchgear DW-11042  
Emergency Control Cabinet DW-11100  
Ravens Stadium Switchgear DW-11066

### A. Initial System Set-up

The initial system set-up should be performed with the Switchgear Emergency Mode Switch (43E) in the "Off" mode.

The Hamburg Street 15kV Vacuum Circuit Breakers should be in the following position:

<u>Circuit Breaker</u>	<u>Designation</u>	<u>Contacts</u>	<u>Position</u>
Generator G1 Ravens Bus	52-G1/R	open	connect
Generator G2 Ravens Bus	52-G2/R	open	connect
Generator G1 Orioles Bus	52-G1/O	open	test/disconnect
Generator G2 Orioles Bus	52-G2/O	open	test/disconnect
Hamburg St. Facility – Ravens Peak Shaving Breaker	52-HP/R	open	test/disconnect
Hamburg St. Facility - Ravens Emergency Breaker	52-HEM	open	connect
Hamburg St. Facility - Orioles Peak Shaving Breaker	52-HP/O	open	test/disconnect

The Ravens Stadium Emergency Switchgear should be in the following position:

<u>Device</u>	<u>Designation</u>	<u>Contacts</u>
Ravens Stadium Emergency Bus Incoming Breaker	52-RE1	closed
Ravens Stadium Emergency Bus Life Safety Load Switch	89-RE2	closed
Ravens Stadium Emergency Bus Non-Crucial Load Switch	89-RE3	closed
Ravens Stadium Emergency Bus/Main Bus Tie Breaker	52-RE4	closed

## B. Local System Mode Switches

This section describes the system mode switches used on this project. The switch name on the schematic diagram is shown below with its location, a brief description of its function and positions available.

Below is a table that lists the priority level of the modes available. The Automated Peak Shaving modes are run by the Peak Shaving PLC separate from the Emergency PLC.

PRIORITY	MODE	MODE ENABLER
1	Emergency Operation	Loss of Utility Contact from Multilin SR760 Relay at Ravens Stadium Emergency Switchgear
2	Automated Peak Shaving	Automated Peak Shave Selection on Peak Shaving Control Cabinet Touchscreen
3	System Test (No Load Test)	43T System Test Switch on Emergency Control Cabinet

### 1. Hamburg Street 15kV Metal-Clad Switchgear Control Switches

Breaker Control Switch (52CS - located on the front door of each breaker)

Operates the vacuum circuit breaker at the switchgear cubicle with the breaker in the test/drawn-out position only. The switch will allow the operator to trip the breaker while in the connect position. In the test position, all electrical interlocks & remote signals are defeated for maintenance operation.

Lockout Relay (86 - located on the front door of 52-HP/O, G1/R, G2/R & HP/R)

Trips and blocks closing of each circuit breaker (in both "Manual" and "Auto" modes) under specific fault conditions.

### 2. Hamburg Street Emergency Control Cabinet Switches

Closed Transition/Open Transition Retransfer Switch (43CT/OT)

Two position switch that allows the system operator to select either a closed transition return or open transition return of the Ravens Stadium Emergency Switchgear to utility power. The switch has two positions, "Closed" and "Open". If a generator is powering the Ravens Stadium Emergency Switchgear, the "Closed" mode allows the PLC to transfer back to utility power without interruption of power by synchronizing across Ravens Stadium Emergency

Bus/Main Bus Tie breaker 52-RE4. In the "Open" mode, the PLC will open Hamburg Street Emergency breaker 52HEM breaker before closing remote breaker 52-RE4.

#### Switchgear Emergency Mode Control Switch (43E)

The switch located on the front door of the emergency control cabinet defines the mode of operation of the 15kV Metal-Clad Switchgear line-up under emergency control. The switch has two positions: "Auto" and "Off". In the "Auto" mode, the system is operated by the Emergency PLC located within the PLC enclosure. It opens and closes local vacuum circuit breakers 52-G1/R, 52G2/R & 52-HEM at the Hamburg Street Generating Plant, opens and closes the Ravens Stadium Emergency Switchgear breakers and switches and controls either of the (2) generators. In the "Off" mode, the Emergency PLC does not have control over the Hamburg Street Generating Plant breakers.

*Note: In the "Off" mode, the generators will not start if there is a utility black-out at Ravens Stadium (Emergency Operation).*

#### Generator Selector Switch (43GSS)

Two position switch that allows the system operator to select which generator is to be used for Emergency Operation. The positions are "Gen G1" and "Gen G2".

#### System Test Switch (43T)

This switch determines the test mode of the generator selected for Emergency Operation. The switch has two positions: "Normal" and "No Load Test". In the "No Load Test" mode, the switch allows manual initiated start of the selected generator by the Emergency PLC and closes its Ravens Stadium generator breaker (breakers 52HEM and 52HP/R must be racked out into the test/disconnect position). In the "Normal" mode, the PLC will not perform any testing of the generator.

#### Utility Retransfer Switch (43UR)

Two position switch that allows the system operator to select either automatic return or manual initiated return of the Ravens Stadium Emergency Switchgear to utility power. The two positions are "Hold" and "Return". With generator(s) powering the Ravens Stadium Emergency Switchgear, the "Return" mode allows the PLC to transfer back to utility power according to the time delay setting in its programming. In the "Hold" mode, the PLC will wait for the system operator to place the switch in the "Return" mode before returning the Ravens Stadium Emergency Switchgear to utility power. (The utility restoration time delay setting

is still in effect when the Utility Retransfer Switch (43UR) is turned from "Hold" to "Return").

#### Lockout Relay (86-HEM)

Trips and blocks closing of 52-HEM vacuum circuit breaker (in both "Manual" and "Auto" modes) under specific fault conditions. A lockout contact is inputted into the PLC so that if 86-HEM trips, the PLC will also trip 86-RE1 at Ravens Stadium and vice-versa.

#### Lamp Test Switch (LT)

Two position switch (On/Off) that allows the system operator to test all the lights on the Emergency Control Cabinet.

### **3. Ravens Stadium Emergency Switchgear Control Switches**

The following switches are entered into the remote Distributed Input/Output PLC rack at the Ravens Stadium Emergency Switchgear to let the system know the status of that switchgear. The information is transmitted back to the Hamburg Street Emergency PLC through the fiber optic cable system.

#### Ravens Stadium Local/Remote Control Mode Switch (43L/R)

(located on the front door of each electrically operated breaker/switch)

The switch defines the mode of operation of the 15kV Breakers (52-RE4 and 52-RE1) and 15kV Electrically Operated Load Break Switch (89-RE3) at Ravens Stadium Emergency Switchgear. The switch has two positions: "Remote" and "Local". In the "Remote" mode, the system is operated by the Hamburg Street Emergency PLC through the DIO rack. It opens and closes the above vacuum circuit breakers and load break switch. In the "Local" mode, the Emergency Switchgear is controlled by the system operator at Ravens Stadium.

*Note: If the Loss of Communications relay has dropped out, 52-RE1 will trip if its control is in "Remote" and 52-RE4 is closed.*

#### Synchronizing Mode Switch (43SM-RE4) - Keep in "Run" mode

Determines the synchronizing mode of the Woodward SPM-A automatic synchronizer at Ravens Stadium during start-up testing. The switch has four positions: (1) Off (2) Run (3) Check and (4) Perm. "Run" is the normal position of this switch.

Off - Turns off the synchronizer.



Run - This is the normal state of the switch. It enables the synchronizer to synchronize the generator(s) across 52-RE4 to the utility line. When they are in phase, it sends a signal to the Emergency PLC to close the 15kV vacuum circuit breaker it is paralleling across.

Check - Synchronizes the generator(s) across 52-RE4 to the utility line but does not allow the Emergency PLC to close the 15kV vacuum circuit breaker it is paralleling across. (i.e. does not issue a breaker close command.)

Perm - In this mode, the synchronizer sends a signal to the Emergency PLC to close the 15kV vacuum circuit breaker if the generator(s) are in phase with the utility line. (Frequency and voltage level of the generator matches the bus.) In this mode, the synchronizer does not change the speed or voltage level of the generator(s).

#### Breaker/Load Break Switch Control Switch (52CS/89CS)

(located on the front door of each electrically operated breaker/switch)

Operates the vacuum circuit breakers and electrically operated load break switch at the Ravens Stadium Emergency Switchgear when the control is set to the "Local" mode. Open/Close operation is subject to all electrical interlocks within the close circuit.

#### Lockout Relay (86-RE1 - located on the front door of unit #5)

Trips and blocks closing of 52-RE1 vacuum circuit breaker under specific fault conditions. A lockout contact is inputted into the PLC so that if 86-RE1 trips, the Emergency PLC will also trip 86-HEM at Hamburg Street and vice-versa.

### **4. Ravens Stadium Emergency Switchgear Alarm Contacts**

The following alarm contacts are available at the Ravens Stadium Emergency Switchgear for alarm purposes. The first six contacts are transmitted across the fiber optic system by the Emergency PLC to the Ravens DIO PLC rack and the last two are hard wired contacts from breaker 52-RE4.

- 1) Emergency Power On – PLC contact closes when any single generator is running, its Ravens Stadium generator breaker closed, 52HEM is closed & 52-RE1 is closed.
- 2) Generator Running – PLC contact closes when any single generator is running (Generator running/crank terminate contact from Gen-Set panel).

- 3) Generator Failure – PLC contact closes when any single generator has failed. (Gen-Set fault contact, 86 generator lockout relay, Ravens Stadium generator breaker overcurrent relay or Ravens Stadium generator breaker is closed in the connect position with its voltage and frequency permissive relay contacts open.)
- 4) Underground Fuel Tank Problem – PLC contact closes when any main fuel tank contact to the Emergency PLC closes.
- 5) Fuel Tank #1 Problem – PLC contact closes when any fuel tank contact for generator G1 to the Emergency PLC closes. (High level or low level)
- 6) Fuel Tank #2 Problem – PLC contact closes when any fuel tank contact for generator G2 to the Emergency PLC closes. (High level or low level)
- 7) Normal (Ravens Utility) Power Available – Contact closes when normal (Ravens utility) power is available on Emergency Switchgear “RE”.
- 8) Normal (Ravens Utility) Power Failure – Contact closes when normal (Ravens utility) power is lost at Emergency Switchgear “RE”.

## **C. Automatic Controls (Emergency PLC Controlled)**

### **1. Emergency Operation Mode**

#### **(a) Initial Set-up**

At the Ravens Stadium Emergency Switchgear:

- Place the Synchronizing Mode Switch (43SM-RE4) in the "Run" position.
- Place all the Ravens Stadium Local/Remote Mode Switches (43L/R) in the "Remote" position to enable PLC control.

At each Generator:

- Place the Generator Controller in "Auto" if that generator is available for operation.

At the Emergency Control Cabinet through the discrete switches:

- Place the Closed/Open Transition Retransfer Switch (43CT/OT) in either "Closed" or "Open".
- Place the System Test Switch (43T) in the "Normal" position.
- Select a generator for Emergency Operation by placing the Generator Selector Switch (43GSS) in either the "Gen G1" or "Gen G2" position.
- Place the Utility Retransfer Switch (43UR) in either "Hold" or "Return".
- Place the Switchgear Emergency Mode Switch (43E) in the "Auto" position to enable the Emergency PLC control.

#### **(b) Loss of Utility Power at Ravens Stadium**

(1) Loss of Utility Power to Ravens Stadium Emergency Switchgear is determined by the "Loss of Utility Power @ Ravens Stadium" contact from the Multilin SR760 relay on 52-RE4.

- a) Closure of this contact will trip 52-RE4, separating the Ravens Stadium Emergency Switchgear from the utility and initiate the Emergency Operation Sequence below.
- b) The generator available for Emergency Operation is determined by the Generator Selector Switch (43GSS). The logic used by the Emergency PLC systems will be as follows:

If the generators are not running: The selected generator will be started and directed to the Ravens Emergency Switchgear.

If the generators are Peak Shaving Ravens Stadium: The selected generator will go to the Ravens Emergency Operation Mode and the remaining generator will go into cooldown. Breakers 52-HP/R, 52-G1/R and 52-G2/R will trip open, stopping Peak Shaving to Ravens Stadium. After the Ravens Stadium Emergency Switchgear transfers back to utility power, the selected generator will go into cooldown. The Emergency PLC will control the Emergency Operation sequence.

If the generators are Peak Shaving Oriole Park: The selected generator will go to the Ravens Emergency Operation Mode while Oriole Park Peak Shaving continues with the remaining generator. The selected generator's Oriole Park breaker and breaker 52-HP/R will trip open to direct the selected generator to the Ravens Emergency Switchgear. After the Ravens Stadium Emergency Switchgear transfers back to utility power, the selected generator will either go into cooldown if a single unit was originally Peak Shaving Oriole Park or it will become the lag unit if both generators were originally Peak Shaving Oriole Park.

If the generators are each Peak Shaving a Stadium: The selected generator will go to the Ravens Emergency Operation Mode and the remaining generator will Peak Shave Oriole Park. Breaker 52-HP/R will trip open along with any of the generator breakers to get the selected generator to the Ravens Emergency Switchgear. After the Ravens Stadium Emergency Switchgear transfers back to utility power, the selected generator will go into cooldown.

- c) If the generators are off-line, the selected unit will be started by the START relay from the Emergency PLC. The generator control panel will receive the start command from the PLC and control the cranking/starting sequence of the generator. The Emergency PLC will signal the Peak Shaving PLC to trip 52-HP/R if closed.
- d) If both generators are on-line and Peak Shaving Ravens Stadium, 52-G1/R and 52-G2/R will trip open, the non-selected unit will go into cooldown and the emergency PLC will signal the Peak Shaving PLC to trip 52-HP/R.
- e) If both generators are on-line and Peak Shaving Oriole Park, the emergency PLC will signal the Peak Shaving PLC to trip the selected generator's Oriole Park breaker and 52-HP/R. The remaining generator will either start or continue Peak Shaving Oriole Park.
- f) If the generators are on-line and each is Peak Shaving a different stadium, the emergency PLC will signal the Peak Shaving PLC to trip the selected generator's Oriole Park breaker and 52-HP/R. The selected generator will be directed to the Ravens Emergency Switchgear for Emergency Operation while the remaining generator will synchronize and Peak Shave Oriole Park.

- g) Ravens Stadium Emergency Bus Non-Crucial Load Switch 89-RE3 will trip open as soon as the Emergency PLC receives the loss of utility signal and that 52-RE4 has opened.
- h) 52-HEM will close.
- i) The selected generator's Ravens Stadium breaker will close after it comes up to speed and voltage as determined by its 69/VOLT & 69/FREQ relays (voltage & frequency permissive for each generator). It will close into a dead bus as 52-RE4 will have tripped open at Ravens Stadium.
- j) Once the selected generator is on-line and its breaker closes, it will power Ravens Stadium Emergency Switchgear through Bus Life Safety Load Switch 89-RE2.
- k) The Emergency PLC will initiate an adjustable timer after the selected generator's Ravens Stadium breaker closes. After the timer expires, 89-RE3 will close.

**(c) Restoration of Utility Power at Ravens Stadium - Closed Transition Retransfer**

- (1) Restoration of Utility Power is determined by the "Loss of Utility Power @ Ravens Stadium" contact from the Multilin SR760 relay on 52-RE4 opening.
  - a) When the "Loss of Utility Power @ Ravens Stadium" contact opens the Emergency PLC will begin an adjustable timer (0-60 minutes). If the timer has timed out and the Utility Retransfer Switch (43UR) is still in "Hold", the selected generator will continue powering the Emergency Switchgear. If the timer has reached its setpoint and the utility fails again while in the "Hold" mode, the timer will restart its counting sequence again. Placing the switch into "Return" after the timer has elapsed will have the system continue to the next step.
  - b) The Emergency PLC will signal the Peak Shaving PLC to activate the Ravens Stadium Emergency Switchgear synchronizer, illuminate the "Synchronizer On At Ravens Stadium" window on the master annunciator and synchronize the selected generator to the Ravens Stadium Emergency Switchgear utility..
  - c) Once synchronized, the Emergency PLC will close 52-RE4 through the DIO PLC at Ravens Stadium.
  - d) 52HEM will trip open immediately after 52-RE4 closes.
  - e) The selected generator's Ravens Stadium breaker will trip open.
  - f) The Peak Shaving PLC will resume control of the selected generator if it was originally in a Peak Shaving mode otherwise the unit will go into cooldown.

- g) If the "Loss of Utility Power @ Ravens Stadium" contact should close again, the Emergency PLC will re-initialize the power failure sequence above - "Emergency Operation Mode - Loss of Utility Power at Ravens Stadium".
- h) If the Emergency PLC senses that the selected engine/generator has failed to start or failed as determined by the gen-set fault shutdown relay, it will signal the remaining generator to start and enter the Emergency Operation Mode.
- i) If the Emergency PLC senses that the selected generator's Ravens Stadium breaker trips on an overcurrent and utility power is available at Ravens Stadium, it will re-transfer to the utility source by following the open transition sequence below. It will bypass the utility restoration timer and position of the Utility Retransfer Switch (43UR).
- j) If the Emergency PLC senses that 52HEM has tripped on a fault (86-HEM) on the emergency feeder but 52-RE1 did not trip first via the "transfer tripping" of the lockout relays by the PLC (i.e. no fault on the Ravens Stadium Emergency Switchgear Bus) and utility power is available at Ravens Stadium, it will re-transfer to the utility source by following the open transition sequence below. It will bypass the utility restoration timer and position of the Utility Retransfer Switch (43UR).

**(d) Restoration of Utility Power at Ravens Stadium - Open Transition Retransfer**

- (1) Restoration of Utility Power is determined by the "Loss of Utility Power @ Ravens Stadium" contact from the Multilin SR760 relay on 52-RE4 opening.
  - a) When the "Loss of Utility Power @ Ravens Stadium" contact opens the Emergency PLC will begin an adjustable timer (0-60 minutes). When the timer has timed out and the Utility Retransfer Switch (43UR) is still in "Hold", the selected generator will continue powering the Emergency Switchgear. If the timer has reached its setpoint and the utility fails again while in the "Hold" mode, the timer will restart its counting sequence again. Placing the switch into "Return" after the timer has elapsed it will have the system continue to the next step.
  - b) The Emergency PLC will trip open 52HEM.
  - c) After 52HEM has been open for an adjustable time delay (*setting by others*), 52-RE4 will close.
  - d) The remainder of the sequence will be the same as the closed transition retransfer sequence above starting with step e), including all failure scenarios.

## **2. Test Mode**

### **(a) Initial Set-up**

At the Ravens Stadium Emergency Switchgear:

- Place the Synchronizing Mode Switch (43SM-RE4) in the "Run" position.
- Place all the Ravens Stadium Local/Remote Mode Switches (43L/R) in the "Remote" position to enable PLC control.

At each Generator:

- Place the Generator Controller in "Auto" if that generator is available for operation.

At the Emergency Control Cabinet through the discrete switches:

- Place the Closed/Open Transition Retransfer Switch (43CT/OT) in either "Closed" or "Open".
- Select a generator for Emergency Operation by placing the Generator Selector Switch (43GSS) in either the "Gen G1" or "Gen G2" position.
- Place the Utility Retransfer Switch (43UR) in either "Hold" or "Return".
- Place the Switchgear Emergency Mode Switch (43E) in the "Auto" position to enable the Emergency PLC control.
- Place the System Test Switch (43T) in the "No Load Test" position.

### **(b) No Load Test - Place System Test Switch (43T) in "No Load Test" position**

(1) Placing the System Test Switch in the "No Load Test" position enables the Emergency PLC to test the generating system by bringing the selected generator (set by the generator selector switch) on-line and running it unloaded. Breakers 52-HP/R and 52HEM must be in the test/disconnect position in order for the Emergency PLC to test the system. If the generators are currently running, either Emergency Operation Mode or Peak Shaving, then the System Test Switch setting will be ignored (lowest priority).

- a) When the switch is placed in the "No Load Test" position, the Emergency PLC will check to see that 52HEM & 52-HPR are in the test/disconnect position. If they are then it will pick-up the START relay for the selected generator.
- b) The generator control panel will receive the start command from the PLC and control the cranking/starting sequence of the generator.

- c) The Ravens Stadium generator breaker of the selected unit will close after the generator comes up to speed and voltage as determined by its 69/VOLT & 69/FREQ relays (voltage & frequency permissive for each generator).
- d) The generator will continue to run unloaded until the System Test Switch is placed in the "Normal" position. When placed in the "Normal" position, the generator breaker will trip and the generator will shutdown without a cooldown cycle.



## **D. Electrical Interlocks**

There are inherent safeties (electrical interlocks) that come with Hamburg Street 15kV Metal-Clad Switchgear line-up and Ravens Stadium Emergency Switchgear line-up to prevent operation in an unsafe manner and protect the safety of equipment and personnel. The schematic diagrams should be referenced to familiarize the operator with the interlocks listed below.

### **1. Hamburg Street 15kV Metal-Clad Switchgear Line-up**

#### **(a) Generator Breaker 52-G1/O**

- 1) Interlocked so that 52-G1/O cannot close unless 52-G1/R is open

#### **(b) Generator Breaker 52-G1/R**

- 1) Interlocked so that 52-G1/R cannot close unless 52-G1/O is open

#### **(c) Generator Breaker 52-G2/O**

- 1) Interlocked so that 52-G2/O cannot close unless 52-G2/R is open

#### **(d) Generator Breaker 52-G2/R**

- 1) Interlocked so that 52-G2/R cannot close unless 52-G2/O is open

#### **(e) Peak Shaving Breaker 52-HP/O**

- 1) Interlocked so that 52-HP/O cannot close unless both 52-G1/O and 52-G2/O are open when in manual

#### **(f) Peak Shaving Breaker 52-HP/R**

- 1) Interlocked so that 52-HP/R cannot close unless 52-HEM is open and
- 2) Interlocked so that 52-HP/R cannot close unless 52-G1/R & 52-G2/R are both open in the manual mode

#### **g) Emergency Breaker 52-HEM**

- 1) Interlocked so that 52-HEM cannot close unless 52-G1/R, 52-G2/R and 52-HP/R are all open and
- 2) Interlocked so that 52-HEM cannot close unless remote Ravens Breaker 52-RE4 is open when in manual

### **2. Ravens Stadium Emergency Switchgear Line-up**

#### **(a) Emergency Bus/Main Bus Tie Breaker 52-RE4**

- 1) Interlocked so that 52-RE4 cannot close manually unless either 52-HEM is open or 52-RE1 is open

**(b) Emergency Bus Incoming Breaker 52-RE1**

- 1) Interlocked so that 52-RE1 cannot close manually unless either 52-HEM is open or 52-RE4 is open