

Revision date = July 29, 2015

(1) NETWORK

(1.1) Serial RS-485 will be used to convey data between the substation PLCs and the HMI in this SCADA system.

(1.1.1) The serial network parameters will be 9600 bits per second, with 8 data bits, an odd parity bit, and 1 stop bit.

(1.2) Substation PLC Modbus addresses and station names (existing):

Modbus address 101 = "Nooksack" substation, PLC for breakers 1 through 5

Modbus address 201 = "Stevens" substation, PLC for breakers 1 through 5

(2) HMI GRAPHIC STANDARDS

(2.1) The HMI will display a "mimic diagram" of the power grid with all generating stations, substations, 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 "CBn\_breaker\_52b" bit within each PLC will be used to drive this color change. A failed breaker will be represented by the breaker color flashing instead of steady, and the "breaker\_fail" bit within each PLC will drive this flashing mode.

(2.4) Remote control of each substation circuit breaker will be possible by means of pushbutton symbols on the HMI display located adjacent to each circuit breaker symbol. These two pushbuttons will be labeled "Trip" and "Close". These pushbuttons will be visible only when the "Local/SCADA" bit for that respective circuit breaker (CBn\_local\_scada) is in its 1 ("SCADA") state, and will be invisible when the circuit breaker is in its 0 ("Local") state.

(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 have its own "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 generating station's detail screen.

(3.2) Each substation will have its own "detail" screen on the HMI, accessible from the main "System Overview" screen showing the overall single-line diagram. Touching the substation symbol (box) or its associated label (name) on the "System Overview" screen will take you to that substation's detail screen.

(3.2.1) Each substation "detail" screen will show all circuit breakers at that substation, in the proper bus configuration as wired at the substation. Each circuit breaker (colored square) will have its status shown as per 2.3 of this document, and will be controlled from the HMI as per 2.4 of this document.

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

(3.4) The main "System Overview" screen will have a screen-saver button on it.

(3.5) The main "System Overview" screen will 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.

(3.6) A "Generating Stations" screen comparing statuses and parameters for all generating stations on the grid will allow comparison of speed commands and other status data, as well as manual speed adjustments of each generator.

#### (4) HMI CONTROL ACCESS

(4.1) The HMI will \*not\* have the ability to manually close any generating station circuit breaker. Generating station 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).

(4.3) The HMI \*will\* have remote trip/close control for all substation circuit breakers. This remote control may be enabled and disabled via selector switches located at each substation, labeled "Local/SCADA".

#### (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 station units with the exception of the unit's unique name as a prefix (e.g. "Nooksack\_CB2\_breaker\_52b" versus "Stevens\_CB2\_breaker\_52b"), 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 wiring 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 substation, the "Nooksack" substation located in the north

half of the lab room and the "Stevens" substation located in the south half of the lab room. These will be the same names identifying each node on the power grid as shown on the "System Overview" screen.