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(1) NETWORK

(1.1) Ethernet will be the network of choice for data exchange between all PLC nodes and HMI nodes.

(1.2) The IP addresses used in this SCADA network will be fully compatible with the IP address scheme used throughout the DMC 122 lab room (e.g. IP = 169.254.15.X). The subnet mask for every node on the SCADA network will be 255.255.255.0 in order to limit communications to the subnet 169.254.15.

(1.2.1) Generator station IP addresses and station names:

- 169.254.15.01 = "Diablo Minor"
- 169.254.15.02 = "Sasquatch"
- 169.254.15.03 = "Bellingdale Valley"
- 169.254.15.04 = "Chuckanut Bay"
- 169.254.15.05 = "Everest"
- 169.254.15.06 = "Baker"

(1.2.2) Substation IP addresses: (for future installations)

- 169.254.15.11 = "Stevens"
- 169.254.15.12 = "Nooksack"

(1.2.3) HMI nodes:

- 169.254.15.101 = Main control

(1.3) The Ethernet network used to link all HMI nodes will be separate from any other network in order to avoid interference or non-SCADA data traffic.

(1.4) A multi-port Ethernet switch located in the DMC communications room will link the following RJ-45 structured cabling jacks together to form this SCADA network: jacks 2-13, 2-14, 1-41, 1-42, 1-38, 1-29, 2-30, 1-24, 1-21, 1-22, 1-15, and 1-16.

(2) HMI GRAPHIC STANDARDS

(2.1) The HMI will display a "mimic diagram" of the power grid with all generating stations and circuit breakers clearly shown. This mimic diagram will only use symbols common to standard power system single-line diagrams.

(2.2) Each screen background will be a light, neutral color. All power line conductors will be represented as black lines.

(2.3) Status of each circuit breaker (square symbol) in the system will be shown as follows: a closed breaker will appear red in color with the word "Closed" adjacent to the symbol. An open breaker will appear green in color with the word "Tripped" adjacent to the symbol. The "breaker\_52a" bit within each PLC will be used to drive this color change.

(2.4) Status of each generator (circle symbol) in the system will be shown as follows: a running generator will appear red in color with the word "Running" adjacent to the symbol. A stopped generator will appear green in color with the word "Stopped" adjacent to the symbol. The "VFD\_forward" bit within each PLC will be used to drive this text change.

(2.5) ISA standards for "clutter" shall be adhered to in all displays (i.e. no less than 25% blank space).

### (3) HMI DISPLAY SCREENS

(3.1) Each generating station will be represented in some way on three different screens on the HMI: a main "System Overview" screen showing a one-line diagram of the power grid, a "Detail" screen dedicated to one generating station, and a "Generating Stations" screen showing all six generators.

#### (3.2) System Overview screen:

(3.2.1) This screen will have a screen-saver button on it to turn the HMI display off.

(3.2.2) This screen will also have an Automation Direct logo, a Snohomish PUD logo, and a Puget Sound Energy logo prominently displayed, with a brief text field crediting these organizations with equipment donations critical to this project.

#### (3.3) Detail screens:

(3.3.1) Each generating station will have its own dedicated "Detail" screen on the HMI, accessible from the main "System Overview" screen showing the overall single-line diagram. Touching the generator symbol or its associated circuit breaker on the "System Overview" screen will take you to that station's "Detail" screen.

(3.3.2) Each "Detail" screen will have a button returning the user to the main "System Overview" screen.

#### (3.4) Generating Station screen:

(3.4.1) This one screen compares statuses and parameters for all six generating stations on the grid, and also allows adjustment of generator drive speed and other status data in such a format that all generators may be easily compared with one another.

### (4) HMI CONTROL ACCESS

(4.1) The HMI will \*not\* have the ability to manually close any generator circuit breaker. Circuit breakers may only be closed from their local panels.

(4.2) The HMI will provide manual adjustment of the drive motor speed for each generating station, at the respective station "Detail" screen as well as on the "Generating Stations" screen comparing all six generators. The "increase" and "decrease" buttons on the HMI will activate bits paralleling the function of the real "increase speed" and "decrease speed" pushbuttons at each generator station. An integer display next to these HMI buttons will show the DAC count value within the PLC in order to show the operator how fast the drive motor is trying to spin. This will be an unscaled number (not in units of RPM or anything like that).

## (5) ALARMS

(5.1) Only critical statuses will be displayed on the main "System Overview" screen (e.g. generator run/idle, breaker closed/tripped). All other status details and statistics will be restricted to station "Detail" screens.

## (6) TAGNAME DATABASE

(6.1) All data tags in the HMI's tagname database will be identical between generator units with the exception of the unit's unique name as a prefix (e.g. "Sasquatch\_breaker\_52a" versus "Everest\_breaker\_52a"), and will follow the PLC tagname conventions as closely as possible for minimal confusion. Direct I/O tagnames are documented in the PLC input/output card diagrams, written in blue next to each I/O terminal. Other tagnames are listed within the PLC control philosophy document.

(6.2) RTU nodes in the tagname database will be named after the geographic location of each generating station or substation. Examples include Bellingdale Valley, Sasquatch, and Baker. These will be the same names identifying each node on the power grid as shown on the "System Overview" screen.