2018 North Dakota Healthcare Engineering Society Conference

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Domestic Water Heaters

Mike Comstock
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Mulcahy Co.

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Outline

- Tank Style Water Heaters
- Operational impact of storing water
- Instantaneous
- Design Examples

Water Heater Types

- General Type
  - Tank Type
  - Side Heaters
  - Instantaneous
- Fuel Source
  - Natural Gas/LP
  - Electric
  - Central Plant

Tank Style Units

- Inexpensive
- Very simple
- Can lose efficiency over time
- Limited Sizes
- Largest standby losses of all options

Fired Water Heaters

- Tank Type –
  - Most houses have one
  - Water is stored at a high temperature
  - Small burner keeps tank from getting low on temperature
  - Storage is large enough to ride out the peaks that the burner can't keep up with

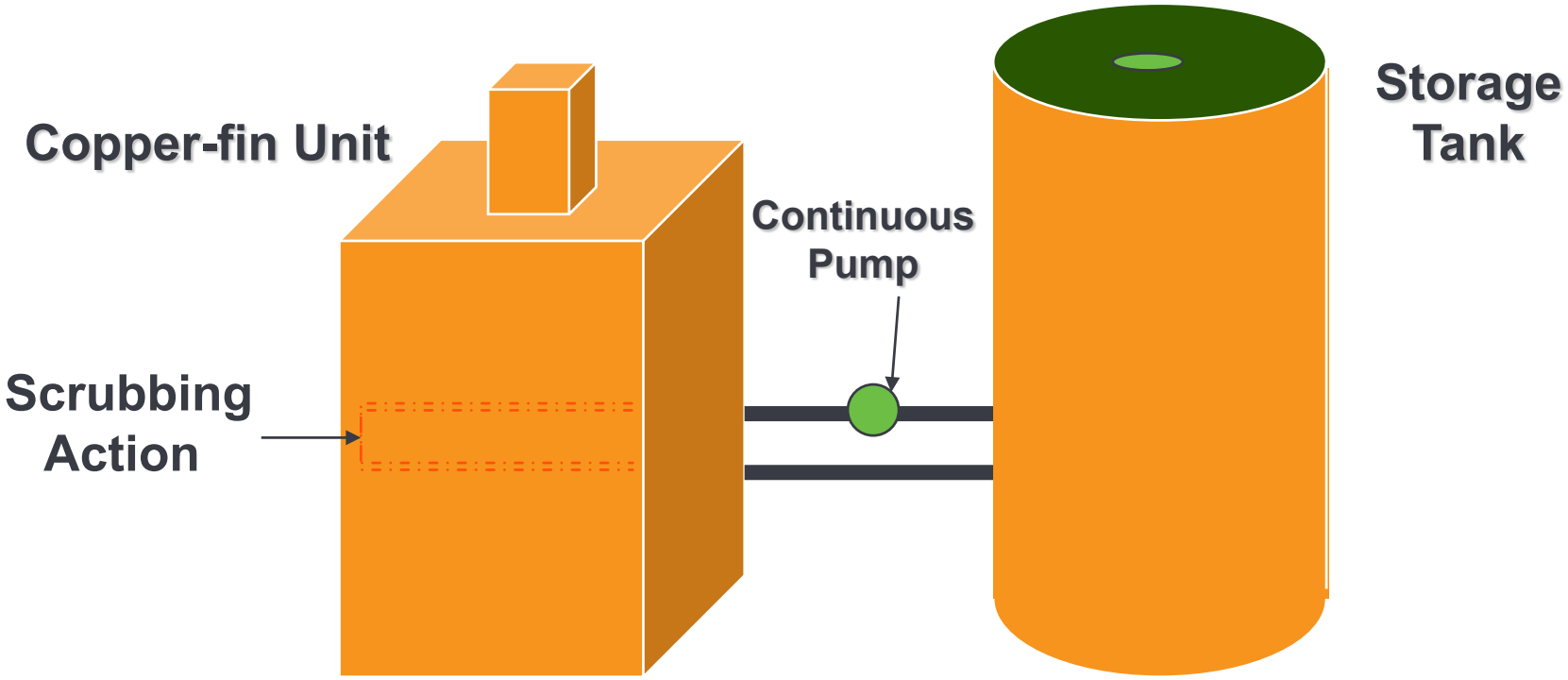
Typical Commercial Tank Sizes

CAPACITY, INPUT AND OUTPUT

Model Number	Input BTU/HR	Gallons or Litres	Tank Size	Litres	Recovery - Gallons or Litres Per Hour at Degree Rise		
					40°F	100°F	140°F
					22°C	56°C	78°C
BTR-120*	120,000	U.S. Gallons	71	GPH	291	116	83
		Litres	268	LPH	1102	439	314
BTR-154	154,000	U.S. Gallons	81	GPH	373	149	107
		Litres	307	LPH	1412	564	405
BTR-180	180,000	U.S. Gallons	81	GPH	434	174	124
		Litres	307	LPH	1643	659	469
BTR-197	199,000	U.S. Gallons	100	GPH	482	193	132
		Litres	379	LPH	1825	731	500
BTR-198	199,000	U.S. Gallons	100	GPH	482	193	132
		Litres	379	LPH	1825	731	500
BTR-199	199,000	U.S. Gallons	81	GPH	482	193	132
		Litres	307	LPH	1825	731	500
BTR-200(A)	199,000	U.S. Gallons	100	GPH	482	193	132
		Litres	379	LPH	1825	731	500
BTR-250(A)**	250,000	U.S. Gallons	100	GPH	606	242	173
		Litres	379	LPH	2294	918	655
BTR-251(A)**	251,000	U.S. Gallons	65	GPH	608	243	174
		Litres	246	LPH	2303	921	658
BTR-275(A)**	275,000	U.S. Gallons	100	GPH	667	267	190
		Litres	379	LPH	2524	1009	721
BTR-305(A)	305,000	U.S. Gallons	65	GPH	739	296	211
		Litres	246	LPH	2799	1120	800
BTR-365(A)	365,000	U.S. Gallons	85	GPH	885	354	253
		Litres	322	LPH	3349	1340	957
BTR-400(A)	390,000	U.S. Gallons	100	GPH	970	388	277
		Litres	379	LPH	3671	1468	1049
BTR-500(A)†**	500,000	U.S. Gallons	85	GPH	1212	485	346
		Litres	322	LPH	4588	1835	1311

Specify when ordering propane (LP) gas.
*Model BTR 120 is shipped with a 6" x 5" flue outlet adapter.
**Models BTR 250, 251, 275 and 500 are shipped with a 8" x 6" flue outlet adapter.
Standard models certified for sea level to 2,000 ft. elevation. Order SMR S54 for elevations up to 8,000 ft.
† BTR-500 model features induced draft design and no damper.
Recovery based on 80% efficiency.

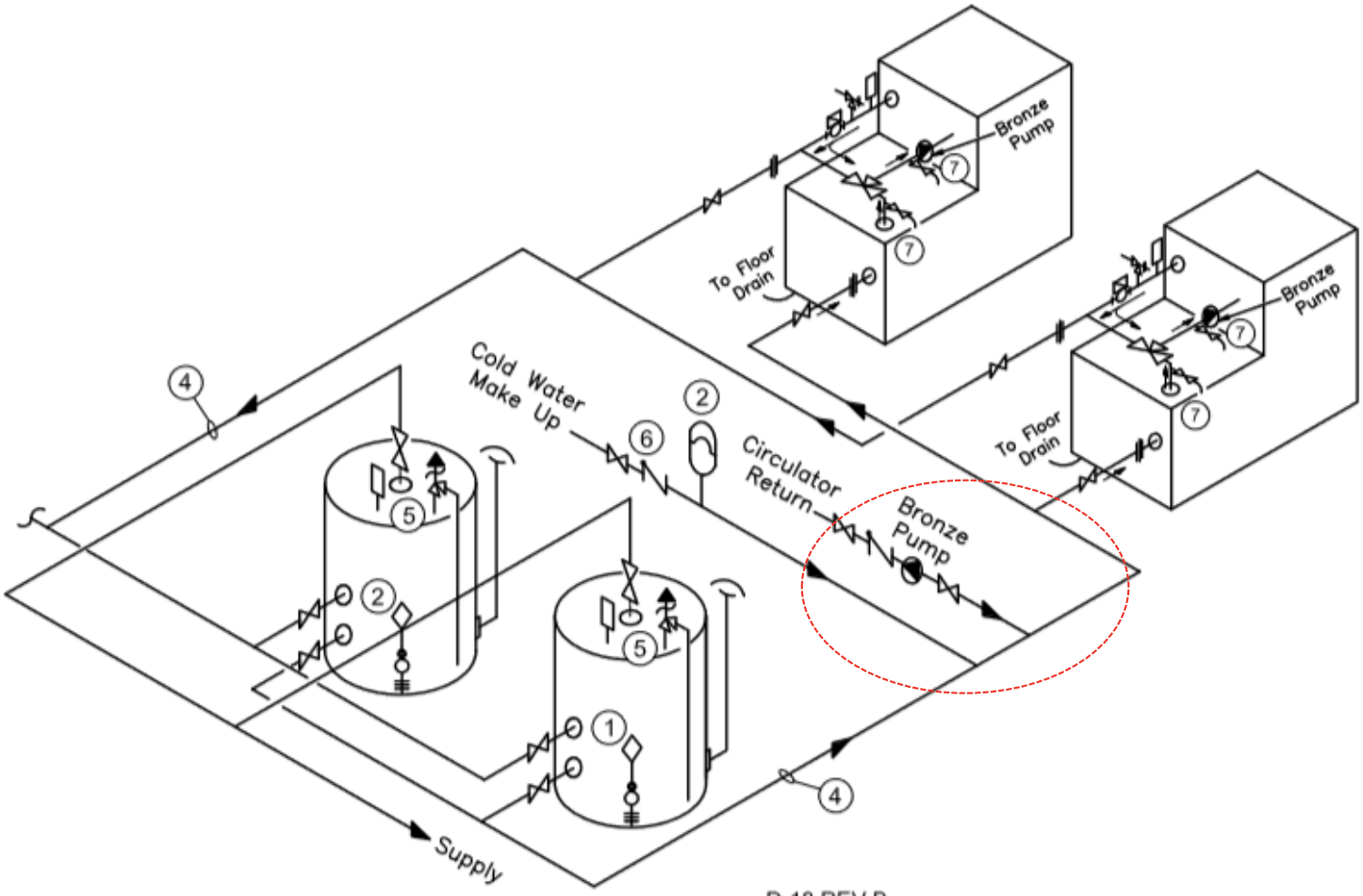
Side Heater and Tank



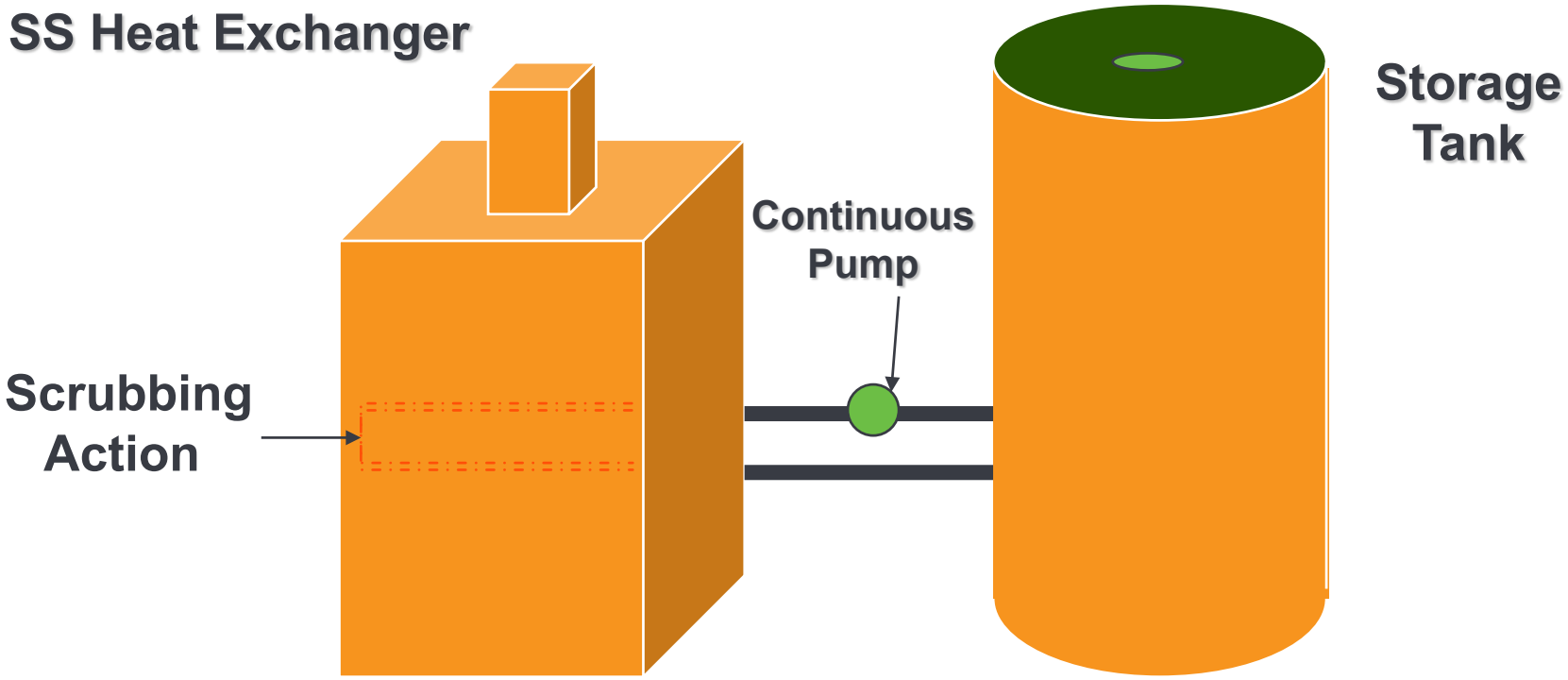
Side Heater

- Circulating pump keeps heat exchanger cleaner
- Minerals deposit in the tank
- A greater versatility in tank and burner sizing
- Can have multiple heaters for reliability

Multiple Tank/Heater Example Condensing



High Efficiency
Circulating Tank Water Heater



Tank can be any dimension you want and of whatever material

Electric Storage Type Water Heater

- Mixture of tank and input sizes
- Popular for Off Peak Energy Usage
- No Venting

Un-fired Water Storage Heaters

- Common in larger facilities, healthcare, schools, Universities
  - Steam or Hot Water
- Uses the energy from a central source
- 100% Efficient!
- Requires no venting and minimal electrical power

Storage Tank

- Similar Gas Fired Units
- Sufficient energy is stored in the tank to ride out the worst case load.
- Unit could be factory or field assembled
- Low peak demand

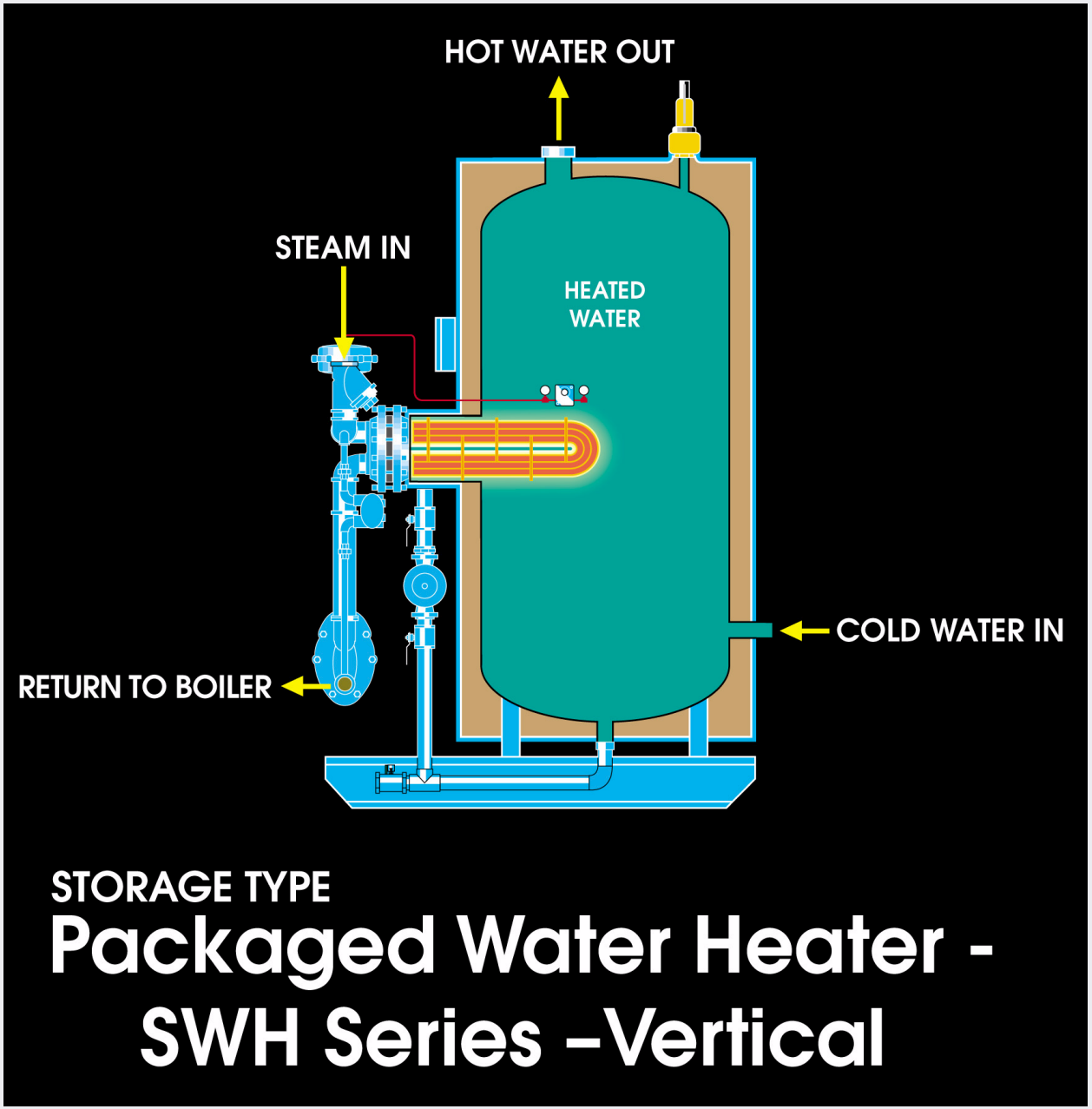
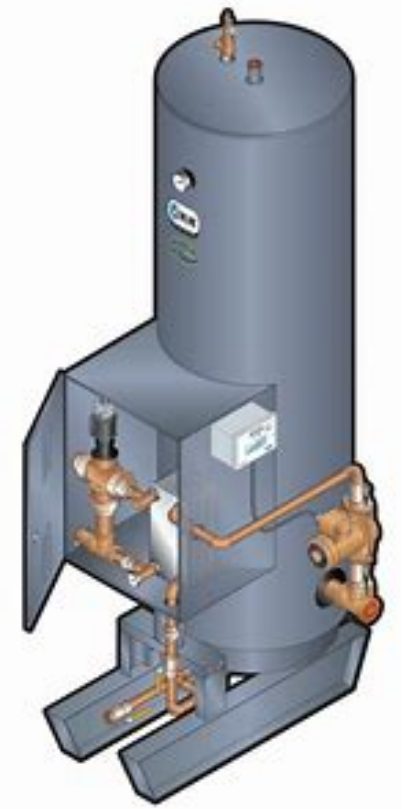

HOT WATER OUT
STEAM IN
HEATED WATER
COLD WATER IN
RETURN TO BOILER
STORAGE TYPE
Packaged Water Heater - SWH Series –Vertical

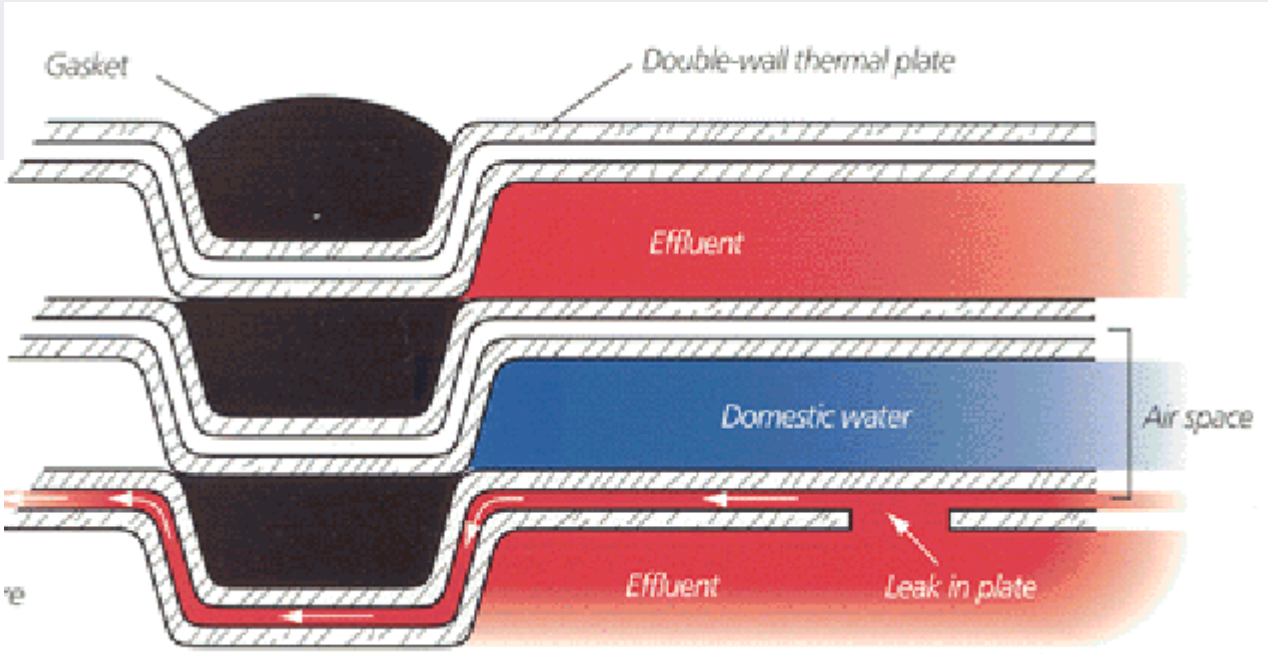
Plate Heat Exchangers

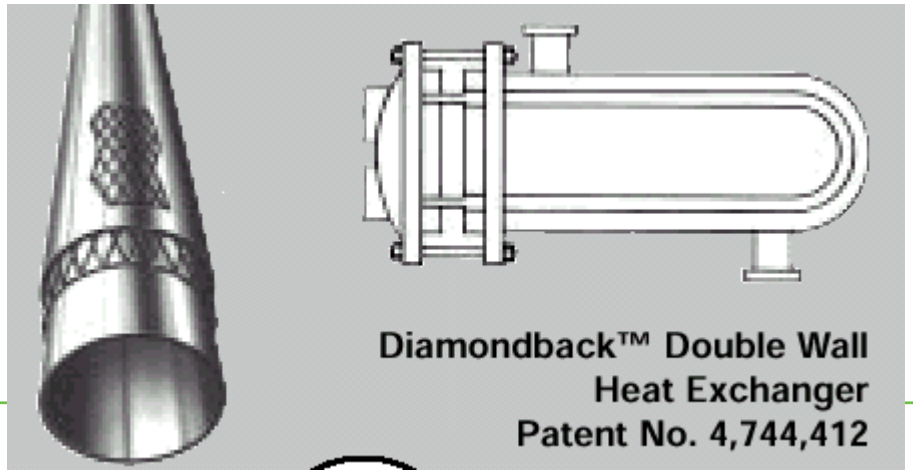
- There are performance limitations of U-Tube Heat Exchangers
- Return water temperature is limited to the tank temperature
- Using a side plate type heat exchanger allows for lower water temperature requirements



Double Wall

- Prevents Cross Contamination
- Used primarily for potable water
- Available for Plate and U-tube units
- Make sure that you specify that there is a “Leak Path”!

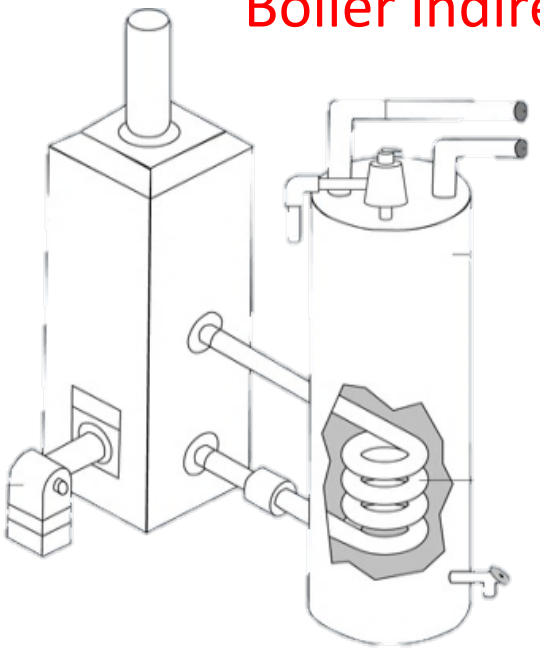




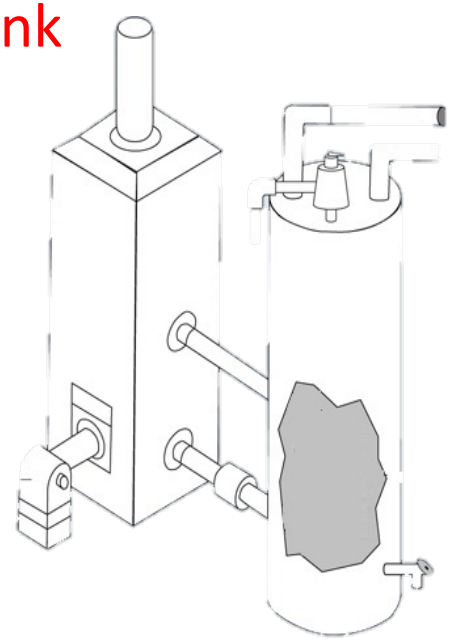
Hot Water Storage

Tank heater
- Store water for temp stability
- Need multiples
- Always on
- Scales, catastrophic leaks

Boiler indirect tank



Boiler with indirect tank
- Store water for temp stability
- Need multiples
- Need pump, indirect heat exchanger
- Always on even in summer



Boiler with direct tank
- Store water for temp stability
- Need multiples
- Need pump
- Boiler scales, leaks

Tank WH Sizing Example

NST NILES STEEL TANK SINCE 1898 | About Us | Products | Warranty & I/O Manuals | Contact Us | Get a G

Electric Power Heater Series

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Get a Quote

Large Volume Electric Power Water Heat

Right Spec Sizing Program

NST NILES STEEL TANK SINCE 1898

Niles Large Volume E
Siz

Select your application below

Quick Sizing	Hosp
Apartments/Condominiums	Hotel
Beauty Salon/Barber Shop	Hotel
Campground	Indus
Car Wash (Automatic)	Laun
Car Wash (Coin-Operated)	Laun
Country Club	Office
Dairy Barn	Photo
Dormitory/Group Housing	Priso
Fitness Center/Gymnasium	Scho
Food Service/Restaurant	

It is the responsibility of the application engineer or installing contractor to pro
correctly size all components within. This includes, but is not limited to: water
mixing valves, piping, pumps, etc. In no event does Niles Steel Tank make an
regarding the design and installation of the plumbing system, or its componen
warranty provided with the water heater(s) and/or storage tank(s).

Tank WH Sizing

Job Specifications	
Date:	7/10/2018
Application:	Apartments/Condominiums
Shower Heads:	2.5 GPM
Inlet Temp:	40°F
Stored Temp:	130°F
General Requirements:	20 Units with 1 Bath 20 Units with 1 1/2 Baths 20 Units with 2 Baths & Clothes Washer
Laundry Requirements:	20 Washers (20 Pound Capacity)

	Commercial Vertical Round Electric Water Heater Recommendation #1	Commercial Vertical Round Electric Water Heater Recommendation #2	Commercial Vertical Round Electric Water Heater Recommendation #3
Heaters Required:	1	1	1
Heater Model No.:	JEV800*270	JEV1000*252	JEV1000*270
Heater Capacity:	800 Gallons	1000 Gallons	1000 Gallons
Input per Hour:	270 kW	252 kW	270 kW
Usable Storage:	640 Gallons	800 Gallons	800 Gallons
Recovery:	1230 GPH @ 90°F Rise	1147 GPH @ 90°F Rise	1230 GPH @ 90°F Rise
Approx. 1st Hour Delivery:	1870 Gallons	1947 Gallons	2030 Gallons
Approx. 3 Hour Avg. Delivery:	1443 GPH	1414 GPH	1496 GPH
Approx. Storage Recovery:	39 Minutes	52 Minutes	49 Minutes
% of Demand Satisfied:	102%	100%	106%
Heater Overall Jacket Height:	104"	128"	128"
Heater Diameter:	52"	52"	52"

Sizings Based on ASHRAE Handbook HVAC Applications - Service Water Heater Chapter

Tank Unit Drawbacks

- There are inherent drawbacks to storage tank systems
- Efficiency of operation
- Scaling of the heat exchanger can be an issue
- Large commercial systems have large footprints
- Stagnant water can be a safety/health concern

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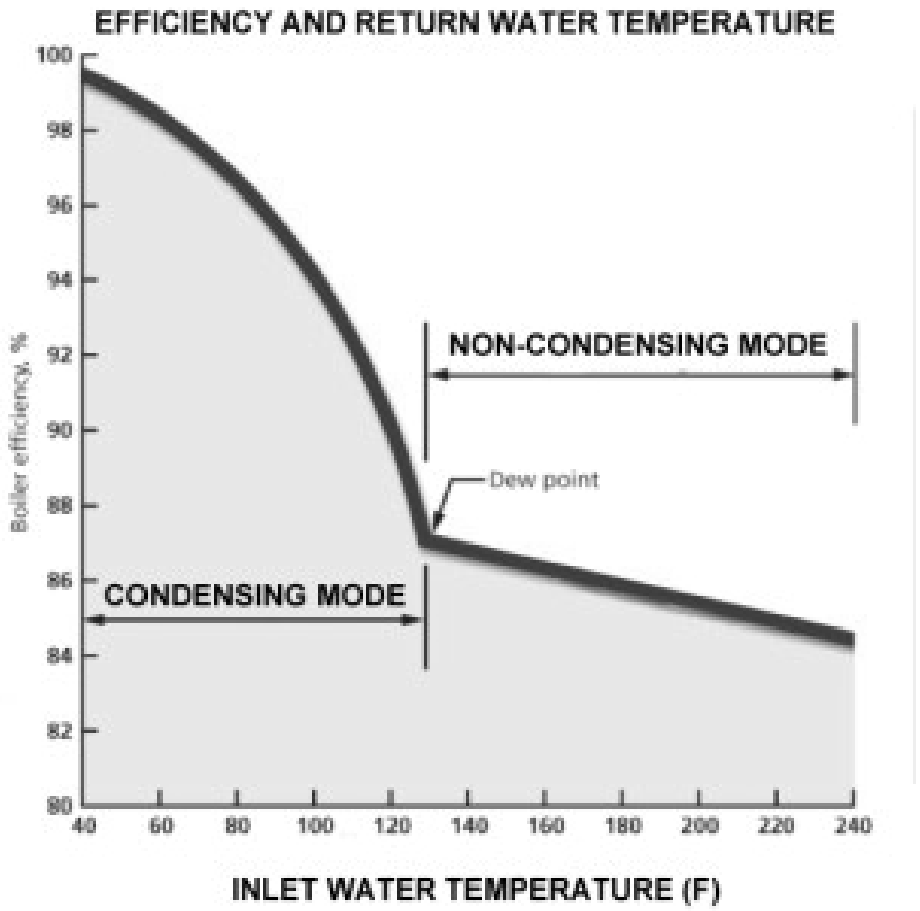
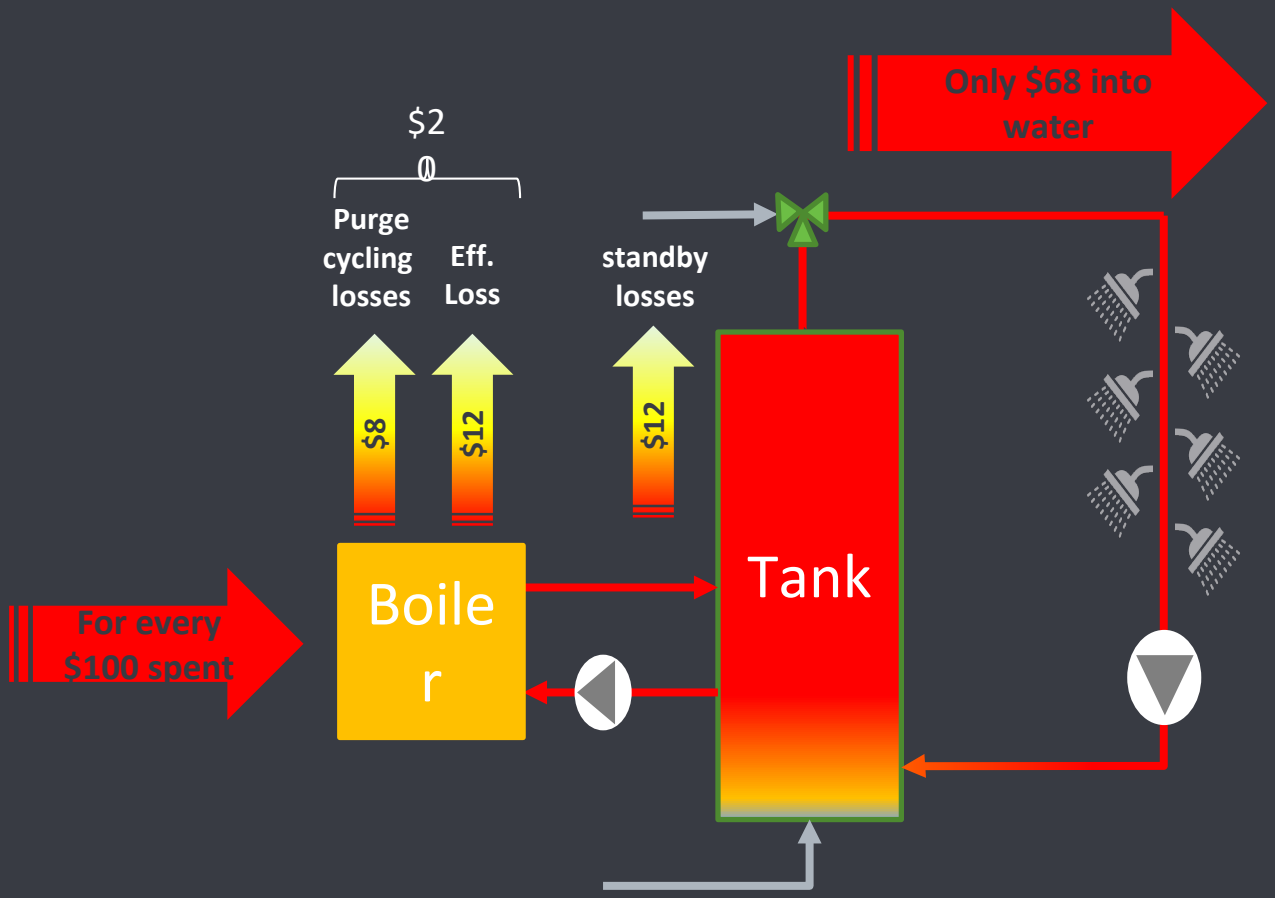
Tank Inefficiency

- Standby-Loss
- Combustion/Thermal Inefficiency



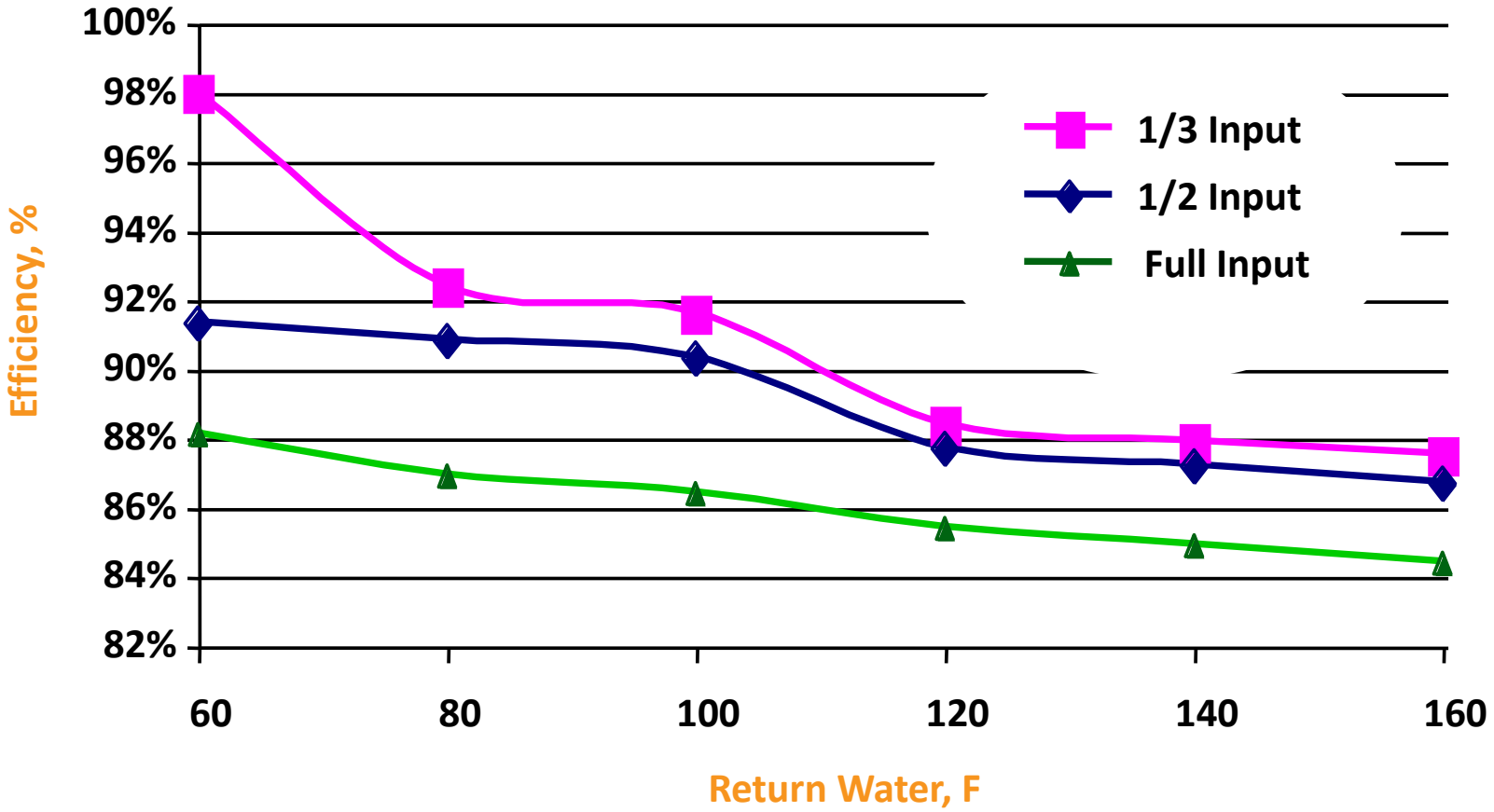
Effect on Operational Expense

For every $100 spent, $32 is wasted*



*Based on a 96% thermal efficiency condensing boiler with a 500 gallon tank

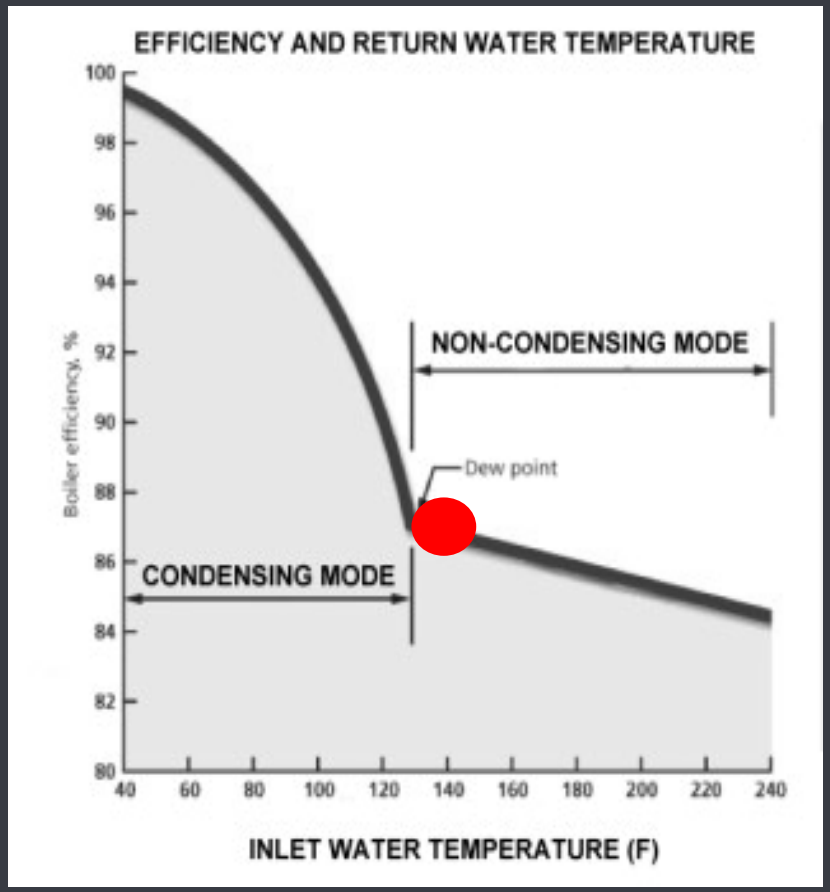
Typical Condensing Boiler Efficiencies- i.e. Laws of Physics Rule

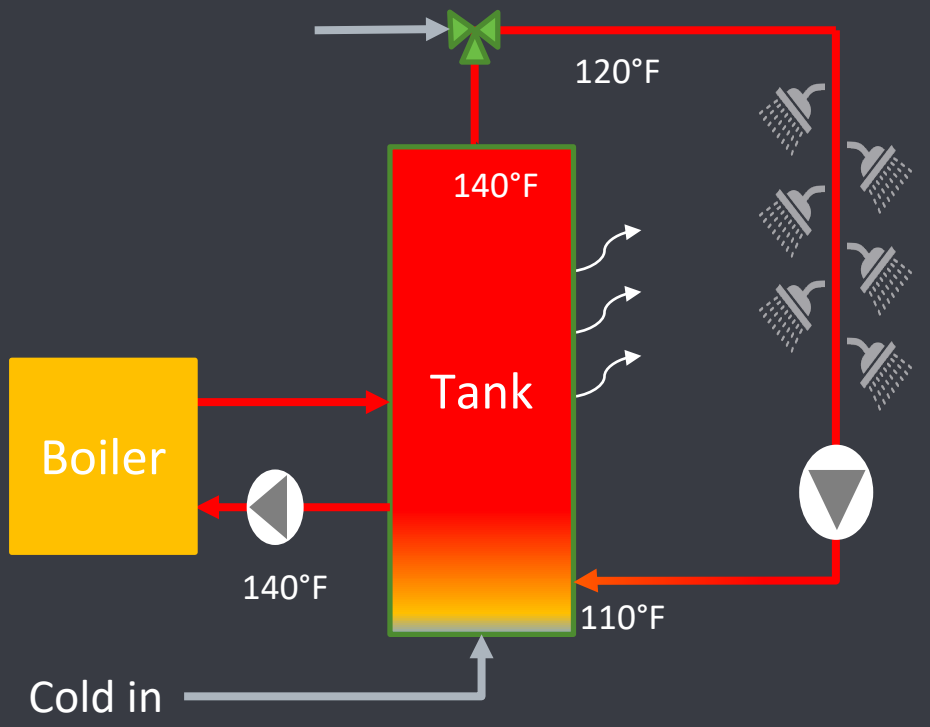


Lower inlet water temperature = Better Efficiency

Impact on tank or boiler-storage

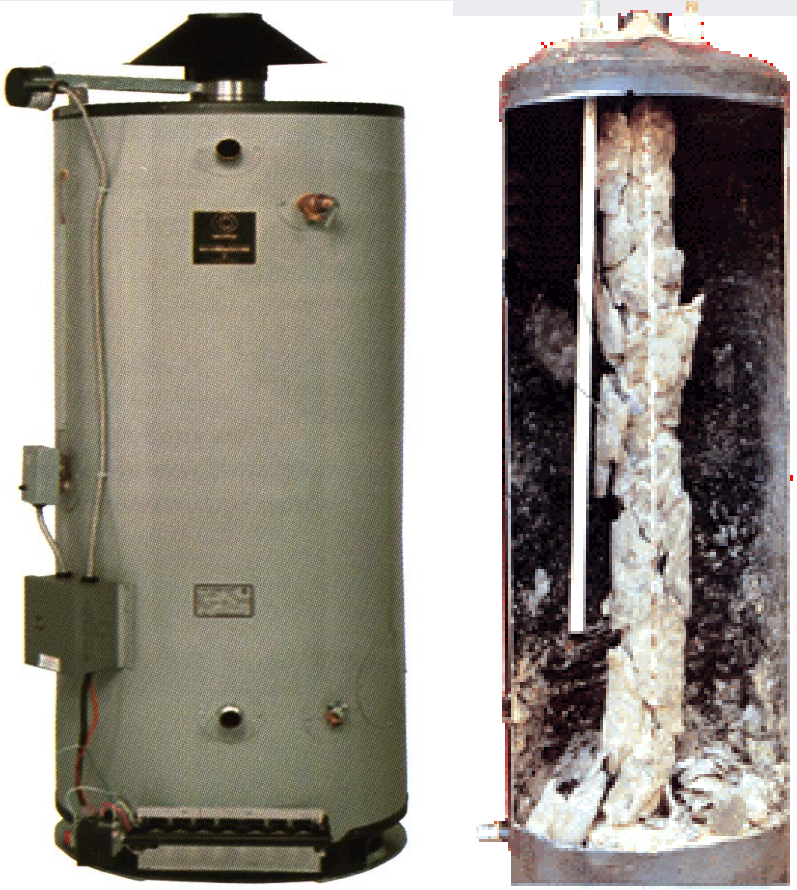
Turns high efficiency into low efficiency, 23 out of 24 hours a day





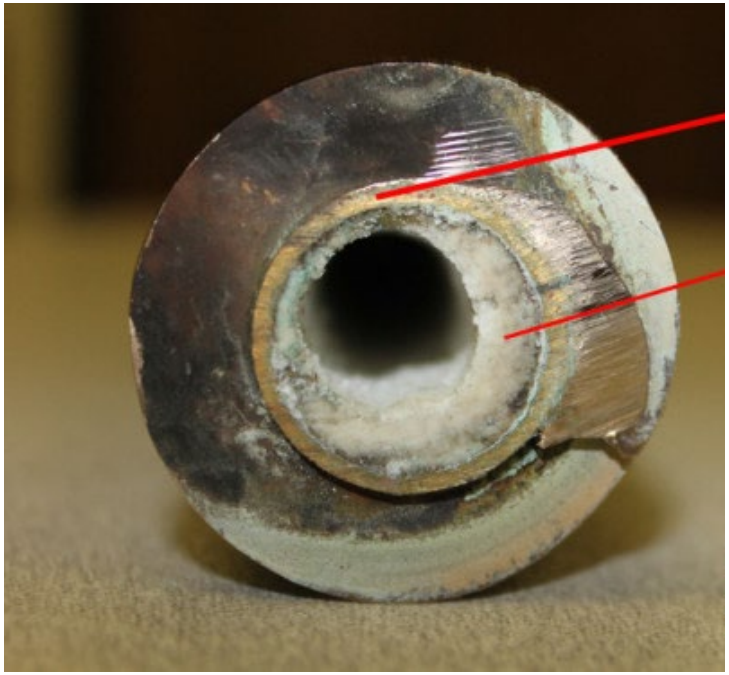
Tank Style Units - Scale

- As water is heated, minerals come out of solution.
- They tend to adhere to low velocity and hot point
- Sounds like the burner!!!!
- The heat exchanger is then insulated which affects efficiency

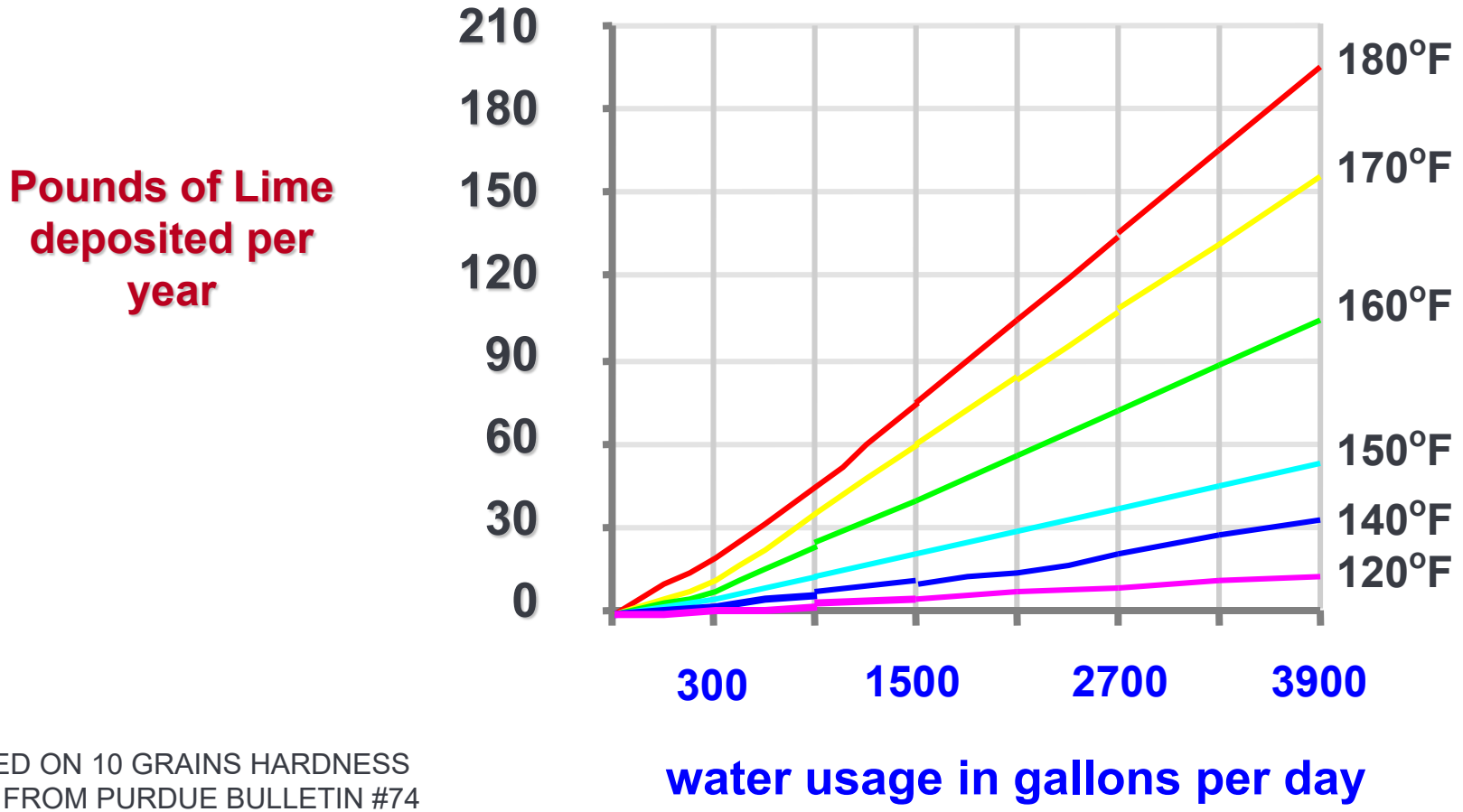


Efficiency Losses

- Purdue University researched and quantified the effect
- Higher temperature releases more minerals
- The thicker the buildup the lower the efficiency



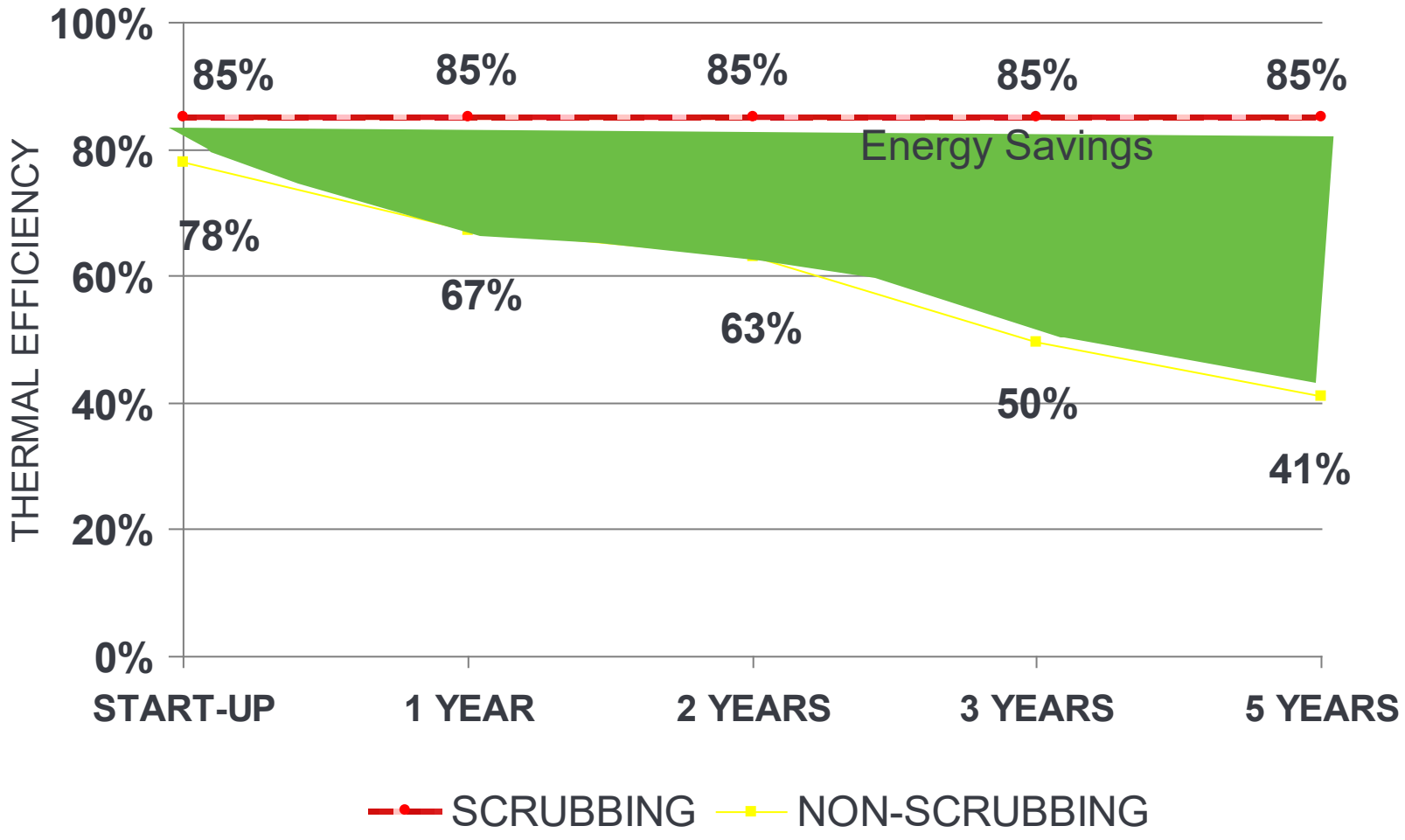
Lime Deposits vs. Temperature & Water Usage



BASED ON 10 GRAINS HARDNESS
DATA FROM PURDUE BULLETIN #74

Continued Efficiency

EFFECTS OF SCALING ON EFFICIENCY



Effects of Scale Build-up

- 1/16” of Scale = 15% Reduction in Water Heater Efficiency
- Premature Heat-X Failure
- Increased Fuel Costs over Time

Legionella

Stopping Legionaires' Disease

In Your Water Heater

Legionnaires Disease, or Legeionellosis, is caused by Legionella Pneumophila, a ubiquitous aquatic bacteria that thrives in warm environments. It was identified after 34 veterans died after attending an American Legion Convention in the Bellevue-Stratford Hotel in Philadelphia in 1976.

Kingdom: Bacteria
Division: Proteobacteria
Class: Gamma Proteobacteria
Order: Legionellales
Family: :egionellaceae
Genus: Legionella

158° to 176° Immediate Disinfection Range
Legionella bacteria can not survive at this temperature or above

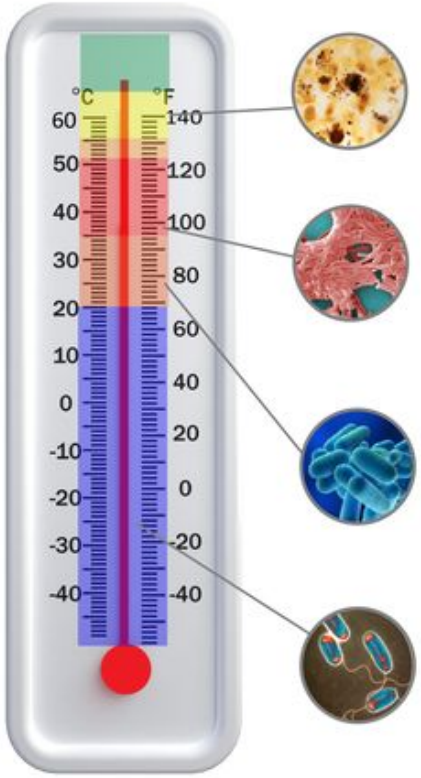
141° to 151° Partial Disinfection Range
Legionella bacteria can not survive at this temperature beyond 2 minutes

132° to 140° Eventual Disinfection Range
Legionella bacteria can not survive at this temperature beyond 32 minutes

123° to 130° Stasis Range
Legionella bacteria can survive but not multiply at this temperature

68° to 122° Ideal Growth Range
Legionella bacteria can survive and multiply at this temperature indefintiely

67° > Dormant Organism Range
Legionella bacteria can survive at this temperature but are dormant, and do not multiply



**Disinfection Temperatures For Legionella Pneumophila*

Scalding

Safety: Scalding vs. Legionella

ASTM C 1055-99

- Curve A: 2nd Degree Burn
- Curve B: 1st Degree Burn

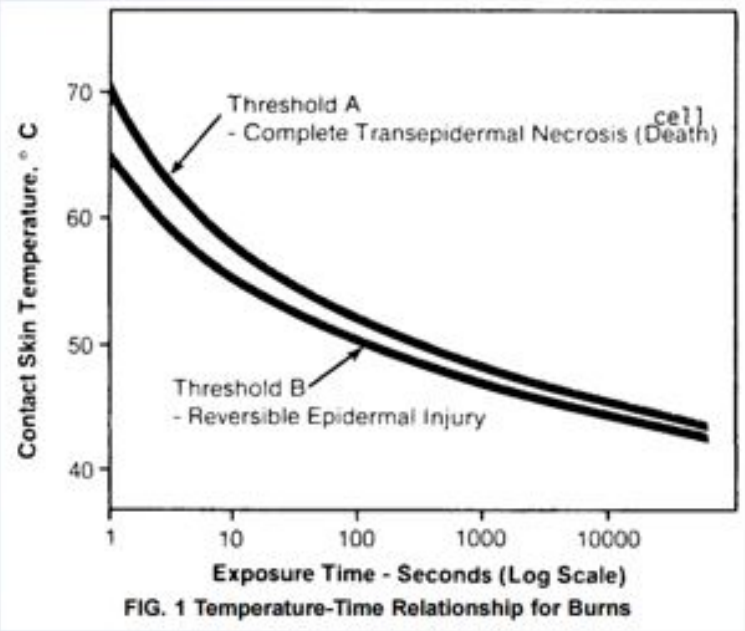


FIG. 1 Temperature-Time Relationship for Burns

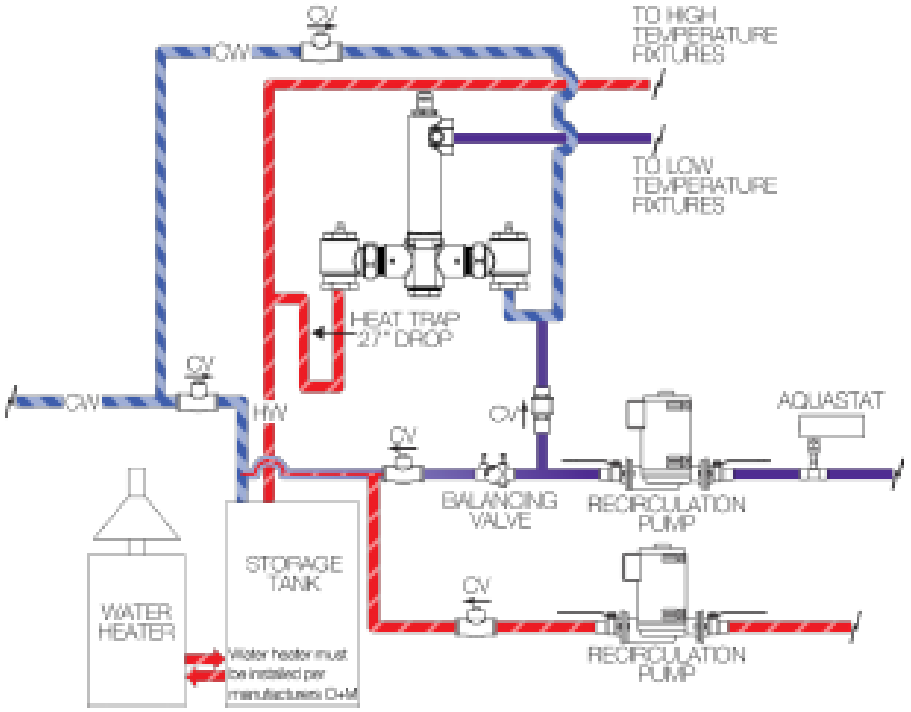
Time (s)	°F (1st deg)	°F (2nd deg)
1	149	159.8
2	142.7	149.9
3	139.1	145.4
4	136.8	142.7
5	135.5	140.9
6	134.2	139.1
7	133.2	138.4
8	132.3	137.8
10	131	136.2
100	122.5	125.6
1000	116.2	119.3
10000	111.7	113.9

Mixing Valves

Mixing Valves

Typical Installation

When used in a dual temperature recirculating system



Mix Valve Pitfalls

- Valve ratings are done at 45 psid
- Minimum flow rates are not to be ignored
- Recirculation is done differently from manufacturer to manufacturer
- Installation details such as pipe orientation and check valves are key to success
- The valves need a significant spread between hot and cold water temps to regulate accurately

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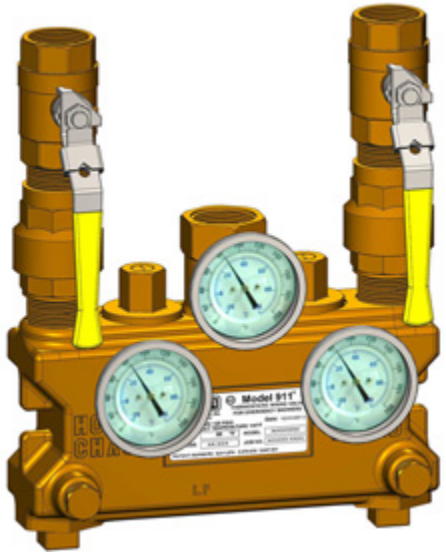
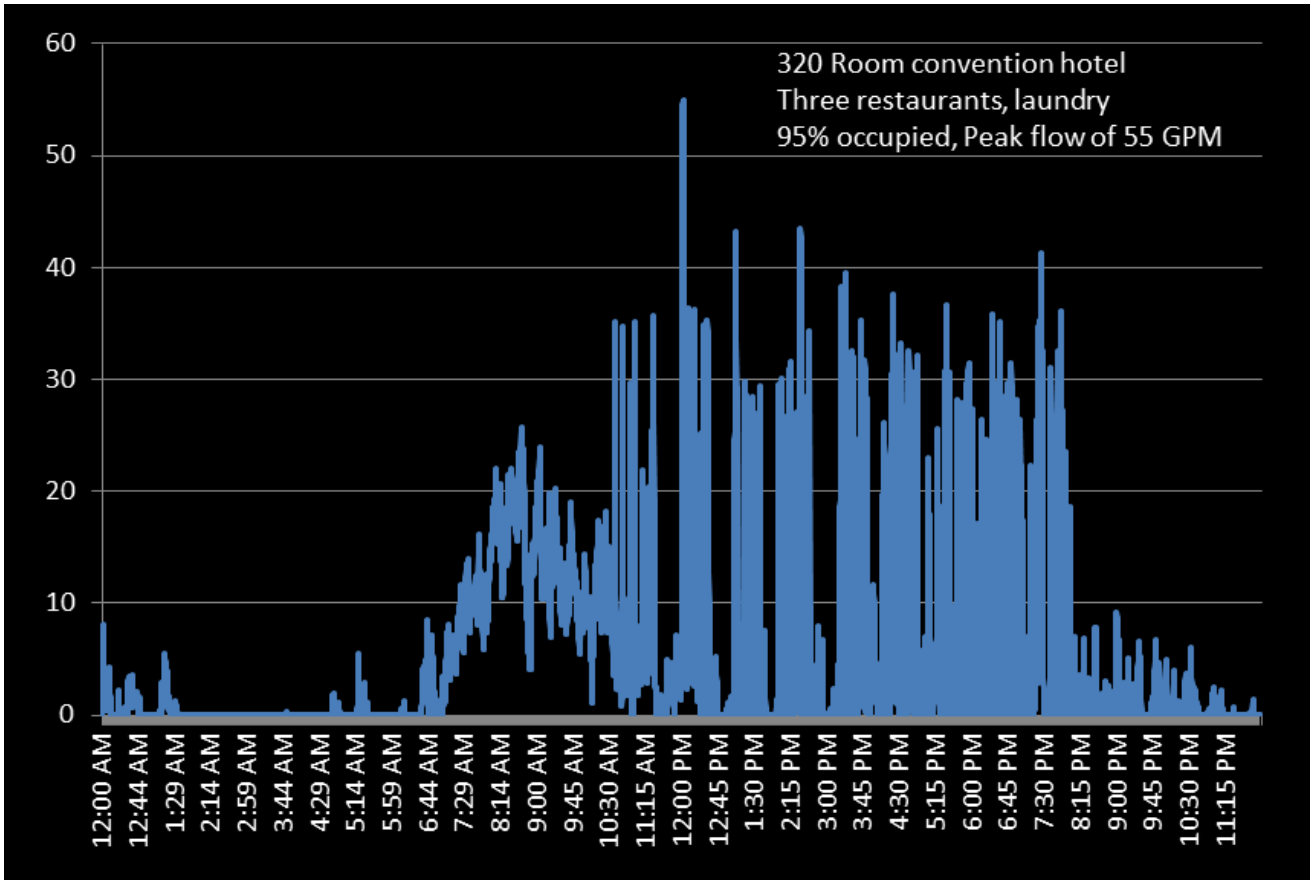
Emergency Fixtures

- Code requires that the water serving emergency showers and eye washes be tepid/lukewarm
- The valves are different than other valves, especially in their failure mode
- 20 gpm flow rate



Instantaneous Water Draw



Instantaneous

- Sized to heat the water up as necessary
- Has to follow with fast changing loads
- Compact
- Efficient
- Temperature can swing with load changes
- Has a high peak energy demand
- MUST be used with a recirculation system
- Steam 1/3 – 2/3 design

Semi-Instantaneous

- Provides a small amount of storage to dampen temperature swings
- Still has the same peak demand as an instantaneous unit
- Handles low load conditions better

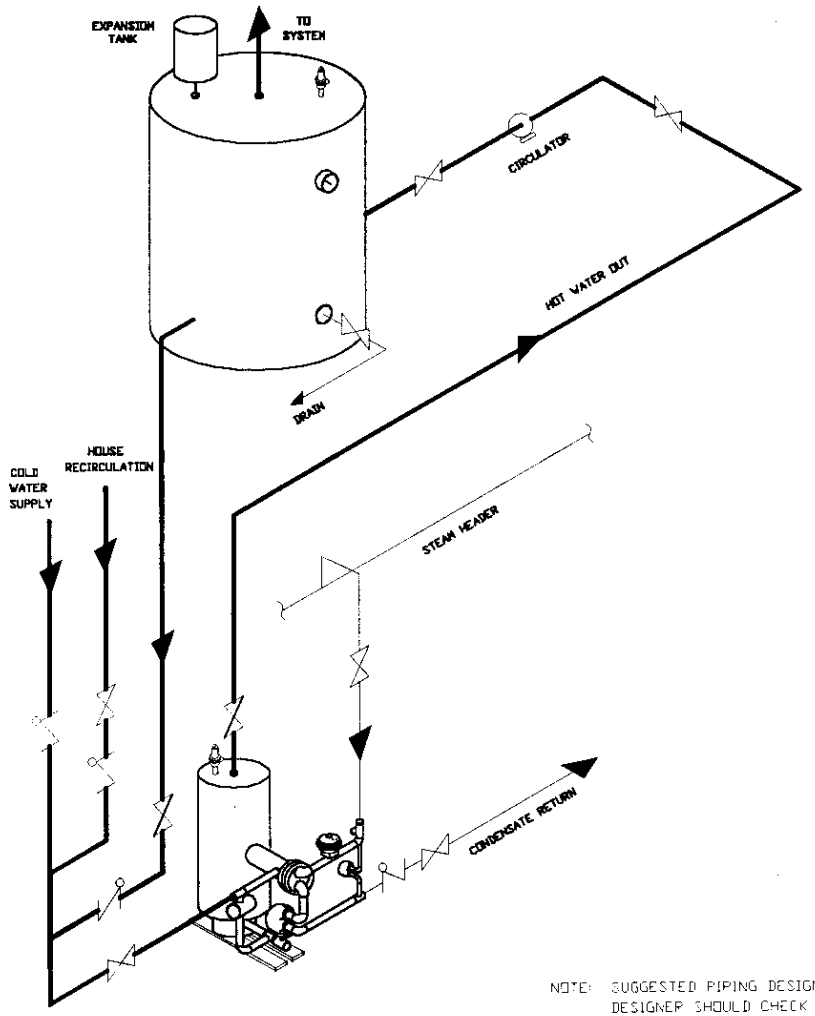
Feed Forward Instantaneous

- Different Control Operation
- Can adapt to the rapid change in HW demand
- Changing water temperatures can be a challenge

CEMLINE CORPORATION

	STOP VALVE
	CHECK VALVE
	CIRCULATOR

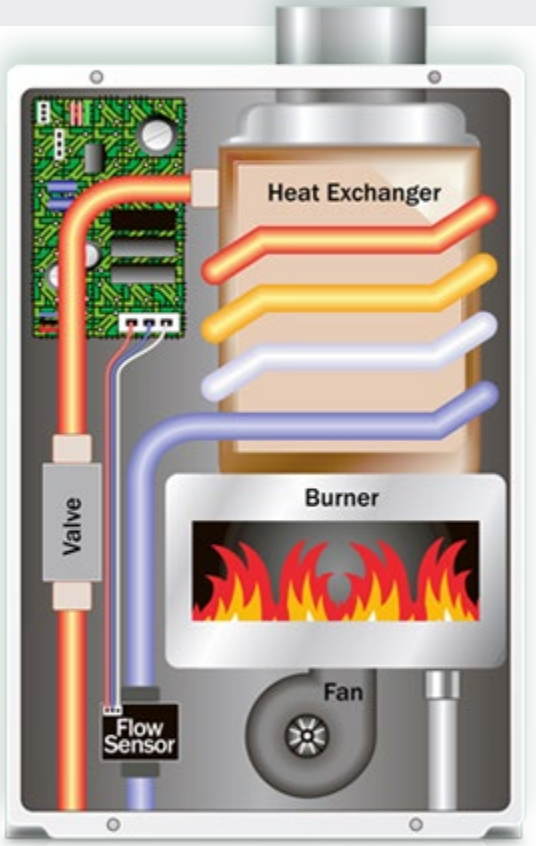
SSH HEATER PIPED TO ONE STORAGE TANK



NOTE: SUGGESTED PIPING DESIGN.
DESIGNER SHOULD CHECK WITH LOCAL CODES TO VERIFY COMPLIANCE.

Gas Fired Instantaneous

- AKA Tankless
- Popular in Residences
- Small size
- “Unlimited Hot water”
- Generally limited sizes
- 150,000-200,000 btu/hr



Tankless Water Heater

- Units can be piped in parallel to meet the design load
- Efficiency is as high as possible since only cold water hits the water heater
- Installation options vary from manufacturer to manufacturer
- Water hardness can be a limiting factor
- Smaller footprint versus tank style water heaters

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Commercial Instantaneous

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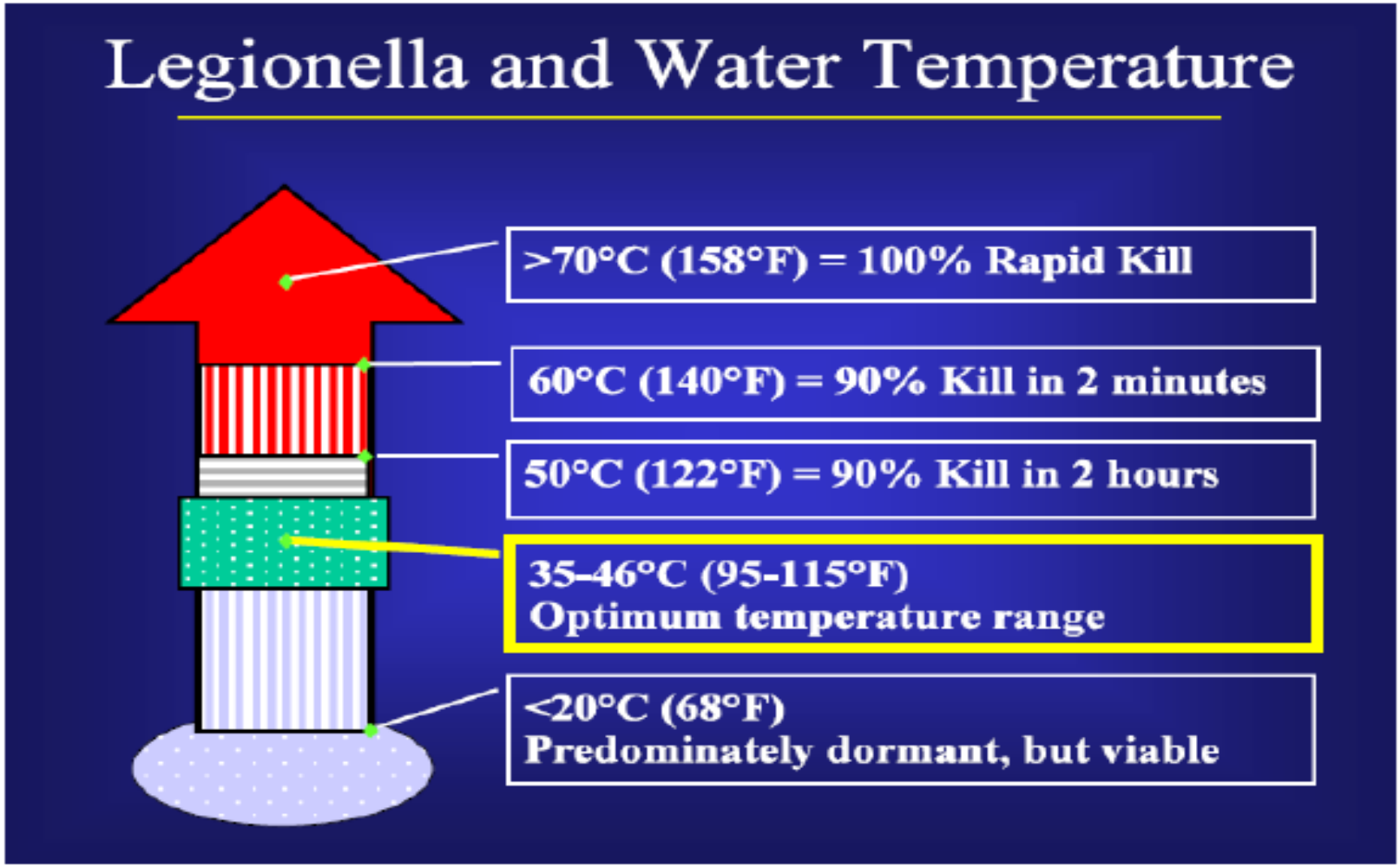
Current Commercial Tankless Installations

Commercial Instantaneous Water Heaters

Another option to single heaters

Storing Water

Figure 2: *Legionella* and Water Temperature



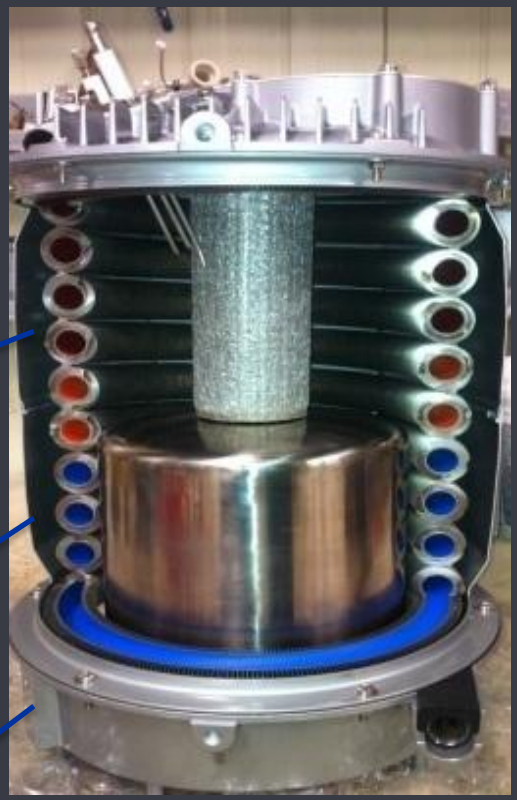
Possible Solution…

- Eliminate the risk of not having hot water
- Eliminate storage and legionella risks
- Eliminate mixing valves (MN – requires)
- Eliminate leaks and flooding

- Cut Opex by up to 40%, Cut Capex by 50%
- Reduce footprint by over 80%
- Qualify for LEED credits
- **Only tankless designed and built in USA**

Possible Solution…

- Floating heat exchanger designed for harsh thermal cycles, rapid flow & temperature changes
- Large passage ways ensure low pressure drop
- State-of-the-art, masterless cascade controls with no single
- Self descaling 316L stainless steel heat exchanger
- Fastest ROI with accurate sizing



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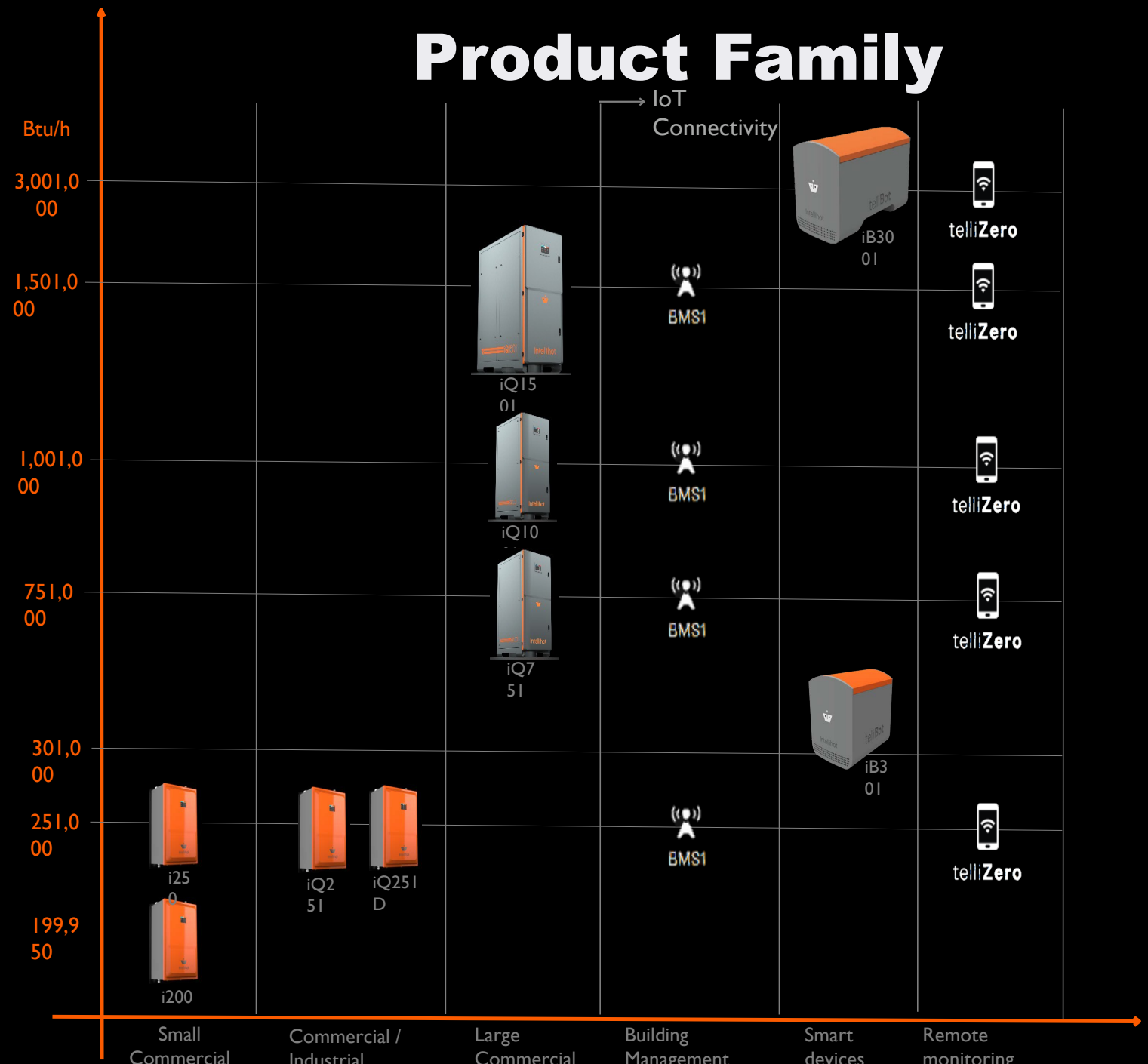
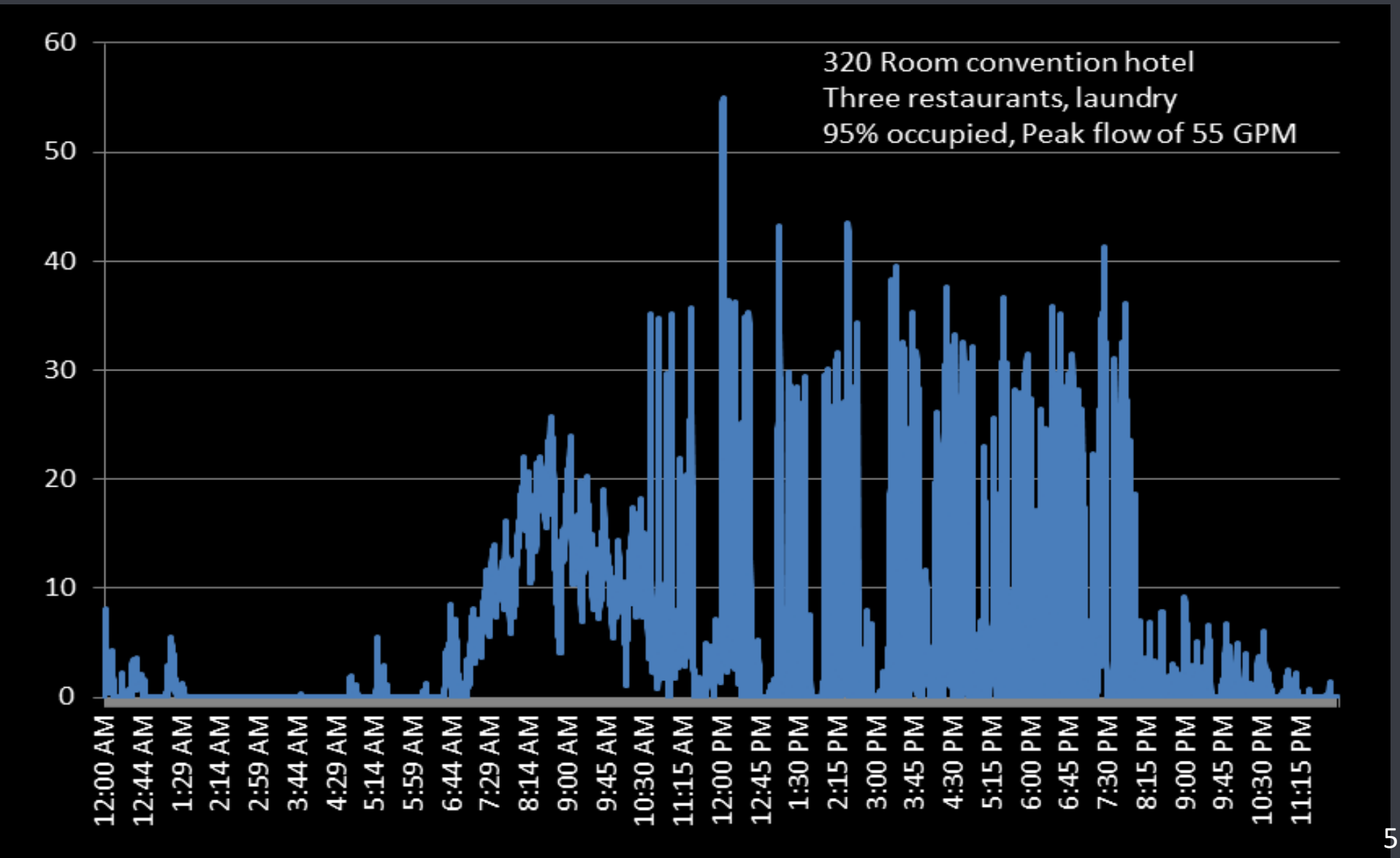
Product Family



How is water consumed?

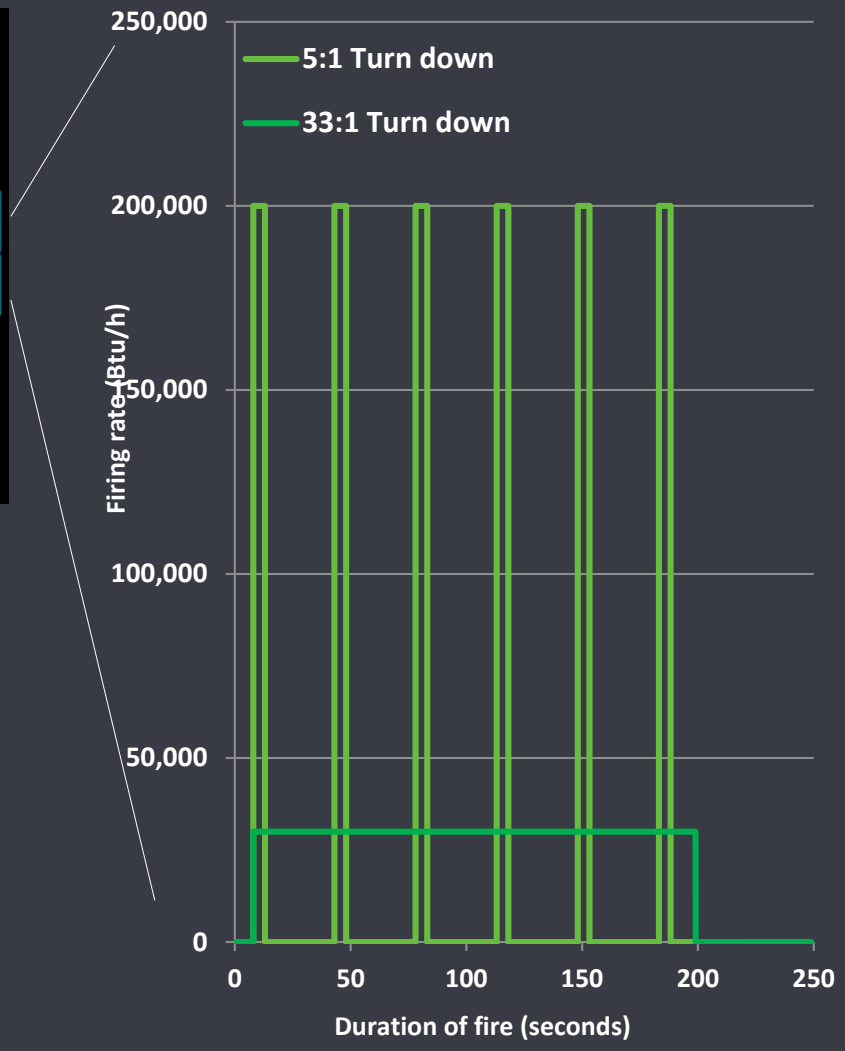
Consumption follows statistical law



Hotel water usage profile

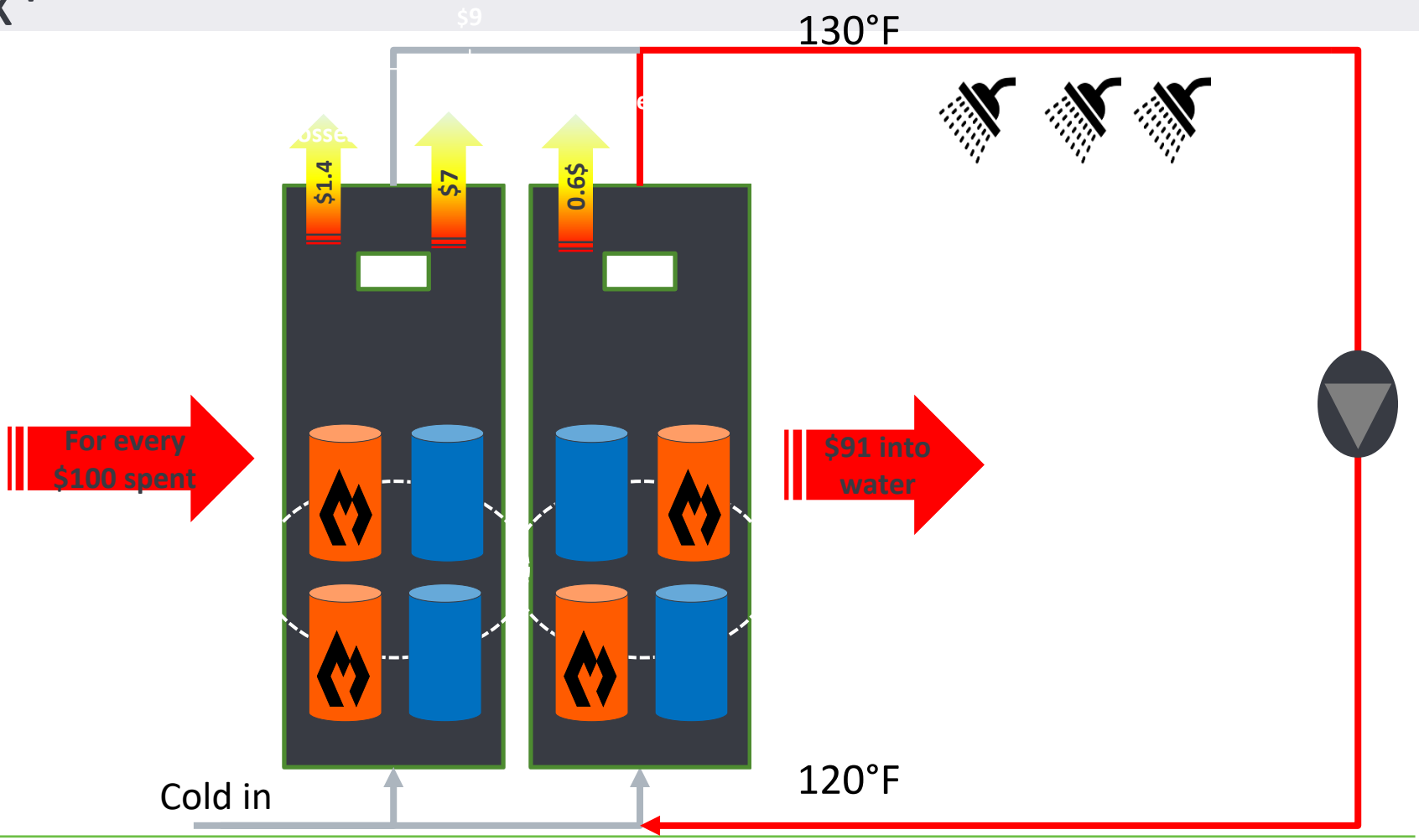
94% of operations occur at low or small flows

	Flow range GPM		Duration Minutes	%	Cumulative flow Gallons
Low draw	0	5	1019	71%	1,321
Small draw	5	20	333	23%	3,473
Medium draw	20	35	78	5%	2,139
High draw	35	50	9	1%	359



Modularity

1X cost, No sudden or single point failures | 34% less Opex*

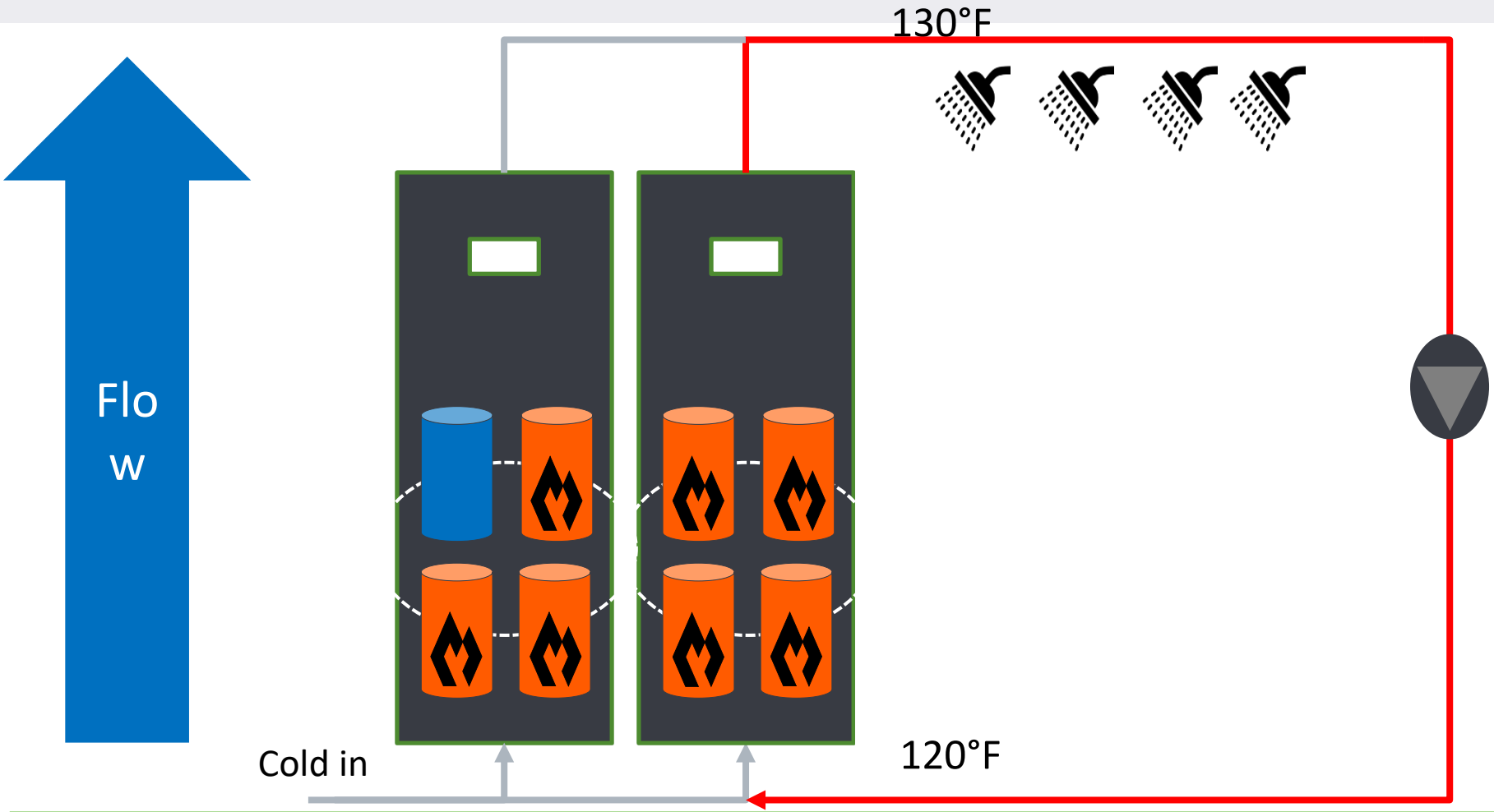


MULCAHY
Engineered Hydronic Solutions Since 1929

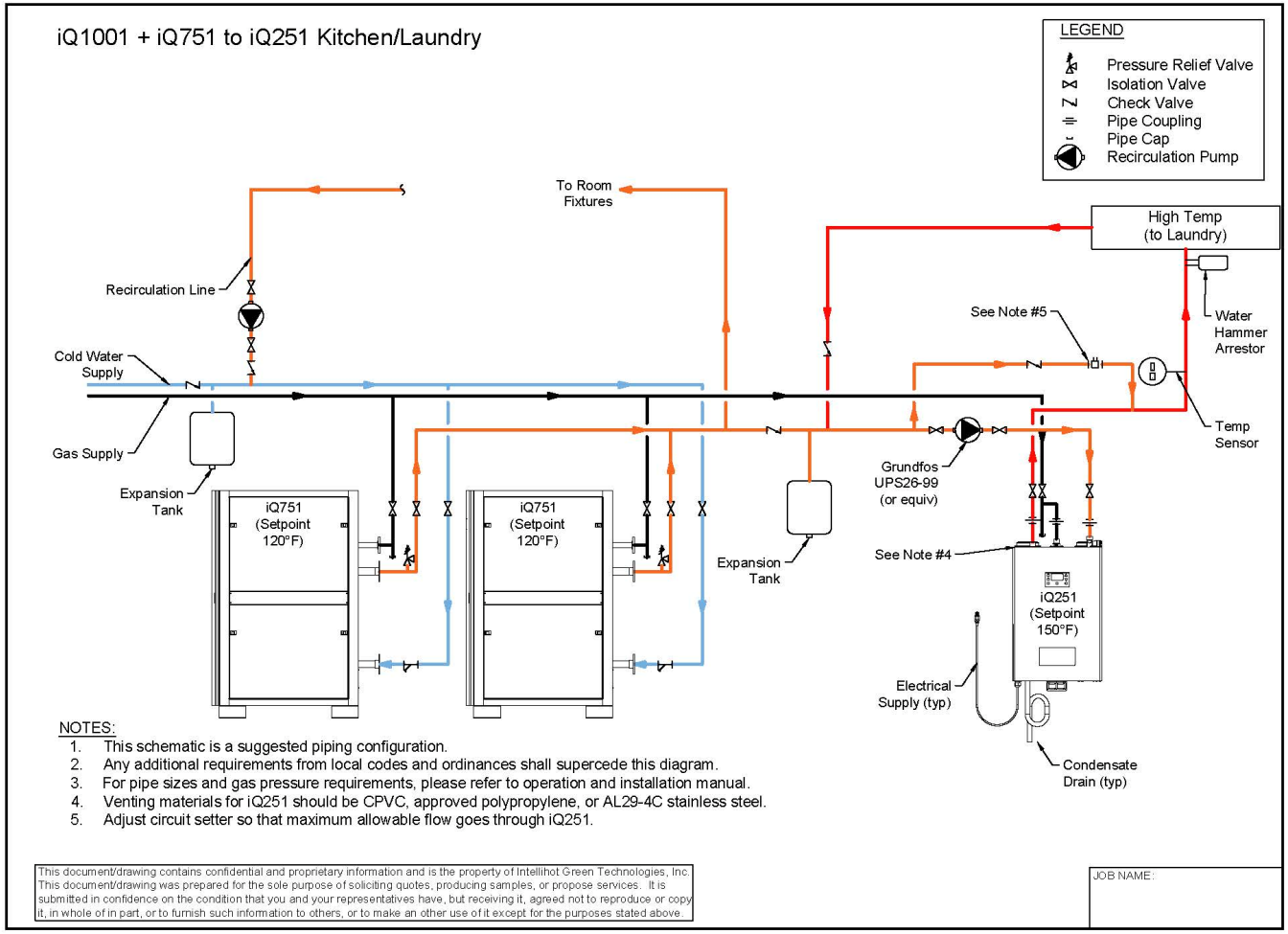
* Versus a 96% thermal efficiency condensing boiler with a 500 gallon tank

Modularity

Peak capacity | 4X reliability without 2X cost



Example System Layout



Potential Solutions

- Lowers Capex up to 50% and Opex up to 35%
- Smaller footprint for tighter spaces
- Intellihot Redundancy eliminated single point failure
    - 250,000MBH /Burner

WARRANTY	Exchanger Coil – 10 years, All Other Parts – 2 year

Actually footprint savings

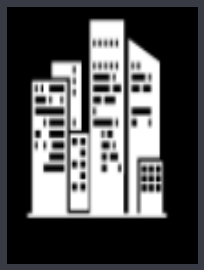
Submittal Information

- Designed and Built in the U.S.
- 7" Color Touch Screen - access to usage data, troubleshooting, and parts wear
- Wi-Fi Connectivity
- Turndown Ratio of 7:1 (i200) & 8.3:1 (i250) per unit
- The industry's leading turndown ratio (25:1 for 751, 33:1 for 1001; 50:1 for 1501) for unparalleled gas savings $$$$
- +/- 4 degrees

End Users

Hospitality and Restaurants

Our technology is especially well-suited to the high domestic hot water demands of hotels. Easily power select service and full service hotels ranging from 60 rooms to 1,200 rooms. Our units also power restaurants of all sizes- full-service, fine dining and fast food.



Multifamily and Educational

We power high-rise, multifamily buildings of varying sizes – from 100 to 400 units. In the educational sector, we can handle ivy league universities to grade schools.

Healthcare and Retail

We power several large hospitals across the USA from a large veteran's hospital in Baltimore to a cancer center in Utah. In the retail sector, we are used by chains of all sizes including national, wholesale, discount stores and regional grocery stores.

Industrial

Our industrial models are well suited to the unique demands of certain manufacturing industries. Today, we power water treatment plants, paint shops, electronic manufacturing, bottle cleaning plants, sunglass manufacturing pretzel factories, breweries and a variety of other manufacturing properties.

Hotels

400 room hotel, San Francisco | 66% reduction in Opex

Multifamily

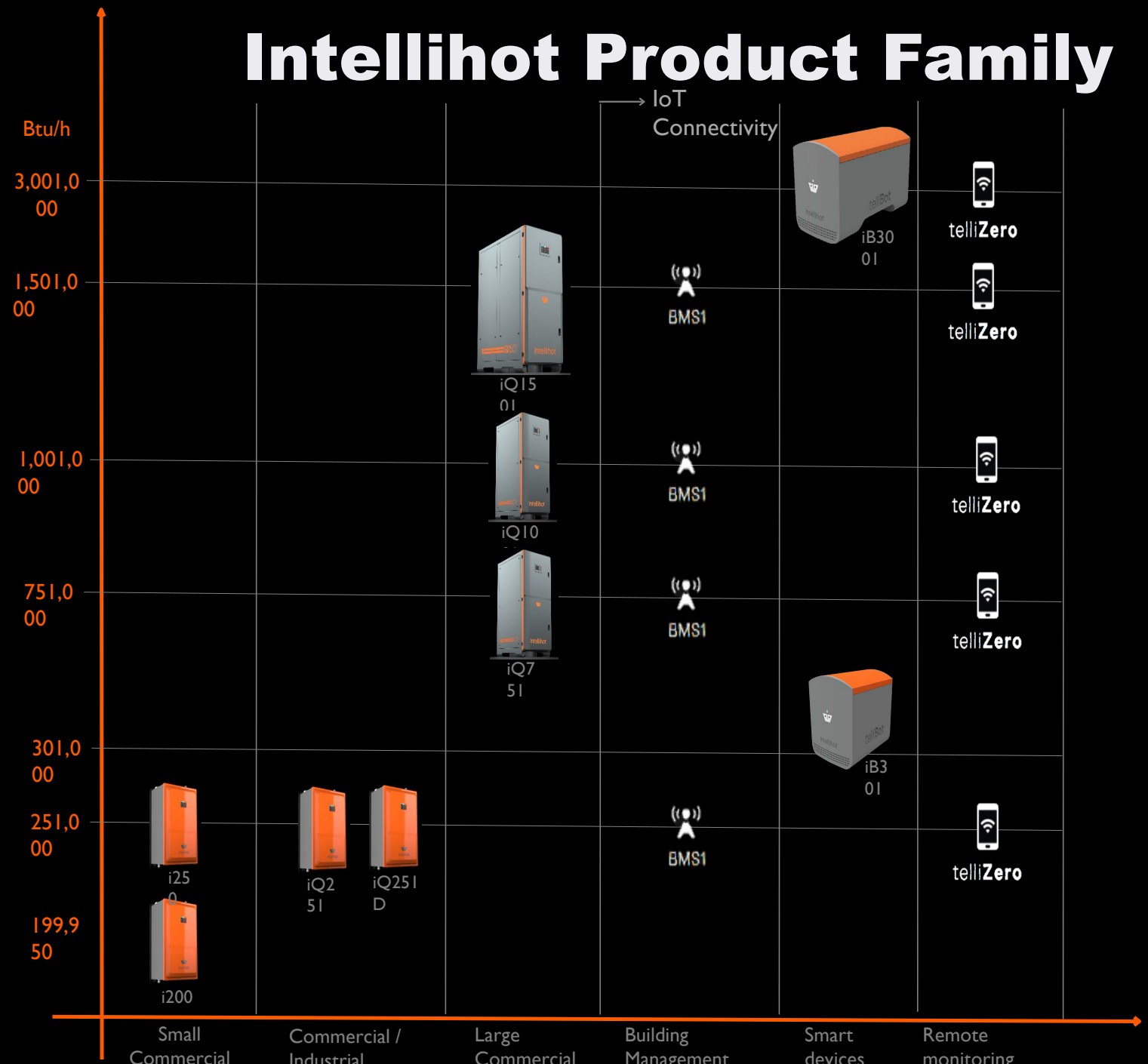
Eliminated 2,000 Gallons Storage | 27% reduction in Opex

62 story luxury condos, Chicago

Replacement Market

- “Plug-and-Play”
- 33” width fits standard doorways
- Single-point connections
- Floor units – 730 LBS to 1,025 LBS
- Wall units – 90 LBS
- Eliminate downtime

Intellihot Product Family

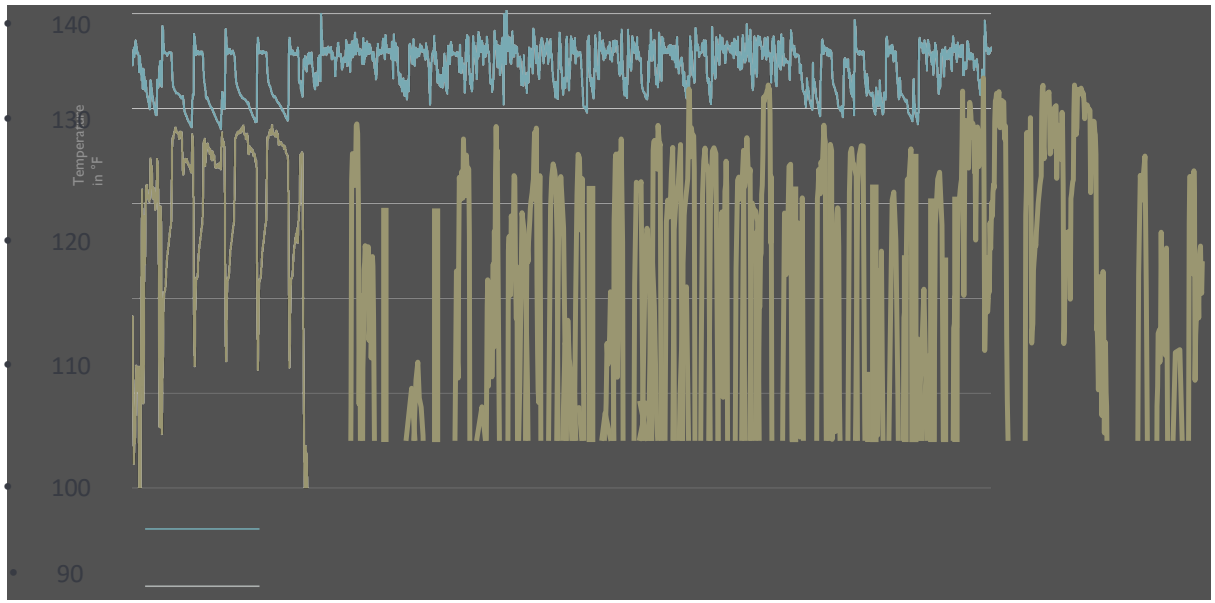


telliZero Mobile App

- Access telliZero mobile app for free and start monitoring unit and receiving status alerts
- Adjust set point, check temperatures, flow rates, combustion rates, and more, from your phone
- Subscribe to telliZero service and get parts for free!

Temperature and Flow Monitoring

Receive Monthly Reports



- Inlet Temperature
- Outlet Temperature

TelliZero

ZERO DOWNTIME

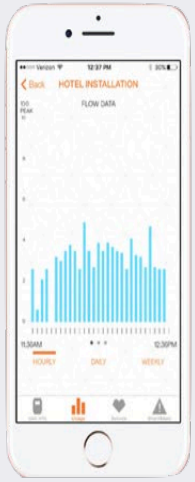
ZERO WORRIES

ZERO PROBLEMStelli**Zero**

Service includes

24 / 7 / 365 monitoring and upkeep;

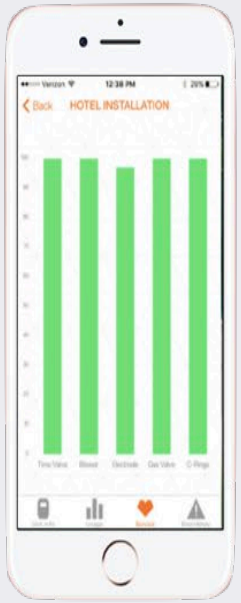
Predictive analytics and parts



MULCAHY
Engineered Hydronic Solutions Since 1929

telliZero

Available for Gen II Intellihot models



Prognostics, Analytics, Monitor → Ship parts before it fails → Scheduled installation → No loss of hot water

Selection Tool

- http://www.intellihot.com/resources/sizing-calculator

- Also a phone App for sizing.

Maintenance

- Replacement ignitor
  - https://www.youtube.com/watch?v=pOxws934qyc
- Replacement of Electrode
  - https://www.youtube.com/watch?v=F0KIh8DSttE

QUESTIONS?

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