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Boiler Plants Research Paper Launch

Feature Webinar: October 10th, 2018

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2017 Boiler Plants



Best Practices for Energy Efficient Boiler Plant Design, Operation and Control

A GREENING HEALTH CARE RESEARCH GUIDE



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2017 Boiler Plant Design, Operation and Controls

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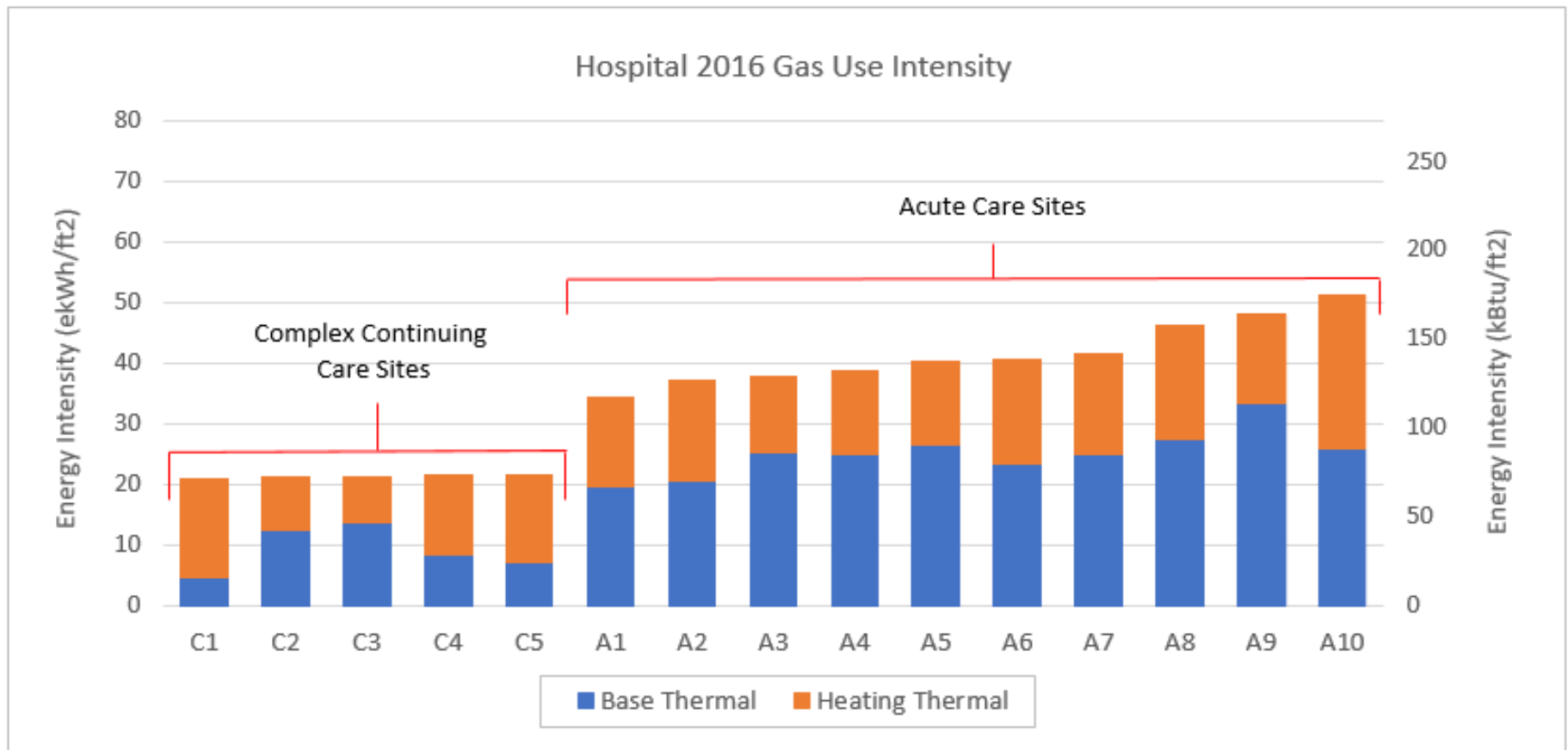
**Yorkland
Controls**
+
ENVIRONMENTAL
SOLUTIONS



THERMOGENICS



Best Practices - Introduction





Best Practices - Database

	GBPS	Baycrest	West Park	Ontario Shores
Hospital Type	Acute/CCC	CCC	CCC	CCC
Beds	#	262		
Building Area	ft2	990,288	465,403	485,004
Base Thermal 2016	ekWh/ft2	4.6	12.4	13.6
Heating Thermal 2016	ekWh/ft2	16.1	8.6	7.5
Total (2016 Toronto)	ekWh/ft2	20.7	21.0	21.1
Heating BT - 2016	degC	19.6	11.6	16.6
STEAM PLANT				
Main Boilers	#	2	3	2
Capacity (each)	BHP	200		
Economizers	Yes/No	No	Yes	Yes
Linkageless Controls	Yes/No	Yes	Yes	
FD Fan VFD	Yes/No	1.0	Yes (1)	
FD Fan HP	HP/boiler	BAS		
Modulating Control	Yes/No	Yes	Yes	
Step Control	# of stages			
Summer Boiler	#	1	1	
Capacity (each)	BHP	100.0		
Feedwater Pumps	#	3.0		



Best Practices - Checklist

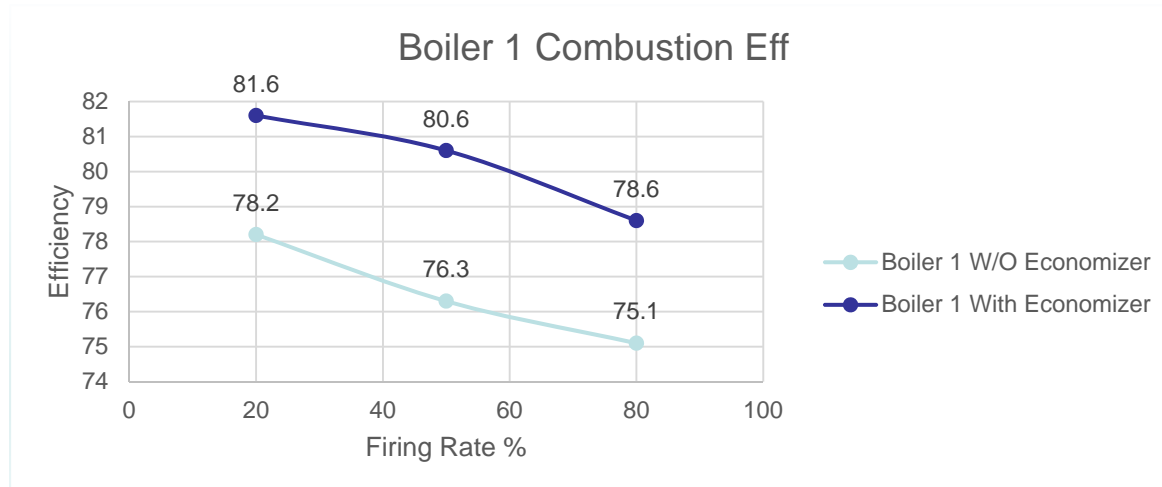
Action	
Guide Section #	Name
Plant Configuration and Design	
3.1.1	Install flue gas economizers
3.1.2	Install summer boiler
3.1.3	Design combination hot water and steam boiler plant
3.1.4	Specify/Retrofit linkage-less controls & O2 trim
3.1.5	Specify/Retrofit modulating burner control
3.1.6	Specify/Retrofit VFD on forced draft (FD) fan
3.1.7	Specify/Retrofit VFD on feedwater pump
3.1.8	Install back-pressure valves
Plant Operation and Control	
3.2.1	Reduce/reset steam pressure and primary HW temperature
3.2.2	Implement steam line isolation
3.2.3	Perform boiler testing and tuning
3.2.4	Sequence boilers to maximize plant efficiency
3.2.5	Increase condensate return, reduce water makeup
3.2.6	Upgrade water treatment to optimize % in control
3.2.7	Introduce electronic operating logs



Best Practices – 3.1.1 Heat Exchanger Surface Area & Flue Stack Economizer

- Increased surface area, recover energy from waste flue gases and transfer to feedwater
- Increases boiler overall efficiency by 3-10%
- Detailed engineering required to determine stack material and configuration for each plant

	CCC	Acute
# of Hospitals with Flue Stack Economizer	3 (5)	7(10)





Best Practices – 3.1.2 Summer Boiler

- Boilers cycle and waste energy in summer under reduced load conditions

Number of Cycles/Hour	Percentage of Energy Loss
2	2
5	8
10	30

- Boiler consumes gas with every purge cycle
- Increased wear and tear with continuous cycling
- Summer boiler to be sized for summer and shoulder season load

	CCC	Acute
# of Hospitals with summer boilers	3 (5)	3(10)



Best Practices – 3.1.3 Combination Hot Water and Steam Plant

- Plant Configuration – Steam Boilers only
 - Typically produce high pressure steam. Use PRVs to reduce steam pressure to equipment requirements
 - Requires heat exchangers where direct steam cannot be used - DHW, reheat, perimeter heating
 - Energy is wasted in high pressure generation and reduction
- Plant Configuration – Combination Hot Water and Steam Plant
 - Hydronic boilers for space heating and DHW (condensing option)
 - Steam boilers for process load, humidification and domestic hot water
 - Increased plant efficiency due to matching temperatures to loads

	CCC	Acute
# of Hospitals with combined hot water & steam plant	2 (5)	4(10)



Best Practices – 3.1.4 Linkage-less Controls & O2 Trim

- Linkage-less Controls
 - Independent control of fuel valve and combustion air damper
 - Maintain consistent air-to-fuel ratio over full range of firing rates
 - Improve boiler efficiency by reducing the excess air
- Linkage-less Controls with O2 Trim
 - Addition to above benefits, the O2 trim adds feedback control
 - Adjust the air-to-fuel ratio based on actual empirical data
 - Increase efficiency by 5-15% with payback of less than 2 years

	CCC	Acute
# hospitals with linkage less controls	3 (3)	7(8)



Best Practices – 3.1.5 Modulating Burner Control

- ON/OFF Control
 - Easiest control but least energy efficient
 - Boiler cycles during off peak hours
- Staged Control
 - Low-medium-high fire stages
 - Boiler cycles during off peak hours
- Modulating Control
 - Best matched to building load
 - Least cycling as burners modulate to low capacity
 - Consider retrofitting existing boilers with ON/OFF and staged control with new modulating burners

	CCC	Acute
# hospitals with modulating burner controls	3 (3)	5(7)



Best Practices – 3.1.6 VFD Forced Draft Fan

- Typically the largest electricity consumer in the boiler plant
 - Inlet damper varies air volume and have much less effect on fan electricity use
- Forced draft fan shall be retrofitted(where applicable) with variable frequency drive
 - Precise combustion air volume control
 - Significantly lower electricity consumption

	CCC	Acute
# of hospitals with VFD forced draft (FD)	2(3)	2(6)



Best Practices – 3.1.7 VFD Feedwater Pump

- Boiler feedwater pump motors are another significant electricity consumer
- Retrofit feedwater pump motors with VFDs (where practical) can significantly lower electricity consumption while maintaining precise feedwater volume control

	CCC	Acute
# of hospitals with VFD feedwater pump	0(3)	0(6)



Best Practices – 3.1.8 Back-pressure valves

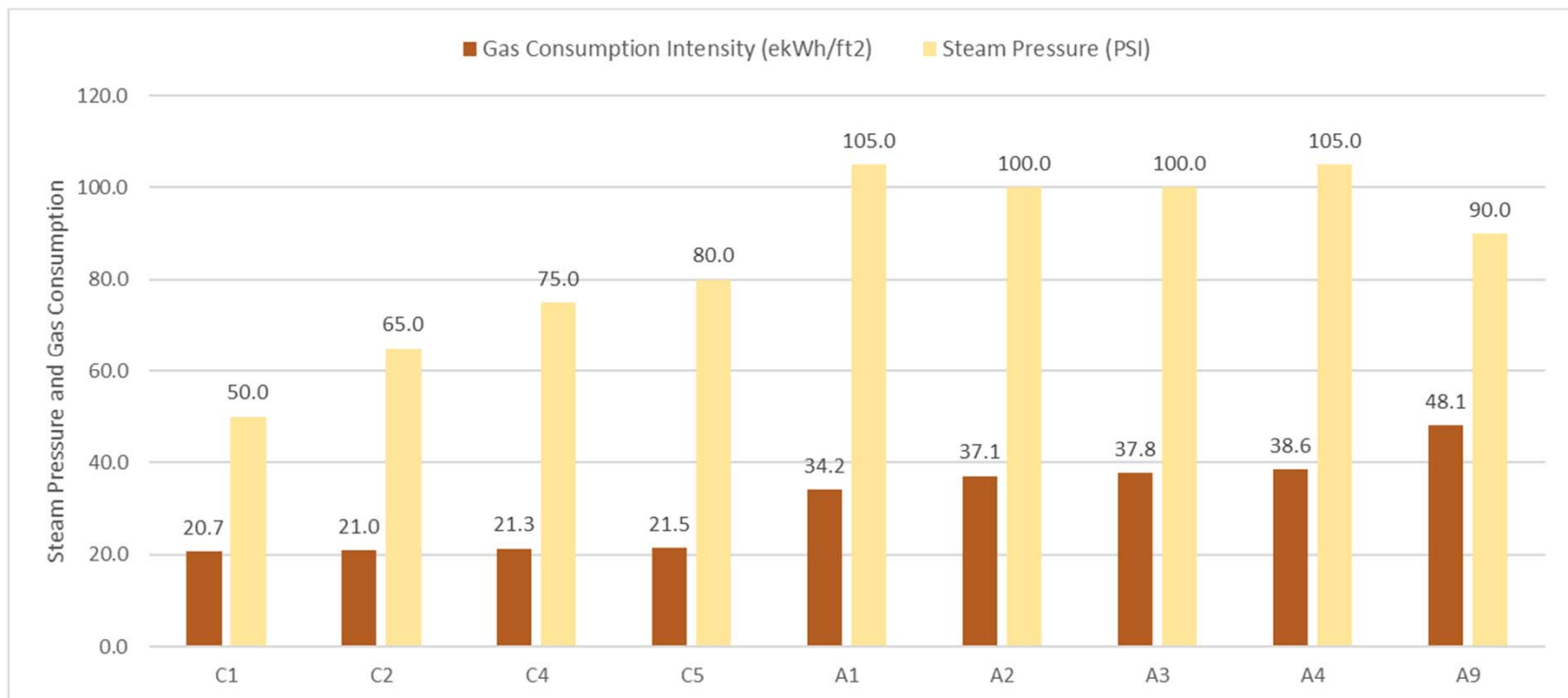
- Back pressure valves prevent changes in pressure at the boilers (upstream of valve)
- Back-pressure valves should be considered for applications where sudden load changes are experienced and cannot be moderated by upgraded controls.

	CCC	Acute
# of hospitals with back-pressure valves	2(3)	5(6)



Best Practices – 3.2.1 Steam Pressure Reset

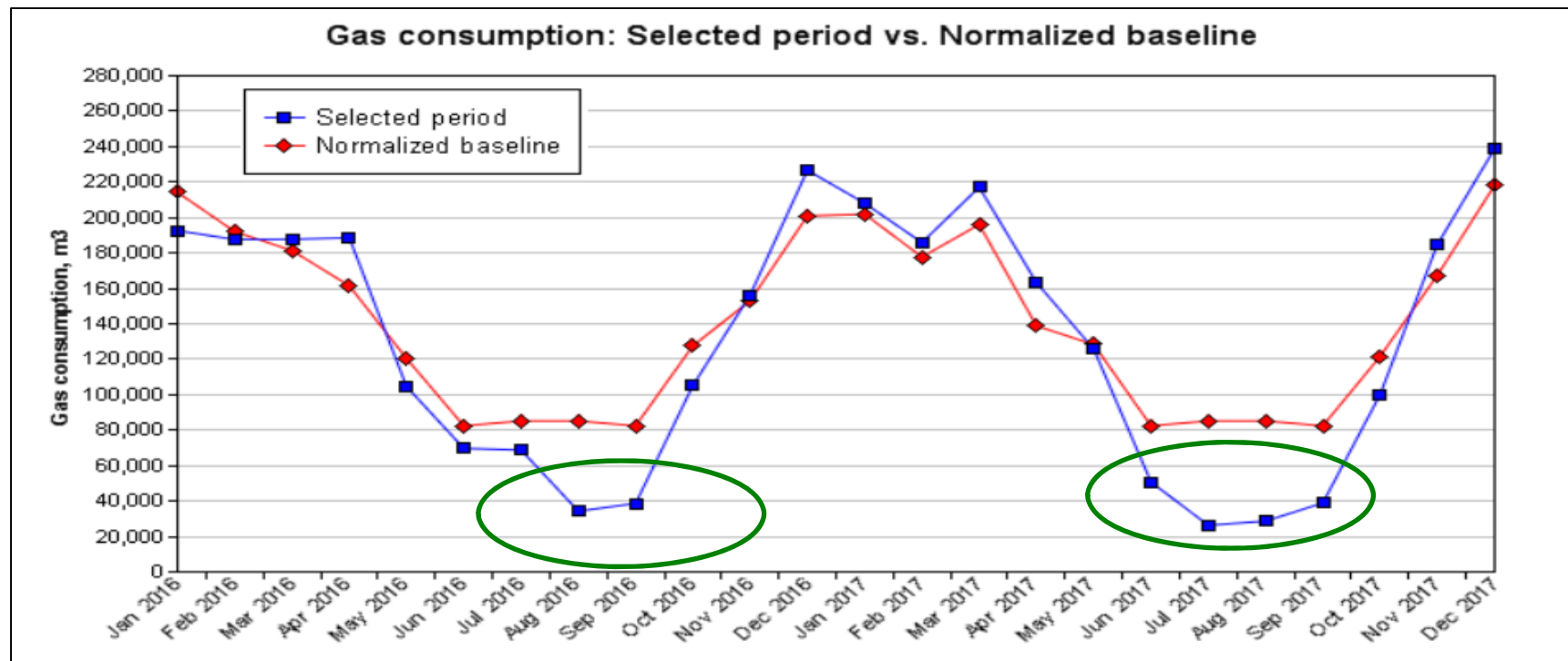
- Just one CCC hospital in database reset the steam pressures at night
- No acute care hospital reset steam pressures. Further investigation will be conducted to determine the feasibility of steam pressure reset in acute care hospitals
- Data suggests that lower steam pressure results in lower gas consumption





Best Practices – 3.2.2 Steam Line Isolation

- Seasonal Isolation of steam line
 - Flush condensate after isolation to avoid pipe corrosion
 - Pressurize with nitrogen to avoid air leaking into steam lines



Steam Meter Savings for: Aug/16-Sep/16: 56.5% - 94,673 m³, \$30,326
Jun/17-Sep/17: 56.9% - 190,626 m³, \$58,366



Best Practices – 3.2.3 Boiler testing and tuning

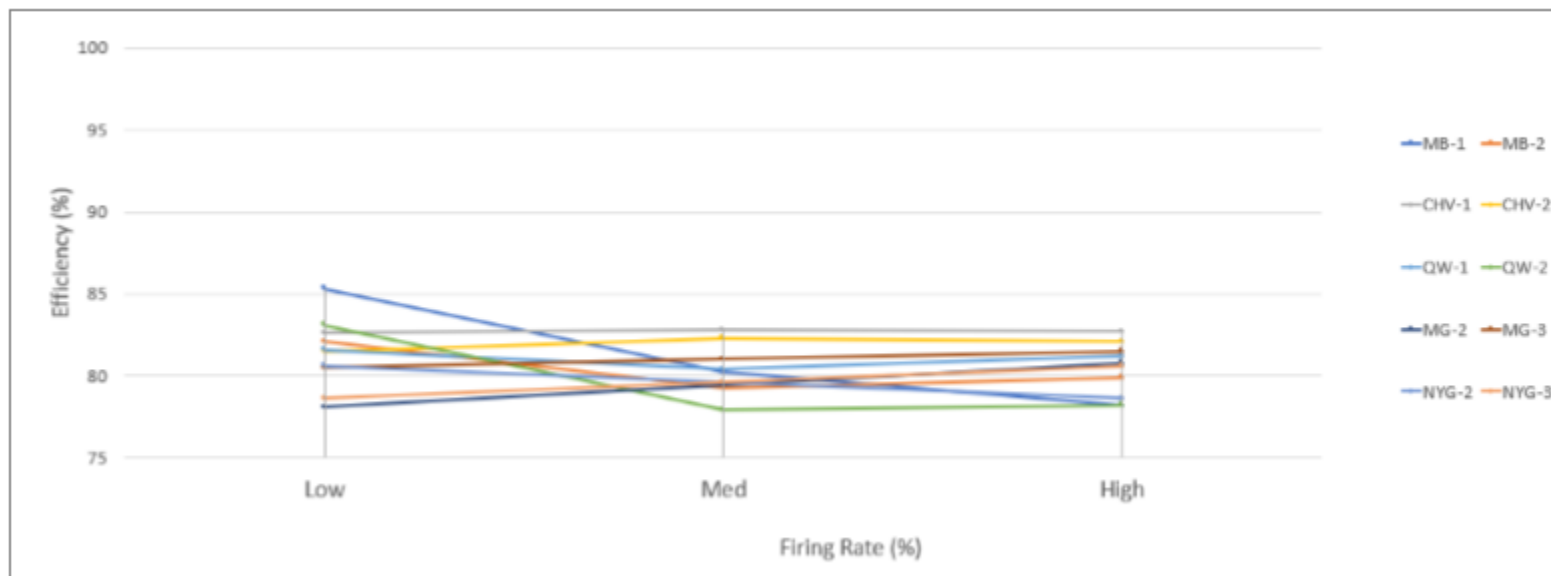
- Boilers should be tested semi-annually for combustion efficiencies
- Following are recommended best practices:
 - Test both upstream and downstream of external flue gas economizers (two sets of results) if installed;
 - Report as-found conditions as well as best performance following tuning;
 - Include previous test date and results and comment on changes
 - Hold a formal performance review meeting with the boiler service and water treatment contractors, the plant operator, the BAS service contractor and the hospital's engineer to evaluate test results and discuss options for improvement.

	CCC	Acute
# of hospitals that conduct boiler efficiency tests	3(3)	6(6)



Best Practices – 3.2.4 Sequence boilers to maximize plant efficiency

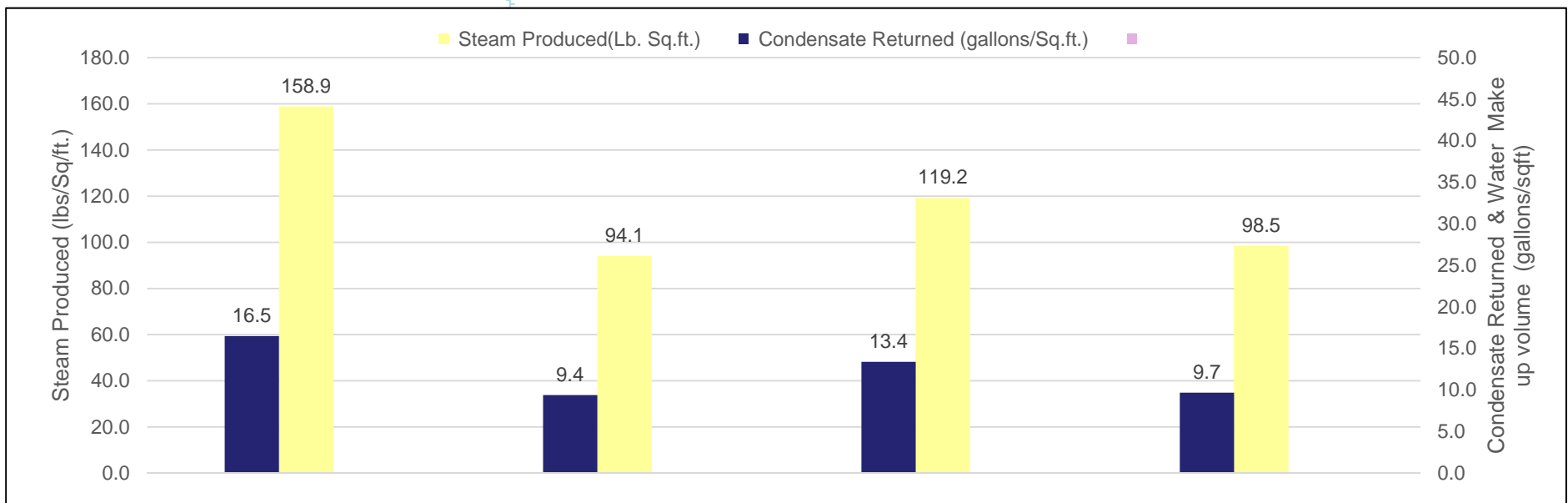
- Automate sequencing of boilers to stay as close as possible to the “sweet spot” efficiency of each boiler
 - Important for maximizing overall plant performance
 - Test reports also show which boilers are more efficient across their firing ranges
 - Review boiler efficiency curves and sequence them accordingly





Best Practices – 3.2.5 Condensate Recovery

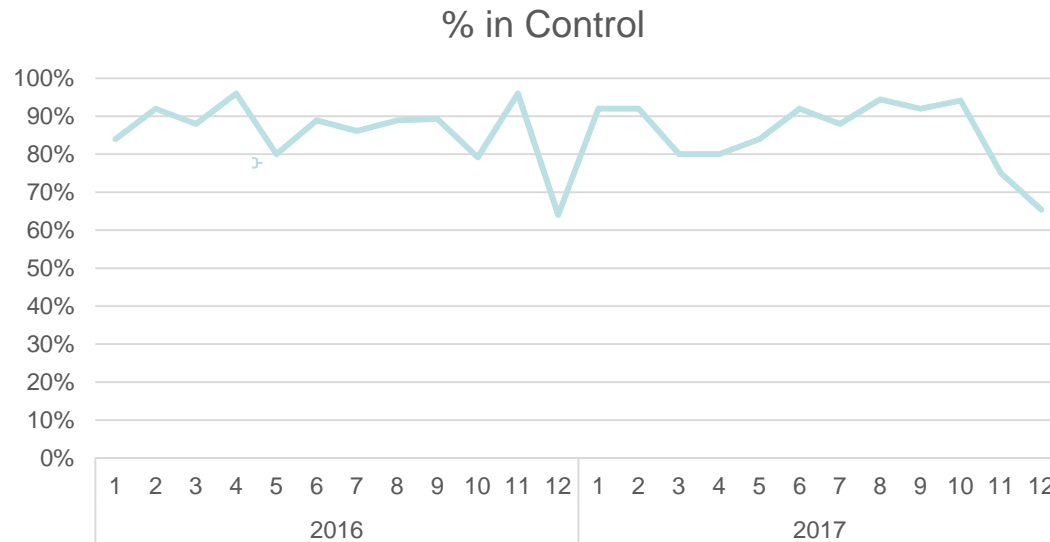
- Less water make up and chemical treatment
- Fuel savings
- No use of domestic water for quenching
- Overall increase in boiler plant efficiency





Best Practices – 3.2.6 Water Treatment: monitor & maximize percent in control

- Monitor water conductivity, pH, sodium sulphite, alkalinity, and hardness
- Maximum percent in control – ratio of number of time the parameter(s) are out of control limits to total number of time parameter(s) are within the control limits



	CCC	Acute
# electronic database	2 (5)	4(10)



Best Practices – 3.2.7 Operating Logs

- Electronic operating logs
 - Easy to access, store historical data
 - Perform data analysis and recommend changes
 - Monitor and track changes and improvements
- Monitor & Respond to Trends
 - Set up trends on key parameters
 - Provide staff training to identify anomalies and respond with appropriate actions
 - Review historical data to identify and correct performance issues

	CCC	Acute
# hospitals with manual operating logs	2	3
# hospitals with electronics operating logs	2	5



Q & A



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