MERLO™
ENERGY

WE OWN IT™

A MEMBER OF THE KENDALL GROUP

Presented by: Dan Gallagher

Energy Opportunities in a Steam System

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What makes up your Steam System

- Boiler Room
- Distribution System
- Mechanical Rooms
- Point of Use Applications
  - Heating hot water
  - Domestic hot water
  - Air preheat
  - Building reheat
  - Humidification
  - Kitchen
  - Laundry
- Condensate Recovery

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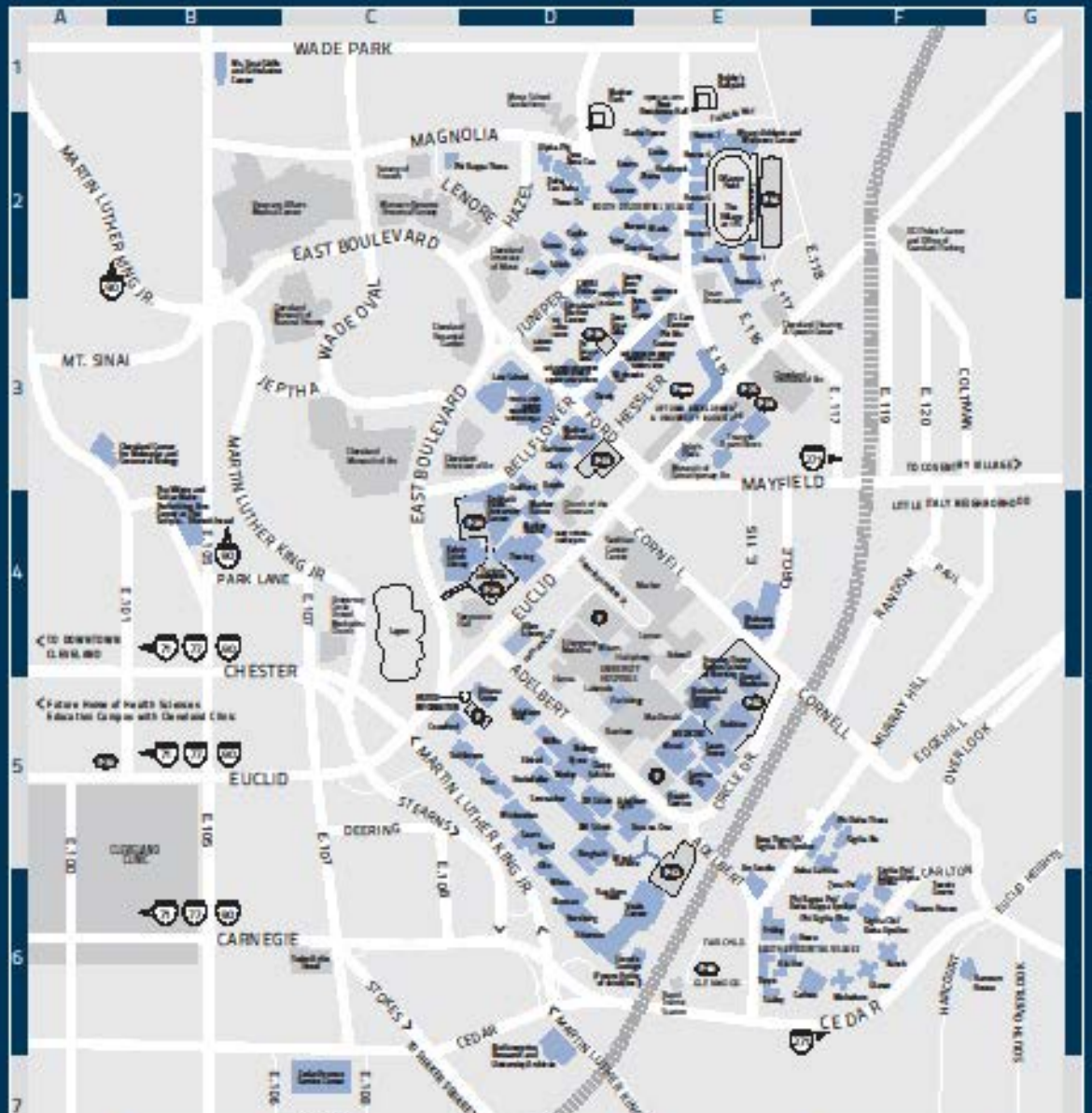
CASE WESTERN RESERVE UNIVERSITY
EST 1826
think beyond the possible



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What are your steam energy goals?

- Maximize steam generation efficiency in the boiler room
- Minimize steam losses in the distribution system
- Maximize heat transfer at point of use
- Maximize condensate recovery
- Minimize condensate loss

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Steam Efficiency Considerations

- Boiler Room
- Steam metering
- Pressure Reducing Valves
- Air in steam
- Steam Trapping
- Condensate
- Insulation

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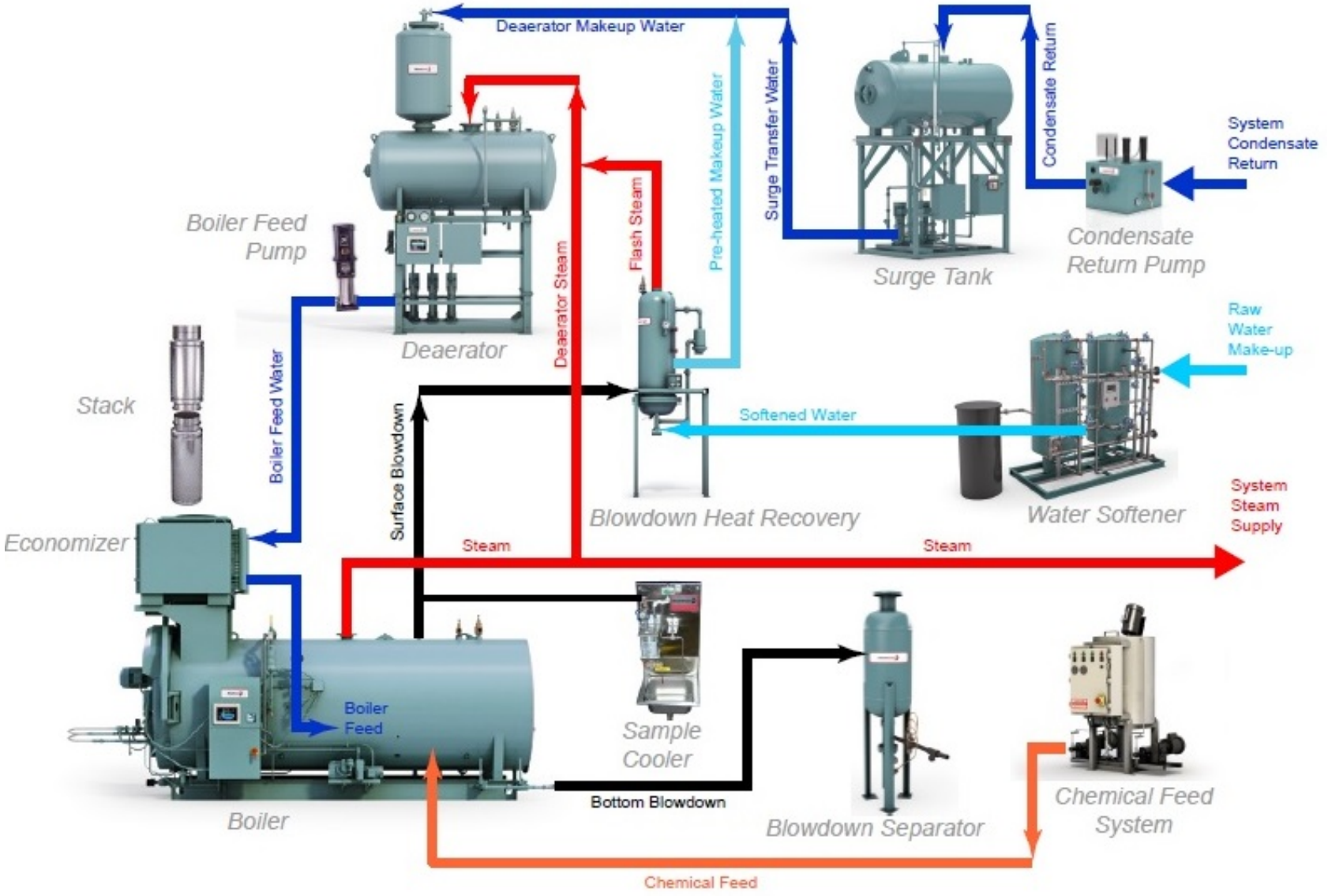
Steam Efficiency Considerations

- **Boiler Room**
  - Boiler efficiency
  - Economizer
  - Blowdown heat recovery
  - DA vent line recovery

- We are not a boiler company, so this is just a list of things that can be looked at in the boiler room, we will not go in depth



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Steam Efficiency Considerations

- **Steam Metering**

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Solid one-piece design
Signal stability and clog-free
Low drag, extended turndown
Accurate

No straight run requirements
Highly accurate
High turndown
Conditioned flow

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Steam Efficiency Considerations

- **Pressure Reducing Valves**

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The Latent Heat Does the Work in a Steam System!

- Low-pressure steam has more latent heat
- Use steam at the lowest feasible pressure for the PROCESS.

How Much Steam Is Needed to Perform a Particular Heat Transfer Job?

$$\frac{\text{Total BTU Required / Hr.}}{\text{Latent Heat at Pressure Given}} = \text{Lbs./Hr. Steam Required}$$

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How much is required?

- How much steam capacity is required to supply a heat exchanger with rating of 1,800,000 Btu/hr at 100 psig?

$$\frac{\text{1,800,000 Btu/hr}}{\text{880 Btu/lb.}} = \text{2045 Lbs./Hr. Steam Required}$$

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How much is required?

- How much steam capacity is required to supply a heat exchanger with rating of 1,800,000 Btu/hr at 30 psig?

$$\frac{1{,}800{,}000 \text{ Btu/hr}}{929 \text{ Btu/lb.}} = 1{,}938 \text{ Lbs./Hr. Steam Required}$$

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Steam Efficiency Considerations

- **Air in Steam**

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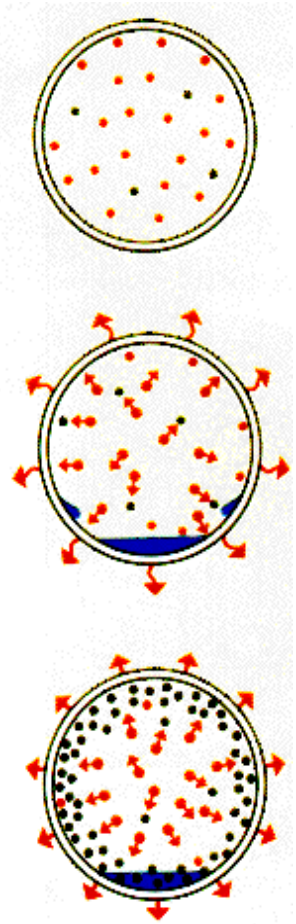
Barriers to Heat Transfer Efficiency

- During heat transfer cycle, steam is drawn to walls of heat exchanger tubes.
- This flow also draws non-condensable gases to inner wall.
- Non-condensable gases can not drain away and form a thin film on tube surface.
- This “air” layer is a great insulator and impedes heat transfer, lowering equipment efficiency.



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Temperature Reduction Caused by Air

Temperature Reduction Caused by Air				
Pressure (psig)	Temp of Steam No. Air Present	Temp. of Steam Mixed With Various Percentages of Air (by Volume)		
		10%	20%	30%
10	240	234	228	221
25	267	261	254	246
50	298	291	283	275
75	320	313	305	296
100	338	330	322	312

Even higher pressure systems can have air in them. Look at the 100 PSIG steam with 30% air by volume.

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Steam Efficiency Considerations

- **Steam Trapping**

What is a Steam Trap?

The three important functions of steam traps are…

- Eliminate air and non-condensable gases
- Drain condensate as it is formed
  - Both of above control corrosion in piping and heat exchangers
- Contain the steam in the system

Cost of Steam Leaks

Assumptions: 100 PSI, Steam $5.00 / 1,000 lbs

Size of Orifice (inches)	Steam Wasted per Month (lbs)	Total Cost per Month ($)	Total Cost per Year ($)
1/2	835,000	4,175	50,100
7/16	637,000	3,185	38,220
3/8	470,000	2.350	28,200
5/16	325,000	1.625	19,500
1/4	210,000	1.050	12,600
3/16	117,000	585	7,020
1/8	52,500	262	3,150

The steam loss values assume clean dry steam flowing though a sharp-edged orifice to atmospheric pressure with no condensate present. Condensate would normally reduce these losses due to the flashing effect when a pressure drop is experienced.

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Steam Efficiency Considerations

- **Condensate Recovery Equipment**

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Steam Efficiency Considerations

- **Condensate recovery allows you to use all of the valuable Btu within the steam system. Depending on the pressure, condensate leaving a trap contains approximately 20% of the heat energy transferred at the boiler in the form of sensible heat.**
- **Condensate recovery systems help you reduce three tangible costs of producing steam:**
  - **Fuel/energy costs**
  - **Boiler water make-up and sewage treatment**
  - **Boiler water chemical treatment**

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Steam Efficiency Considerations

- **Insulation**

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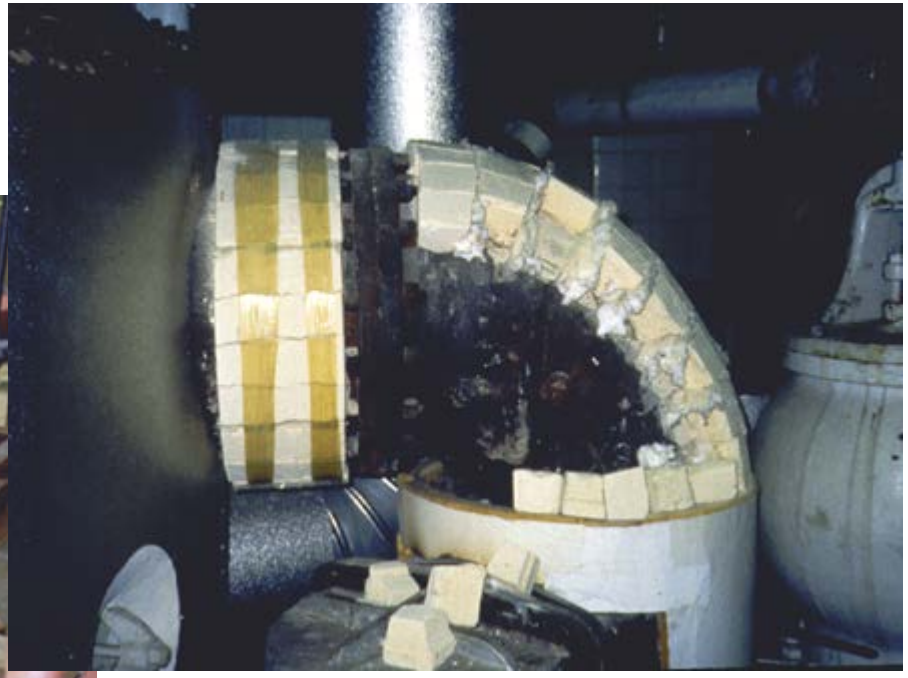
Barriers to Heat Transfer Efficiency

- **Radiant losses -No insulation / poor insulation**



Insulation Effects

- Energy loss on uninsulated steam equipment and steam lines
- Calculate the loss on 300 ft of 6” 125 psig steam main

Condensation in UNINSULATED Pipes Carrying Saturated Steam in Still Air at 70 Deg. F.										
PSIG		15	30	60	125	180	250	450	600	900
Pipe Size (Nom)	Area (sq.ft./lineal ft.	Pounds of Condensate Per Hour Per Lineal Foot								
1	0.344	0.19	0.22	0.26	0.33	0.37	0.41	0.51	0.57	0.69
2	0.622	0.32	0.40	0.47	0.59	0.66	0.74	0.91	1.04	1.25
3	0.916	0.47	0.58	0.70	0.87	0.97	1.09	1.35	1.52	1.84
4	1.178	0.56	0.75	0.90	1.11	1.25	1.40	1.73	1.96	2.36
6	1.735	0.82	1.10	1.32	1.64	1.85	2.06	2.55	2.89	3.48
8	2.260	1.04	1.44	1.72	2.14	2.40	2.69	3.32	3.76	4.53
10	2.810	1.18	1.79	2.14	2.66	2.99	3.34	4.13	4.68	5.64
12	3.340	1.51	2.13	2.55	3.16	3.55	3.97	4.91	5.56	6.70
14	3.670	1.64	2.34	2.80	3.47	3.90	4.36	5.39	6.11	7.36
20	5.250	2.34	3.34	4.00	4.96	5.59	6.24	7.71	8.74	10.53
24	6.280	2.80	4.00	4.79	5.94	6.68	7.46	9.22	10.45	12.60

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Insulation Effects

- Energy loss on insulated steam equipment and steam lines
- Calculate the loss on 300 ft of 6” 125 psig steam main

Condensation in Insulated Pipes Carrying Saturated Steam in Still Air at 70 Deg. F.										
PSIG		15	30	60	125	180	250	450	600	900
Pipe Size (Nom)	Area (sq.ft./lineal ft.	Pounds of Condensate Per Hour Per Lineal Foot								
1	0.344	0.05	0.06	0.07	0.10	0.12	0.14	0.186	0.221	0.289
2	0.622	0.08	0.10	0.13	0.17	0.20	0.23	0.320	0.379	0.498
3	0.916	0.12	0.14	0.18	0.24	0.28	0.33	0.460	0.546	0.714
4	1.178	0.15	0.18	0.22	0.30	0.36	0.43	0.578	0.686	0.897
6	1.735	0.20	0.25	0.32	0.44	0.51	0.59	0.809	0.959	1.253
8	2.260	0.27	0.32	0.41	0.55	0.66	0.76	1.051	1.244	1.628
10	2.810	0.32	0.39	0.51	0.68	0.80	0.94	1.301	1.542	2.019
12	3.340	0.38	0.46	0.58	0.80	0.92	1.11	1.539	1.821	2.393
14	3.670	0.42	0.51	0.65	0.87	1.03	1.21	1.688	1.999	2.624
20	5.250	0.58	0.71	0.91	1.23	1.45	1.70	2.387	2.830	3.725
24	6.280	0.68	0.84	1.09	1.45	1.71	2.03	2.833	3.364	4.434

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Insulation Effects

- Calculate the loss on 300 ft of 6” 125 psig steam main

Uninsulated =	**1.64 lb/hr/lf**
Insulated =	**0.44 lb/hr/lf**
Difference of length of main	**1.20 lb/hr/lf**
	x300 ft
HEAT LOSS OF	**360 lb/hr**
24x365 =	**3,153,600 lb/yr**
Divide by 1000 =	**3,154**
COST @ $5 per 1000 lb =	**$15,770 (3154 x 5)**

What if its only 30 feet of main?

Uninsulated = 1.64 lb/hr/lf
Insulated = 0.44 lb/hr/lf
Difference of 1.20 lb/hr/lf
length of main x 30 ft
HEAT LOSS OF 36 lb/hr
24x365 = 315,360 lb/yr
Divide by 1000 = 315

COST @ $5 per 1000 lb = $1,575 per yr

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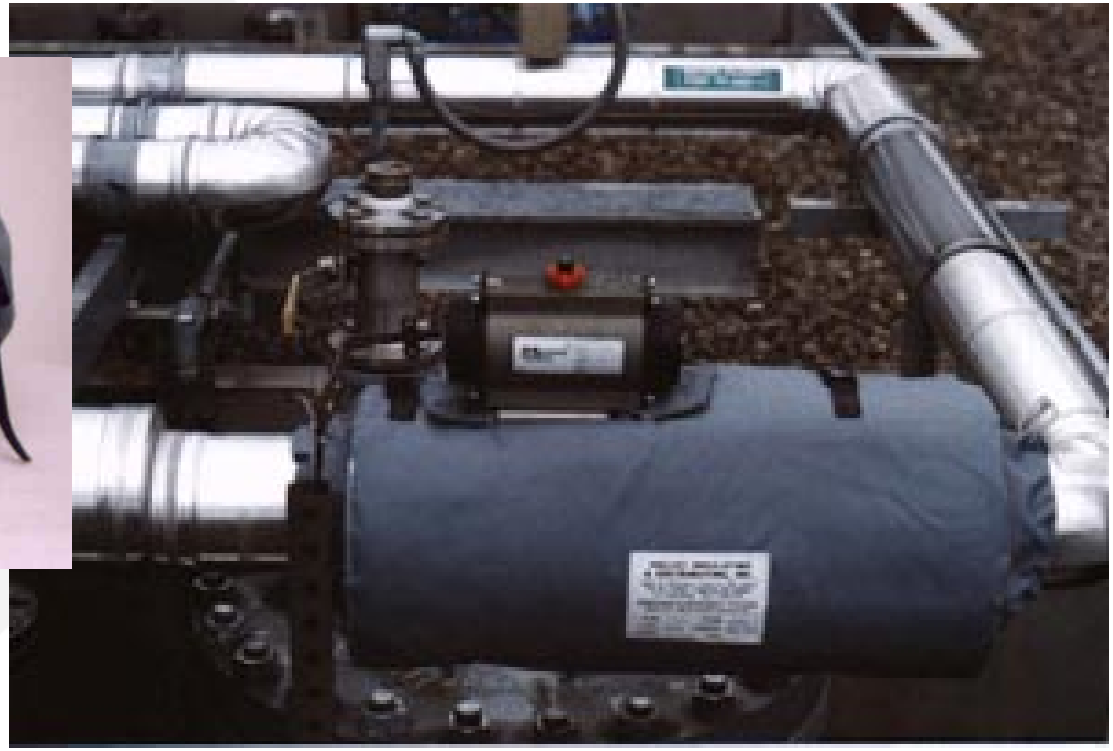
Insulation

- When easy access to equipment is needed...

Removable Insulation Cover or Jacket



Insulation

- Insulated vs. Uninsulated valve

Removable Insulation Cover or Jacket

6” Gate valve on 125 PSIG

Steam cost at $5.00 per 1000 lbs

$663.00 / yr. savings with insulated the valve

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The TARGETS! Today

- Insulation
- Steam Traps
- Condensate

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The TARGETS! Today

- **Insulation**
  - **2 week to 2 year project payback**
- **Find and insulate!**

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The TARGETS! Today

- **Steam Traps**
  - **6 month to 3 year payback**
- **Implement Steam Trap Maintenance Program!**

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The TARGETS! Today

- **Steam Trap Survey**
  - **Testing**
    - **Qualified Technicians**
    - **Testing Methods**
  - **Collecting Data**
    - **Log Sheets**
  - **Data Summary**
  - **Steam Star & Sage Reports**

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Steam Trap Survey

- **Testing**
  - **Qualified Technicians**
  - **Testing Methods**

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Steam Trap Survey

- **Collecting Data**
  - **Log Sheets**

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DEFECTIVE TRAP REPORT

April 2016 survey

Date 4/29/16	Customer
Technician	Location Biomedical Research Building
Page 1 2	
Months/Year	Drip 12 Coil 6 Tracer 12 Process 12

	Application	Equip	MFR / Model	PMO / Conn Size	Line Sz In / Out	Condensate Lift / Load	Pressure In / Out	Insulation	Piping: Direction, Strainer, Valve In, Valve Out	Steam: Supply, Discharge	Condition

---

Tag# 03 Outside | Location: Garage, F10 corner by fence | Elevation 10 ft | Route No. ____

DR | SPI / B1H | 125 psig / 3/4" | 3/4" / 3/4" | 85.0 / 0 psig | H 1 1 2 | C C | PL

Months/Year 12 | Frequency ____ | Installed Date ____ | Conn Type: Check Valve [x] | Superheat [ ] | Shutdown Req'd [ ] | Transmitter ____ | Receiver ____ | Critical Trap [ ] | Temp Alarm ____ | Conductive ____ | Do not monitor [ ] | Follow up Date ____

Recommendation: Inspect / replace valve

Comments: Inlet valve may have dropped gate

Tag# 04 Outside | Location: Garage HP drip between D5&D6 | Elevation 8 ft | Route No. ____ | Steam Cost 14.00 USD | Steam Loss: 355,097 lb/yr | Annual Cost: 4,971 USD

DR | SPI / B1H | 125 psig / 3/4" | 3/4" / 3/4" | 85.0 / 0 psig | H 1 1 2 | C C | BT

Months/Year 12 | Frequency ____ | Installed Date ____ | Conn Type: Check Valve [ ] | Superheat [ ] | Shutdown Req'd [ ] | Transmitter ____ | Receiver ____ | Critical Trap [ ] | Temp Alarm ____ | Conductive ____ | Do not monitor [ ] | Follow up Date ____

Recommendation: Replace with 3/4" 811, 125# orifice

Comments: Trap installed backwards

Tag# 13 Outside | Location: Mech Rm ARC A-4 – Humidifier by condensate pump | Elevation 3 ft | Route No. ____

DR | HU | DUN / 40-215 | 15 psig / 3/4" | 3/4" / 3/4" | 8.0 / 0 psig | S 1 1 1 | C C | PL

Months/Year 12 | Frequency ____ | Installed Date ____ | Conn Type: Check Valve [x] | Superheat [ ] | Shutdown Req'd [ ] | Transmitter ____ | Receiver ____ | Critical Trap [ ] | Temp Alarm ____ | Conductive ____ | Do not monitor [ ] | Follow up Date ____

Recommendation: Replace with 15-B3

Comments:

Tag# 1766 Outside | Location: R-B41A Mech Rm - PRV station | Elevation 2 ft | Route No. ____

DR | SPI / B1H | 125 psig / 3/4" | 85.0 / 0 psig | H 1 1 1 | C C | CD

Months/Year 12 | Frequency ____ | Installed Date ____ | Conn Type: NTP Threaded, Check Valve [x] | Superheat [ ] | Shutdown Req'd [ ] | Transmitter ____ | Receiver ____ | Critical Trap [ ] | Temp Alarm ____ | Conductive ____ | Do not monitor [ ] | Follow up Date ____

Recommendation: Should be in service

Comments: Valved off

Tag# 1770 Outside | Location: R-B41A Mech Rm - Coil supply drip | Elevation 1 ft | Route No. ____

DR | SPI / FT15 | 15 psig / 3/4" | 8 ft | 5.0 / 8 psig | S 1 1 1 M | C | CD

Months/Year 6 | Frequency ____ | Installed Date ____ | Conn Type: NTP Threaded, Check Valve [ ] | Superheat [ ] | Shutdown Req'd [ ] | Transmitter ____ | Receiver ____ | Critical Trap [ ] | Temp Alarm ____ | Conductive ____ | Do not monitor [ ] | Follow up Date ____

Recommendation: Repipe for gravity drainage if possible. Merlo to review

Comments: Modulating steam pressure, 8' lift to return line

Steam Trap Survey

- **Steam Star & Sage Reports**

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SteamStar™

Best Practice Steam System Measurement

The **Multi-Site Executive Summary** includes the following:

- Trap Type Summary - a listing of steam traps by generic type
- Manufacturer Summary - a listing of steam traps by manufacturer
- Application Summary - a listing of steam traps by application
- Annualized Loss Summaries - a total breakdown of estimated steam and monetary loss
- Condition Summary - a listing of steam traps by operating mode

---

The following surveys were used to generate this report:

Location Name	Description	Start Date	Completion Date
Cottage	2011 Survey	11/23/11	12/22/11
Adelbert Gym	2011 Survey	11/16/11	12/22/11
Guilford House	2011 Survey	11/29/11	12/22/11
Millis	2011 Survey	11/7/11	12/22/11
Pete B. Lewis Building	2011 Survey	12/16/11	12/22/11
Mather Dance Center	2011 Survey	11/29/11	12/22/11
Mather House	2011 Survey	11/29/11	12/22/11
Rockefeller	2011 Survey	11/23/11	12/22/11
KHS	2011 Survey	11/16/11	12/22/11
Bingham	2011 Survey	12/27/11	12/22/11
Harkness Chapel	2011 Survey	11/28/11	12/22/11
Mather Memorial	2011 Survey	11/28/11	12/22/11
Mandel School	2011 Survey	12/1/11	12/22/11
Dively	2011 Survey	12/1/11	12/22/11
Kelvin Smith Library	2011 Survey	11/30/11	12/22/11
New Mandel	2011 Survey	12/2/11	12/22/11
Allen Memorial Library	2013 Survey	12/18/13	1/3/14
Amasa	2011 Survey	11/16/11	12/22/11
AW Smith	2011 Survey	11/16/11	12/22/11
Biology	2011 Survey	11/17/11	12/22/11
Law School	2011 Survey	12/16/11	12/22/11
Nord	2014 Survey	7/23/14	7/23/14
Old Med	2012 Survey	4/23/12	4/24/12
Olin	2014 Survey	6/5/14	6/8/14
Sears	2014 Survey	7/23/14	11/19/14
Strosaker	2011 Survey	11/23/11	12/22/11

Steam Trap Survey

- **Data Summary**

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Steam Trap Multi-Site Executive Summary

Case Western Reserve University

Printed 1/9/16

TRAP TYPE SUMMARY

Generic Type		Population Count	% of Total	Failure Count	In Service Failure
BI	Bi-Metal	10	1.0%	2	20.0%
DC	Disc	8	0.8%	0	0.0%
FL	Float	676	66.0%	40	7.4%
IB	Inverted Bucket	93	9.1%	16	19.5%
OR	Orifice	22	2.1%	0	0.0%
TH	Thermostatic	135	13.2%	6	4.6%
UK	Unknown	3	0.3%	0	0.0%
Other		78	7.6%	6	9.5%
Totals:		1,025	100%	70	8.1%

TOTAL ANNUALIZED SUMMARIES

Steam Loss (lb)	59,053,551
Monetary Loss (USD)	826,750
Fuel used to generate lost steam (MMBTU/yr)	78,478
CO2 Emissions (lb)	16,369,809

MANUFACTURER SUMMARY

Manufacturer		Population Count	% of Total	Failure Count	In Service Failure
ARM	Armstrong	21	2.0%	0	0.0%
BAR	Barnes & Jones	2	0.2%	0	0.0%
DUN	Dunham-Bush	13	1.3%	0	0.0%
HOF	Hoffman	46	4.5%	0	0.0%
ILL	Illinois	1	0.1%	0	0.0%
MEP	MEPCO	84	8.2%	4	8.0%
NIC	Nicholson	4	0.4%	1	25.0%
NOT	NO TRAP	1	0.1%	0	0.0%
S-G	Steam Guard	22	2.1%	0	0.0%
SAR	Sarco	182	17.8%	14	7.8%
SPE	Spence	1	0.1%	0	0.0%
SPI	Spirax Sarco	522	50.9%	42	9.6%
STE	Sterling	5	0.5%	0	0.0%
STR	Strong	1	0.1%	0	0.0%
TSL	Tunstall	4	0.4%	0	0.0%
UNK	UNKNOWN	2	0.2%	0	0.0%
W-M	Watson Mcdaniel	12	1.2%	1	10.0%
W-W	Warren-Webster	24	2.3%	2	9.5%
Other		78	7.6%	6	9.5%
Totals:		1,025	100%	70	8.1%

CONDITION SUMMARY

Condition		Population Count	% of Total
BT	Blow Thru	63	6.1%
LK	Leaking	3	0.3%
OK	Good	775	75.6%
OS	Out of Service	164	16.0%
PL	Plugged	4	0.4%
UNK	Unknown	16	1.6%
Totals:		1,025	100%

APPLICATION SUMMARY

Application		Population Count	% of Total	Failure Count	In Service Failure
AV	Air Vent	37	3.6%	1	2.9%
CL	Coil	245	23.9%	15	8.5%
DR	Drip	412	40.2%	38	9.9%
LD	Liquid Drainer	105	10.2%	6	5.9%
PR	Process	204	19.9%	10	6.7%
RAD	Radiator	4	0.4%	0	0.0%
UNK	Unknown	15	1.5%	0	0.0%
Other		3	0.3%	0	0.0%
Totals:		1,025	100%	70	8.1%

Steam Trap Multi-Site Executive Summary
Case Western Reserve University

Printed 1/9/16

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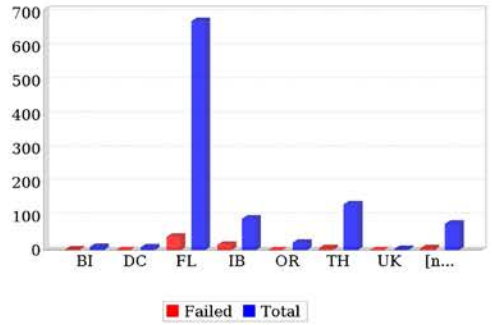

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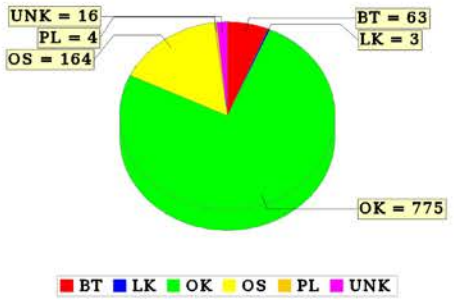

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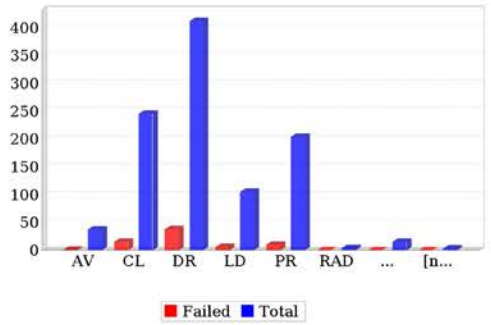

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PR	Process	204	19.9%	10	6.7%
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UNK	Unknown	15	1.5%	0	0.0%
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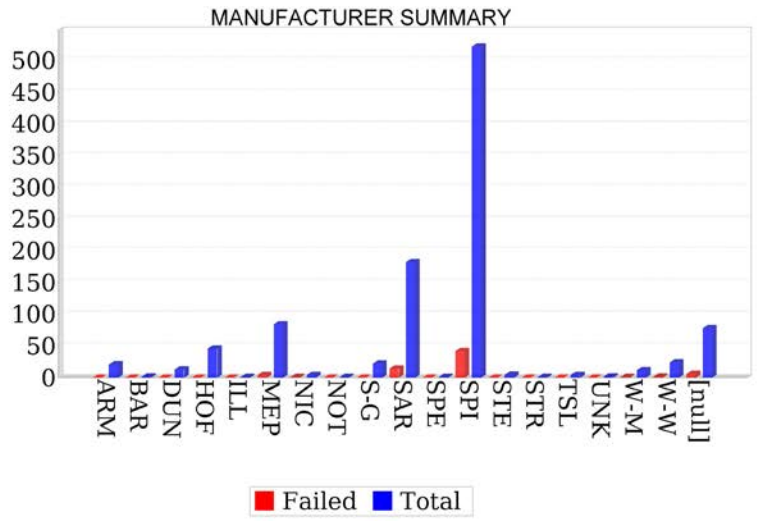
Steam Trap Multi-Site Executive Summary
MANUFACTURER SUMMARY
Case Western Reserve University

Printed 1/9/16



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NOT	NO TRAP	1	0.1%	0	0.0%
S-G	Steam Guard	22	2.1%	0	0.0%
SAR	Sarco	182	17.8%	14	7.8%
SPE	Spence	1	0.1%	0	0.0%
SPI	Spirax Sarco	522	50.9%	42	9.6%
STE	Sterling	5	0.5%	0	0.0%
STR	Strong	1	0.1%	0	0.0%
TSL	Tunstall	4	0.4%	0	0.0%
UNK	UNKNOWN	2	0.2%	0	0.0%
W-M	Watson Mcdaniel	12	1.2%	1	10.0%
W-W	Warren-Webster	24	2.3%	2	9.5%
Other		78	7.6%	6	9.5%
Totals:		1,025	100%	70	8.1%

Site Summary

Allen Memorial Library
2013 Survey

Printed 1/9/16

TRAP TYPE SUMMARY

Generic Type		Population Count	% of Total	Failure Count	In Service Failure
FL	Float	15	16.5%	1	6.7%
IB	Inverted Bucket	3	3.3%	0	0.0%
TH	Thermostatic	73	80.2%	2	2.8%
Totals:		91	100%	3	3.3%

TOTAL ANNUALIZED SUMMARIES

Steam Loss (lb)	905,361
Monetary Loss (USD)	12,675
Fuel used to generate lost steam (MMBTU/yr)	1,195
CO2 Emissions (lb)	249,269

MANUFACTURER SUMMARY

Manufacturer		Population Count	% of Total	Failure Count	In Service Failure
ARM	Armstrong	2	2.2%	0	0.0%
DUN	Dunham-Bush	2	2.2%	0	0.0%
HOF	Hoffman	24	26.4%	0	0.0%
SAR	Sarco	51	56.0%	2	3.9%
SPE	Spence	1	1.1%	0	0.0%
SPI	Spirax Sarco	1	1.1%	0	0.0%
W-W	Warren-Webster	10	11.0%	1	10.0%
Totals:		91	100%	3	3.3%

CONDITION SUMMARY

Condition		Population Count	% of Total
BT	Blow Thru	2	2.2%
OK	Good	86	94.5%
OS	Out of Service	1	1.1%
PL	Plugged	1	1.1%
UNK	Unknown	1	1.1%
Totals:		91	100%

APPLICATION SUMMARY

Application		Population Count	% of Total	Failure Count	In Service Failure
DR	Drip	10	11.0%	0	0.0%
LD	Liquid Drainer	77	84.6%	3	3.9%
RAD	Radiator	4	4.4%	0	0.0%
Totals:		91	100%	3	3.3%

The TARGETS! Today

- **Condensate**
  - **2 year to 10 year payback**
- **Are existing condensate pumps working?**
- **Is all condensate being recovered?**

MERLO ENERGY

Summary of tools available from Merlo Energy

- We sell all steam system components discussed today
  - Steam separators, steam traps, air vents, insulation jackets, condensate pumps, steam control valves, pressure reducing valves
- Metering
- Trap Survey
- SteamEye
  - Steam traps
  - Condensate pumps
  - Relief valves

MERLO ENERGY

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- 800-362-4994
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  - www.armstronginternational.com
  - www.checkallvalve.com
  - www.shipcopumps.com

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