THERMO SYSTEMS

INDUSTRIAL AUTOMATION & INFORMATION

Deploying more intuitive HMI graphics in accordance with the ISA standards

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Introduction

- Are you / your operators able to understand the information displayed on your HMI?
- Have you ever found yourself searching for information on an HMI?
- Can you quickly and effectively recognize deviances in your process through your HMI?

ISA-101

- ISA 101 – Human Machine Interfaces for Process Automation Systems. (July, 2015)
  - "provide guidance to design build, operate and maintain HMIs to achieve a safer, more effective process control system under all operating conditions."
  - "improve the user's abilities to detect, diagnose, and properly respond to abnormal situations."

- Standardized approach to HMI Design – not restricted by brand of HMI, type of process, PLC, DCS, etc.
- Industry standard but not widely implemented – due to release date.
- Not restricted to new systems. Older systems can be converted to some of the standards outlined with a quick turn over.

By implementing ISA 101 philosophies we have found that the goals set fourth are satisfied, allowing users to focus on information desired, better than the previous generation HMIs.

Overview of Topics

1. **Informational Guidelines** - Grouping, Coloring, Types of displays.

   - How it will immediately affect Operations.

2. **Separation of Screens** - Based on diversity of needs within the end user's organization.

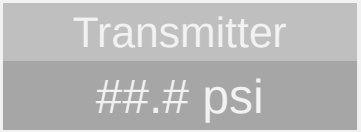
   - To allow users to obtain the information they want

3. **Density of Information** - How it affects the end user's understanding / operation / maintenance.

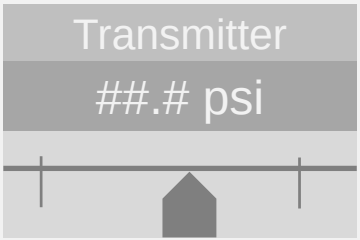
Informational Guidelines

Types of Displays

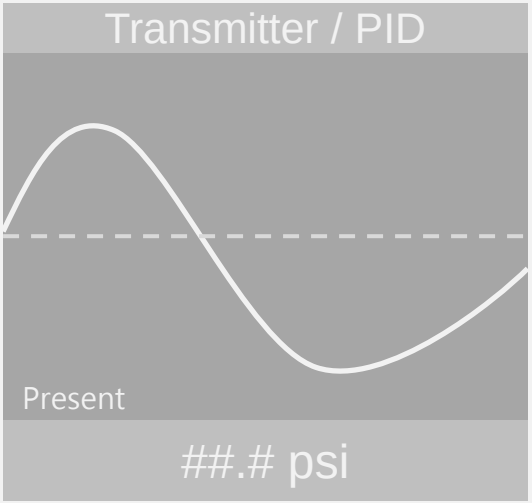
One display does not fit all scenarios…



Process Information

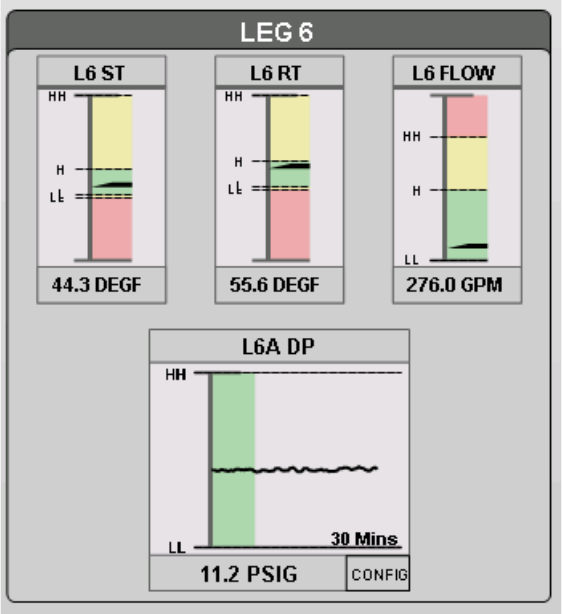


Process with Tolerances



Process Dependent
e.g. PID Loop

Types of Displays - Example



Grouping of Information

When deployed correctly:

1. Allows users to quickly focus in on the information they need.
2. Can show a large amount of information in a simplified format.

Grouping is not present / not intuitive:

1. Users will spend more time searching for information.
2. Information will become cluttered and possibly distracting.

Grouping – Example

PLANT EFFICIENCY			
	LIVE	DAILY	MONTHLY
TOTAL POWER	1796.4 KW	12360.5 KWH	371200.4 KWH
TOTAL COOLING	2309.0 TONS	15660.1 TONH	509881.9 TONH
KW/TON	0.778	0.789	0.728
COP	4.520	4.456	4.831

CHILLER 1	
POWER	0.0 KW
COOLING	0.0 TONS
KW/TON	0.000
DELTA T	5.0 DEGF
FLOW	0.0 GPM

CHILLER 2	
POWER	599.0 KW
COOLING	1213.3 TONS
KW/TON	0.494
DELTA T	8.9 DEGF
FLOW	3289.0 GPM

CHILLER 3	
POWER	537.0 KW
COOLING	1095.7 TONS
KW/TON	0.490
DELTA T	8.1 DEGF
FLOW	3242.0 GPM

CHILLER 4	
POWER	1.0 KW
COOLING	0.0 TONS
KW/TON	0.000
DELTA T	5.7 DEGF
FLOW	0.0 GPM

CONDENSER WATER PUMPS	
CWP-1, CWP-3, CWP-5	120.0 KW
CWP-2, CWP-4	115.0 KW
TOTAL	235.0 KW

CHILLED WATER PUMPS		
CHP-1	0.0 %FS	121.5 KW
CHP-2	57.3 %FS	123.9 KW
CHP-3	0.0 %FS	123.9 KW
CHP-4	0.0 %FS	0.0 KW
CHP-5	57.5 %FS	0.0 KW
TOTAL		369.3 KW

COOLING TOWERS		
CT-2	0.0 %FS	0.0 KW
CT-3	0.0 %FS	0.0 KW
CT-4	68.1 %FS	27.1 KW
CT-5	67.6 %FS	27.0 KW
TOTAL		54.1 KW

Coloring

Why is Coloring Important?

1. Users may be colorblind / vision deficient.
    - Certain color combinations may not be clear / visible to users.
2. Coloring will influence the amount of eyestrain user experience over extended time.
    - High contrast should be limited.
3. Will affect users situational awareness.
    - When a consistent clear format is used, users can identify problems / alarms quicker because the problem will stand out.

Coloring - Examples

Normal

Transmitter
##.# psi

Eyestrain
##.# psi

Alarm

Transmitter
##.# psi

Colorblind
##.# psi

Coloring - Example

PRI CHWS TEMP	PRI CHWR TEMP	PRI CHW DELTA T	PRI CHWS FLOW	PCHWS/PCHWR DIFF PRESS	SEC CHW DELTA T	ETS #
ETS-1-1TE-11000 42.9 DEGF	ETS-1-1TE-11001 52.8 DEGF	9.9 DegF	ETS-1-1FT-11007 1222 GPM	ETS-1-1PDT-11002 54.4 IN WC	6.4 DegF	1
ETS-2-2TE-11000 42.1 DEGF	ETS-2-2TE-11001 54.1 DEGF	12.0 DegF	ETS-2-2FT-11007 1767 GPM	ETS-2-2PDT-11002 80.8 IN WC	11.8 DegF	2
ETS-3-3TE-11000 43.0 DEGF	ETS-3-3TE-11001 60.2 DEGF	17.2 DegF	ETS-3-3FT-11007 578.0 GPM	ETS-3-3PDT-11002 53.6 IN WC	5.9 DegF	3
ETS-4A-4ATE-11000 42.0 DEGF	ETS-4A-4ATE-11001 47.8 DEGF	5.8 DegF	ETS-4A-4AFT-11007 933.0 GPM	ETS-4A-4APDT-11002 105.0 IN WC	2.5 DegF	4
ETS_5_5TE_15012 AUTO 42.1 DegF	ETS_5_5TE_15013 AUTO 52.8 Deg F	10.8 DegF	ETS_5_5FT_15002 AUTO 2031 GPM	ETS_5_5PDI_15003 AUTO 0.0 IN WC	10.0 DegF	5
ETS-6-6TE-11000 41.8 DEGF	ETS-6-6TE-11001 45.4 DEGF	3.6 DegF	ETS-6-6FT-11007 272.0 GPM	ETS-6-6PDT-11002 78.9 IN WC	1.7 DegF	6
ETS_7_7TE_17012 AUTO 42.3 DegF	ETS_7_7TE_17013 AUTO 57.1 Deg F	14.8 DegF	ETS_7_7FT_17002 AUTO 228.4 GPM	ETS_7_7DPT_17003 AUTO 107.4 IN WC	22.0 DegF	7
ETS-8-8TE-18000 42.0 DEGF	ETS-8-8TE-18001 46.4 DEGF	4.4 DegF	ETS-8-8FT-18004 151.0 GPM	ETS-8-8PDT-18002 0.0 IN WC	7.0 DegF	8
ETS-9-9TE-19000 42.5 DegF	ETS-9-9TE-19001 65.0 DegF	22.5 DegF	ETS-9-9FT-19004 209.0 GPM	ETS-9-9PDT-19002 116.7 IN WC	1.8 DegF	9
ETS-10-10TE-11000 42.6 DEGF	ETS-10-10TE-11001 49.3 DEGF	6.7 DegF	ETS-10-10FT-11007 352.0 GPM	ETS-10-10PDT-11002 108.7 IN WC	4.5 DegF	10
ETS-11-11TE-11000 42.3 DEGF	ETS-11-11TE-11001 54.4 DEGF	12.1 DegF	ETS-11-11FT-11007 57.6 GPM ETS-11-11FT-11011 59.0 GPM	ETS-11-11PDT-11002 133.9 IN WC	11.2 DegF	11
ETS-12-12TE-11000 42.2 DEGF	ETS-12-12TE-11001 47.8 DEGF	5.6 DegF	ETS-12-12FT-11007 747.0 GPM ETS-12-12FT-11011 1102 GPM	ETS-12-12PDT-11002 84.0 IN WC	3.7 DegF	12

PRI CHWS TEMP	PRI CHWR TEMP	PRI CHW DELTA T	PRI CHWS FLOW	PCHWS/PCHWR DIFF PRESS	SEC CHW DELTA T	ETS #
ETS-1-1TE-11000 43.0 DEGF	ETS-1-1TE-11001 51.0 DEGF	8.0 DegF	ETS-1-1FT-11007 1469 GPM	ETS-1-1PDT-11002 77.2 IN WC	7.0 DegF	1
ETS-2-2TE-11000 42.1 DEGF	ETS-2-2TE-11001 53.7 DEGF	11.6 DegF	ETS-2-2FT-11007 1805 GPM	ETS-2-2PDT-11002 118.9 IN WC	11.2 DegF	2
ETS-3-3TE-11000 43.0 DEGF	ETS-3-3TE-11001 59.2 DEGF	16.2 DegF	ETS-3-3FT-11007 695.0 GPM	ETS-3-3PDT-11002 76.5 IN WC	6.7 DegF	3
ETS-4A-4ATE-11000 42.2 DEGF	ETS-4A-4ATE-11001 46.6 DEGF	4.4 DegF	ETS-4A-4AFT-11007 1250 GPM	ETS-4A-4APDT-11002 126.1 IN WC	2.5 DegF	4
ETS_5_5TE_15012 AUTO 41.9 DegF	ETS_5_5TE_15013 AUTO 50.8 Deg F	8.9 DegF	ETS_5_5FT_15002 AUTO 2445 GPM	ETS_5_5PDI_15003 AUTO 0.0 IN WC	11.2 DegF	5
ETS-6-6TE-11000 42.0 DEGF	ETS-6-6TE-11001 44.9 DEGF	2.9 DegF	ETS-6-6FT-11007 369.0 GPM	ETS-6-6PDT-11002 91.6 IN WC	1.9 DegF	6
ETS_7_7TE_17012 AUTO 42.3 DegF	ETS_7_7TE_17013 AUTO 57.0 Deg F	14.7 DegF	ETS_7_7FT_17002 AUTO 216.8 GPM	ETS_7_7DPT_17003 AUTO 156.2 IN WC	21.7 DegF	7
ETS-8-8TE-18000 42.1 DEGF	ETS-8-8TE-18001 46.0 DEGF	3.9 DegF	ETS-8-8FT-18004 183.0 GPM	ETS-8-8PDT-18002 0.0 IN WC	7.4 DegF	8
ETS-9-9TE-19000 42.6 DegF	ETS-9-9TE-19001 65.0 DegF	22.4 DegF	ETS-9-9FT-19004 220.0 GPM	ETS-9-9PDT-19002 170.4 IN WC	1.8 DegF	9
ETS-10-10TE-11000 42.5 DEGF	ETS-10-10TE-11001 49.0 DEGF	6.5 DegF	ETS-10-10FT-11007 369.0 GPM	ETS-10-10PDT-11002 162.2 IN WC	4.7 DegF	10
ETS-11-11TE-11000 42.2 DEGF	ETS-11-11TE-11001 53.3 DEGF	11.1 DegF	ETS-11-11FT-11007 63.6 GPM ETS-11-11FT-11011 67.2 GPM	ETS-11-11PDT-11002 188.2 IN WC	11.1 DegF	11
ETS-12-12TE-11000 42.4 DEGF	ETS-12-12TE-11001 48.0 DEGF	5.6 DegF	ETS-12-12FT-11007 638.0 GPM ETS-12-12FT-11011 1121 GPM	ETS-12-12PDT-11002 147.0 IN WC	3.1 DegF	12

Separation of Screens

When should Screens be Separated?

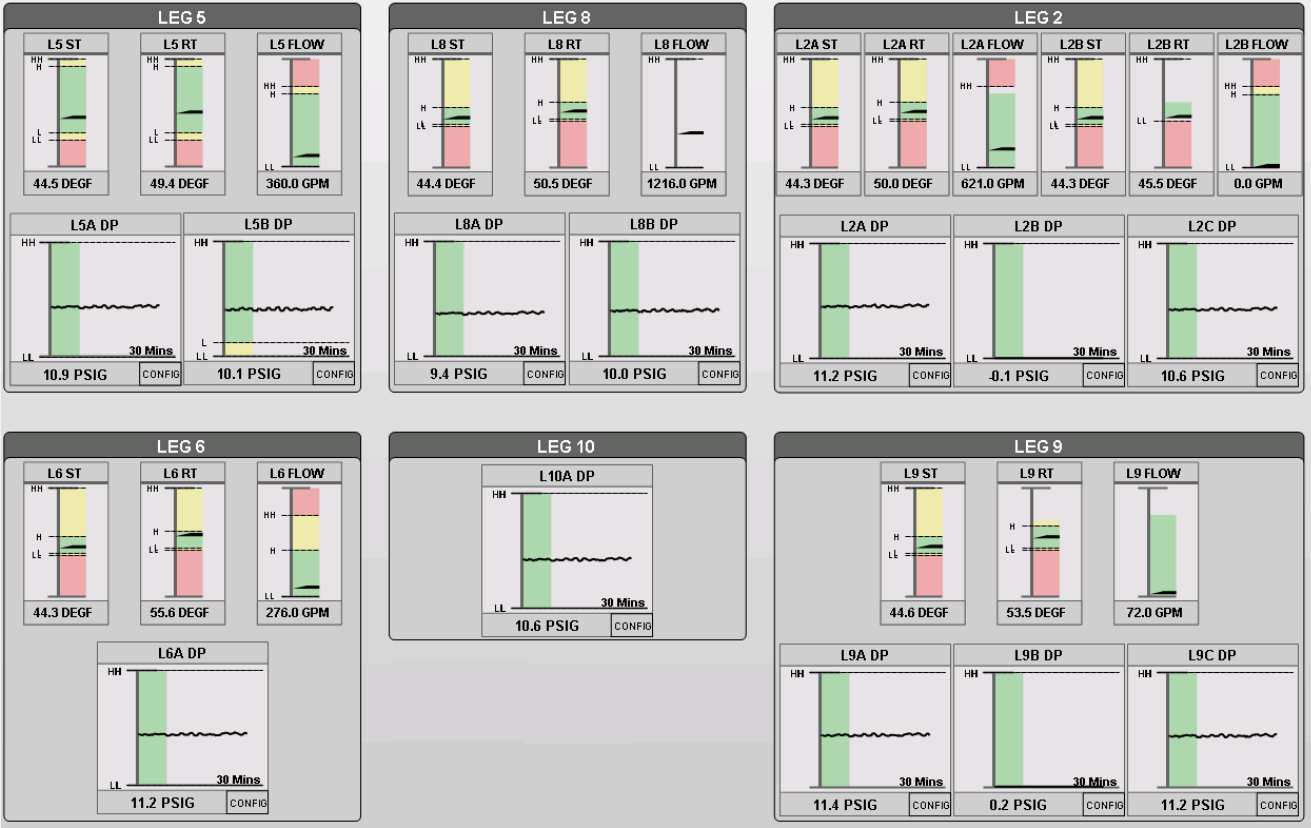
1. Information is not related to the process shown.
2. Too much information on the screen.
3. Information is does not pertain to primary users.

When should Screens be Separated?

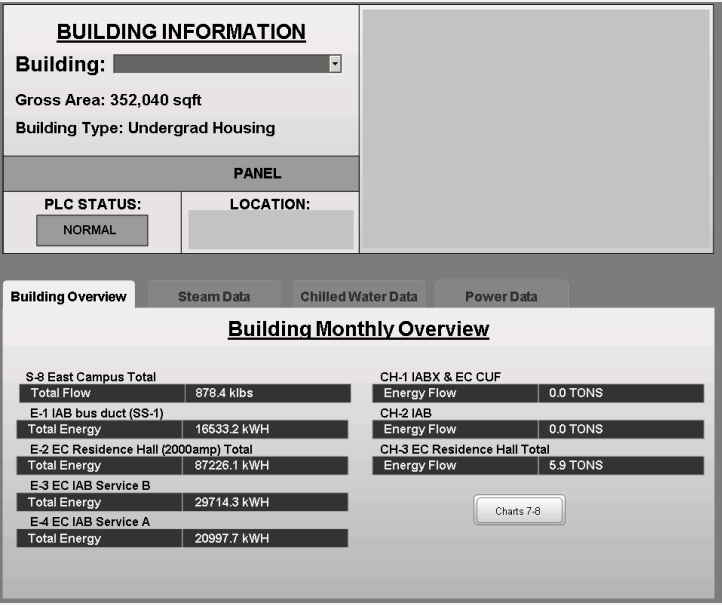
Example - Chilled Water Plant – Leg Piping overview

- Operators want to know differential pressures to adjust pump speed setpoints. (Primary users)
- Managers / Admin want to know totalized tonnage for billing purposes / efficiency calculations. (Secondary users)
- Engineers want to know pipe diameters and use screen as a reference. (Tertiary users)

Operations Screen



Management / Admin Screens



Monthly Totals	
December	75
November	1
October	29536
September	116334
August	150665
July	129489
June	107021
May	67102
April	16203
March	7481
February	477
January	463
Last Updated:	##:##:##

Monthly Totals	
December	1
November	735
October	4187
September	8399
August	12347
July	12523
June	9851
May	5679
April	5660
March	3173
February	1
January	1
Last Updated:	##:##:##

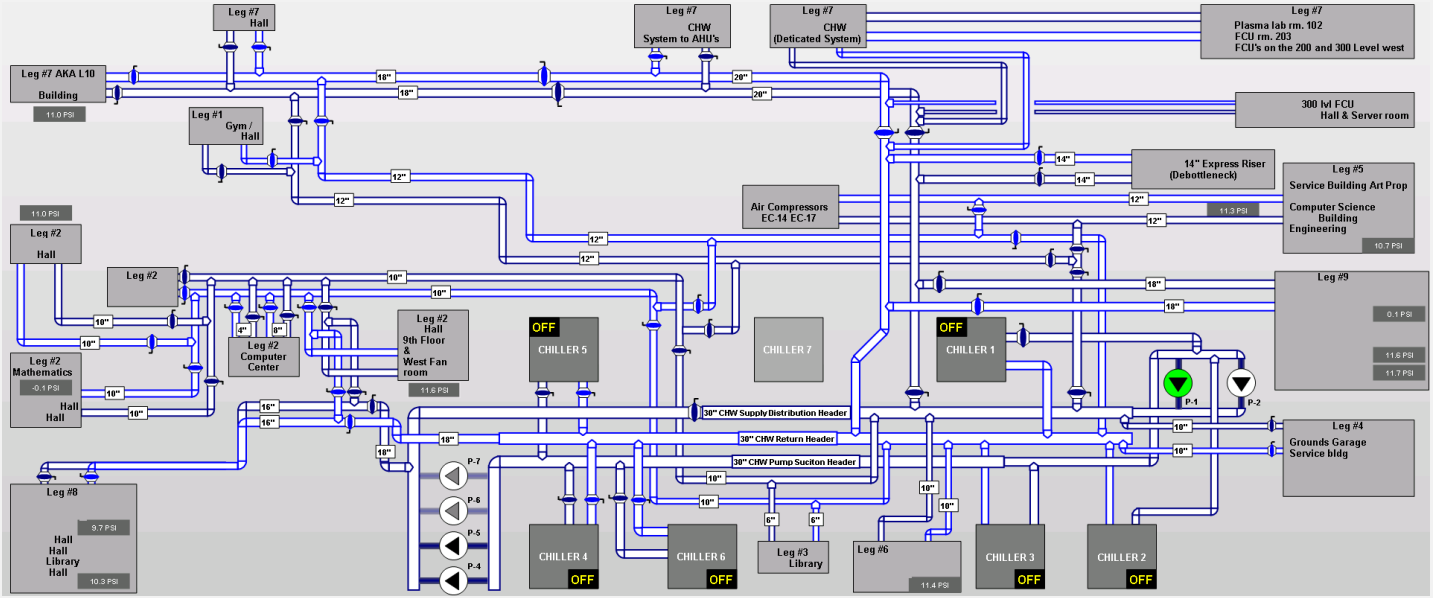
Monthly Totals	
December	112
November	2314
October	2654
September	15162
August	42419
July	52230
June	19635
May	7823
April	957
March	418
February	9
January	8
Last Updated:	##:##:##

Monthly Totals	
December	1848
November	1249
October	864
September	206
August	79
July	247
June	335
May	642
April	1237
March	1403
February	1922
January	1715
Last Updated:	##:##:##

Monthly Totals	
December	67514
November	70529
October	70048
September	66290
August	64925
July	72153
June	70149
May	78620
April	74856
March	71879
February	67572
January	42886
Last Updated:	##:##:##

Monthly Totals	
December	87227
November	87227
October	87227
September	87227
August	87227
July	87227
June	87227
May	87227
April	167914
March	192858
February	111385
January	111385
Last Updated:	##:##:##

Engineering Screen

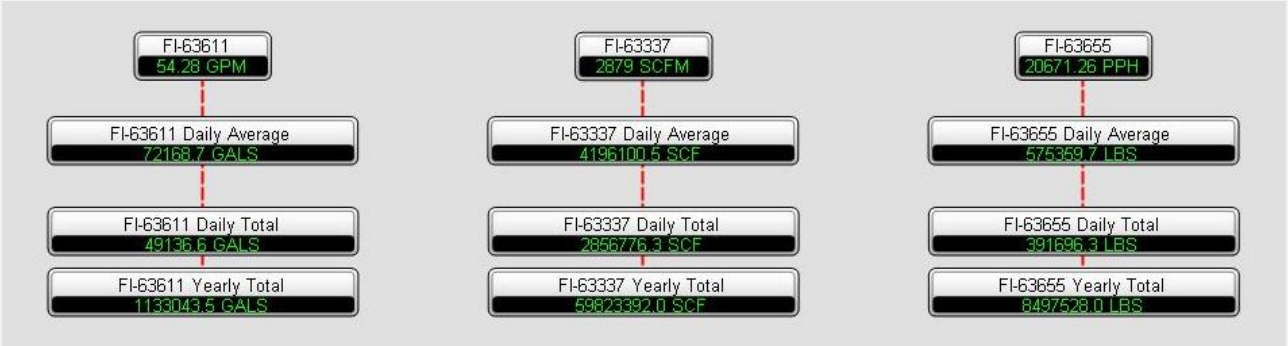


Density of Information

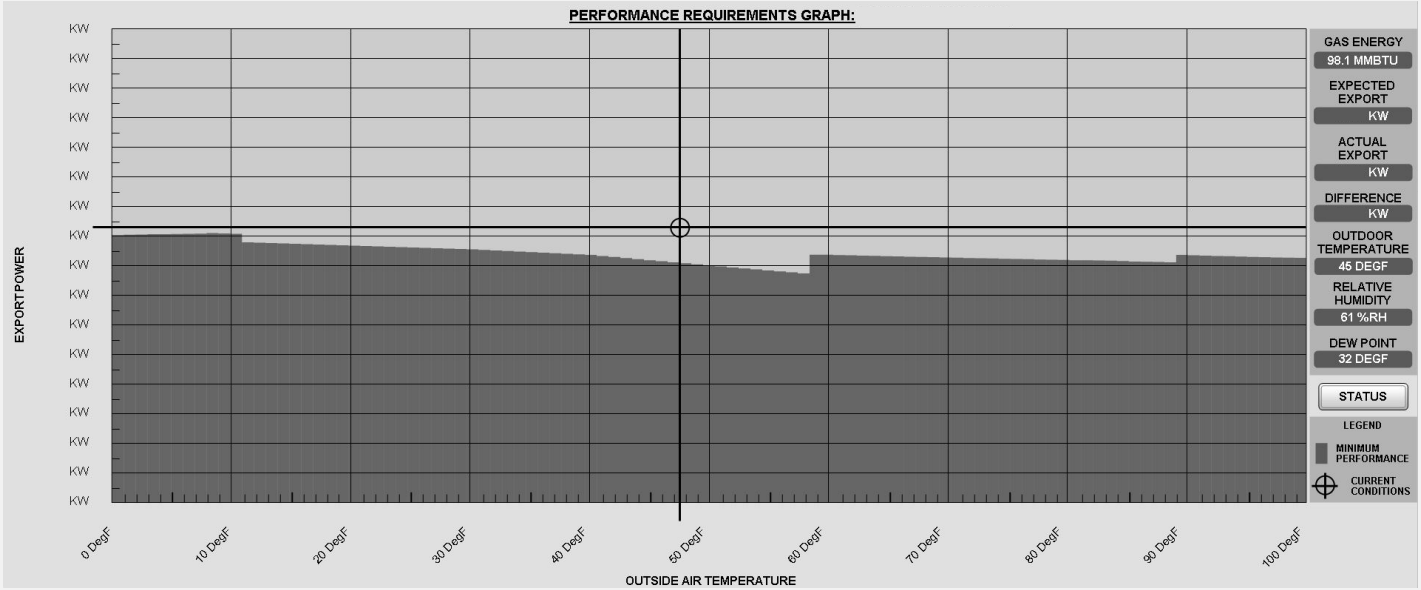
Density of Information

Showing related process information

- Increases users understanding of the process.
- Makes troubleshooting easier.
- Can usually be accomplished by simple techniques.



Combining Information - Example



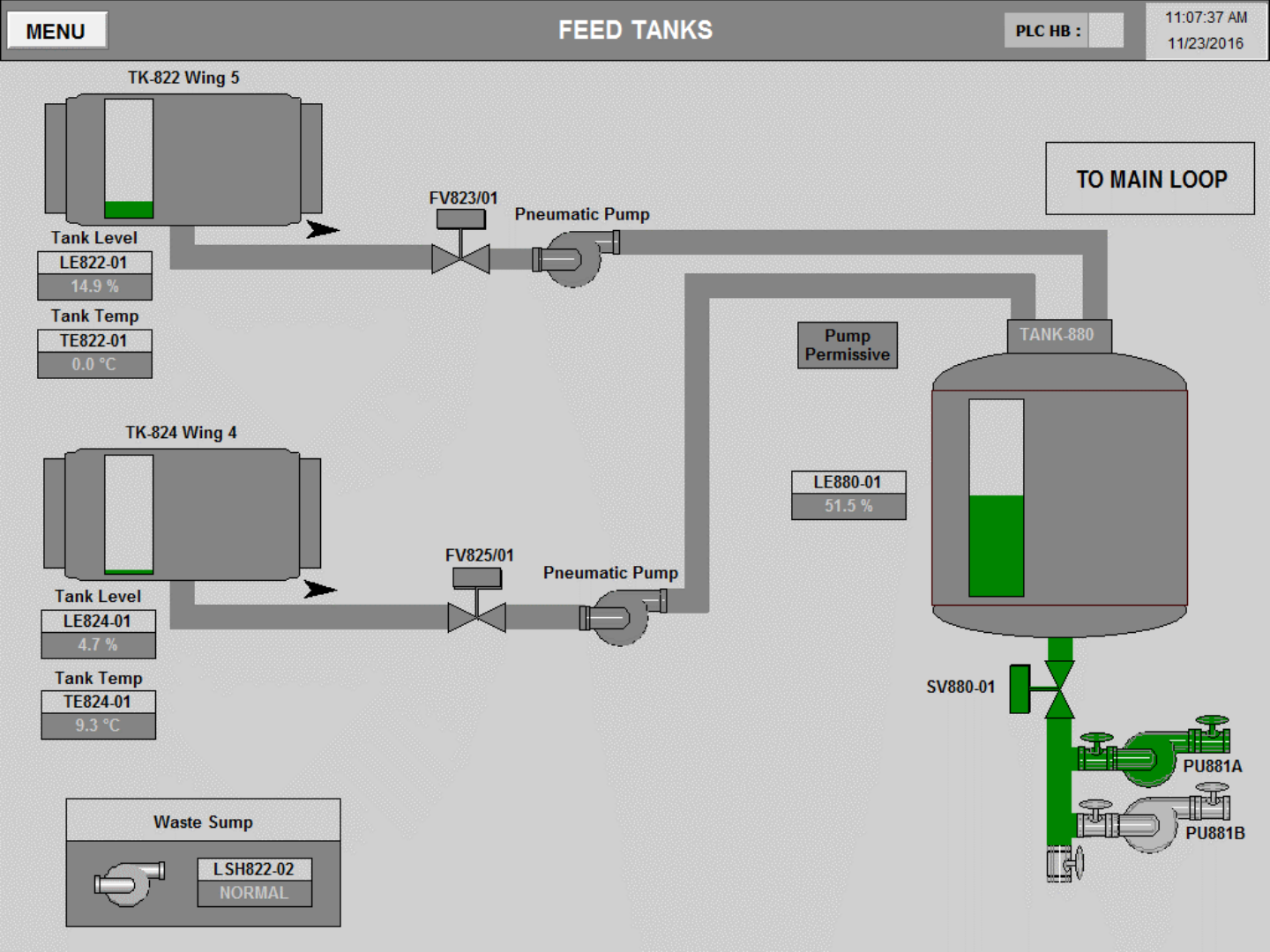
Less is More

1. Too Much information on the screen:

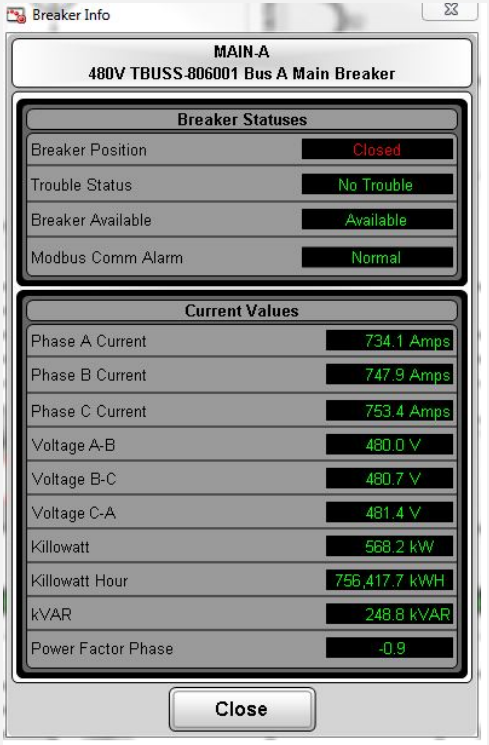
   - Can cause confusion in operations.
   - Information is misinterpreted.
   - User has to focus on the information desired.

2. Less is more approach:

   - Information shown is important to the running process.
   - Detailed information is shown in popups / secondary screens.
   - Allows operations to focus on the process and still allows for additional information to be shown (in secondary screens / popups).


MENU
FEED TANKS
PLC HB :
11:07:37 AM
11/23/2016
TK-822 Wing 5
Tank Level
LE822-01
14.9 %
Tank Temp
TE822-01
0.0 °C
FV823/01
Pneumatic Pump
TO MAIN LOOP
Pump Permissive
TANK-880
LE880-01
51.5 %
TK-824 Wing 4
Tank Level
LE824-01
4.7 %
Tank Temp
TE824-01
9.3 °C
FV825/01
Pneumatic Pump
SV880-01
PU881A
PU881B
Waste Sump
LSH822-02
NORMAL

Less is More - Example



Lessons Learned

1. Planning is Key

   - Removes secondary information from screens to increase performance.
   - Working with Operations in development is critical to success – Operations will take ownership of the screens.
   - Customer is aware of the design / knows the philosophy of showing / removing certain information from the primary screens.

2. Operations Will Adapt Quickly

   - Operators typically struggle with changes to the system, however because the ISA Standard is focused around them (primary users), Operators adapt much quicker, and benefit faster.