



**The City of Winnipeg**  
**Water & Waste Department**

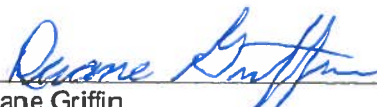

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**HMI Layout and Animation Plan**

Document Code:

Revision: 01

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|--------------|---|---|
| Approved By: |  |  |
|              | Duane Griffin,<br>Branch Head – WW Planning & Projects                              | Date  |





# HMI Layout and Animation Plan

Revision: 01 Page 3 of 49

Document Code:

## REVISION REGISTER

| Rev. | Description             | Date       | By        | Checked     | Approved   |
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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 Sewage Treatment Plant (NEWPCC),
- South End Sewage Treatment Plant (SEWPCC),
- West End Sewage Treatment Plant (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.

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 and agreed by the City.

### 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                         |
| kW     | Kilo Watts   |
| I/O    | Input/Output   |
| MCC    | Motor Control Centre   |
| 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. Electrical Design Guide, document code 510276-0000-47ER-0001.
2. Automation Design Guide, document code 612620-0013-40ER-0001.
3. Tagname Identification Standard, document code 612620-0014-40ER-0001.
4. Historical Data Retention Standard, document code 612620-0016-40ER-0001.

|   |                                      |                |              |
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## 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.

Use the following general principles when designing and implementing HMI applications for facility desktop HMI and touchscreen HMI systems:

1. Utilize a “shades-of-grey” approach to show all process and systems, other than those in an abnormal state.
2. Design graphic displays around the tasks and goals of the operators, rather than the sensors and equipment that produce the data.
3. Organize information in a way that allows operators to make effective decisions. Group related information together, and make important information stand out.
4. 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 blind to the facility operation.
5. Illustrate equipment on graphic displays using a flat, 2-dimensional (2D) style. Use of 3-dimensional (3D) style is only accepted for pushbuttons.
6. Do not use gradients, drop shadows, or other similar graphics techniques to enhance the visual appearance of graphic displays.
7. Use the minimum amount of detail to represent equipment. Excessive detail does not promote operator understanding, but rather acts as a visual distraction.
8. Do not incorporate unnecessary animation that is distracting to operators. Examples of unnecessary animation include rotating equipment, flowing water, and flickering flames.
9. Use colour to facilitate discrimination between important information and less-important information. Important information shall be shown in red, orange, yellow, and blue. Less important information is typically shown in a shade of grey. Further information is provided in Section 2.2.
10. Use different shapes, in addition to different colours, to facilitate discrimination between important information such as alarm icons.
11. Use different shades of grey to differentiate between running and stopped equipment, opened and closed valves, and energized/de-energized cables.
12. Do not depict instruments on overview displays or process mimic displays. Only display the instrument reading, along with the units of measure.
13. 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.
14. 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.
15. Minimize the amount of typing that is required by operators by providing selection lists, radio buttons, up/down arrows, or check boxes where possible.
16. 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

Process graphics are to be implemented using the *Shades of Grey* colour scheme. Equipment and process lines are shown using a shade of grey, and abnormal conditions are shown in bright colours such as red, orange, yellow, and blue.

Refer to Table 2-1 for the standard colours used within City of Winnipeg HMI systems.

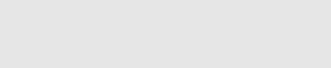



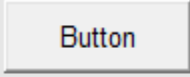
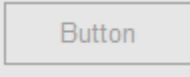
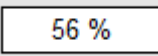

**Table 2-1: RGB Colour Reference**










| Colour     | Sample | RGB Value     | Typical Purpose   |
|------------|--------|---------------|---|
| White      |        | 255, 255, 255 | Background of numeric displays, text displays, bar graphs, and gauges.  |
| Grey 242   |        | 242, 242, 242 | Active tab fill colour on the Header display.   |
| Grey 230   |        | 230, 230, 230 | Graphic Display Background, Stopped Equipment Fill.   |
| Grey 208   |        | 208, 208, 208 | Popup Window Inactive Background  |
| Grey 192   |        | 192, 192, 192 | Piping, fill colour of static equipment such as tanks and vessels, object outlines for equipment that is "Not Ready" or are out of service, and bar graph alarm ranges. |
| Grey 160   |        | 160, 160, 160 | Border colour of static equipment such as tanks and vessels, Bar graph process variable.  |
| Grey 154   |        | 154, 154, 154 | Background colour of trend displays   |
| Grey 128   |        | 128, 128, 128 | Fill colour for Running Equipment, Bar graph alarm ranges.  |
| Grey 96    |        | 96, 96, 96    | Process Loops, Object outlines for equipment that is ready  |
| Black      |        | 0, 0, 0       | Text, Setpoint (SP) indicator arrows.   |
| Red        |        | 255, 0, 0     | Priority 1 Alarms (High Priority)   |
| Orange     |        | 255, 128, 0   | Priority 2 Alarms (Medium Priority)   |
| Yellow     |        | 255, 255, 0   | Priority 3 Alarms (Low Priority)  |
| Light Blue |        | 66, 186, 255  | Abnormal States (e.g. Equipment in Manual Mode)   |
| Blue       |        | 0, 0, 255     | Hyperlinks  |




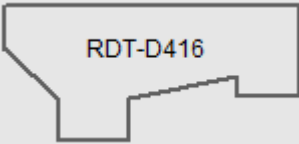

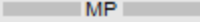
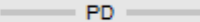
## 2.3 Standard Graphic Display Objects

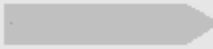







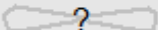
Refer to Table 2-2 for standard graphic display objects. If additional objects are required, use the same style as that shown in this standard.

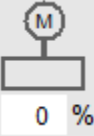
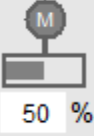
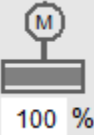
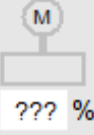




**Table 2-2: Standard Graphic Display Objects**











| Object                    | State                | Colour  | Sample   | Notes  |
|---------------------------|----------------------|---|--|--|
| Display Background        | -                    | Grey 230                                      |    |  |
| Primary Titles            | -                    | Black   | <b>Primary Title</b>   | Arial, 14 point, bold  |
| Secondary Titles          | -                    | Black   | <b>Secondary Title</b>   | Arial, 12 point, bold  |
| General Text              | -                    | Black   | General Text   | Arial 10 point, regular  |
| Medium Text               | -                    | Black   | Medium Text  | Arial 9 point, regular   |
| Small Text                | -                    | Black   | Small Text   | Arial 8 point, regular   |
| Hyperlink                 | -                    | Blue  | <a href="#">Hyperlink</a>  | Arial 10 point, underlined   |
| Display Navigation Button | -                    | Grey 160, Grey 208                            |     | Located in the Header Display of a facility HMI application.                 |
| Back Button               | -                    | Grey 160, Grey 208, White                     |  | Located in the Header Display of a facility HMI application.                 |
| Forward Button            | -                    | Grey 160, 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.                 |
|                           | Disabled             | Grey 230 Fill, Grey 160 Text, Grey 160 Border |  | Do not change the text on a pushbutton. Disabled buttons are to appear flat. |
| Input Field               | Enabled (read/write) | White Fill, Black Border                      |  | Use <i>General Text</i>  |
|                           | Disabled (read only) | Grey 230 Fill, Grey 160 Text, Black Border    |  | Use <i>General Text</i>  |

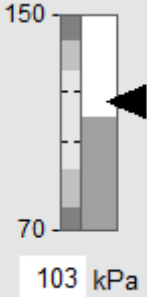
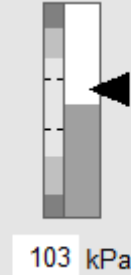
| Object                              | State              | Colour     | Sample  | Notes   |
|-------------------------------------|--------------------|------------|---|---|
| Lock Icon                           | Locked             | Grey 160   |    | Show beside a secured object (eg. an <i>Input Field</i> ) that is locked.       |
| Priority 1 Alarm Icon               | Active             | Red        |    | Blink when unacknowledged, solid when acknowledged.                             |
|                                     | Inactive           | -          | Invisible   |   |
| Priority 2 Alarm Icon               | Active             | Orange     |    | Blink when unacknowledged, solid when acknowledged.                             |
|                                     | Inactive           | -          | Invisible   |   |
| Priority 3 Alarm Icon               | Active             | Yellow     |    | Blink when unacknowledged, solid when acknowledged.                             |
|                                     | Inactive           | -          | Invisible   |   |
| Control Mode Icon (PLC)             | Manual             | Light Blue |   | Not blinking  |
|                                     | Auto               | -          | Invisible   |   |
| Control Mode Icon (Physical Switch) | Local              | Light Blue |  | Not blinking  |
|                                     | Hand               | Light Blue |  | Not blinking  |
|                                     | Remote             | -          | Invisible   |   |
| Not Ready Icon                      | Not Ready          | Light Blue |  | Used if equipment is not ready to run (eg. power is switched off). Not blinking |
|                                     | Ready              | -          | Invisible   |   |
| Alarms Disabled Icon                | Alarms Disabled    | Light Blue |  | Show next to equipment that has one or more alarms disabled. Not blinking.      |
|                                     | No Alarms Disabled | -          | Invisible   |   |

| Object                          | State              | Colour                         | Sample   | Notes  |
|---------------------------------|--------------------|--------------------------------|--|--|
| Override Icon                   | Override Active    | Light Blue                     |     | Show next to an instrument or equipment that has one or more signals overridden.<br>Not blinking.  |
|                                 | No Override Active | -                              | Invisible  |  |
| Static Tank / Vessel            | -                  | Grey 160, Grey 192, Black text |    | May adjust shape to reflect actual tank or vessel shape.<br>Do not show inner detail.<br>Show equipment identifier inside object.  |
| Non-Static Equipment            | Running            | Grey 96, Grey 128, White text  |   | Adjust the shape to reflect the shape of the equipment (typically as it is shown on the P&IDs).<br>Do not show inner detail unless required to help clarify equipment type or operation. |
|                                 | Stopped            | Grey 96, Grey 230, Black text  |  | Show equipment identifier inside object.   |
| Large Pipe (300+ mm) or Channel | -                  | Grey 192, Black text           |  | 11 Pixels in width/height.<br>Indicate Fluid Commodity Code using <i>Small Text</i> .  |
| Medium Pipe (90 - 250 mm)       | -                  | Grey 192, Black text           |  | 7 Pixels in width/height.<br>Indicate Fluid Commodity Code using <i>Small Text</i> .   |
| Small Pipe (3 - 80 mm)          | -                  | Grey 192, Black text           |  | 3 Pixels in width/height.<br>Indicate Fluid Commodity Code using <i>Small Text</i> .   |
| Process Loops                   | -                  | Grey 96                        |  | 1 Pixel  |

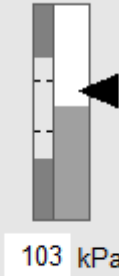

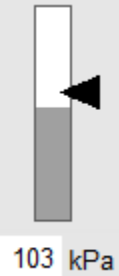

| Object                      | State         | Colour                               | Sample   | Notes   |
|-----------------------------|---------------|--------------------------------------|--|---|
| Process/Signal Continuation | -             | Grey 192                             | From Post Dilution<br>Polymer Pump 1<br> | Provide touch link to the referenced display.<br><br>Use <i>Medium Text</i> (9 point).                  |
| Pump / Fan                  | Running       | Grey 96,<br>Grey 128                 |    | For variable speed pumps/fans, indicate the speed in units of percent using an <i>Indicator</i> object. |
|                             | Stopped       | Grey 96,<br>Grey 230                 |    |   |
|                             | Not Ready     | Grey 192,<br>Grey 230                |    |   |
|                             | Unknown State | Grey 192,<br>Grey 230,<br>Black text |   | Show an <i>Alarm Icon</i> and an appropriately coloured rectangle around the object as per Table 2-3.   |
| Mixer                       | Running       | Grey 96,<br>Grey 128                 |                                        | For variable speed mixers, indicate the speed in units of percent using an <i>Indicator</i> object.     |
|                             | Stopped       | Grey 192,<br>Grey 230                |                                        |   |
|                             | Not Ready     | Grey 192,<br>Grey 230                |                                        |   |
|                             | Unknown State | Grey 192,<br>Grey 230,<br>Black text |                                        | Show an <i>Alarm Icon</i> and an appropriately coloured rectangle around the object as per Table 2-3.   |

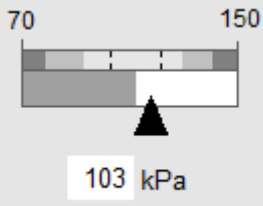
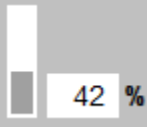







| Object                              | State                     | Colour                                  | Sample   | Notes   |
|-------------------------------------|---------------------------|---|--|---|
| Actuated Modulating Valve or Damper | Closed                    | Grey 96, Grey 128, Grey 230             |    | The width of the bar graph inside the object reflects percentage open.<br><br>Show the actual position in units of % open using an <i>Indicator</i> object. |
|                                     | Intermediary Position     | Grey 96, Grey 128, Grey 230             |    | The actuator shown is a motor actuator. Other actuator symbols are provided below.  |
|                                     | Open                      | Grey 96, Grey 128, Grey 230             |    | The actuator may be colour animated to reflect the running state if known.  |
|                                     | Unknown State or Position | Grey 192, Grey 230, Black text          |   | Show an <i>Alarm Icon</i> and an appropriately coloured rectangle around the object as per Table 2-3.   |
| Actuated On/Off Valve or Damper     | Closed                    | Grey 96, Grey 230, Black text           |  | The actuator shown is a motor actuator. Other actuator symbols are provided below.  |
|                                     | Intermediary Position     | Grey 96, Grey 128, Grey 230, White text |  |   |
|                                     | Open                      | Grey 96, Grey 128, Grey 230, White text |  | The actuator may be colour animated to reflect the running state if known.  |
|                                     | Unknown State or Position | Grey 192, Grey 230, Black text          |  | Show an <i>Alarm Icon</i> and an appropriately coloured rectangle around the object as per Table 2-3.   |






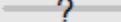




| Object                                   | State                                  | Colour                           | Sample   | Notes  |
|--|--|----------------------------------|--|--|
| Valve Actuator - Motor                   | Energized (Running)                    | Grey 96, Grey 128, White text    |     | Use in combination with a valve symbol.<br><br>See ISA 5.1 for additional actuator symbols.  |
|  | De-Energized (Stopped)                 | Grey 192, Grey 230, Black text   |     |  |
|  | Out of Service                         | Grey 192, Grey 230, Black text   |     |  |
| Valve Actuator - Pneumatic Spring Return | Stopped or Unknown if Moving           | Grey 96, Grey 128                |     | Use in combination with a valve symbol.<br><br>See ISA 5.1 for additional actuator symbols.  |
|  | Actuator Moving (if known)             | Grey 96, Grey 230                |     |  |
|  | Out of Service                         | Grey 192, Grey 230               |     |  |
| Valve Actuator - Solenoid                | In Service (Energized or De-energized) | Grey 95, Grey 230, Black text    |   | Use in combination with a valve symbol.<br><br>See ISA 5.1 for additional actuator symbols.  |
|  | Out of Service                         | Grey 192, Grey 230, Black text   |   |  |
| Indicator                                | -                                      | White, Black                     |  | Use <i>General Text</i> .<br>Show the units outside the white box.   |
| Gauge                                    | -                                      | Black, Grey 128, Grey 192, White |  | Setpoint or control limits indicated with dashed line(s) (as required).<br><br>Process reading indicated with black arrow.<br><br>Alarm limits indicated with darker shades of grey. |




| Object                     | State   | Colour   | Sample   | Notes  |
|----------------------------|---|--|--|--|
| <p>Bar Graph, Vertical</p> | <p>All elements shown</p>   | <p>Black, Grey 92, Grey 128, Grey 160, Grey 192, Grey 230, White</p> |    | <p>Process variable (PV) is shown inside the right-hand rectangle using Grey 160 vertical fill animation.</p> <p>Left-hand rectangle is filled with Grey 230, and has the alarm limits and control limits overlaid on it. Low-Low and Hi-Hi alarm ranges are shown using Grey 128. Low and Hi alarm ranges are shown using Grey 192.</p> <p>Control limits are indicated in the left-hand rectangle with black dashed lines.</p> <p>Setpoint (SP) indicated on the right with a black arrow (triangle).</p> <p>PV is indicated in text below the bar graph. SP indication in text is shown on the faceplate only.</p> <p>Min/max values indicated in text to the left of the alarm limits.</p> <p>Object outlines using Grey 92.</p> |
|                            | <p>Hi-Hi, Hi-Low, Low-Low alarm ranges, control limits, PV, and SP are shown. Min/max values are not shown.</p> | <p>Black, Grey 92, Grey 128, Grey 160, Grey 192, Grey 230, White</p> |  | <p>Alarm ranges for Low-Low, Low, Hi, and Hi-Hi are shown.</p> <p>PV is indicated in text below the bar graph. SP indication in text is shown on a faceplate.</p>  |



| Object | State   | Colour  | Sample   | Notes   |
|--------|---|---|--|---|
|        | Hi, Low alarm ranges, control limits, PV, and SP are shown.<br><br>Hi-Hi, Low-Low alarm ranges, Min/max values are not shown. | Black,<br>Grey 92,<br>Grey 128,<br>Grey 160,<br>Grey 230,<br>White              |    | Alarm limits for Low and Hi are shown using Grey 128.<br><br>Alarm limits for Low-Low and Hi-Hi are not applicable. PV is indicated in text below the bar graph. SP indication in text is shown on a faceplate. |
|        | Alarm ranges and PV are shown.<br><br>Min/max values, control limits, and SP are not shown.                                   | Black,<br>Grey 92,<br>Grey 128,<br>Grey 160,<br>Grey 192,<br>Grey 230,<br>White |    | Show min/max values as required.  |
|        | PV and SP are shown.<br><br>Min/max values, alarm ranges, and control limits not shown.                                       | Black,<br>Grey 92,<br>Grey 160,<br>White  |  | Show min/max values as required.  |
|        | Only PV is shown.<br><br>Min/max values, alarm ranges, control limits, and SP not shown.                                      | Black,<br>Grey 92,<br>Grey 160,<br>White  |  | Show min/max values as required.  |

| Object                       | State                      | Colour  | Sample  | Notes   |
|------------------------------|----------------------------|---|---|---|
|                              | All elements shown.        | Black,<br>Grey 92,<br>Grey 128,<br>Grey 160,<br>Grey 192,<br>Grey 230,<br>White |   | Elements may be removed as required in a similar manner as the vertical bar graph.<br><br>SP indication in text is only to be shown on an equipment faceplate.    |
| Bar Graph, Horizontal        | -                          | White,<br>Grey 160,<br>Black  |   | The vertical bar graph is animated to reflect the tank level.<br><br>Typically used on process mimic displays.  |
| Tank Level Indicator         | Racked in and Closed       | Grey 96,<br>Grey 128  |    |   |
| Power Circuit Breaker        | Racked in and Open         | Grey 96,<br>Grey 230  |    | Also show an <i>Alarm Icon</i> and an appropriately coloured rectangle around the object as per Table 2-3.  |
|                              | Racked Out, Out of Service | Grey 192  |  |   |
|                              | Unknown State              | Grey 192,<br>Black text   |  |   |
|                              | Closed                     | Grey 128  |  | State feedback is not typically from the breaker itself. State may be inferred based on data from protection relays, power meters, or intelligent overloads, etc. |
| Moulded Case Circuit Breaker | Open                       | Grey 192  |  | Also show an <i>Alarm Icon</i> and an appropriately coloured rectangle around the object as per Table 2-3 as required.  |
|                              | Unknown State              | Grey 192,<br>Black text   |  |   |

| Object                                      | State         | Colour               | Sample   | Notes  |
|---|---------------|----------------------|--|--|
|   | Energized     | Grey 128             |     | State feedback is not from the fuse itself. State may be inferred based on data from protection relays, power meters, or intelligent overloads, etc. |
| Fuse  | De-Energized  | Grey 192             |     | Also show an <i>Alarm Icon</i> and an appropriately coloured rectangle around the object as per Table 2-3 as required.                               |
|   | Unknown State | Grey 192, Black text |     |  |
|   | Energized     | Grey 128             |    | 3 pixels. Energized state is inferred based on other data.   |
| Bus or Cable                                | De-Energized  | Grey 192             |   | 3 pixels. De-energized state is inferred based on other data.  |
|   | Unknown State | Grey 192, Black text |  | 3 pixels.  |
|   | -             | Grey 230             |  | Refer to Section 2.7.7 for information on Equipment Faceplates.  |
| Equipment Faceplate Active Tab Background   | -             | Grey 208             |  |  |
| Equipment Faceplate Inactive Tab Background | -             | Grey 128             |   |  |
| Equipment Faceplate Tab Icon, Home          |               | Grey 128             |   |  |
| Equipment Faceplate Tab Icon, Details       | -             | Grey 128             |   |  |
| Equipment Faceplate Tab Icon, Configuration | -             | Grey 128             |   | Overlay an alarm icon if an alarm is active.   |

| Object                               | State | Colour   | Sample  | Notes  |
|--------------------------------------|-------|----------|---|--|
| Equipment Faceplate Tab Icon, Alarms | -     | Grey 128 |  |  |
| Equipment Faceplate Tab Icon, Trends | -     | Grey 128 |  |  |
| Equipment Faceplate Link, Webpage    | -     | Grey 128 |  | Not normally provided. Provide only if required. |
| Equipment Faceplate Link, Help       |       |          |   |  |

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## 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 enabled it shall be filled with white colour. When an *Input Field* is disabled it shall be filled with grey colour.

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 when the equipment is in manual mode.

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:

1. 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),
2. 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),
3. Units of measure are unaltered in the plural. Example: 5 cm, not 5 cms,
4. Capitalization of unit prefixes (p, n,  $\mu$ , m, c, k, M, G, etc.) shall be as per standard convention,
5. Provide a space between numeric readings and the unit of measure.
6. Percentage (%) is typically used to indicate the position of valves (percent open), the speed of variable-speed motors (percent of full speed), tank level (percent full), and for other process readings that natively use percentage as the unit of measure. However, exceptions to these may be applied in specific cases. It is also permissible to indicate a process measurement in units of percent along with another unit of measure (eg. wetwell level may be shown in units of percent and in meters).

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## 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 inner detail of the equipment is changed to reflect the current state, as per the following.

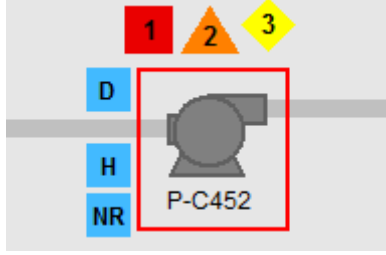
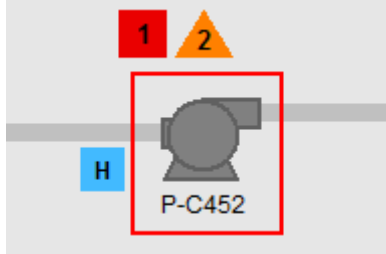
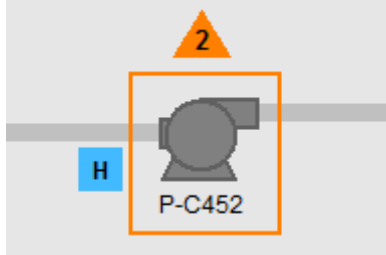
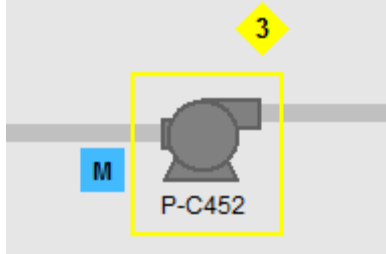
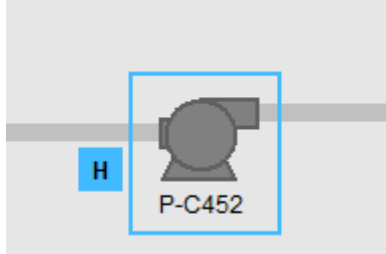
1. For equipment such as motors, pumps, fans, and mixers that have the capability of being started and stopped, colour is used to represent the equipment running status. Equipment that is running is shown using Grey 128 fill with a Grey 96 border, and equipment that is stopped is shown using Grey 230 fill with a Grey 96 border.
2. Equipment that is Not Ready, in an unknown state, or in an unknown position, should be shown using Grey 230 fill and a Grey 192 border. If the equipment is in an unknown state or position then question marks are shown on the equipment (eg. equipment control is via an intelligent motor starter using Modbus/TCP but the communication link is down).
3. For on/off valves, fill colour is used to indicate whether the valve is opened or closed. Do not animate the fill colour of the valve based on the running status (eg. running open or running closed) – this information can be provided on a faceplate if needed. However, if the “running” state of the actuator is known then the actuator fill colour is to be animated based on the running status. On/off valves in the open state are shown using Grey 128 fill and Grey 96 border, and in the closed state using Grey 230 fill and Grey 96 border. Diagonal lines are shown in the body of the valve if the valve is known to be in an intermediary position (the open limit and closed limit switches are not made). Question marks are shown on the valve if it is in an unknown position (eg. an intelligent on/off actuator using Profibus communication, but the communication link is down).
4. On/off dampers are shown in an identical manner as on/off valves.
5. 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. When the valve is fully closed, the width of the horizontal bar graph shall be zero. However, if the “running” state of the actuator is known then the actuator fill colour is to be animated based on the running status.
6. Modulating dampers are shown in an identical manner as modulating valves.
7. For *Indicator objects*, indicate three question marks inside the indicator if the value is unknown as a result of some failure in the system (eg. a communication failure).

The applicable alarm and abnormal condition icons, as per Table 2-2, shall be shown adjacent to each piece of equipment that have alarms or abnormal states. Standard icons are provided for each alarm priority level, and for indicating the equipment is in hand mode, manual mode, not ready, has alarms disabled, or a signal is overridden. Use visibility animation to show and hide these icons depending on the state of the equipment. Some operating modes are mutually exclusive and therefore the icons may overlap each-another since they will not both be shown 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.

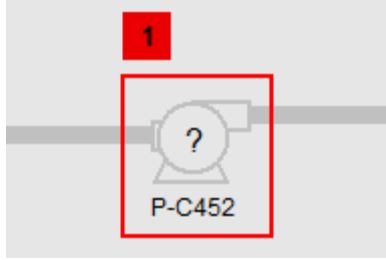
Refer to the sample figures in Table 2-3 for the standard method of displaying equipment status.

Table 2-3: Display of Equipment Status

| State  | Sample   | Notes  |
|--|--|--|
| <p>All symbols shown<br/>(in development environment)</p>                |    | <p>All symbols are organized around the equipment in close proximity.</p> <p>The “Hand” (H) icon overlaps the “Manual” (M) icon as these are mutually exclusive. As such, the “Manual” (M) icon is unseen.</p> |
| <p>Equipment Running in Hand with a Priority 1 and Priority 2 alarm.</p> |    | <p>The rectangle is shown in red since the Priority 1 alarm condition supersedes both the Priority 2 alarm condition and the “Hand” abnormal condition.</p>  |
| <p>Equipment Running in Hand with Priority 2 alarm.</p>                  |   | <p>The rectangle is shown in orange since the alarm condition supersedes the abnormal condition (Hand).</p>  |
| <p>Equipment Running in Manual mode with a Priority 3 alarm.</p>         |  | <p>The rectangle is shown in yellow colour since the alarm condition supersedes the abnormal condition (Manual).</p>   |
| <p>Equipment Running in Hand mode with no alarms.</p>                    |  | <p>The rectangle is shown in blue because there are no active alarms.</p>  |

| State  | Sample | Notes   |
|--|--------|---|
| 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 and blue matches the Manual (M) icon.             |
| Equipment Not Ready and stopped with no alarms.                              |        | The rectangle is shown in blue because there are no active alarms and blue matches the Not Ready (NR) icon.         |
| Equipment running in remote with one or more disabled alarms.                |        | The rectangle is shown in blue because there are no active alarms and blue matches the Disabled Alarms (D) icon.    |
| Equipment running in Remote with no alarms.                                  |        | No rectangle is shown around the equipment since there are no alarms.   |
| Equipment stopped in Remote with no alarms.                                  |        | No rectangle is shown around the equipment since there are no alarms.   |



| State  | Sample   | Notes   |
|--|--|---|
| <p>Unknown State –<br/>Communication Failure between<br/>PLC and equipment</p> |  | <p>A question mark is shown inside the equipment to reflect that the equipment state is unknown.</p> <p>A Priority 1 alarm is shown as a result of the communication failure, however the priority level may vary depending on the application.</p> |

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## 2.7 Display Types

### 2.7.1 General

HMI applications will include several types of displays for viewing various levels of 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. Equipment Detail Displays
6. Equipment Faceplates (Popups)
7. Trend Displays
8. Alarm Summary Displays

Where a header or footer display is provided in an HMI system, the term “full-screen display” refers to a display that occupies all of the remaining screen space that is not already occupied by the header or footer.

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

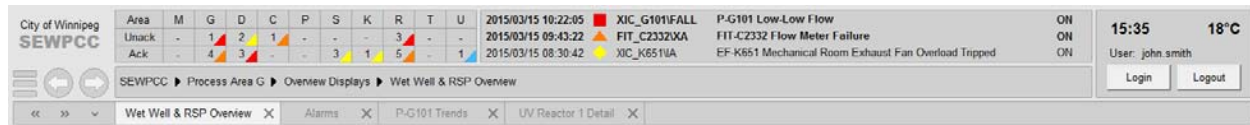
### 2.7.2 Header/Footer Displays

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:

1. The facility name (eg. NEWPCC, SEWPCC, or WEPCC) to convey to operators which site they are operating, which is useful for remote applications (eg. control of SEWPCC from NEWPCC),
2. A Display Navigation button (icon) that links to the primary navigation display,
3. Back and forward buttons (icons) for display navigation,
4. A breadcrumb trail showing the path to the current display within the display hierarchy,
5. A table of alarms by process area,
6. An alarm list that shows the three most recent alarms at the facility,
7. The currently logged in user,
8. The present date and time, and
9. A row of tabs listing the open full-screen displays.

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



**Figure 2-1: Sample Facility HMI Header**

The Display Navigation button is located on the far left of the header, below the facility name. This button takes operators to the top-most 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. These buttons shall return the operator to the previous full-screen display they were on. The forward button is normally disabled unless the 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 to other displays. Levels within the hierarchy are separated by right-hand arrows. Clicking an arrow opens a list of all displays at that level in the hierarchy, and clicking on a display in the list shall open the display. This is similar to the breadcrumb navigation system of Windows Explorer (File Explorer) in Windows 7 and above.

The table of alarms lists the quantity of unacknowledged alarms and acknowledged alarms in each process area. Coloured triangles are used to indicate the priority level of the highest priority alarm. 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. If no alarms are active in a specific process area, a hyphen rather than a zero (“0”) shall be shown.

The alarm list shows the three most recent alarms at the facility, along with the date/time that the alarm occurred and the associated alarm icons (without the numbers “1”, “2”, or “3” inside the icons). Clicking on the alarm list brings the operator to a full-screen Alarm Summary display that lists all of the alarms for the facility. In the three-line alarm list, unacknowledged alarms are shown using bold and blinking text and acknowledged alarms are shown using non-bold and non-blinking text. The state of the alarms (eg. “ON” or “OFF”) are shown at the far right of the alarm list.

Along the bottom of the header is tab bar that may be used to immediately go to any open display. When an operator opens a new display a new tab is added to the tab bar. New tabs are added to the right-hand side of the list of tabs. The active tab is shown using Grey 242 fill with black text, and non-active tabs are shown using Grey 208 fill and Grey 128 text. Clicking an in-active tab brings the associated display to the foreground. Left of the tabs are three buttons that allow operators to scroll through and select tabs:

1. A double-left arrow to scroll the list of tabs leftward.
2. A double-right arrow to scroll the list of tabs rightward.
3. A down arrow to show a list of all tabs, and allows the operator to click an item in the list to bring the associated display to the foreground.

The background (fill) colour of the items the header display (except for the active tab) shall be Grey 208.

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. Header displays are generally not provided on local touchscreen HMIs.

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

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### 2.7.3 Navigation Displays

Navigation displays are provided within facility HMI applications as the primary means for display navigation, and to open external applications and documentation used by operators. Navigation displays are implemented as full-screen displays.

Navigation displays contain links to all the full-screen displays in the HMI application. Equipment faceplates or other popup displays are not typically listed on navigation displays.

Each link is implemented using a rectangle that contains a description of the item it links to. The rectangles are sufficiently sized to ensure compatibility with touchscreen HMI clients. The borders of the rectangles are colour coded based on the type of display or item they link to. Use blue colour for overview displays, green for process mimic displays, and purple for equipment detail displays. Other colours may be used as required, but do not use alarm colours (red, orange, and yellow).

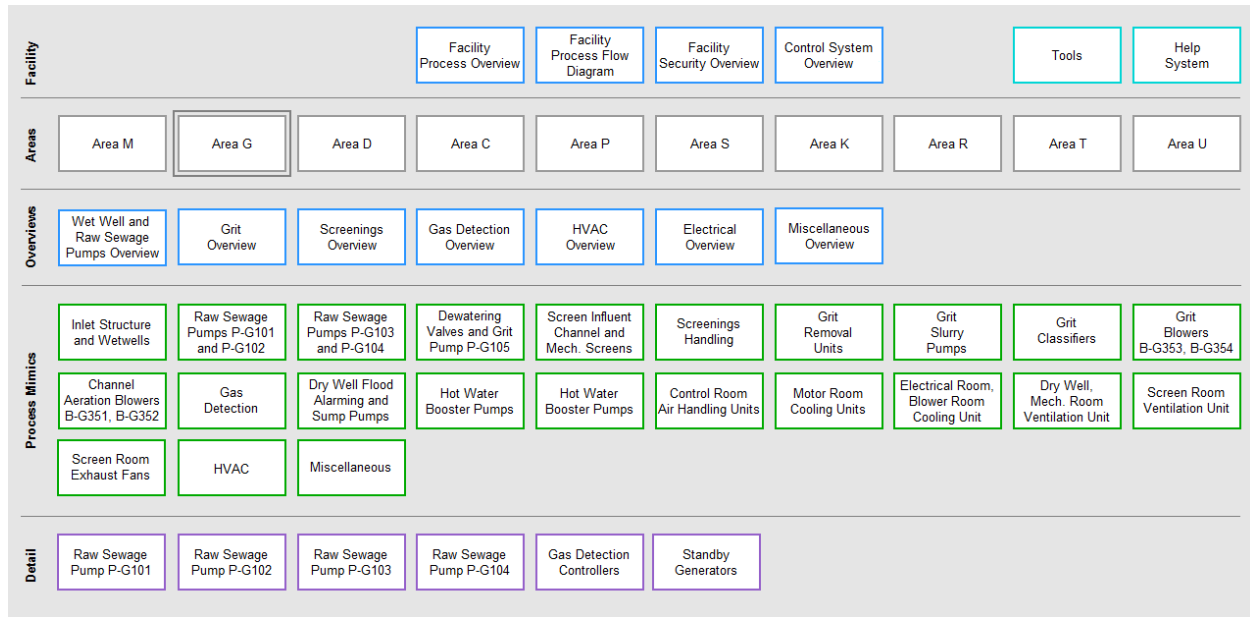
Design and implement navigation displays such that the operator is able to access any full-screen display with ideally three (3) or fewer clicks. Note that clicking on the Display Navigation button in the header counts as one click, leaving two more clicks on the navigation display to open the desired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

Organize links to operator displays in a hierarchical-grid arrangement to mimic the organization of the displays within the application, as per the following:

1. 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 the Control System Overview.
2. In the second row, list all of process areas in the facility using similar rectangles.
3. Below the second row, list all of the process overview displays, mimic displays, and equipment detail displays for each process area. When a process area rectangle is clicked on, the display links for the selected process area are shown.

In the top-right corner, provide links to the “Tools” navigation display and the “Help System”. The “Tools” navigation display contains links to external applications, documentation, and drawings that are used by operations personnel. The “Help System” link takes the operator to a help system that displays the standard equipment symbols and provides guidance on the use of the HMI system.

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

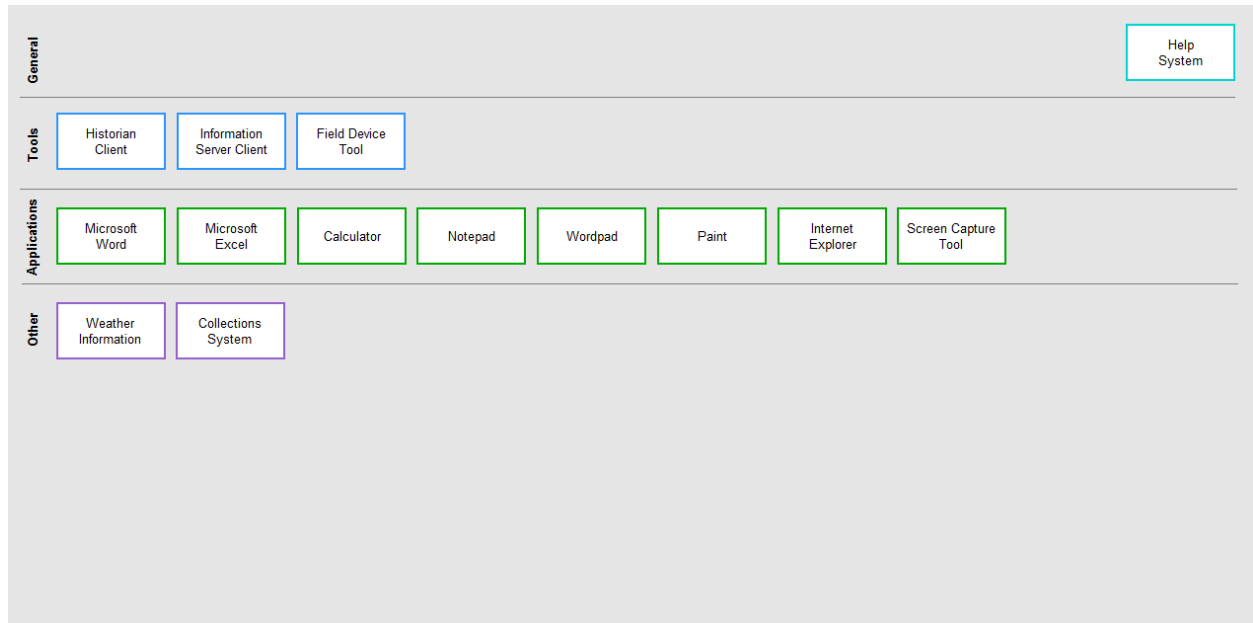


**Figure 2-2: Sample Navigation Display**

**Notes:**

1. Links to the facility overview displays, tools, and the help system are shown in the top row.
2. A row of process area links (rectangles with grey outline) are provided in the 2<sup>nd</sup> row. These are used to show the display links for each 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 associated with Area G, since it is the selected area.
5. A typical navigation screen for a major process area would contain more Detail Displays.

A sample “Tools” navigation display is shown in Figure 2-3. Links are provided to process-related software tools such as the historian client, information server client, and a field device analytical tool. Below this are links to commonly used Windows applications such as Microsoft Word, Excel, Calculator, Notepad, WordPad, Paint, Internet Explorer, and a screen capture tool. The bottom row contains links to other information and systems such as the weather and the collections SCADA system. Additional links to other applications and documents may be provided as required.



**Figure 2-3: Sample Navigation Display – Tools**

**Notes:**

1. The first row contains links to process control system related tools.
2. The second row contains links to commonly used Windows applications.
3. The third row contains links to facility documentation and drawings, weather information, and the Wastewater Collections system.
4. To return to the main navigation display (Figure 2-2), the operator may click the “Navigation” button or the “Back” button in the header display.

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## 2.7.4 Overview Displays

An overview display shows an overview of a facility, process area, or one or more process trains and appears 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 as required for larger process areas.

A local touchscreen HMI 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 together 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 gauges and bar graphs wherever possible.

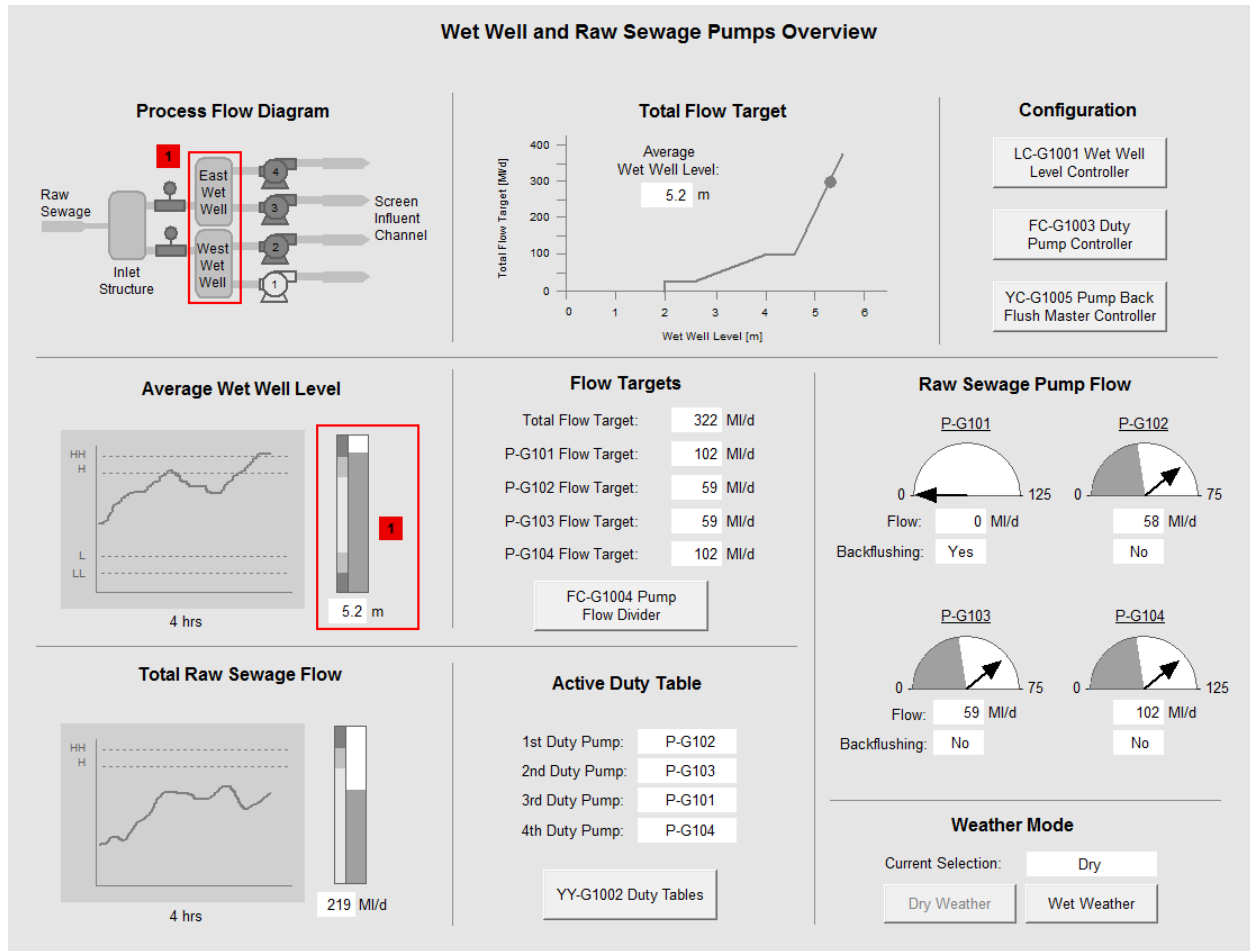
If a fraction of a reading, difference between two readings, or an average of two readings is important to operators, provide the information on the display rather than making operators do the mental arithmetic. Note that the computation of these shall be in the PLC, and the HMI is used for display only.

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 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 diagram helps 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 the raw sewage pumps at a wastewater treatment facility is shown in Figure 2-4.



**Figure 2-4: Sample Overview Display – Wet Well and Raw Sewage Pumps**

**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 and are accompanied by text displays to give the exact value.
4. Text displays (without bar graphs and gauges) are used for information that does not change frequently and does not have alarm limits, such as the pump duty assignments.
5. A Priority 1 high-high level alarm associated with the Average Wet Well Level is shown. The wet wells in the process flow diagram and the wet well level bar graph are highlighted with a red rectangle, which matches the Priority 1 alarm colour.
6. 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 where not available by clicking on the equipment.



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## 2.7.5 Process Mimic Displays

Process mimic displays are full-screen displays that show a mimic of the process, similar to a P&ID drawing 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, though instrument readings are still shown.

Instrument readings are shown using the *Indicator* graphic symbol (see 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. Provide touch animation on instrument readings as required to open the associated instrument faceplate display.

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

Equipment such as pumps, motors, mixers, and valves that have state feedback to the PLC shall be colour animated, using shades of grey, to reflect their state. Refer to Table 2-2 for standard graphic display objects. Note that Table 2-2 only lists typical objects and additional objects may be created as required.

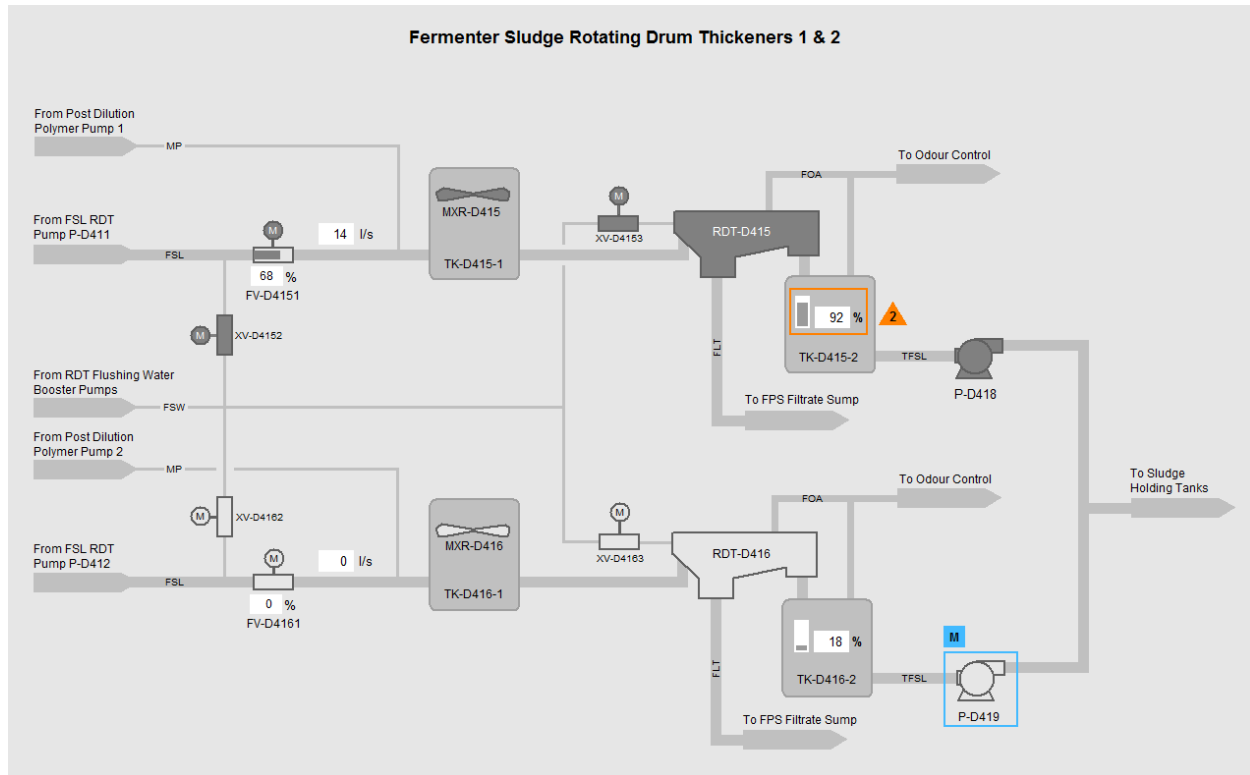
Pipes are shown using Grey 192. Pipes are shown in three different widths (see Table 2-2) to reflect the sizes (diameters) of pipes in the field.

Tanks and other static equipment are shown using a Grey 160 border and Grey 192 fill.

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 or instrument reading, as per Section 2.6.

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

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 2-5: Sample Process Mimic Display**

**Notes:**

1. A high-level alarm in tank TK-D415-2 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 as running and stopped, respectively.
3. Rotating drum thickeners RDT-D415 and RDT-D416 are shown as running and stopped, respectively.
4. Pump D-D419 is in Manual mode, therefore a blue rectangle is shown around the equipment.
5. The width of the pipes shown is indicative of the pipe size in the field, as per Table 2-2.

## 2.7.6 Detail Displays

### 2.7.6.1 General

Detail displays are full-screen displays that contain detailed information and controls for a specific piece of equipment or part of the process.

Detail displays are typically provided for equipment that has many status and control points that cannot fit on an equipment faceplate (popup). As such, equipment detail displays are not usually provided for pieces of equipment that have an equipment faceplate, such as a motor or valve.

Detail displays can be implemented in several ways, depending on the type of information to be displayed. Several types of detail displays are defined below.

### 2.7.6.2 Equipment Detail Displays

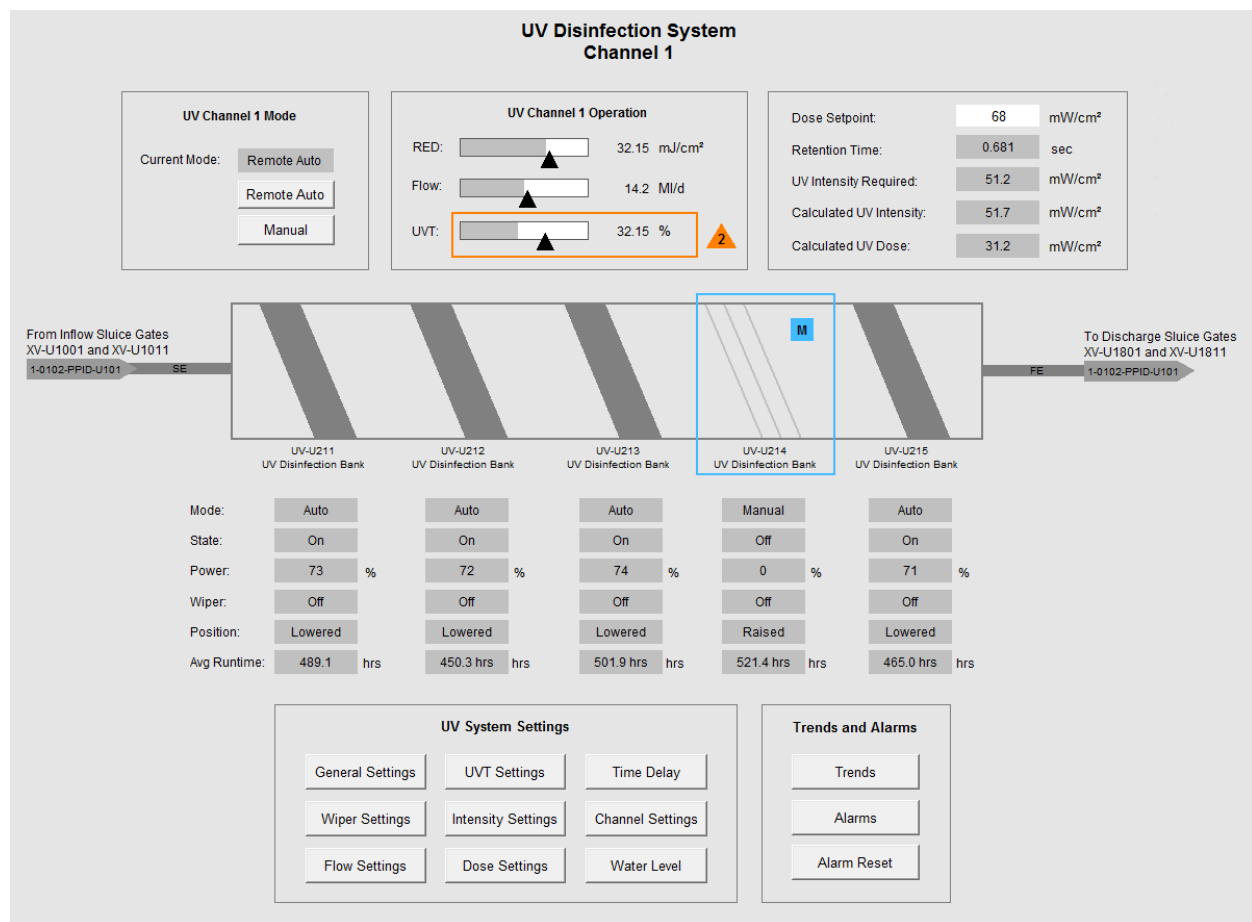
Sophisticated pieces of equipment typically require a dedicated full-screen display to show all the equipment information and HMI controls. While process mimic displays typically only show high-level information, equipment detail displays show most or all of the information associated with the equipment.

The exact equipment shape and inner detail is omitted from process mimic displays but may be shown on equipment detail displays if required. This may help convey instrument locations, etc..

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

Pushbuttons may be provided to open popup windows that contain additional information and controls that would not fit on the equipment detail display. However, if the information is critical to operators it should be shown on the equipment detail display rather than a popup.

A sample equipment detail display for a UV reactor is shown in Figure 2-6 below.



**Figure 2-6: Sample Equipment Detail Display – UV Reactor**

Notes:

1. The most important operating modes and status information are provided at the top of the display.
2. The equipment is shown with some inner detail to reflect the equipment in the field.

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3. *Pushbuttons are provided at the bottom of the display to open popup windows with additional information and controls.*
4. *A Priority 2 alarm is shown next to the UVT bar graph. The bar graph is also outlined with an orange rectangle.*
5. *UV Disinfection Bank UV-U214 is in manual mode and therefore a blue rectangle is shown around this bank.*

### 2.7.6.3 Sequencer Detail Displays

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

Show all states of the sequence on the left side of the 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 (eg. for fault conditions) 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.

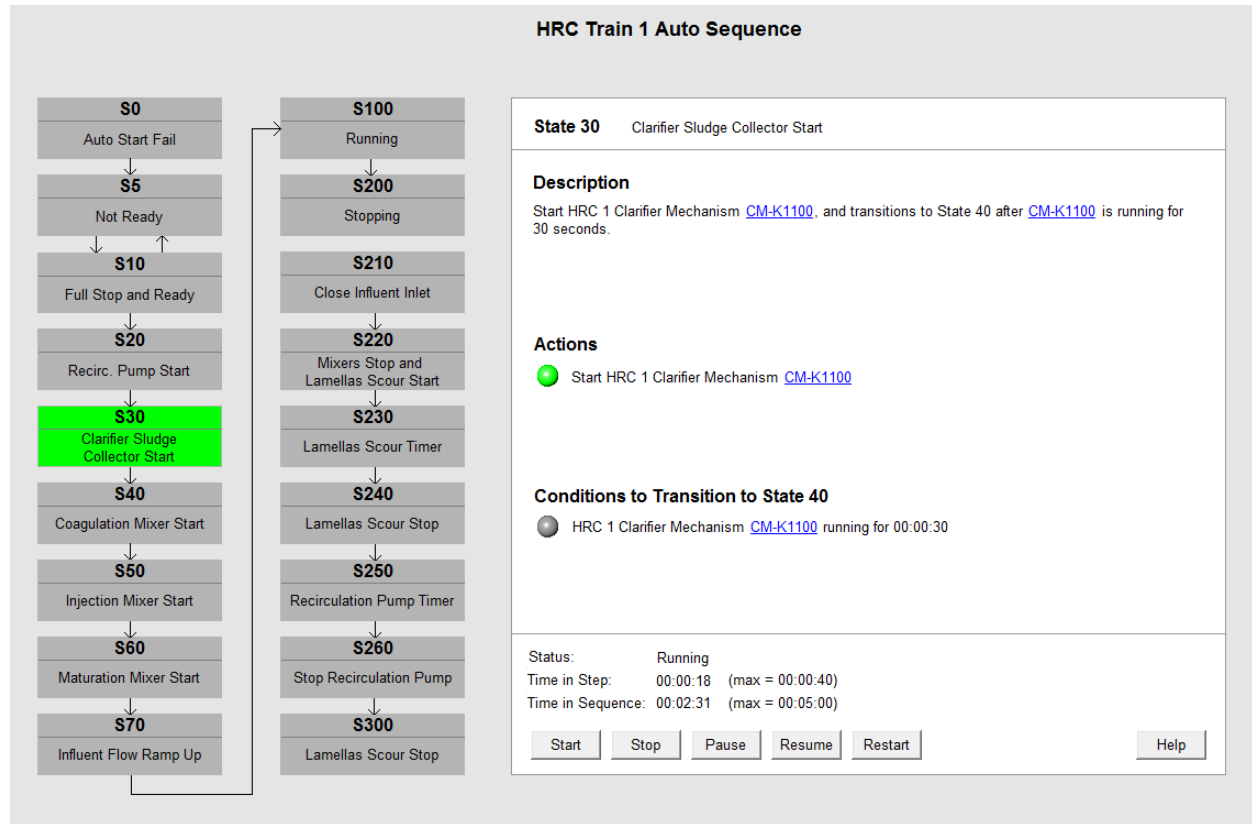
Provide hyperlinks to equipment faceplates inside the information area using blue underlined text. Operators may use these hyperlinks to view equipment faceplates or equipment detail displays to reset equipment-specific alarms, should they occur.

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 at the bottom of the display to pause, resume, and reset the operation of the sequence. These buttons may not always be required, and shall be customized for the applicable sequencer.

A sample sequencing display for a high-rate clarifier is shown in Figure 2-7.



**Figure 2-7: 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.

**2.7.6.4 Electrical Single Line Detail Displays**

Single line diagrams are provided in the facility HMI system to view the operation of the electrical system. The electrical system should be shown down to the lowest monitored level, which at minimum shall include the 600V buses.

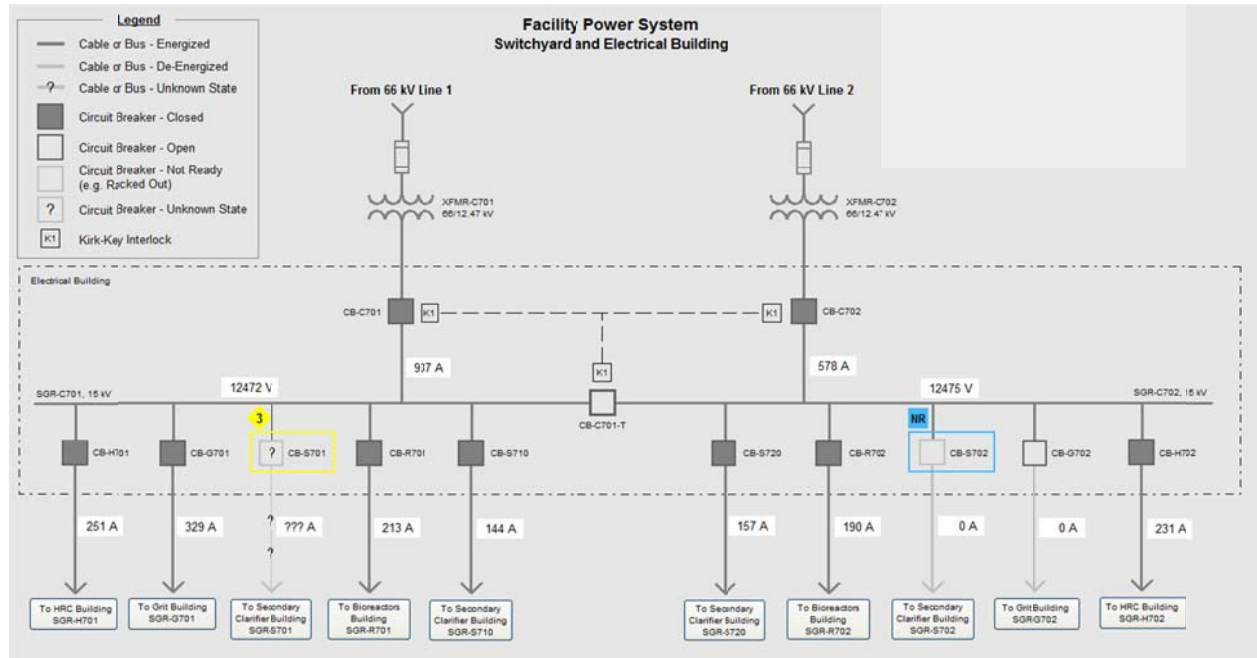
For switchgear that contains power meters or feeder protection relays, provide the voltage and ampere readings from these devices on the detail display. Clicking these will open the associated power meter or protection relay equipment faceplate (popup).

Electrical equipment detail displays are also shown using the “shades of grey” colour scheme. Energized equipment is shown in darker grey, and de-energized equipment is shown in lighter grey. If the state of the equipment is unknown, it is shown in light grey with a question mark. Provide a legend at the top corner for all electrical single line displays.

Refer to Table 2-1 and Table 2-2 for the specific colours and symbology used on electrical single line detail displays.

Avoid showing transformer kVA or MVA ratings, circuit breaker ampere ratings, or fuse ampere ratings as these details are not required for normal operations.

A sample electrical equipment detail display is shown in Figure 2-8 below.



**Figure 2-8: Sample Electrical Single Line Detail Display**

**Notes:**

1. Circuit breaker CB-S701 status is unknown and therefore the breaker and downstream cable are shown in the unknown state.
2. Circuit breaker CB-S702 is shown as “Not Ready” (eg. racked out).
3. Circuit breakers CB-C701-T and CB-G702 are shown in the open state.

### 2.7.7 Equipment Faceplates

Equipment faceplates are provided for individual instruments and equipment such as pumps, fans, and valves to view equipment status and facilitate control. Some control system functions, such as PID controllers, will also require a faceplate for viewing the process value and control value.

Equipment faceplates may be sized as required to accommodate the required status and control objects. If a particular faceplate needs to be larger than approximately 600x800 (WxH) pixels then an equipment detail display, rather than an equipment faceplate, should be used.

If possible, configure equipment faceplates such that they can be pinned or unpinned. When pinned, the equipment faceplate shall not automatically close when the operator navigates to a new full-screen display. However, when un-pinned the faceplates do automatically close when navigating to a new full-screen display. This allows multiple equipment faceplates to be open at a time for simultaneous control and monitoring.

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 suit 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 equipment faceplate content for various types of equipment is provided in Table 2-4.

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

| Equipment     | Tabbed Page | Typical Content   |
|---------------|-------------|---|
| Motors (FVNR) | Home        | <ul style="list-style-type: none"> <li>• Ready indication</li> <li>• Running indication</li> <li>• Interlocked indication</li> <li>• Local/Remote mode indication</li> <li>• Auto/Manual mode indication</li> <li>• Auto/Manual mode pushbuttons</li> <li>• Manual mode Start/Stop pushbuttons</li> <li>• Fault indication</li> <li>• Alarm Reset pushbutton</li> </ul> |
|               | Details     | <ul style="list-style-type: none"> <li>• Contactor Delay setting</li> <li>• Start Time Delay after Power On setting</li> <li>• Runtime Totalizer</li> <li>• Elapsed time of current run</li> <li>• Elapsed time since last run</li> <li>• Pushbuttons to reset runtime totalizers</li> </ul>  |

| Equipment    | Tabbed Page | Typical Content  |
|--------------|-------------|--|
| Motors (VFD) | Home        | Typical content for Motors (FVNR) plus: <ul style="list-style-type: none"> <li>• Motor Speed (feedback) indication</li> <li>• Manual Motor Speed setting</li> </ul>  |
|              | Details     | Typical content for Motors (FVNR)  |
| Pumps        | Home        | Typical content for Motors (FVNR or VFD) plus: <ul style="list-style-type: none"> <li>• Low Flow status</li> <li>• Low Seal Water Pressure status</li> </ul>   |
|              | Details     | Typical content for Motors (FVNR or VFD) plus: <ul style="list-style-type: none"> <li>• Low Flow alarm delay setting</li> <li>• Low Seal Water Pressure alarm delay setting</li> </ul>   |
| Valves       | Home        | <ul style="list-style-type: none"> <li>• Power Fail Indication</li> <li>• Interlocked indication</li> <li>• Local/Remote mode indication</li> <li>• Auto/Manual mode indication</li> <li>• Auto/Manual mode pushbuttons</li> <li>• Position command (Open / Close, or % Open)</li> <li>• Position indication (Open / Closed, or % Open)</li> <li>• Manual mode Open/Close pushbuttons</li> <li>• Interlocked indication</li> <li>• Fault indication</li> <li>• Alarm Reset pushbutton</li> </ul> |
|              | Details     | <ul style="list-style-type: none"> <li>• Feedback delay setting</li> </ul>   |
| Instruments  | Home        | <ul style="list-style-type: none"> <li>• Process Variable(s)</li> <li>• Alarm / Fault indication</li> <li>• Alarm Reset pushbutton</li> </ul>  |
|              | Details     | <ul style="list-style-type: none"> <li>• Hi-Hi Alarm setpoint</li> <li>• Hi-Hi Alarm delay setting</li> <li>• Hi Alarm setpoint</li> <li>• Hi Alarm delay setting</li> <li>• Low Alarm setpoint</li> <li>• Low Alarm delay setting</li> <li>• Low-Low Alarm setpoint</li> <li>• Low-Low Alarm delay setting</li> </ul>   |



| Equipment               | Tabbed Page | Typical Content  |
|-------------------------|-------------|--|
| Electrical Power Meters | Home        | <ul style="list-style-type: none"> <li>• Voltage <ul style="list-style-type: none"> <li>○ Line-to-line (Vab, Vbc, Vca)</li> </ul> </li> <li>• Current: <ul style="list-style-type: none"> <li>○ Per Phase (Ia, Ib, Ic)</li> <li>○ Demand (average of phases, Ia, Ib, Ic, and date/timestamp of peak demand)</li> </ul> </li> <li>• Power <ul style="list-style-type: none"> <li>○ Real Power</li> <li>○ Reactive Power</li> <li>○ Apparent Power</li> </ul> </li> <li>• Energy <ul style="list-style-type: none"> <li>○ kWh with timestamp since start of accumulated value</li> </ul> </li> <li>• Power Factor <ul style="list-style-type: none"> <li>○ Per phase</li> <li>○ Total</li> </ul> </li> <li>• Frequency</li> <li>• Harmonics <ul style="list-style-type: none"> <li>○ TDD</li> <li>○ THD (Ia, Ib, Ic), (Vab, Vbc, Vca)</li> </ul> </li> </ul> |
| Power Circuit Breakers  | Home        | <ul style="list-style-type: none"> <li>• State (open / closed) (from protection relay)</li> <li>• Open / Close Command (if available)</li> <li>• Average Line-to-Line Voltage (from protection relay)</li> <li>• 3 Phase Currents (from protection relay)</li> <li>• Power Factor (from protection relay)</li> <li>• Average Reactive Power (from protection relay)</li> <li>• Average Apparent Power (from protection relay)</li> <li>• On the details page (tab): <ul style="list-style-type: none"> <li>○ Date of last trip / operation,</li> <li>○ Cause of trip (first out),</li> <li>○ Readings (Current, Voltage, Power) prior to trip.</li> </ul> </li> </ul>  |

On the right side of the tab bar, provide links to resources that open in an external popup window or an external application. Links may be provided for, but not limited to, the following:

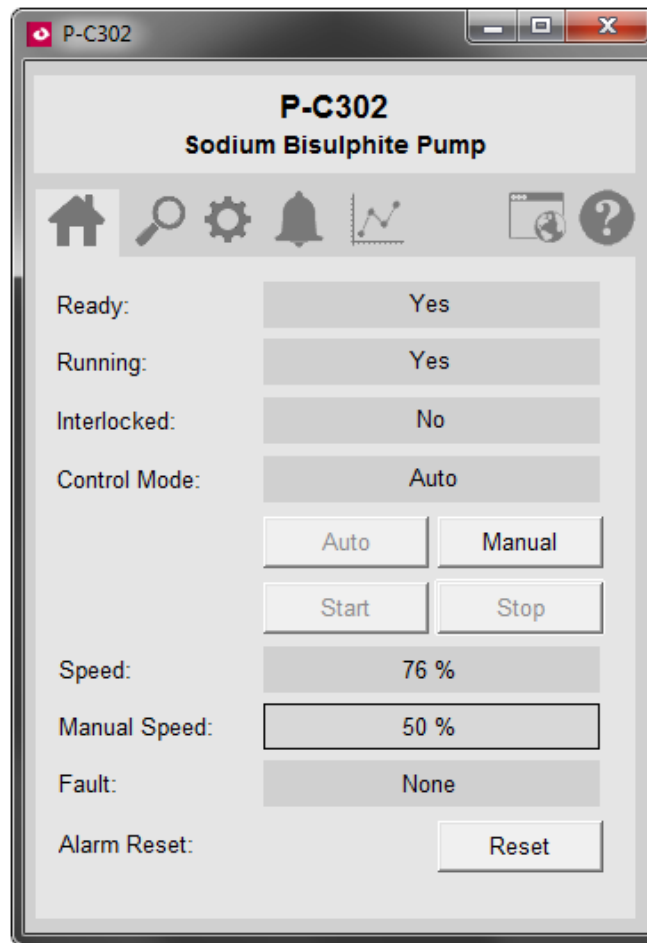
- Device Webpage: link to open the device webpage in a web browser window.
- Drawings: link to a set of drawings (typically in PDF format) for the equipment.
- Documents: link to an external document associated with the equipment.
- Help: link to help system.

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.

The Help system link may be provided on equipment faceplates to open a help system for the specific equipment. Help systems are typically implemented with PDF documents and as such the Help link is right-aligned on the toolbar. If the help system is implemented within the HMI system (eg. the information appears within the equipment faceplate, or a different popup) then the Help link in the toolbar should be left-aligned on the toolbar.

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.

A sample equipment faceplate for a VFD-driven pump is provided in Figure 2-9.



**Figure 2-9: Sample VFD Pump Equipment Faceplate**

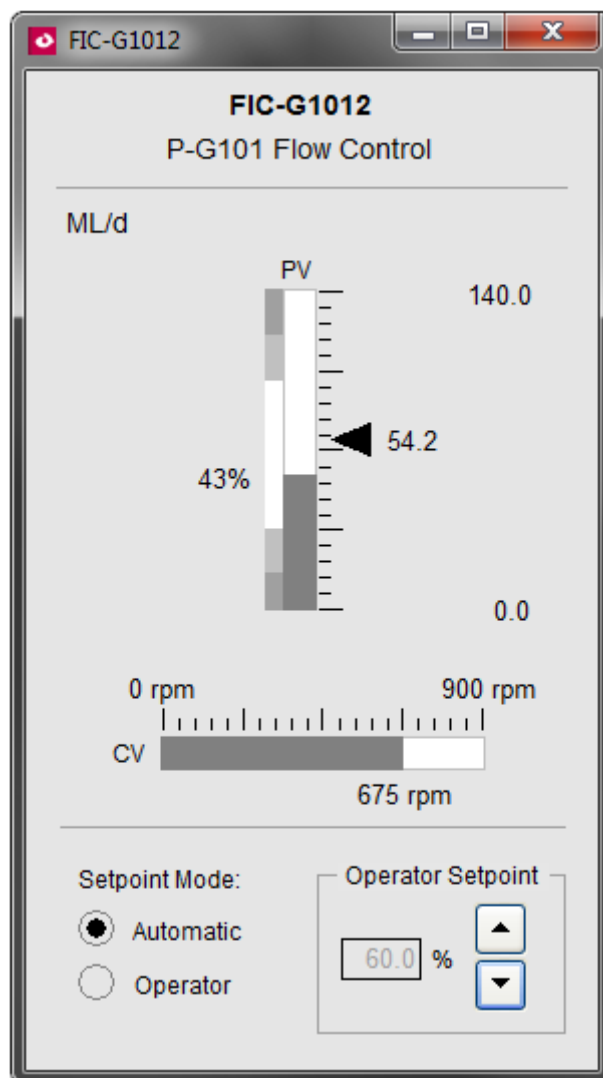
**Notes:**

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.

A sample PID controller faceplate is provided in Figure 2-10, and shall be used as the basis for PID controller faceplates.

The PID controller faceplate is organized in a specific manner, as follows:

1. The units of measure of the process variable are indicated in the top left corner.
2. The process variable (PV) is indicated in the centre with a vertical bar graph.
3. The shaded grey areas left of the PV bar graph represent alarm limits of the process variable.
4. The numeric display to the left of the PV bar graph represents the current process value.
5. The arrow and numeric indicator to the right of the PV bar graph represent the setpoint (SP).
6. The control variable (CV) output is indicated using a horizontal bar graph.



**Figure 2-10: Sample PID Controller Equipment Faceplate**

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### 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 contain 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 PAGE – Acknowledge all unacknowledged alarms on the current alarm page.
- ACK ALL – Acknowledge all unacknowledged alarms.

Provide a means for operators to filter alarms by one or more user-defined text filters, including an ability for operators to filter or display disabled 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.

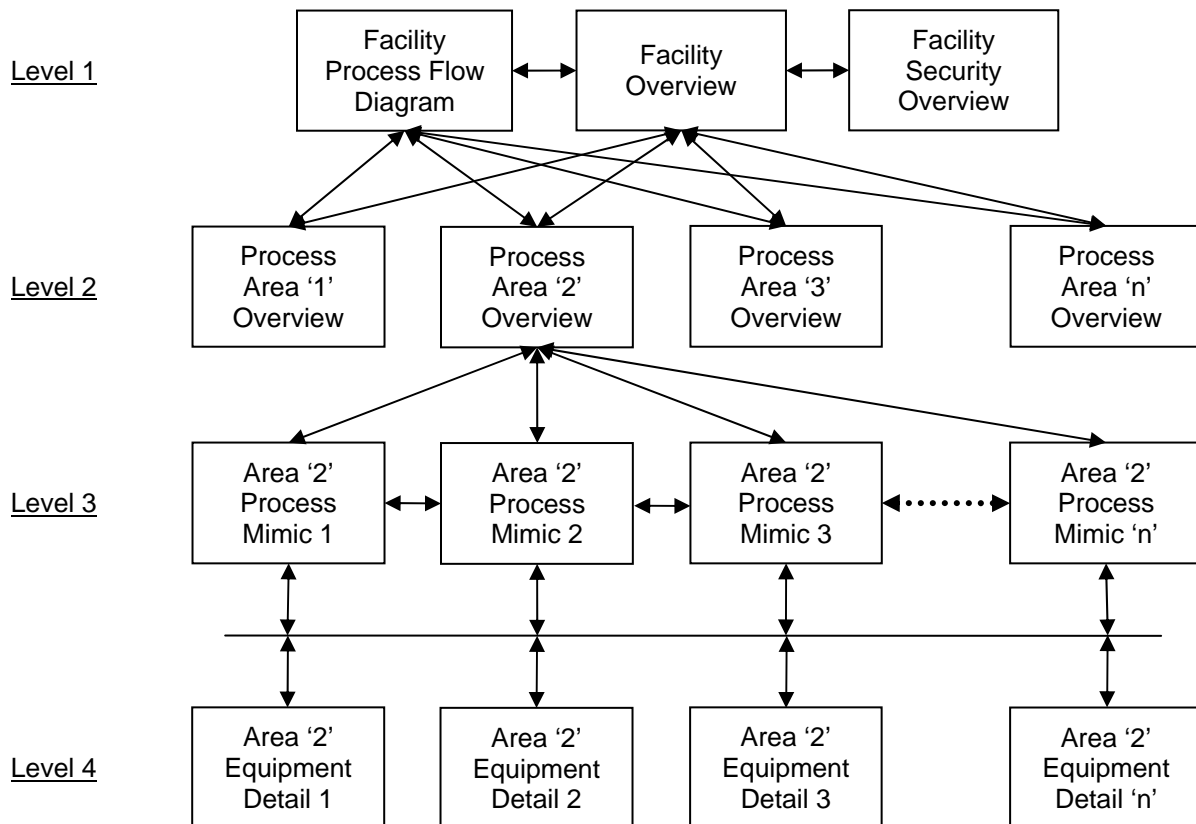
Four display levels are defined within the display hierarchy, as follows:

- 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 equipment 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 2-11.



**Figure 2-11: Typical Facility HMI Application Display Hierarchy**

Notes regarding Figure 2-11:

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 typically provided using process and signal line continuation symbols.

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3. *A mesh is shown to represent the relationship between process mimics at Level 3 and the equipment detail displays at Level 4. The specific relationship is dependent on the equipment and the implementation of the 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.*

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## 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 equipment 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 – High Priority / Emergency. The alarm indicates a condition that required manual or automatic functions to avoid unacceptable operating conditions or product. Also, indicates a callout when unmanned. See Section 3.3 for further information on Alarm Callouts.
- Priority 2 – Medium Priority. The alarm indicates a condition that requires manual or automatic functions to avoid unacceptable operating conditions or product. The alarm requires attention, but on its own, does not require a callout when unmanned.
- Priority 3 – Low Priority. The alarm indicates a condition that may result in off-quality product or may lead to more severe consequences.
- Priority 4 – Abnormal Condition. This priority indicates an abnormal condition that does not require immediate attention. In general, Local, Manual, or Not Remote mode alarms will be in this category.

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.

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## 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 stuck 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, below.



**Table 4-1: HMI User Security Levels**

| Security Level | User Job Function | Typical Capabilities   | Typical Restrictions  |
|----------------|-------------------|--|---|
| High (H)       | Senior Operator   | <ul style="list-style-type: none"> <li>• Viewing HMI</li> <li>• Automatic mode control limit and control setpoint adjustment</li> <li>• Manual equipment control</li> <li>• Alarm acknowledgement</li> <li>• Alarm limit adjustment</li> <li>• Enabling and disabling alarms</li> <li>• Viewing reports, trends, and alarms</li> </ul> | <ul style="list-style-type: none"> <li>• None</li> </ul>  |
| Low (L)        | Operator          | <ul style="list-style-type: none"> <li>• Viewing HMI</li> <li>• Manual equipment control</li> <li>• Alarm acknowledgement</li> <li>• Viewing reports, trends, and alarms</li> </ul>  | <ul style="list-style-type: none"> <li>• Automatic mode control limit and control setpoint adjustment</li> <li>• Alarm limit adjustment</li> <li>• Enabling and disabling alarms</li> </ul> |
| None (N)       | N/A               | <ul style="list-style-type: none"> <li>• Viewing HMI in read-only mode</li> </ul>  | <ul style="list-style-type: none"> <li>• Manual equipment control</li> <li>• Equipment setpoint adjustment</li> <li>• Alarm acknowledgement</li> <li>• Alarm setpoint adjustment</li> </ul> |

*Notes:*

1. *The capabilities and restrictions indicated above are typical. The functional requirements specification for each project may have different user security requirements.*