Winnipeg

The City of Winnipeg

Water & Waste Department

HMI Layout and Animation Plan

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	Duane Griffin, Branch Head – WW Planning & Projects	Date

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1 INTRODUCTION

This Wastewater Department HMI Layout and Animation Plan is intended to serve as a reference for consistent implementation of new HMI software applications for City of Winnipeg owned wastewater facilities. This document provides guidance to department personnel, as well as external consultants and external contractors, in the implementation of HMI systems for the Winnipeg Sewage Treatment Program (WSTP).

1.1 Scope of the Document

These implementation requirements apply to HMI systems at the following facilities:

- North End Water Pollution Control Centre (NEWPCC),
- South End Water Pollution Control Centre (SEWPCC),
- West End Water Pollution Control Centre (WEWPCC).

These requirements will also be applied to the collection system where relevant and useful.

1.2 Application

The scope and intent of this document is to convey guidance regarding implementation of HMI applications. The standard shall apply to facility HMI systems as well as local touchscreen HMIs that are specific to a piece of equipment. The document will indicate where specific standards are applicable to facility HMI systems only.

This document addresses specifics related to HMI software applications, however, the information is presented without knowledge of the specific process implementation. It is not within the scope of this document to provide detailed implementation direction, and it will be the responsibility of the respective system designers to fully develop the HMI application details with general conformance to the concepts presented herein. This document shall not be construed as comprehensive implementation requirements or negate the requirement for professional engineering involvement. Any design and implementation must be executed under the responsibility and seal of the respective engineer in each instance, and must be performed in conformance with all applicable codes and standards, as well as good engineering practice.

Where significant deviations from this guide are deemed to be appropriate by the design engineer, these shall be approved by the City.

As technology evolves and new application requirements are identified, it is recommended that this document is updated to ensure that it remains relevant and applicable.

Existing facilities do not necessarily comply with this guide. The expectations regarding application of this guide to new HMI systems at existing facilities must be assessed on a case-by-case basis, however general guidelines for application are presented as follows:

- All new implementations, not related to an existing facility, are expected to comply with this guide.
- All major upgrades to a facility, or a larger facility's process area, are expected to comply with this document, however in some cases compromise with the configuration of the existing facility implementation may be required.
- All minor upgrades should utilize this document as far as practical, however in some cases compromise with the implementation of the existing facility HMI system, which will be retained after an upgrade, will be required. Where these compromises are made they shall be kept to a minimum.

1.3 Definitions

A	Amperes
CPU	Central Processing Unit
CV	Control Variable (PID control)
FRS	Functional Requirements Specification
HMI	Human-Machine Interface
HOA	Hand - Off - Auto (switch)
HOR	Hand - Off - Remote (switch)
HP, hp	Horsepower
HVAC	Heating, Ventilation, and Air Conditioning
I/O	Input/Output
PDF	Portable Document Format
PLC	Programmable Logic Controller
PV	Process Variable (PID control)
SI	International System (of Units) (Système International (d'Unités))
SP	Setpoint Variable (PID control)
WSTP	Winnipeg Sewage Treatment Program
V	Volts
VFD	Variable Frequency Drive

1.4 References

The following City of Winnipeg standards and guides are applicable to HMI systems:

1. Automation Design Guide, document code 612620-0013-40ER-0001.
2. Tagname Identification Standard, document code 612620-0014-40ER-0001.
3. Historical Data Retention Standard, document code 612620-0016-40ER-0001.

2 GRAPHIC DISPLAYS

2.1 General Principles

Graphic displays shall be designed and implemented in a manner that promotes operator situational awareness. Operators shall be provided with an HMI system that allows them to quickly identify and react to abnormal conditions, thereby reducing equipment downtime and improving overall facility operation.

Utilize the following general principles when implementing HMI applications for facility desktop HMI systems and touchscreen HMIs for local equipment control.

- Design graphic displays around the tasks and goals of the operators, rather than the sensors and equipment that produce the data.
- Organize information in a way that allows operators to make effective decisions. Group related information together, and make important information stand out.
- Keep users aware of the state of the system. Avoid providing too much information on any one display, but ensure that enough information is provided that operators are not out of the loop.
- Illustrate equipment on graphic displays using a flat, 2-dimensional (2D) style. Use of 3-dimensional (3D) style is only accepted for pushbuttons.
- Do not use gradients, drop shadows, or other similar graphics techniques to enhance the visual appearance of graphic displays.
- Use the minimum amount of detail to represent equipment. Excessive detail does not promote operator understanding, but rather acts as a visual distraction.
- Wherever possible, do not use borders around graphic display objects or symbols.
- Do not incorporate unnecessary animation that is distracting to operators. Examples of unnecessary animation include rotating equipment, flowing water, and flickering flames.
- Use colour to facilitate discrimination between important information and non-important information. Important information shall be shown in red, orange, yellow, and blue. Less important information shall be shown in a shade of grey. Further information on the use of colour is provided in Section 2.2.
- Use different shapes, in addition to different colours, to facilitate discrimination between important information.
- Use different shades of grey to differentiate between running and stopped equipment, opened and closed valves, and to represent flow within piping.
- Do not depict instruments on overview displays or process mimic displays. Only display the instrument reading, along with the units of measure.
- Use toggle buttons to allow operators to show and hide details that are useful, but clutter the display. For example, a toggle could be used to show and hide minor equipment identifiers, process control loops, and process interlocks on the graphic displays.
- Configure all operator setting/setpoint tags with an engineering zero scale and full scale to ensure operators do not input an out of range value.
- Minimize the amount of typing that is required by operators by providing selection lists, radio buttons, or check boxes where possible.
- Ensure that sufficient space is provided between selectable display objects, and that the objects are appropriately sized, to ensure compatibility with touchscreen HMI clients.

2.2 Colour Scheme

Implement HMI graphic displays using the *Shades of Grey* colour scheme. All equipment and process lines are shown using a shade of grey, and abnormal conditions are shown in bright colours such as red, orange, and yellow.

Table 2-1: RGB Colour Reference

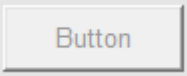
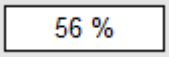
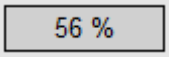
Colour	Sample	RGB Value	Typical Purpose
White		255, 255, 255	Background of Text Displays
Grey 229		229, 229, 229	Graphic Display Background, Popup Window Active Background
Grey 208		208, 208, 208	Popup Window Inactive Background
Grey 180		180, 180, 180	Stopped Equipment
Grey 154		154, 154, 154	Tanks and Static Equipment
Grey 128		128, 128, 128	Running Equipment
Grey 96		96, 96, 96	Process Loops
Black		0, 0, 0	Text
Red		255, 0, 0	Priority 1 Alarms
Orange		255, 128, 0	Priority 2 Alarms
Yellow		255, 255, 0	Priority 3 Alarms
Light Blue		66, 186, 255	Abnormal States
Blue		0, 0, 255	Hyperlinks

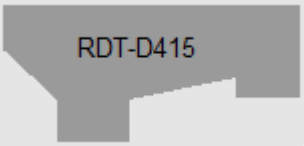
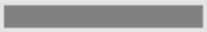
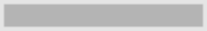
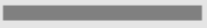
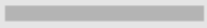
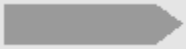
2.3 Standard Graphic Display Objects

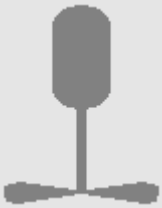
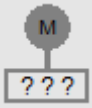
Refer to Table 2-2 for standard graphic display objects. If additional objects are required, utilize the same style as shown in this standard.

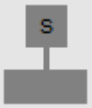
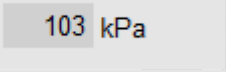
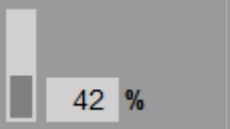
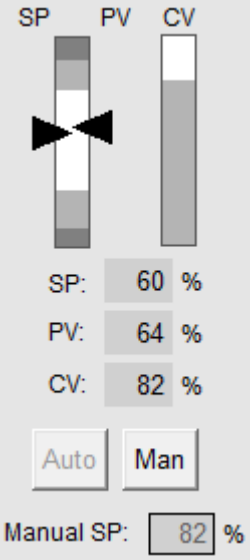
Table 2-2: Standard Graphic Display Objects

Object	State	Colour	Sample	Notes
Display Background	-	Grey 229		
Primary Titles	-	Black	**Primary Title**	Arial, 14 point, bold
Secondary Titles	-	Black	**Secondary Title**	Arial, 12 point, bold
General Text	-	Black	General Text	Arial 10 point, regular
Small Text	-	Black	Small Text	Arial 8 point, regular
Hyperlink	-	Blue	Hyperlink	Arial 10 point, underlined
Display Navigation Button	-	Grey 180, Grey 208		Located in the Header Display of a facility HMI application.

Object	State	Colour	Sample	Notes
Back Button	-	Grey 180, Grey 208, White		Located in the Header Display of a facility HMI application.
Forward Button	-	Grey 180, Grey 208, White		Located in the Header Display of a facility HMI application.
Pushbutton	Enabled	System Default / Black Text		Pushbuttons are to appear enabled or disabled as applicable. Do not change the text on a pushbutton.
	Disabled	System Default / Grey 208 Text		
Input Field	Enabled (read/write)	White, Black		Use *General Text*
	Disabled (read only)	Grey 229, Black		Use *General Text*
Lock Icon	Locked	Grey 154		Show inside or beside secured object that is locked.
Priority 1 Alarm Icon	Inactive	-	Invisible	
	Active	Red		Blink when unacknowledged, solid when acknowledged.
Priority 2 Alarm Icon	Inactive	-	Invisible	
	Active	Orange		Blink when unacknowledged, solid when acknowledged.
Priority 3 Alarm Icon	Inactive	-	Invisible	
	Active	Yellow		Blink when unacknowledged, solid when acknowledged.
Control Mode Icon (PLC)	Auto	-	Invisible	
	Manual	Light Blue		Not blinking
Control Mode Icon (Physical Switch)	Remote	-	Invisible	
	Local	Light Blue		Not blinking
	Hand	Light Blue		Not blinking
Not Ready Icon	Ready	-	Invisible	
	Not Ready	Light Blue		Not blinking

Object	State	Colour	Sample	Notes
Tank / Vessel	-	Grey 154		May adjust shape to reflect actual tank or vessel shape. Do not show inner detail. Show equipment identifier inside object. Use *General Text*.
Equipment	-	Grey 154		Adjust the shape to reflect the shape of the equipment. Do not show inner detail. Show equipment identifier inside object. Use *General Text.*
Pipe, Large	Flow	Grey 128		11 Pixels
	No Flow	Grey 180		11 Pixels
Pipe, Medium	Flow	Grey 128		7 Pixels
	No Flow	Grey 180		7 Pixels
Pipe, Small	Flow	Grey 128		3 Pixels
	No Flow	Grey 180		3 Pixels
Process Loops	-	Grey 96		1 Pixel
Process/Signal Continuation	-	Grey 154		Links to the previous/next screen
Pump / Fan	Running	Grey 128		
	Stopped	Grey 180		
Sump Pump	Running	Grey 128		
	Stopped	Grey 180		

Object	State	Colour	Sample	Notes
Mixer	Running	Grey 128		
	Stopped	Grey 180		
Motor	Running	Grey 128		
	Stopped	Grey 180		
Modulating Valve or Damper	Closed	Grey 128		
	Mid Position	Grey 128		The width of the bar graph inside the valve is animated to reflect the valve position.
	Open	Grey 128		
	Unknown Position	Grey 128		
On/Off Valve or Damper	Closed	Grey 128		
	Open	Grey 128		
	Unknown Position	Grey 128		

Object	State	Colour	Sample	Notes
Solenoid Valve	Closed	Grey 128		
	Open	Grey 128		
Indicator	-	Grey 208		Show a small line connecting the indicator to the equipment or piping if required. Use *General Text.*
Tank Level Indicator	-	Grey 208, Grey 128		The vertical bar graph is animated to reflect the tank level. Use on process mimic displays.
PID Controller	-	Grey 208, Grey 180, Grey 128, Black, White		Setpoint and process variables indicated with arrows. Alarm Levels indicated with medium and dark grey. Control variable indicated with medium grey. Use *General Text*.
Gauge	-	Grey 180, Grey 128, Black, White		Control limits indicated with dashed lines (as required). Process reading indicated with black arrow. Setpoint indicated with white arrow (as required). Alarm limits indicated with dark grey.

Object	State	Colour	Sample	Notes
Bar Graph	-	Grey 180, Grey 128, Black, White		Control limits indicated with dashed lines (as required). Process reading indicated with black arrow. Alarm limits indicated with shades of grey.
Popup Window Active Tab Background	-	Grey 229		
Popup Window Inactive Tab Background	-	Grey 208		
Equipment Faceplate Tab Icon, Home	-	Grey 128		
Equipment Faceplate Tab Icon, Details	-	Grey 128		
Equipment Faceplate Tab Icon, Alarms	-	Grey 128		Overlay an alarm icon if an alarm is active.
Equipment Faceplate Tab Icon, Trends	-	Grey 128		
Equipment Faceplate Link, Webpage	-	Grey 128		
Equipment Faceplate Link, Help	-	Grey 128		Not normally provided. Provide only if required.

2.4 Display of Text Values

Text values on graphic displays are shown using either the *Input Field* or *Indicator* graphic objects that are listed in Table 2-2. The *Input Field* graphic object has a black border to convey the fact that it is a field that accepts input by the operator. The *Indicator* field does not have a black border, which signifies that this field does not ever accept input by the operator.

Use the fill colour of an *Input Field* object to indicate whether the field is currently accepting input by the operator. When an *Input Field* is filled with white it is currently enabled and therefore accepts input from the operator. When an *Input Field* is filled with grey it is disabled and does not accept input from the operator. Note that the *Indicator* graphic object is always filled with grey to convey that operator input is not accepted (*Indicators* are for indication only, and not for operator setpoint or setting adjustment).

The *Input Field* object may be linked to a discrete point or an expression to control whether it is enabled or disabled. For example, the manual speed setpoint field on an equipment faceplate for a VFD-driven

pump should be linked to the auto/manual mode status to enable the field (white fill) when the equipment is in manual mode.

Where text values are shown on overview displays and equipment detail displays, provide a description of the text to the left of the input field or indicator object.

Instrument readings on process mimic displays shall use the *Indicator* object.

2.5 Units of Measure

All units of measure shall be in the International System of Units (SI). One exception is that motor ratings shall be displayed in both SI units (kW) and the imperial horsepower (hp) with the horsepower rating shown in brackets.

Follow these rules when units of measure are shown on HMI systems:

- The first letter of the unit of measure is upper-case when the name of the unit is derived from the name of a person. Examples: Volt (V), Amp (A), Watt (W),
- The first letter of the unit of measure is lower-case when the name of the unit is not derived from the name of a person. Examples: litre (l), meter (m), gram (g), second (s), day (d),
- Units of measure are unaltered in the plural. Example: 5 cm, not 5 cms,
- Capitalization of unit prefixes shall be as per standard convention,
- Provide a space between numeric readings and the unit of measure.

2.6 Display of Equipment Status

Equipment shall be shown on graphic displays using the standard graphic symbols shown in Table 2-2. Where the status of equipment is provided to the control system, the colour and/or inner detail of the equipment is changed to reflect the current state, as per the following.

- For equipment such as motors, pumps, fans, and mixers, that have the capability of being “started” and “stopped” fill colour is used to represent the equipment running status. Equipment that is running is shown with grey fill, and equipment that is stopped is shown with white fill.
- For on/off valves, fill colour is used to indicate whether the valve is opened or closed. Do not animate the colour of the valve based on the running status (eg. running open or running closed). On/off valves in the open state are shown with grey fill, and on/off valves in the closed state are shown with white fill.
- On/off dampers are shown in an identical manner as on/off valves.
- Modulating valves do not change colour. The width of the horizontal bar graph within the body of the valve changes to reflect the valve position. When the valve is fully open, the width of the horizontal bar graph shall be at its maximum, causing the valve to appear grey. When the valve is fully closed, the width of the horizontal bar graph shall be zero, causing the valve to appear white.
- Modulating dampers are shown in an identical manner as modulating valves.
- Where the equipment status is unknown, a series of three question marks “???” may be used inside the graphic symbol to indicate an unknown state or value.

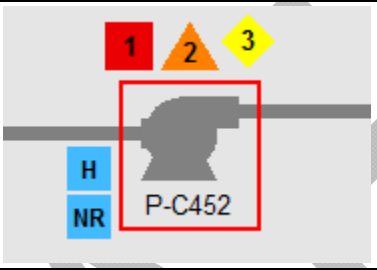
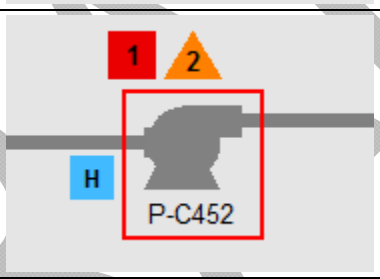
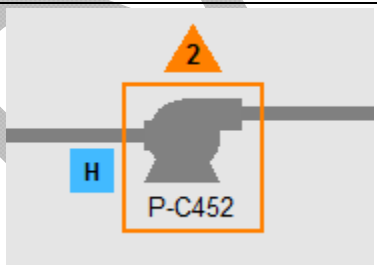
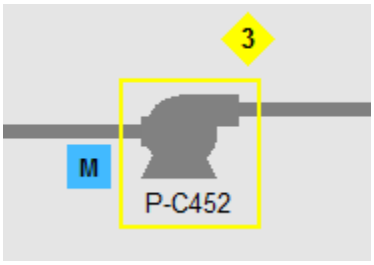
The applicable alarm and abnormal condition icons, as per Table 2-2, shall be shown adjacent to each piece of equipment that has alarms or multiple control modes. Standard icons are provided for each alarm priority level, each control mode, and for indication of “starter not ready”. Use visibility animation to

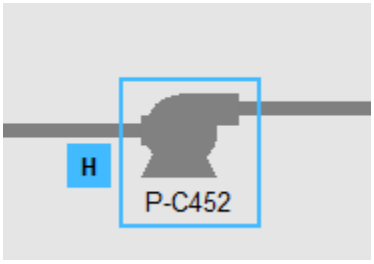
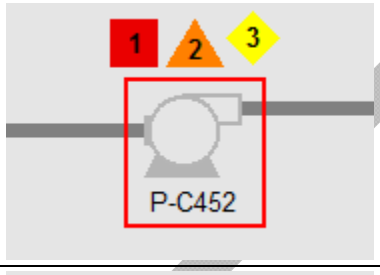
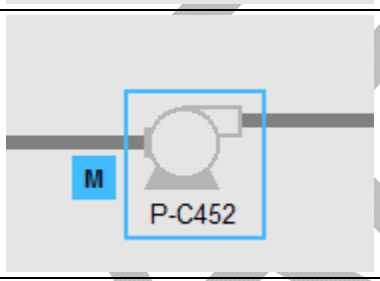
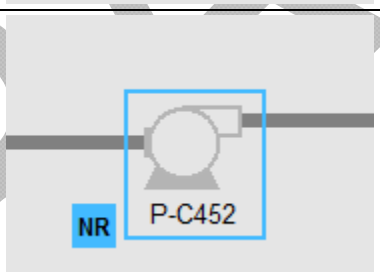
show and hide the icons depending on the state of the equipment. Some operating modes are mutually exclusive and as such the icons may overlap each-another, since they will not be active at the same time. For example, the 'Hand' control mode is mutually exclusive with the 'Manual' PLC mode, therefore the "H" and "M" icons may overlap.

When an alarm or control mode flag icon for an equipment appears visible, a rectangle of the same colour as the icon shall be shown around the equipment. The rectangle is coloured the same colour as the highest priority alarm or abnormal condition to handle cases where multiple alarms of different priority levels may be active at the same time. If no alarms are active but a control mode icon is shown, show a light blue rectangle around the equipment. If an alarm is active, show the rectangle around the equipment using the colour of the highest priority active alarm.

Refer to the sample figures in Table 2-3 for the standard methods of displaying equipment status.

Table 2-3: Display of Equipment Status

State	Sample	Notes
All symbols shown (in development environment)		All symbols are organized around the equipment in close proximity. The "Hand" (H) icon overlaps the "Manual" (M) icon.
Equipment Running in Hand with a Priority 1 and Priority 2 alarm.		The rectangle is shown in red since the Priority 1 alarm condition supersedes both the Priority 2 alarm condition and the "Hand" abnormal condition.
Equipment Running in Hand with Priority 2 alarm.		The rectangle is shown in orange since the alarm condition supersedes the abnormal condition (Hand).
Equipment Running in Manual mode with a Priority 3 alarm.		The rectangle is shown in yellow colour since the alarm condition supersedes the abnormal condition (Manual).

State	Sample	Notes
Equipment Running in Hand mode with no alarms.		The rectangle is shown in blue because there are no active alarms.
Equipment stopped with Priority 1, Priority 2, and Priority 3 alarms active.		The rectangle is shown in red since the Priority 1 alarm condition supersedes the Priority 2 and Priority 3 alarms.
Equipment stopped in Manual mode with no alarms.		The rectangle is shown in blue because there are no active alarms.
Equipment Not Ready and stopped with no alarms.		The rectangle is shown in blue because there are no active alarms.

2.7 Display Types

2.7.1 General

HMI applications will include several types of displays for viewing various levels of equipment detail, and for operator tasks such as viewing trends and alarms. Displays are generally broken down into the following categories:

1. Header/Footer Displays
2. Navigation Displays
3. Overview Displays
4. Process Mimic Displays
5. Process Detail Displays
6. Equipment Faceplates (Popups)
7. Trend Displays
8. Alarm Summary Displays

Where a header or footer display is provided, the term “full-screen display” implies a display that occupies all of the available screen space that is not already occupied by the header or footer display.

Each of these display types are discussed in the following sections.

2.7.2 Header/Footer Displays

A header or footer display shall be provided on each HMI system for locating elements that are common to all displays. The header or footer will always be present on the screen, and not covered or replaced by other displays.

For facility HMI systems, a header display shall be provided which contains the following:

- The facility name (eg. NEWPCC, SEWPCC, or WEWPCC),
- A Display Navigation button (icon) that links to the primary navigation display,
- Back and forward buttons (icons) for display navigation,
- A breadcrumb trail showing the path to the current display within the display hierarchy,
- A table of alarms by process area,
- An alarm list that shows the three most recent alarms at the facility,
- The currently logged in user, and
- The present date and time.

The Display Navigation button (icon) takes operators to the primary navigation display for the HMI system. Refer to Section 2.7.3 for further information on navigation displays.

The back and forward buttons shall behave like the back and forward buttons in a web browser. The back and forward buttons shall return the operator to the previous full-screen display that they were viewing. The forward button is normally disabled until an operator presses the back button.

The breadcrumb trail indicates the path to the current full-screen display within the display hierarchy and allows operators to navigate up or across the hierarchy. Levels within the hierarchy are separated by

right-hand arrows. Clicking an arrow shall open a list of all displays that reside at that path in the display hierarchy, and clicking on a display in that list shall open the display.

The table of alarms shall list the quantity of unacknowledged alarms and acknowledged alarms in each process area. Clicking on a column (process area) within the table of alarms brings the operator to an Alarm Summary Display that lists only the alarms in that process area.

The alarm list shall show the three most recent alarms at the facility, along with the date/time that the alarm occurred and the date/time the alarm was acknowledged. Clicking on the alarm list brings the operator to an Alarm Summary display that lists all of the alarms for the facility.

A sample header for a wastewater treatment facility HMI application is shown in Figure 2-1.

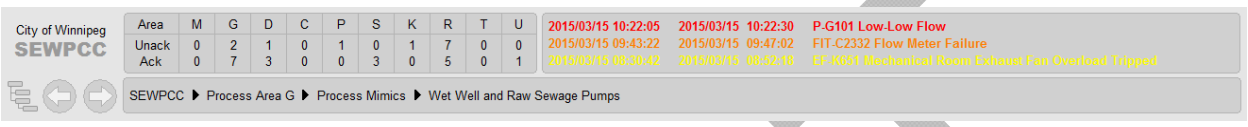


Figure 2-1: Sample Facility HMI Header

Regarding touchscreen HMIs used for local equipment control, a footer display shall be provided which contains a button bar for display navigation, an indication of the number of unacknowledged and acknowledged alarms, the current user, and the present date and time, as applicable.

Additional information or controls that are common to all full-screen displays may be added to header/footer displays as required.

2.7.3 Navigation Displays

Navigation displays shall be provided within facility HMI applications as the primary means for navigation. Navigation displays are implemented as full-screen displays.

Navigation displays contain links to all the full-screen displays in the HMI application. Each display link is a rectangle containing a short description of the display it links to. The display links are organized in a hierarchical-grid arrangement to mimic the organization of the displays within the application. The rectangles are sufficiently sized to ensure compatibility with touchscreen HMI clients.

The organization of the display links shall be as per the following. Locate all links to facility-wide displays in the top row of the grid. Typical examples of these include the Facility Process Overview (dashboard), the Facility Process Flow Diagram, the Facility Security System Overview, and help page(s). In the second row, list all of process areas in the facility using similar rectangles. When a process area rectangle is clicked on, all the links to the process mimic displays and process detail displays for the selected process area will be shown.

Design and implement the navigation displays such that the operator is able to access any full-screen display with three (3) or fewer clicks. Note that clicking on the Display Navigation button (icon) in the header display counts as one click, leaving two more clicks for the navigation display.

The borders of the display link rectangles shall be colour coded as per the type of display they link to. Use blue colour for overview displays, green for process mimic displays, and purple for process detail displays.

Equipment faceplates or other popup displays shall not to be listed on navigation displays.

A sample navigation display is shown in Figure 2-2.

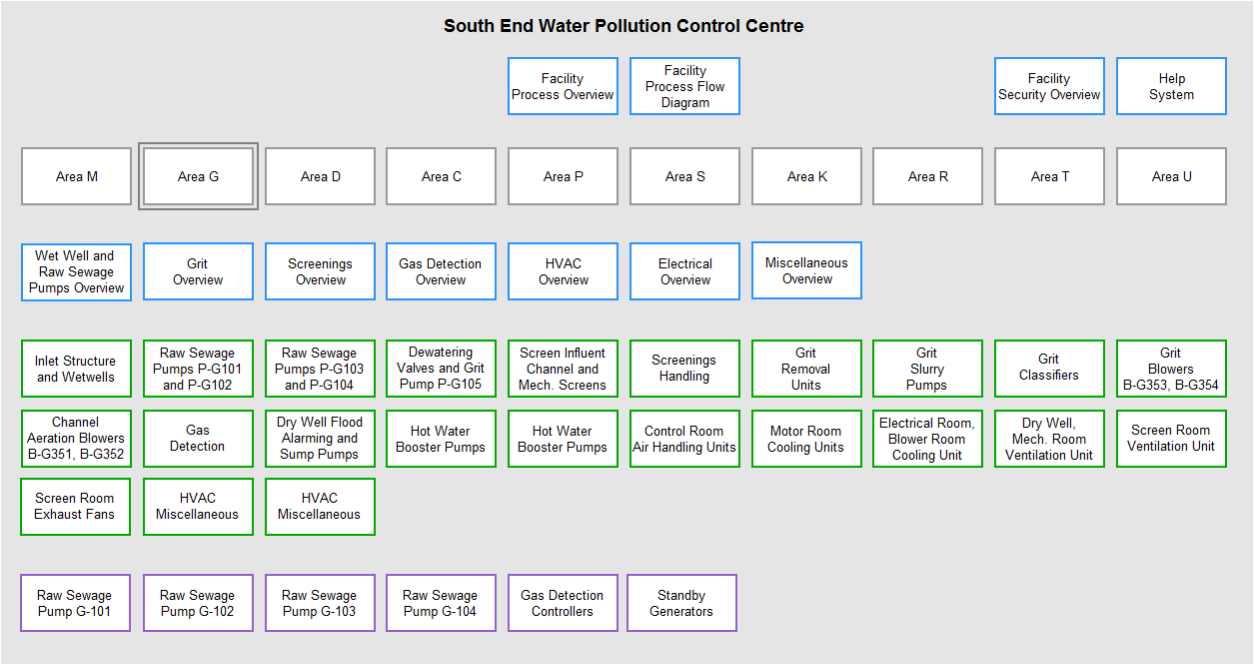


Figure 2-2: Sample Navigation Display

Notes:

1. *Links to the facility overviews and the help system are shown in the top row.*
2. *A row of process areas (rectangles with grey outline) is provided to show and hide the rectangle links to graphic displays for each specific process area.*
3. *Area G has been selected. A darker grey rectangle is shown around the Area G rectangle.*
4. *The display links below the row of process areas are for Area G, as it is the selected area.*
5. *There are no sequencing displays for the selected process area.*

2.7.4 Overview Displays

An overview display shows an overview of a facility, process area, or one or more process trains and appear like a dashboard or instrument panel.

A facility HMI system will incorporate numerous overview displays, one for the entire facility, one for each small process area, and multiple overview screens for larger process areas as required.

A touchscreen HMI for local equipment control will typically have a single overview display, but additional overview displays may be provided if required.

The content and organization of overview displays shall be focused on the operators' tasks and goals. The display should not appear like a process mimic, but rather a dashboard or instrument panel. Show only the important operating modes and major process readings such as major flows, levels, and analytical readings.

Overview displays should not be designed to represent the physical configuration of the facility or process. They should generally be organized left to right, top to bottom, in terms of major process flow.

Group related information together. In some cases it may be useful to group together all elements associated with a single piece of equipment. In other cases it may be useful to group one element from multiple pieces of equipment for the sake of comparison.

Important numerical information shall be presented inside a gauge or bar graph to give the operator a sense of where the reading lies with respect to the control and alarm limits. Indicate control and alarm limits on the gauge or bar graph wherever possible.

If a fraction of a reading, difference between two readings, or an average of two readings is important to operators, provide the information on the display rather than making operators to do the mental arithmetic. Note that the computation of these shall be in the PLC, and the HMI is used for display only.

Where practical, incorporate small trends into overview displays to allow operators to anticipate future alarm conditions, and react before the alarm occurs. The trends should have minimal detail, showing only the applicable setpoint, control limits, and alarm limits, and do not need to be fully-functional in terms of zooming and scrolling back in time. Link these small trends to full-screen trend displays that have the complete functionality.

A small process flow diagram should be included on overview displays where it is applicable. A process flow diagram is a high-level flow diagram without all the detail that would be shown on a process mimic display. The process flow diagrams help operators understand the process and may also be used as an alternative means to navigate between displays. The process flow diagram may appear like a typical block diagram, or the standard equipment symbols of Table 2-2 may be used. Where the standard equipment symbols are used, they may be reduced in size.

Indicate alarms and abnormal conditions using the standard icons listed in Table 2-2. In addition, a coloured rectangle shall be shown around the equipment, as per Section 2.6.

A sample overview display for an intake wetwell and raw sewage pumps at a wastewater treatment facility is shown in Figure 2-3.

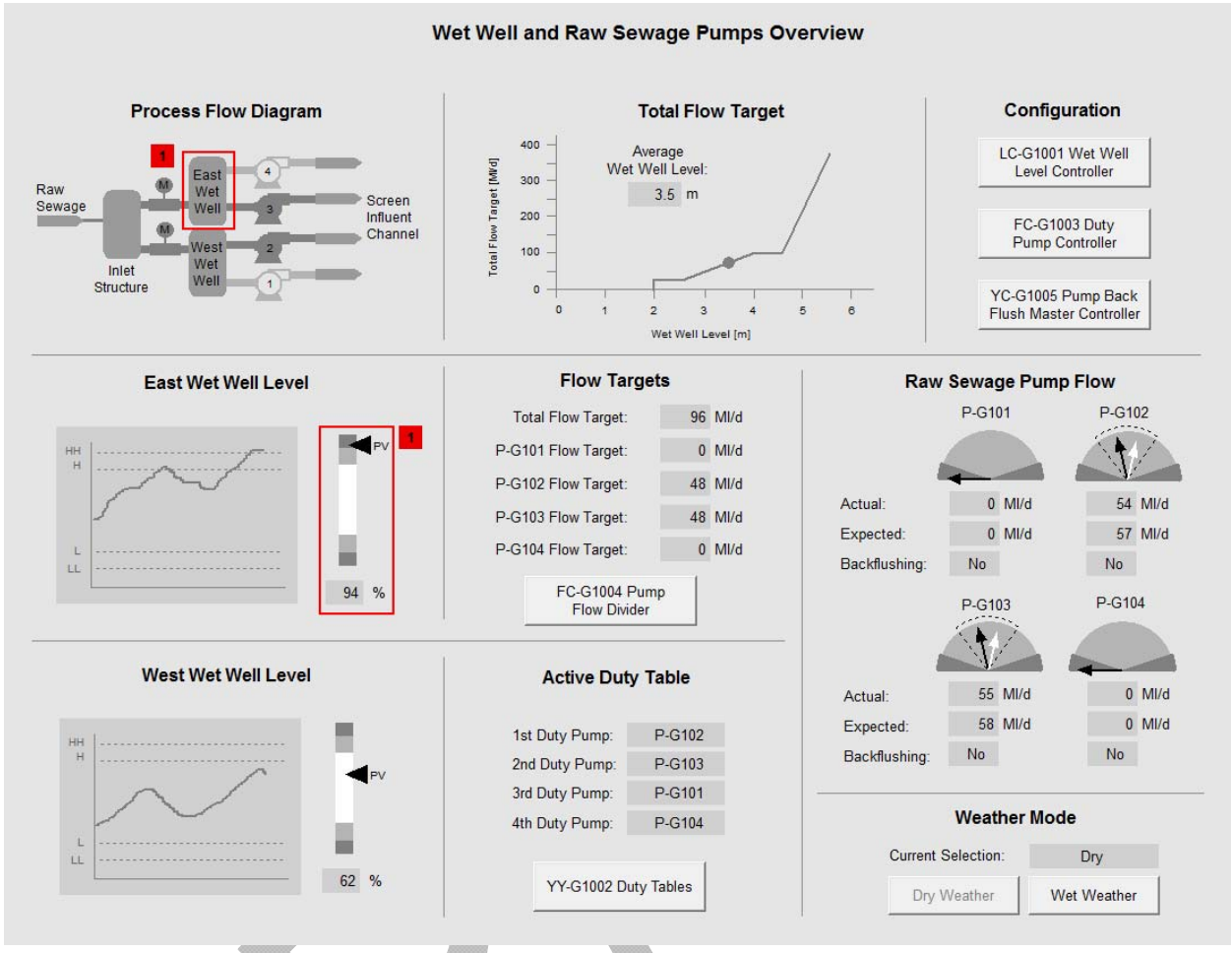


Figure 2-3: Sample Process Equipment Overview Display

Notes:

1. *This overview display is applicable to a portion of the Headworks Area at a wastewater treatment facility. Additional overview displays would be provided for the remaining equipment in the Headworks Area.*
2. *Small trends are incorporated into the display to show the wet well level. This allows operators to predict future low or high level conditions, and react before they occur.*
3. *Bar graphs and gauges are used to indicate process readings. Text displays are used for information that does not change frequently and does not have alarm limits.*
4. *A Priority 1 high-high level alarm associated with the East Wet Well is shown. The wet well in the process flow diagram and the wet well level indicator (bar graph) are highlighted with a red rectangle, which matches the Priority 1 alarm colour.*
5. *Only the important information is shown on the display. Setpoints and operating modes that are infrequently changed are accessible via equipment faceplates. Pushbuttons are provided to open the equipment faceplates.*

2.7.5 Process Mimic Displays

Process mimic displays are full-screen displays and show a mimic of the process, similar to the P&ID drawings but without unnecessary detail. Equipment that is not controlled or monitored by the PLC system shall be omitted from the process mimic. Examples of such equipment include hand valves, strainers, flex couplings, reducers, pressure regulators, and back-flow preventers. Instruments, PLC I/O, and PLC functions that are typically shown on P&IDs are also omitted from process mimic displays.

Display all instrument readings that are available to the process control system on process mimic displays using the *Indicator* graphic symbol shown in Table 2-2. Instrument readings for tanks are shown inside the tank, whereas readings for instruments installed within pipes are shown adjacent to the pipe. If there are several indicators concentrated in one area on the display, small lines connecting the indicators to the equipment or piping may be added to clarify the location of the instrument. Provide touch animation on all instrument readings to open the associated faceplate display.

Where a particular piece of equipment is outfitted with numerous sensors, it may be more appropriate to display only the important readings, and show the other readings on a process detail display or equipment faceplate.

Equipment such as pumps, motors, mixers, and valves that have state feedback to the PLC shall be colour animated to reflect their state. Refer to Table 2-2 for standard graphic display objects.

HOLD - Discuss pipe colours

Indicate alarms and abnormal conditions using the standard icons listed in Table 2-2. In addition, a coloured rectangle shall be shown around the equipment, as per Section 2.6.

Display equipment identifiers for major pieces of equipment. Identifiers for tanks shall be shown inside the tank wherever possible. For equipment other than tanks, the identifier should be located below the equipment. Use *General Text* (see Table 2-2) for equipment identifiers.

Provide a toggle function to show and hide supplementary information such as minor equipment identifiers, process loops, and piping line designations. While this sort of supplementary information is useful to operators, it is not always required and may clutter the display. The toggle shall be a global toggle, applicable to all process mimic displays in the HMI application, but only affect the local display terminal so as to not interrupt operators at other terminals. Note that providing supplementary information is not required in all HMI applications, but may be added if required for clarification.

Provide a means to navigate across the process mimic displays, such as with pushbuttons or with touch links on process line continuation symbols. Provide pushbuttons to navigate up to the associated overview display as required.

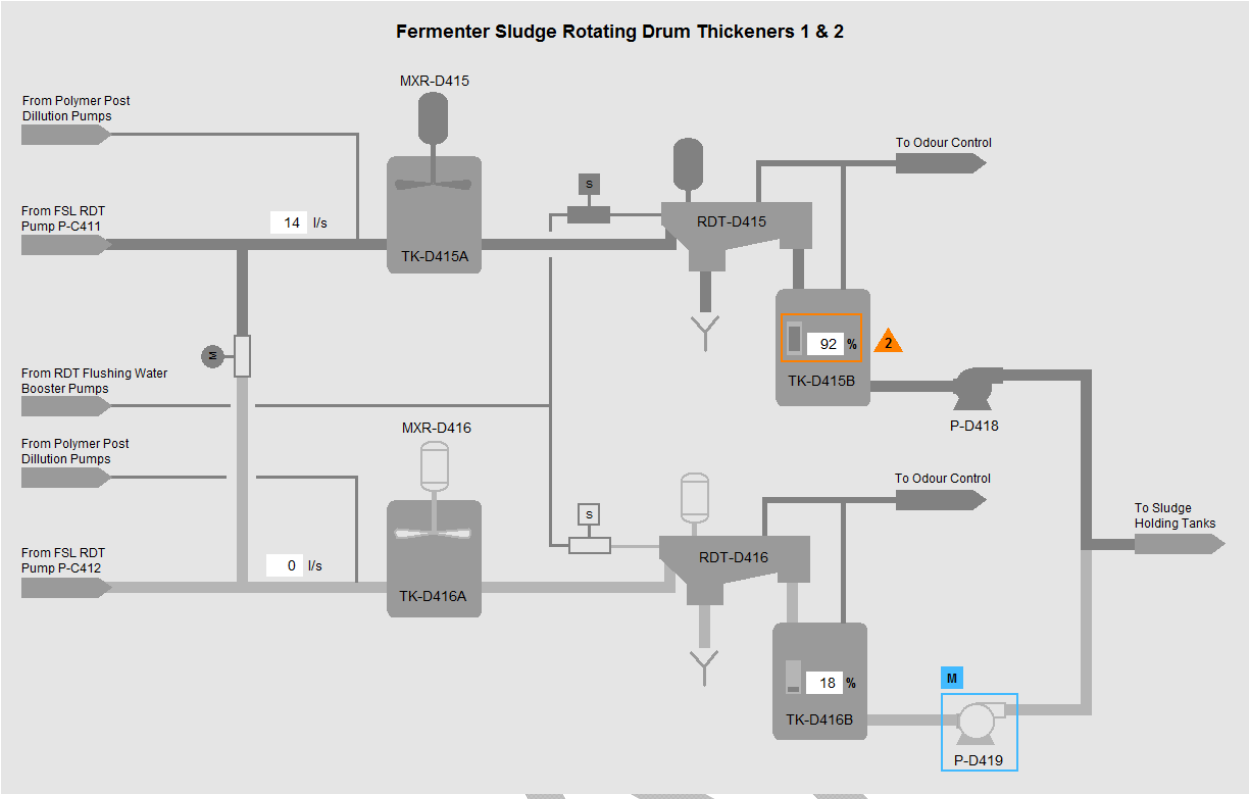


Figure 2-4: Sample Process Mimic Display

Notes:

1. *A high-level alarm in tank TK-D415B is shown with a Priority 2 Alarm. An orange rectangle is shown around the level indicator.*
2. *Mixers MXR-D415 and MXR-D416 are shown running and stopped, respectively.*
3. *Rotating drum thickeners RDT-D415 and RDT-D416 are shown running and stopped, respectively.*
4. *Pump D-D419 is in Manual mode, and as such a blue rectangle is shown around the equipment.*
5. *Different shades of grey are used to represent flow within piping.*

2.7.6 Process Detail Displays

Process detail displays are full-screen displays that contain detailed information for a specific part of the process, be it a process train or an individual piece of equipment. These displays are typically provided for equipment that has many status and control points that cannot fit on an equipment faceplate (popup). These displays are not provided for individual pieces of equipment that have an equipment faceplate.

The typical information to present on process detail displays includes the equipment operating modes, status information, operating statistics, and instrument readings. Pushbuttons, numeric input fields, sliders, and dials are provided to facilitate control and setpoint adjustment. A small process or equipment mimic diagram may be provided as required to assist operators.

Where equipment is controlled via sequencing logic in the PLC system, the details of the sequence shall be provided on a process detail display. The following is applicable to process displays associated with sequencing logic in a PLC system.

Show all states of the sequence on the left side of a process detail display. Each state is represented with a rectangle containing the state number at the top and a brief description within. The state rectangles shall normally be grey, and turn green when the associated state is active. Arrows are used to illustrate the normal progression through the sequence. Arrows may be shown to illustrate abnormal progression through the sequence but may be omitted if there is insufficient room for them.

Clicking on a specific state will show information regarding that state on the right side of the display. Additionally, when the sequencing logic in the PLC transitions from one state to the next, the information area shall be automatically updated to show the information related to the new state.

The information area on the right side of the screen contains a brief description of the state, the actions that will be taken in that state, and the conditions required to progress to the next state(s). In the list of actions, list all actions that are performed by the sequencer, such as starting/stopping of equipment. Note that actions are the commands generated by the sequencer, and are not based on feedback from the field. In the list of conditions to transition to the next state, list all the conditions that are required to progress to the next state, such as seeing that equipment is currently running/stopped, seeing that equipment is running/stopped for a period of time, or waiting for a certain process condition. Provide circular indicator lights beside each action and condition to indicate whether they have been satisfied. The indicator light shall be grey if not satisfied, and green if satisfied. Alarm conditions are shown using a red, orange, or yellow indicator lights, coloured based on the priority of the alarm.

Provide hyperlinks to equipment faceplates inside the information area using blue underlined text. Operators may use these hyperlinks to view equipment faceplates or process detail displays to reset equipment-specific alarms, should they occur.

Near the bottom of the information area, indicate the current status of the sequencer, such as “Running”, “Waiting”, “Faulted”. This status information shall be customized for the associated sequencer.

Some sequencers have maximum step timers that generate an alarm if the sequencer becomes stuck. Where maximum step timers are used, show the elapsed time and maximum allowable time for each state in the sequence at the bottom of the information area.

Pushbuttons are provided as required to pause, resume, and reset the operation of the sequence. The buttons shall be customized for the applicable sequencer.

A sample process detail display associated with a sequencer is shown in Figure 2-5.

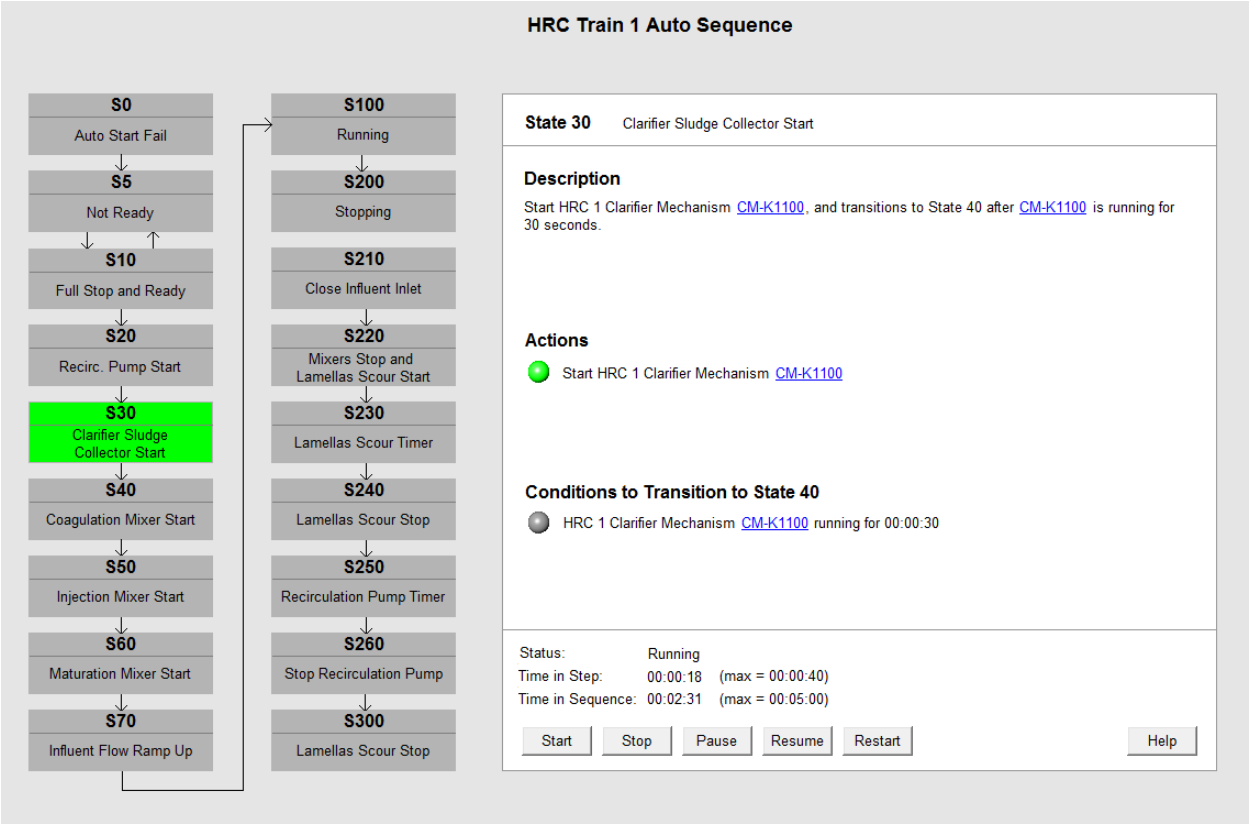


Figure 2-5: Sample Process Detail Display for a Sequencer

Notes:

1. *State 30 is the active state and is shown in green colour.*
2. *Information regarding State 30 is shown on the right side of the screen.*
3. *Hyperlinks to the CM-K1100 equipment faceplate are provided in blue, underlined text.*
4. *In the list of Actions, the HRC 1 clarifier mechanism has been commanded to start, which is represented using a green indicator light.*
5. *If the list of conditions, the sequencer has not seen the clarifier mechanism running for 30 seconds, therefore the indicator light is still grey.*

2.7.7 Equipment Faceplates

Equipment faceplates are provided for individual instruments and equipment such as pumps, fans, mixers, and valves. Faceplates are used to view device status, adjust setpoints, and for manual control of equipment through the PLC system.

Equipment faceplates may be sized as required to accommodate the required status and control display objects. If a particular faceplate needs to be larger than approximately 600x700 (WxH) pixels then a process detail display, rather than an equipment faceplate, should be used.

Provide a title at the top of the faceplate containing the equipment identifier and a description of the equipment. Use the *Primary Title* font style for the equipment identifier and the *Secondary Title* font style for the equipment description. Refer to Table 2-2 for standard font styles.

Provide a series of tabbed pages on equipment faceplates for grouping common elements. Refer to Table 2-2 for standard tab icons. The following tabs are typically provided, but may be customized to suite the equipment:

- Home: primary tab for viewing status information and for manual control.
- Details: tab for viewing detailed equipment status information, and for adjusting equipment control setpoints and alarm setpoints.
- Alarms: filtered alarm list, showing only those alarms that are applicable to the equipment.
- Trends: integrated trend viewer for viewing equipment trends.

The specific content on each tabbed page is dependent on the type of equipment the faceplate is associated with, and will be detailed in the equipment class definitions of the project's Functional Requirements Specifications. Typical status and controls information are provided in Table 2-4 for various types of equipment. These are based on the standard classes that are currently in development for the City of Winnipeg Sewage Treatment Program.

Table 2-4: Typical Equipment Faceplate Status and Controls Information

Equipment	Tabbed Page	Typical Content
Motors (FVNR)	Home	• Ready indication • Running indication • Interlocked indication • Local/Remote mode indication • Auto/Manual mode indication • Auto/Manual mode pushbuttons • Manual mode Start/Stop pushbuttons • Fault indication • Alarm Reset pushbutton
	Details	• Three phase average motor current • Contactor Delay setting • Start Time Delay after Power On setting • Runtime Totalizer • Elapsed time of current run • Elapsed time since last run • Pushbuttons to reset runtime totalizers

Equipment	Tabbed Page	Typical Content
Motors (VFD)	Home	Typical content for Motors (FVNR) plus: • Motor Speed (feedback) indication • Manual Motor Speed setting
	Details	Typical content for Motors (FVNR)
Pumps	Home	Typical content for Motors (FVNR or VFD) plus: • Low Flow status • Low Seal Water Pressure status
	Details	Typical content for Motors (FVNR or VFD) plus: • Low Flow alarm delay setting • Low Seal Water Pressure alarm delay setting
Valves	Home	• Power Fail Indication • Interlocked indication • Local/Remote mode indication • Auto/Manual mode indication • Auto/Manual mode pushbuttons • Position command (Open / Close, or % Open) • Position indication (Open / Closed, or % Open) • Manual mode Open/Close pushbuttons • Interlocked indication • Fault indication • Alarm Reset pushbutton
	Details	• Feedback delay setting
Instruments	Home	• Process Variable(s) • Alarm / Fault indication • Alarm Reset pushbutton
	Details	• Hi-Hi Alarm setpoint • Hi-Hi Alarm delay setting • Hi Alarm setpoint • Hi Alarm delay setting • Low Alarm setpoint • Low Alarm delay setting • Low-Low Alarm setpoint • Low-Low Alarm delay setting

To the right of the tab icons, provide links to resources that open in an external popup window or an external application. The icons associated with these shall be right-aligned to the display. The following links may provided, depending on the equipment.

- Device Webpage: link to open the device webpage in a web browser window.
- Help: link to help system.

Regarding the device webpage link, some field devices such as the Schneider Electric TeSys T intelligent overload have a built-in device webpage that is accessible through a web browser. The device webpage

may be used by operators and maintenance personnel to view detailed information that is not provided on the HMI system.

Help systems for equipment are not typically provided in facility HMI applications, but if a help system is provided for a specific equipment then the *Help* icon provides a link to the associated help system.

Numeric values and strings shall be shown on equipment faceplates using either the *Indicator* or *Input Field* graphic display objects. If the field shows a read-only variable, such as equipment running status, then an *Indicator* shall be used. If the field is read/write, such as the manual speed entry field for a VFD, then an *Input Field* shall be used.

Equipment faceplates shall automatically close after 10 minutes of inactivity.

A sample equipment faceplate is provided in Figure 2-6.

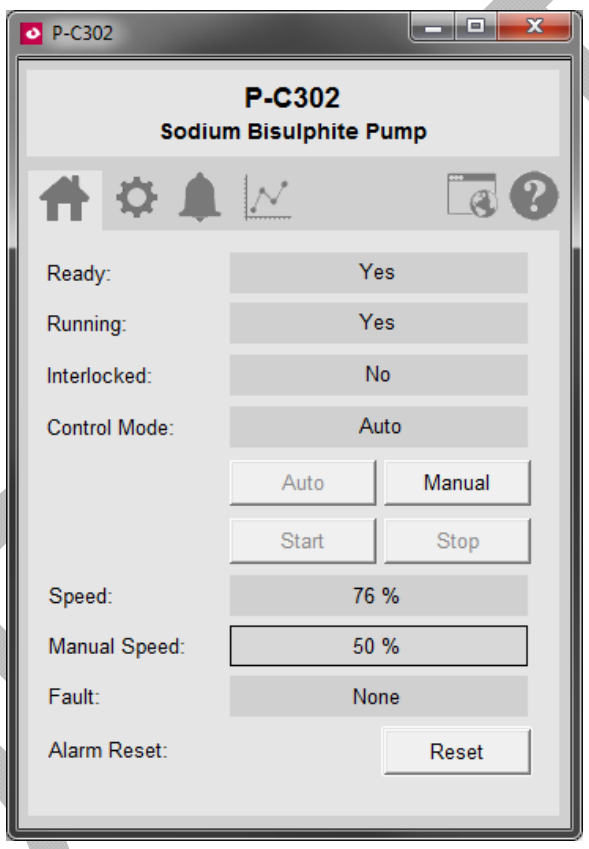


Figure 2-6: Sample Equipment Faceplate

Notes:

1. *The sample shown is for a VFD driven pump. The specific layout and information provided on equipment faceplates is dependent on the equipment.*
2. *The equipment faceplate comprises multiple tab pages of information, to group together common information and controls.*
3. *The device webpage and help system icons in the toolbar are on the right-side, implying these will open in a new window.*

2.7.8 Trend Displays

Trend displays are provided for operators to view real-time and historical signals associated with an instrument or equipment. Trend displays may also be used to view setpoints, control limits, and alarm limits.

Trend displays are full screen displays and typically comprise a single trend viewer object. For facility HMI systems that use Schneider Electric Vijeo Citect, the trend viewer object shall be the Process Analyst object. Historical data shall be read from the facility historian system.

Set the background colour of the trend object to *Grey 154*. Use red, orange, and yellow coloured pens to represent alarm limits and white pens to represent control limits. Colours other than these shall be used for the process signals.

The trend object shall show the engineering units of measure on the vertical axis, and time on the horizontal axis. It is generally preferred to use automatic scaling of the vertical axis, but fixed values may be specified if appropriate. The horizontal time axis should be scaled appropriately for the given signals. For example, if the trend is used to view daily flows, the range of the time axis should be set to 24 hours.

2.7.9 Alarm Summary Displays

Alarm summary displays are full-screen displays that show a listing of all active and historical alarms for the facility or a process area.

For facility HMI systems, clicking the three-line alarm summary in the header display takes the operator to an unfiltered alarm summary, showing all alarms at the facility. Clicking on a process area in the header's table of alarms takes the operator to a filtered alarm summary showing only the alarms for the selected process area.

Alarms shall be sorted by alarm occurrence with the most recent alarms appearing at the top.

Each alarm shall be colour coded as per the assigned priority; red for Priority 1, orange for Priority 2, and yellow for Priority 3 alarms. Unacknowledged alarms are shown using blinking text, and acknowledged alarms are shown using solid (non-blinking) text.

For each alarm, indicate the date and time of alarm occurrence, and the date and time of alarm acknowledgement.

For facility HMI systems using Schneider Electric Vijeo Citect, provide the ability to right-click on an alarm to view additional information on the alarm, disable the alarm, and acknowledge the alarm.

Provide pushbuttons on the display to acknowledge alarms as follows:

- ACK – Acknowledge the selected alarm.
- ACK AREA – Acknowledge all unacknowledged alarms for the current process area (applicable only to filtered alarm summary displays for a specific process area).
- ACK ALL – Acknowledge all unacknowledged alarms.

2.8 Organization

Organize graphic displays in a hierarchical manner that allows operators to drill down for further information on a process area and/or equipment of interest. The display hierarchy shall mimic the facility equipment hierarchy.

Four display levels are defined within the display hierarchy, as follows:

- Level 1 displays are for facility overview displays such as the Facility Process Overview, Facility Process Flow Diagram, the Facility Security Overview, and help system.

- Level 2 displays are for process area overview displays.
- Level 3 displays are for process mimic displays.
- Level 4 displays are for process detail displays.

While distinct levels are defined within the display hierarchy, it is not required to follow a strict drill-down approach to display navigation. Shortcuts may be provided to jump from any level to any other level if it is practical for the operator.

In most cases there will be a one-to-one relationship between the Level 3 and Level 4 displays but there may be cases where a one-to-one relationship does not exist.

A typical facility HMI application would have a display hierarchy like that shown in Figure 2-7.

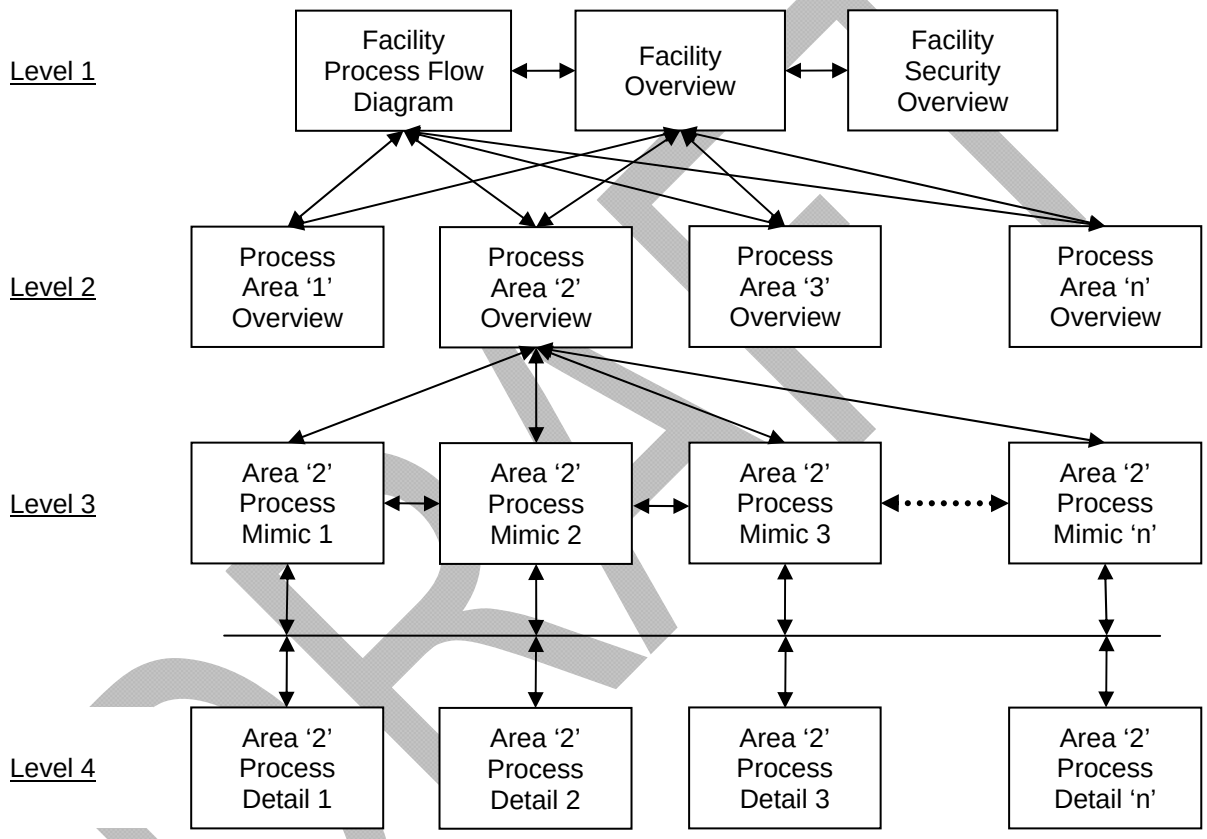


Figure 2-7: Typical Facility HMI Application Display Hierarchy

Notes:

1. *The Level 3 and Level 4 displays shown are associated with Process Area '2' only. A similar arrangement would exist for the other process areas.*
2. *Links between the Level 3 displays (process mimics) are provided using process and signal line continuation symbols.*
3. *A mesh is shown to represent the relationship between process mimics at Level 3 and the process detail displays at Level 4. The specific relationship is dependent on the equipment and the implementation of the process mimic displays.*
4. *Shortcuts between displays are omitted for clarity. For example, it may be possible to link from a Level 2 process area overview to a Level 4 process detail display if such a shortcut was provided.*

3 ALARMING SYSTEM

3.1 Alarm Presentation Philosophy

For facility HMI systems, new alarms are presented in the three-line alarm banner within the header display. Unacknowledged alarms are to appear blinking in order to get the attention of the operator, and acknowledged alarms are shown using non-blinking text.

For touchscreen HMIs used for local equipment control based on the Schneider Electric Magelis HMI, new alarms shall appear in a scrolling marquee across the top of the screen, which is the default method for display alarms on the Magelis HMI terminal.

An alarm summary screen shall also be provided which lists the active and historical alarms.

Alarms associated with equipment shall be shown on the overview displays, process mimics, and process detail displays as per Section 2.6 for both facility HMIs and touchscreen HMIs for local equipment control.

3.2 Alarm Priorities

Three priority levels of alarms are defined within the HMI alarming system:

- Priority 1 – Alarms that are critical to the operation of the process, and/or may have adverse effect on plant assets or the environment. The alarm requires immediate attention by the operators. Priority 1 alarms from SEWPCC and WEWPCC are sent to NEWPCC. See Section 3.3 for further information on Alarm Callouts.
- Priority 2 – The alarm requires attention, but does not require a callout.
- Priority 3 – The alarm does not require immediate attention.

Alarm priority levels for new alarms are to be specified in the project's Functional Requirements Specification (FRS).

3.3 Alarm Callouts

SEWPCC and WEWPCC are not manned 24 hours per day. When a Priority 1 alarm occurs at SEWPCC or WEWPCC, the alarm shall be forwarded to NEWPCC to notify the operators.

Until such time that NEWPCC is upgraded with a PLC-based control system, a temporary alarming gathering system is required at NEWPCC for collection of PLC-based alarms from SEWPCC and WEWPCC.

4 MISCELLANEOUS

4.1 Help System

A help system shall be provided for each HMI system that include the following:

1. A symbol legend for equipment, alarm icons, and abnormal state icons,
2. Display navigation procedures,
3. User login/logout procedures,
4. User security information, and
5. Operating procedures for complex equipment as required.

4.2 Commands Originating from the HMI

Commands that originate from the HMI shall utilize the SET action, rather than the Momentary ON action. The PLC shall reset the bit after it is utilized in the program. This prevents discrete PLC tags from being stock on in the event of communication failures, timing issues, or control from multiple HMI nodes.

4.3 HMI Security

HMI systems shall incorporate security to prevent unauthorized setpoint changes and to prevent unauthorized control of equipment. All graphic display objects that can change a tag value in a PLC shall incorporate user security. Typical examples of such display objects include pushbuttons for starting/stopping equipment and numeric input fields for setpoint adjustment.

Where a graphic display object is secured and the current user does not have the required access privileges, show the *Lock* icon inside the field to represent the fact that the field is currently locked.

Three levels of security are to be implemented as per Table 4-1.

Table 4-1: HMI User Security Levels

Security Level	User Job Function	Capabilities	Restrictions
High (H)	Engineering	• All	• None
Medium (M)	E&I Technician	• Viewing HMI • Manual equipment control • Equipment setpoint adjustment • Viewing reports, trends, and alarms • Alarm acknowledgement • Alarm setpoint adjustment	• Enable and disable alarms
Low (L)	Operator	• Viewing HMI • Manual equipment control • Equipment setpoint adjustment • Viewing reports, trends, and alarms • Alarm acknowledgement	• Alarm setpoint adjustment • Enable and disable alarms
None (N)	N/A	• Viewing HMI in read-only mode	• Manual equipment control • Equipment setpoint adjustment • Alarm acknowledgement • Alarm setpoint adjustment