WIRELESS COMPLIANCE INSTITUTE™

ISA100 WCI Webinar

Webinar date: March 20, 2024

The presentation will begin at 11:00 EST (UTC-5)

Wireless Steam Trap Monitoring to Reduce Energy Losses and CO_2 emissions

Presenter:

Armstrong

Philippe Moock

pmoock@armstronginternational.com

Agenda

1. About the speaker
2. Introduction Industrial Wireless
3. ISA100 Wireless Industry Standard
4. Armstrong International
5. Roadmap to Decarbonization
6. Steam & Condensate Loop
7. Cost of Steam
8. Steam Trap Failures
9. Steam Losses & CO_2 Emissions
10. Wireless Monitoring
11. Armstrong University
12. Conclusion

About the Speaker

Philippe Moock

Global Director Thermal Insight Group

Armstrong International

Philippe started his career in factory automation before joining Armstrong in 2011. He currently leads the "Thermal Insight Group" focused on digital transformation of thermal utilities and providing insights to optimized them.

He holds a master in mechanical engineering from Belgium where he is from as well as an MBA from the US. Citizen of the world, he has lived and worked in Belgium, Florida, India, and China before moving to Michigan in 2017.
He has also frequently traveled for business, optimizing customers' thermal utilities, in Middle East, Asia, and Africa.

His promise is to deliver intelligent system solutions that improve utility performance, lower energy consumption and reduce environmental emissions while providing an enjoyable experience.

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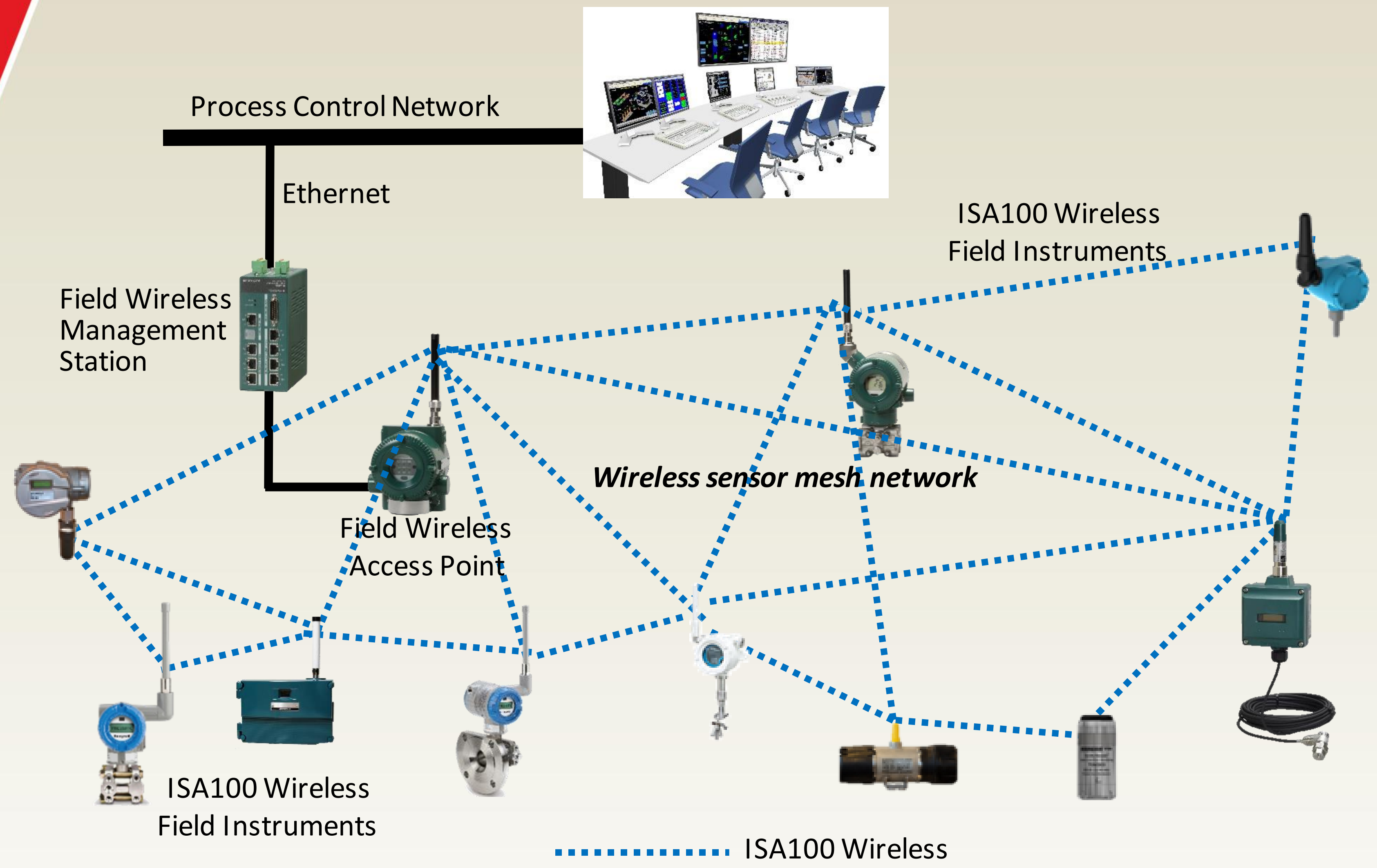
Introduction to Industrial Wireless



Applications examples

- Machine health monitoring
- Basic process control
- Monitoring of well heads
- Remote process monitoring
- Leak detection monitoring
- Diagnosis of field devices
- Condition monitoring of equipment
- Environmental monitoring
- Tank level monitoring
- Gas detection
- Fuel tank gauging
- Steam trap monitoring
- Open loop control
- Stranded data capture
- And more

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ISA100 Wireless Fast Facts

- International standard IEC 62734 since 2014
- Complies with ETSI EN 300 320 v1.8.1 (LBT)
- End-User Driven Standard - meeting all current and future industrial needs
- Sensor routing or field routers for best performance – Freedom of choice
- Broad Multi-Vendor Portfolio of ISA100 Wireless Devices
- ISA100 Wireless enables SIL-2 Certification
- Ensured Interoperability - best-in-class solutions from best-in-class suppliers
- Readily available ISA100 Wireless Modules and Stacks
- Enable fast-track development and go to market

Benefits of ISA100 Wireless Instrumentation

Cost Savings	• Up to 90% of installed cost of conventional measurement technology can be for cable conduit and related construction • Typically: 1/2 the costs, 1/5 of the time • New and scaled applications are now economically feasible
Improved Reliability	• Wired sensors may be prone to failure in difficult environment • Wireless can add redundancy to a wired solution
Improved Visibility	• Condition monitoring of secondary and remote equipment • Process monitoring, fast additional data for trouble shooting
Improved Control	• Add wireless to existing processes for more optimal control
Improved Safety	• Safety related alarms - end to end SIL2 certifiable

ISA100 Wireless Product Portfolio

Infrastructure

Independent Gateway
- Honeywell, Yokogawa

Access Point (AP)
- Honeywell, Yokogawa

Integrated Gateway/AP
- Honeywell, Yokogawa, CDS, Nexcom

GW/AP + Recorder
- Yokogawa

Adapter (HART, etc.)
- Honeywell, Yokogawa

Measurement & Control

Temperature
- Honeywell, Yokogawa

Pressure / Flow
- Honeywell, Yokogawa

Level
- Honeywell, Yokogawa

DI/DO, AI
- Honeywell, Yokogawa

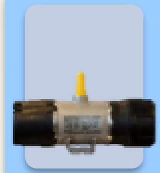
Valve Position
- Eltav, Flowserve, Honeywell

HSE + Life cycle

Corrosion
- RCS , Honeywell

Steam Trap
Armstrong, Bitherm, Spirax Sarco, TLV

Vibration
- GE's Bently Nevada, Divigraph



Gas
- GasSecure, Scott Safety, New Cosmos, Riken Keiki

pH
- Honeywell, Yokogawa

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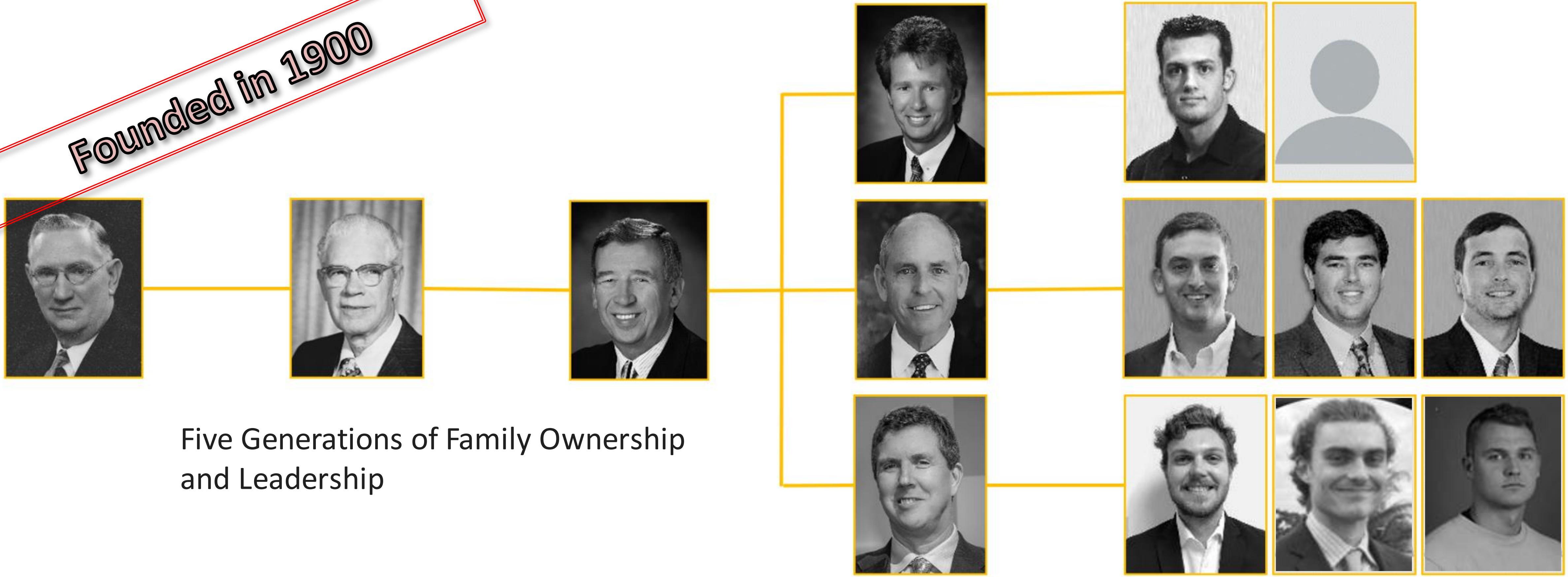
Armstrong International

Armstrong®

Founded in 1900



Five Generations of Family Ownership and Leadership

Armstrong International

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Roadmap to Decarbonization

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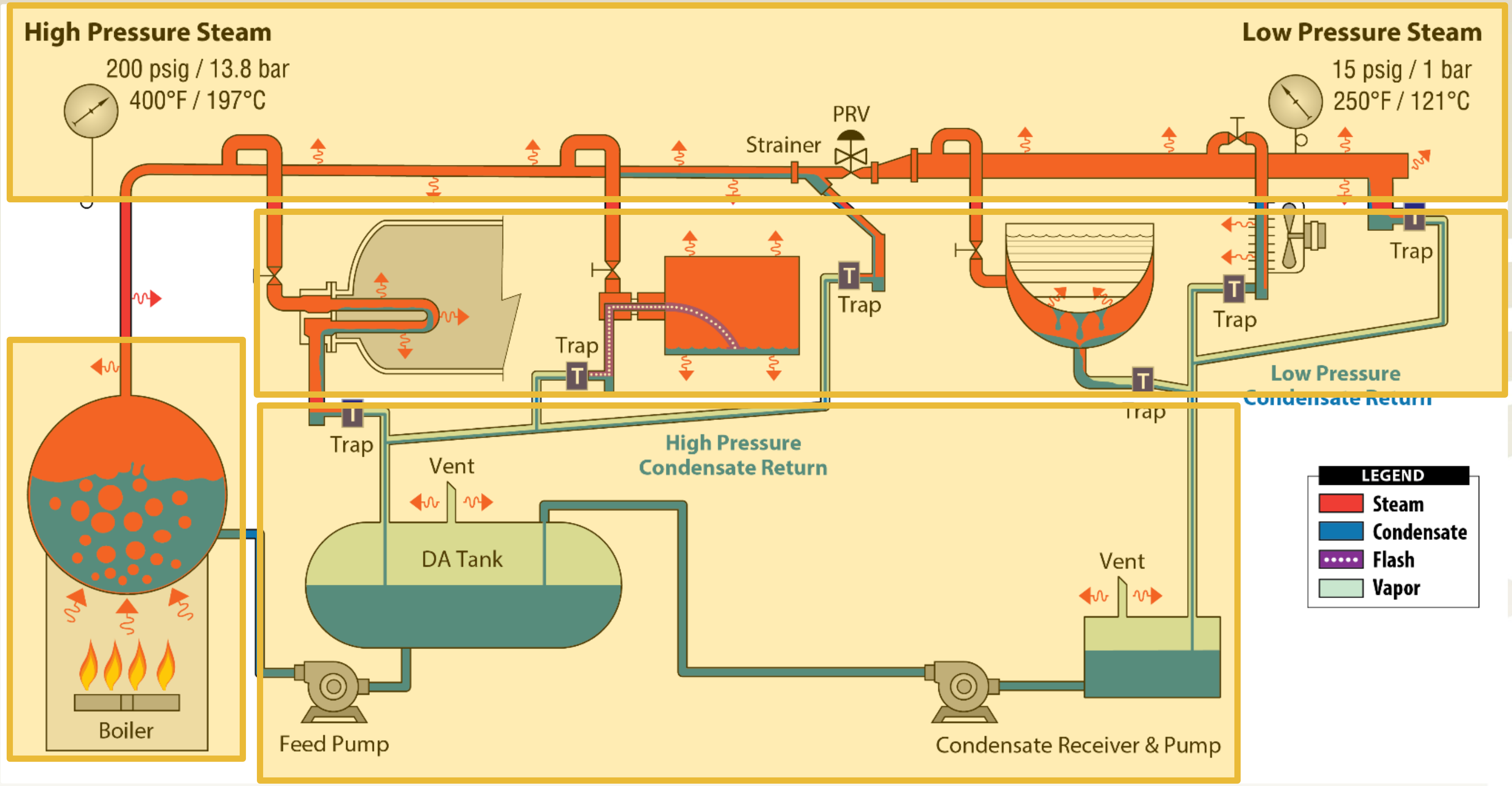
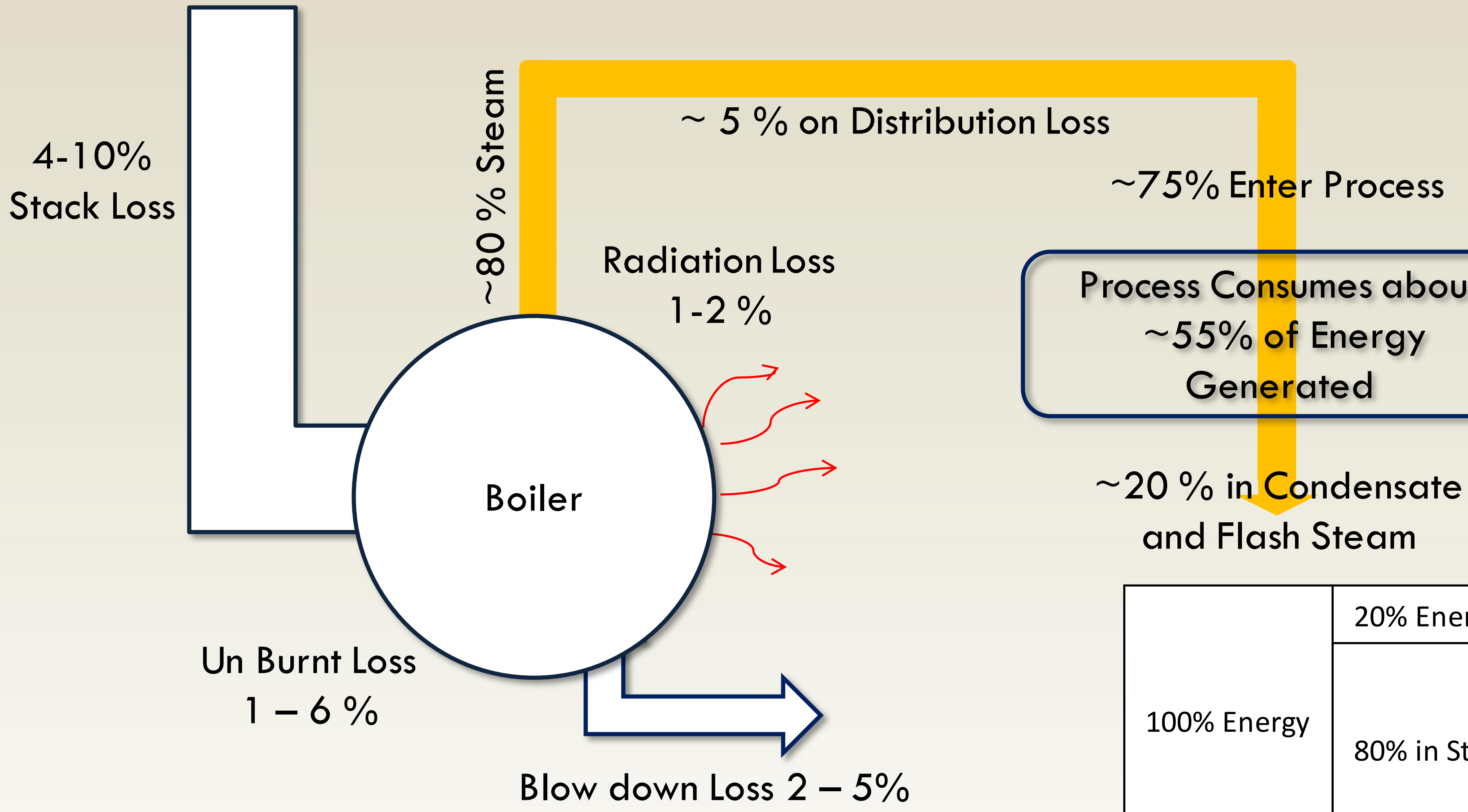
Typical Steam and Condensate loop



Typical Steam and Condensate loop



100% Energy	20% Energy Losses	
	80% in Steam	5% Distribution Losses
		55% Process
		20% Condensate

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Cost of Steam

Cost of steam includes

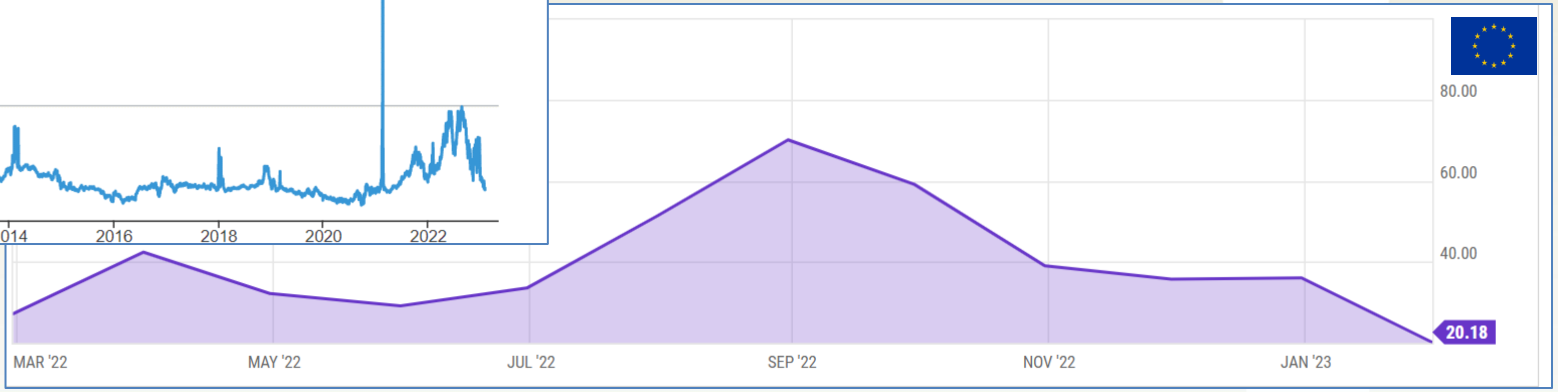
- Fuel
- Make-up water
- Chemicals
- Sewage
- …

If we only take the fuel cost into consideration:

Heat Cost for 100psig steam [$/1,000lbs]= **Fuel costs** [$/MMBtu] / **Boiler Efficiency**

Cost of Steam

Cost of Natural gas	Heat cost for 100psig steam
$5/MMBtu	$6.25/1,000lbs
$10/MMBtu	$12.50/1,000lbs
$20/MMBtu	$25/1,000lbs
$60/MMBtu	$120/1,000lbs



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Steam Traps

Armstrong

Trap/Operator Types

Thermostatic

Sense **temperature change** of condensate to operate valve

Thermodynamic

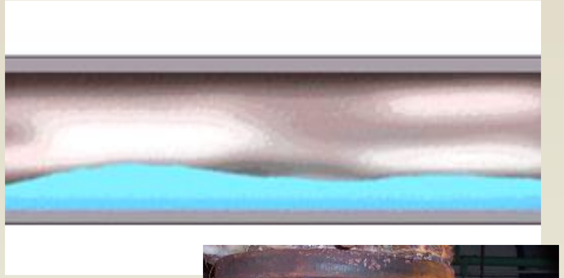
The controlled disc trap is a time-delayed device that operates on the **velocity** principle

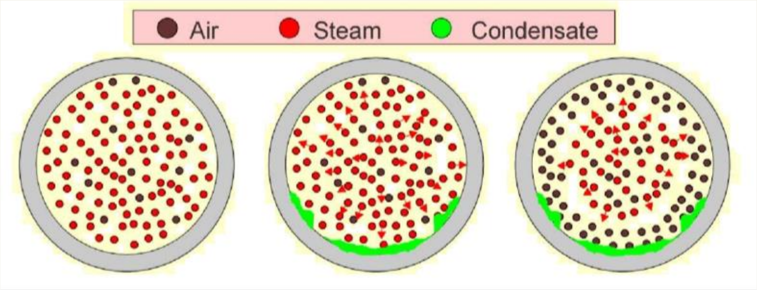
Mechanical

Use difference in **density** between steam and condensate to operate valve. A float operates the valve.

Steam Trap Failures

- If a steam trap **fails closed** (cold):
  - Wet steam
    - Water hammering
    - Damaged turbine LP saturated steam stage
    - Piping corrosion
    - Erosion on valves, reducers
  - Flooded heat exchanger
    - Decrease in production
    - Reduced heat transfer
    - Batch process losses
    - Thermal stress
  - Non-Condensable Gases in the system
    - Air is an insulator: heat exchanger less efficient
    - Oxygen in the pipe = corrosion: $H_2O + CO_2 \rightarrow H_2CO_3$ (Carbonic Acid)
    - System binding: flow of steam and condensate can be blocked
    - Temperature drops because steam pressure drops





Steam Trap Failures

- If a steam trap **fails open** (leaking or blow-thru):
  - Increased back pressure in condensate return line
    - Reduced flow for surrounding steam traps
    - Stalling surrounding heat exchanger
  - Steam losses (monetary losses)
  - Safety issue
  - Environmental issue

Steam Trap Failures

	Service Life (in Years)	Annual Failure Rate	General Industry
Low Pressure (< 75 psig) – Tracing or Drip			**50%**
Thermodynamic (Disc)	7	14%	20%
Inverted Bucket	15	7%	15%
Bimetallic	10	10%	30%
Wafer or Bellow	8	13%	25%
Float & Thermostatic	8	13%	10%
Medium Pressure (75 – 200 psig) – Process			**45%**
Thermodynamic (Disc)	5	20%	40%
Inverted Bucket	10	10%	10%
Bimetallic	8	13%	0%
Wafer or Bellow	5	20%	0%
Float & Thermostatic	5	20%	50%
High Pressure (200 – 400 psig) – Drip			**5%**
Thermodynamic (Disc)	3	33%	60%
Inverted Bucket	7	14%	20%
Bimetallic	6	17%	10%
Wafer or Bellow	3	33%	0%
Float & Thermostatic	6	17%	10%
Annual Failure Rate		**14.6%**	

Steam Trap Failures

	Service Life (in Years)	Annual Failure Rate	Heavy Industry
Low Pressure (< 75 psig) – Tracing or Drip			**75%**
Thermodynamic (Disc)	7	14%	20%
Inverted Bucket	15	7%	15%
Bimetallic	10	10%	30%
Wafer or Bellow	8	13%	25%
Float & Thermostatic	8	13%	10%
Medium Pressure (75 – 200 psig) – Process			**5%**
Thermodynamic (Disc)	5	20%	40%
Inverted Bucket	10	10%	10%
Float & Thermostatic	5	20%	50%
High Pressure (200 – 400 psig) – Drip			**5%**
Thermodynamic (Disc)	3	33%	60%
Inverted Bucket	7	14%	20%
Bimetallic	6	17%	10%
Float & Thermostatic	6	17%	10%
Superheated Steam Pressure (> 400 psig)			**15%**
Thermodynamic (Disc)	2	50%	33%
Inverted Bucket	3	33%	2%
Bimetallic	7	14%	65%
Annual Failure Rate		**12.8%**	

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Steam Losses - UNFCCC

United Nations Framework Convention on Climate Change

$$L_{t,y} = \frac{1kg}{2.2046lbs} FT_{t,y} FS_{t,y} CV_{t,y} h_{t,y} \sqrt{(P_{in,t} - P_{out,t})(P_{in,t} + P_{out,t})}$$

- $L_{t,y}$ the loss of steam due to the steam trap t during the period y in kg of steam.
- $FT_{t,y}$ the failure type factor of steam trap t during the period y.
- $FS_{t,y}$ the service factor of steam trap t during the period y.
- $CV_{t,y}$ the flow coefficient of steam trap t during the period y.
- $h_{t,y}$ the hours steam trap t is operating during the period y in hours.
- $P_{in,t}$ the pressure of the steam at the inlet of steam trap t in psia.
- $P_{out,t}$ the pressure of the condensate at the outlet of steam trap t in psia.

Steam Losses - UNFCCC

United Nations Framework Convention on Climate Change

$$L_{t,y} = \frac{1kg}{2.2046lbs} FT_{t,y}\, FS_{t,y}\, CV_{t,y}\, h_{t,y} \sqrt{(P_{in,t} - P_{out,t})(P_{in,t} + P_{out,t})}$$

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Steam Losses - UNFCCC

United Nations Framework
Convention on Climate Change

$$L = 24 \frac{1kg}{2.2046lbs} FT\ FS\ CV \sqrt{(P_{in} - P_{out})(P_{in} + P_{out})}$$

L	*the loss of steam in kg of steam.*
FT	*the failure type factor during the period y.*
FS	*the service factor.*
CV	*the flow coefficient.*
h	*the hours the steam trap is operating in hours.*
Pin	*the pressure of the steam at the inlet of the steam trap in psia.*
Pout	*the pressure of the condensate at the outlet of the steam trap in psia.*

Steam Losses - UNFCCC

United Nations Framework
Convention on Climate Change

$$L = 24 \frac{1kg}{2.2046lbs} FT\ FS\ CV \sqrt{(P_{in} - P_{out})(P_{in} + P_{out})}$$

Type of failure	FT
Blow-thru (BT)	1
Leaking (LK)	0.25
Rapid cycling (RC)	0.2

Application	FS
Process steam traps	0.9
Drip and tracer steam traps	1.4
Steam flow (no condensate)	2.1

$CV = 22.1\ D^2$

CV *the flow coefficient.*

D *the diameter of the orifice of the steam trap in inches*

Steam Losses [lbs/day] - UNFCCC

United Nations Framework Convention on Climate Change

	psig							
Orifice	**15**	**30**	**60**	**100**	**150**	**250**	**400**	**600**
#60	31	46	77	118	169	272	427	632
3/64"	42	63	106	162	233	374	586	869
1/16"	75	112	188	288	414	665	1,042	1,544
5/64"	117	175	293	450	646	1,039	1,628	2,413
3/32"	168	253	422	648	931	1,496	2,344	3,474
#38	197	296	495	760	1,091	1,754	2,747	4,072
7/64"	228	344	575	882	1,267	2,036	3,190	4,729
1/8"	298	449	751	1,153	1,655	2,660	4,167	6,177
9/64"	378	568	950	1,459	2,095	3,366	5,274	7,817
5/32"	466	702	1,173	1,801	2,586	4,156	6,511	9,651
11/64"	564	849	1,419	2,179	3,129	5,029	7,878	11,678
3/16"	671	1,011	1,689	2,593	3,724	5,984	9,376	13,897
7/32"	914	1,376	2,299	3,530	5,068	8,145	12,761	18,916
1/4"	1,194	1,797	3,002	4,610	6,620	10,639	16,668	24,706
9/32"	1,511	2,274	3,800	5,835	8,378	13,465	21,095	31,269
5/16"	1,865	2,807	4,691	7,203	10,343	16,623	26,043	38,603

$10/1,000 lbs.

⇩

$ 4,625/year

Steam Losses [lbs/day] - UNFCCC

United Nations Framework Convention on Climate Change

	psig							
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9/32"	1,511	2,274	3,800	5,835	8,378	13,465	21,095	31,269
5/16"	1,865	2,807	4,691	7,203	10,343	16,623	26,043	38,603

$10/1,000 lbs.

⇩

$ 2,500/year

CO_2 Emissions

Armstrong

Carbon Dioxide Emissions Coefficients by Fuel

Carbon Dioxide (CO_2) Factors	Pounds CO_2 per Million BTU
Natural Gas	116.65
Coal (All types)	211.47
Residual Heating Fuel	165.55

https://www.eia.gov/environment/emissions/co2_vol_mass.php

CO_2 Emissions

1,000lbs of steam per day = 1,188,800 BTU @ 100psig

Boiler efficiency = 82% → need 1,449,756 BTU of natural gas per day

→ 169 lbs of CO_2 per day
→ 0.077 metric ton of CO_2 per day = 28 metric tons per year

Cost of CO_2 emissions = $50/metric ton
→ $1,400/year

CO_2 Emissions [metric ton/day]

United Nations Framework Convention on Climate Change

	psig							
Orifice	15	30	60	100	150	250	400	600
#60	0.002	0.003	0.006	0.009	0.013	0.021	0.033	0.049
3/64"	0.003	0.005	0.008	0.012	0.018	0.029	0.046	0.067
1/16"	0.006	0.008	0.014	0.022	0.032	0.052	0.081	0.120
5/64"	0.009	0.013	0.022	0.035	0.050	0.081	0.127	0.187
3/32"	0.013	0.019	0.032	0.050	0.072	0.116	0.182	0.270
#38	0.015	0.022	0.038	0.058	0.084	0.136	0.214	0.316
7/64"	0.017	0.026	0.044	0.068	0.098	0.158	0.248	0.367
1/8"	0.022	0.034	0.057	0.088	0.128	0.206	0.324	0.480
9/64"	0.028	0.043	0.072	0.112	0.162	0.261	0.410	0.607
5/32"	0.035	0.053	0.089	0.138	0.200	0.322	0.506	0.749
11/64"	0.042	0.064	0.108	0.167	0.241	0.390	0.612	0.907
3/16"	0.050	0.076	0.129	0.199	0.287	0.464	0.729	1.079
7/32"	0.069	0.104	0.175	0.271	0.391	0.632	0.992	1.469
1/4"	0.090	0.136	0.229	0.354	0.511	0.825	1.295	1.918
9/32"	0.113	0.172	0.290	0.448	0.646	1.044	1.640	2.428
5/16"	0.140	0.212	0.357	0.553	0.798	1.289	2.024	2.997

Steam Losses & CO_2 Emissions

Armstrong®

ISA 100 WIRELESS COMPLIANCE INSTITUTE™

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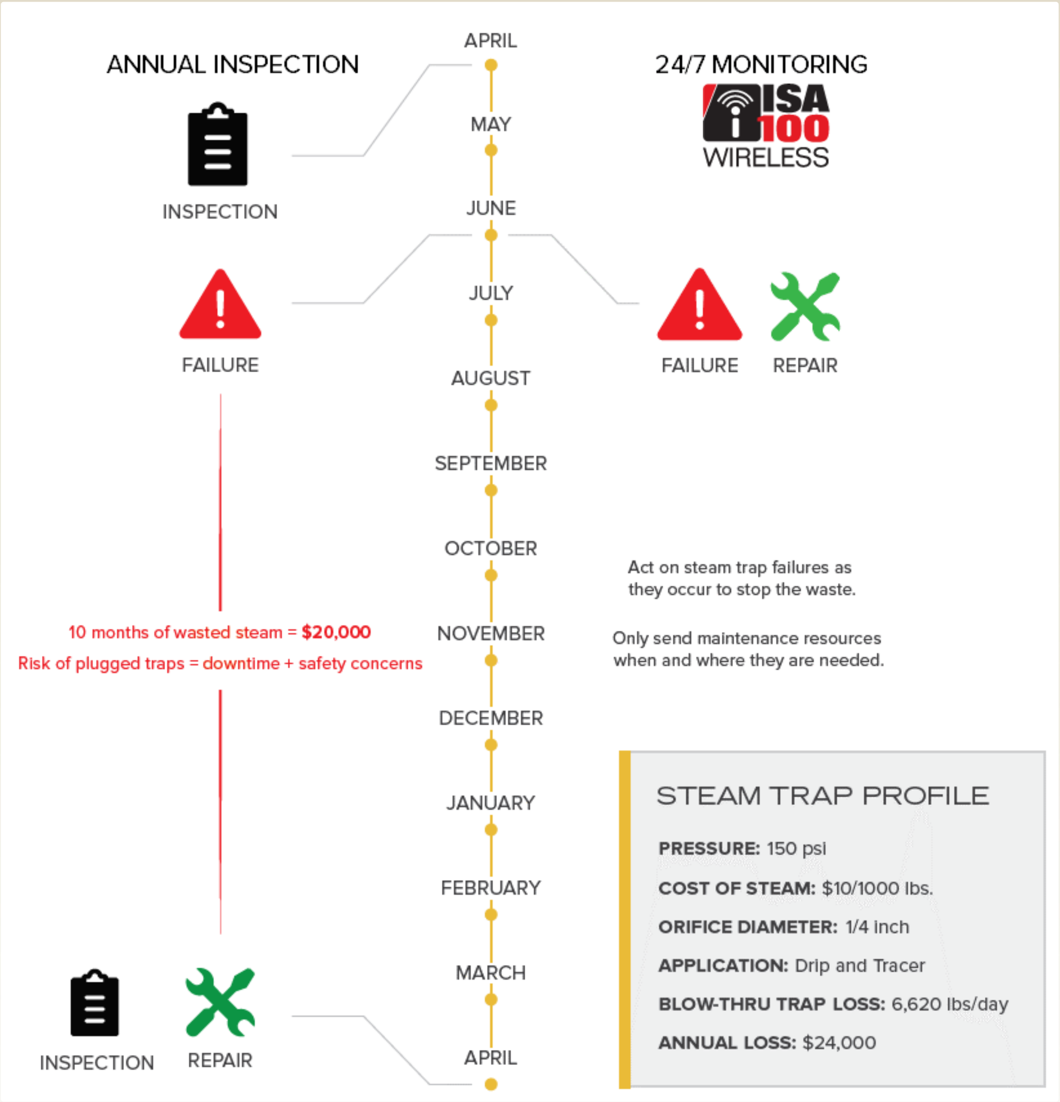
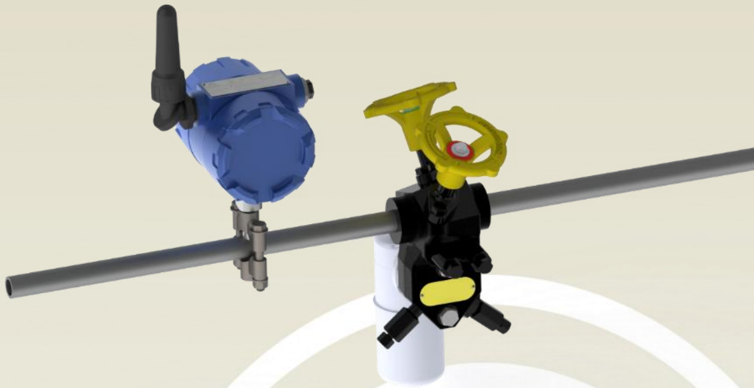
Why Wireless Monitoring?





Armstrong Intelligent Monitoring (AIM®)

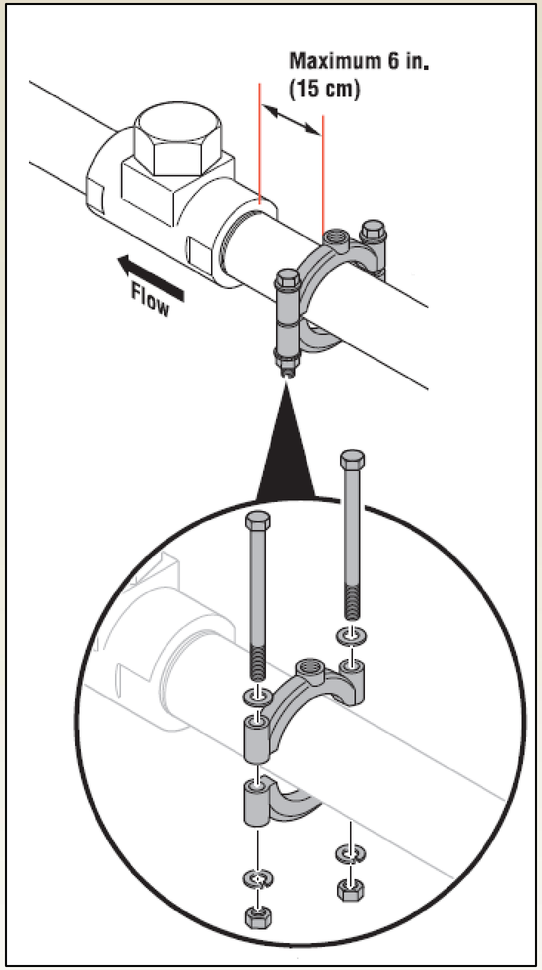
Armstrong

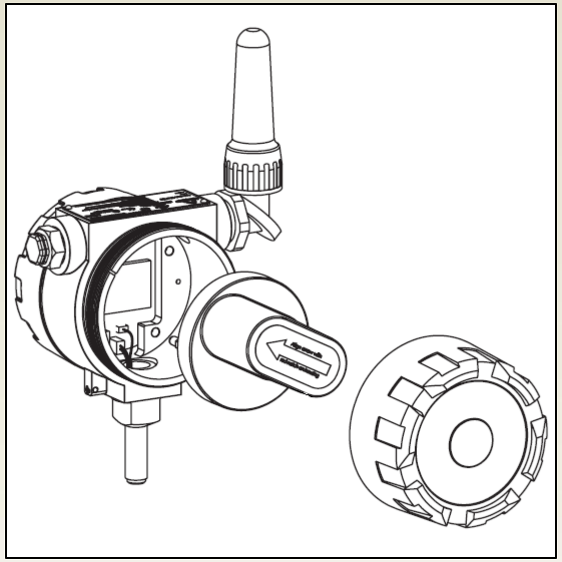
- ST6700 model
- Launched in 2016
- NAMUR NE107 compliant
- 4-year battery life
- Non-intrusive installation
- Class I, Division 1 - ATEX Zone 0

Channel	Description
#9	Steam Trap Condition: 1=OK, 2=COLD, 3=BLOW-THRU
#10	Current Temperature (°C or °F)
#11	Temperature Set Point (°C or °F)
100+ NAMUR NE107 diagnostics available including battery life	

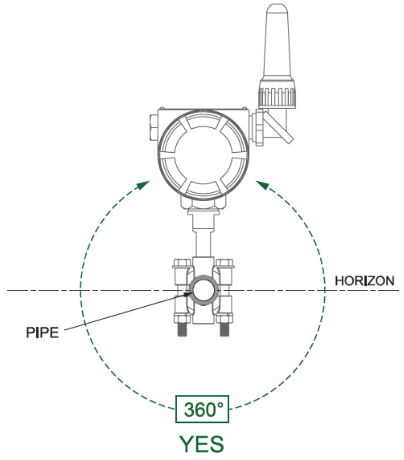
UL LISTED CE Ex ISA100 Wireless COMPLIANT

Armstrong Intelligent Monitoring (AIM®)





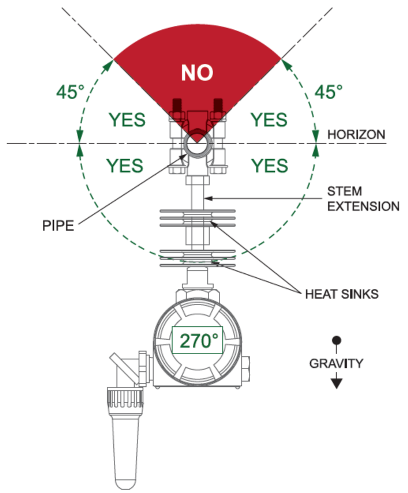
Pipe Temperature	0-160°C / 32-320°F
Corresponding Saturated Steam Pressure	0.0061-6.2 bar(a) / 0.089-89.6 PSIA



Pipe Temperature	255-440°C / 491-824°F
Corresponding Saturated Steam Pressure	43.2 bar(a) - * / 612 PSIA - *

*Steam is superheated at this temperature.

Note: Dual heat sinks and a stem extension are required.

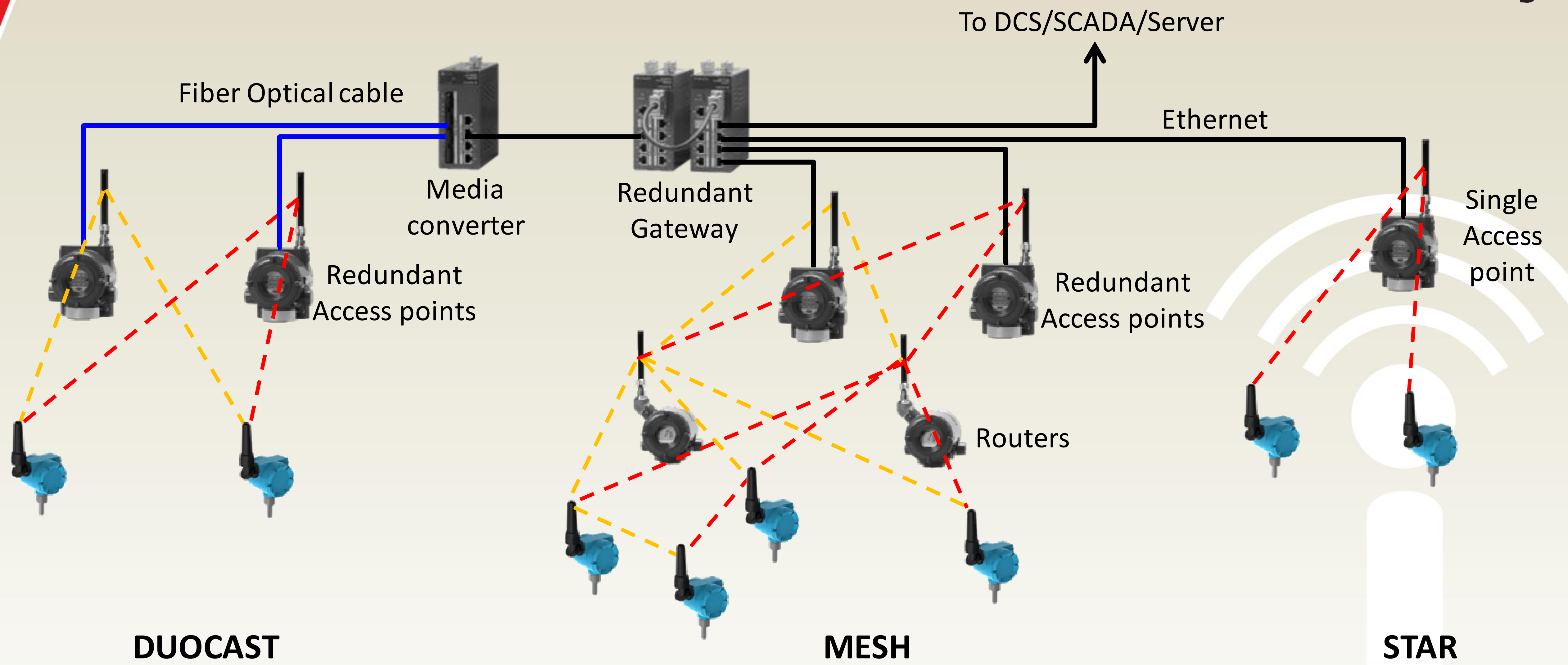


Armstrong Intelligent Monitoring (AIM®)

UL LLC Approval	
United States	Intrinsic Safe for Class I/II/III, Division 1, Groups A, B, C, D, E, F, and G Zone 0, for Class I, Group IIC Temperature Code: T4 [275ºF (135ºC)] Ambient Temperature Range: T_{amb} -40ºC to 70ºC (-40ºF to 158ºF) For use with Armstrong model D64519 lithium metal battery only Standards used for Compliance: UL 913, Ed. 8; UL 60079-0, Ed. 7; UL 60079-11, Ed. 6

Ingress Protection Rating	IP66
Output Signal	ISA100.11a protocol over 2.45-GHz, ISM radio band
Temperature Operating Range	-40ºC to 70ºC (-40ºF to 158ºF)
Materials of Construction	Housing – Low Cu, Al alloy Paint – Powder Coat O-ring – EPDM Stem – 304 SS Antenna – Nylon 6,6 Nameplate – 316 SS
Battery Type	Encapsulated, Lithium Metal Cells
Weight	4.1 lbs (1.9 Kg)

ISA100 Wireless Infrastructure



Agenda

1. About the speaker
2. Introduction Industrial Wireless
3. ISA100 Wireless Industry Standard
4. Armstrong International
5. Roadmap to Decarbonization
6. Steam & Condensate Loop
7. Cost of Steam
8. Steam Trap Failures
9. Steam Losses & CO_2 Emissions
10. Wireless Monitoring
11. Armstrong University
12. Conclusion

Armstrong University Online

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Armstrong University Onsite

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ISA100 Wireless Adoption Development Eco-system

WCI ISA100 Wireless Rapid Development Kit

- Everything you need to develop an ISA100 Wireless (IEC 62734) connected field instrument
- Develop ISA100 Wireless (IEC 62734) compliant and certifiable field instruments with minimal effort using application layer code provided
- Includes reference hardware design for ISA100 Wireless (IEC 62734) field instrument implementation
- Certified WISA modules run ISA100 Wireless communication stack
- User friendly SPiN development board includes OLED display and a large variety of sensors

https://centerotech.com/product/wci-isa100-rapid-development-kit/

Online Resources

www.isa100wci.org

- Learning Center with White Papers
- Articles, End-user stories, Forum
- Receiving over 20,000 web views per month
- Full list of certified/registered ISA100 Wireless devices
- And more useful content for you and your business

ISA100 Wireless Interest Group

- Latest news, end-user and expert discussions, insights
- 1100 members and growing; please join and invite your peers to join as well !
- Receiving over 5,000 web views per month
- Limited Time Offer: Join the group and you will be entered in a prize draw to win a new iPad

ISA100 Wireless LinkedIn Interest Group

Limited Time Promotion

SCAN ME

Scan the QR code and join the ISA100 Wireless Linkedin group. **If you join during our limited time offer**, you will be entered in a prize draw to win a new iPad!

Questions?

www.isa100wci.org

ISA100 Wireless Interest Group

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Philippe Moock
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