COLLAB HOUR

Weekly Webcast for Members

Engineering a Kettle Boilover Prevention Device

Brewers Association Engineering Subcommittee

Kent Taylor

Co-Founder

Blackstone Brewing Company
Nashville, Tennessee

Chris McCombs

Head Brewer

Coopersmith’s Pub and Brewing
Fort Collins, Colorado

John Blystone, PE

Manager of Engineering & Maintenance

Great Lakes Brewing Co
Cleveland, Ohio

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Introduction to Boilovers

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Breathe, Breathe, Breathe

Scream

https://www.masterbrewerspodcast.com/49

Kerry Caldwell suffered severe injuries from an accident in the brewhouse. She was airlifted and overcame the 34% chance of survival calculated by the hospital.

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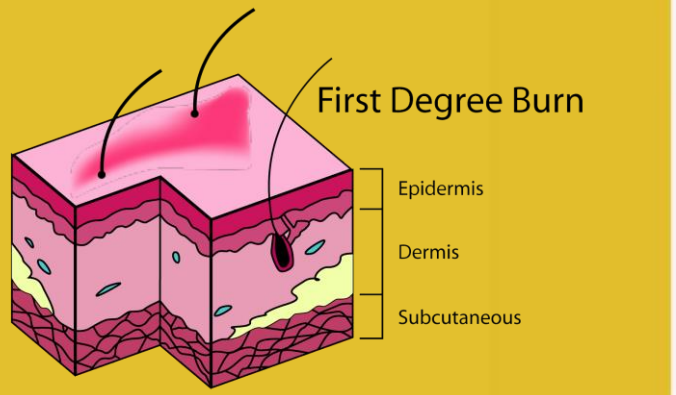
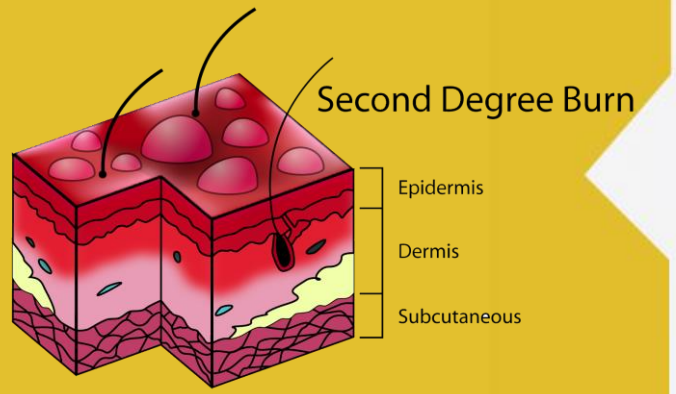
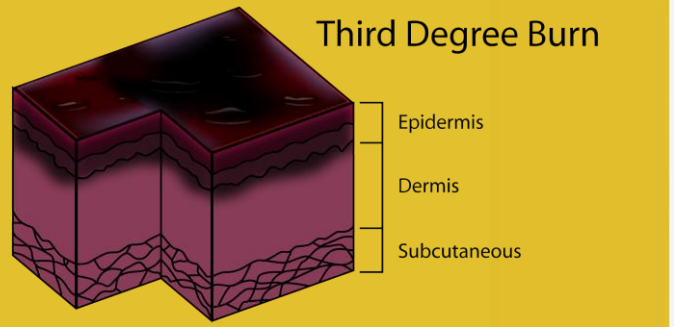


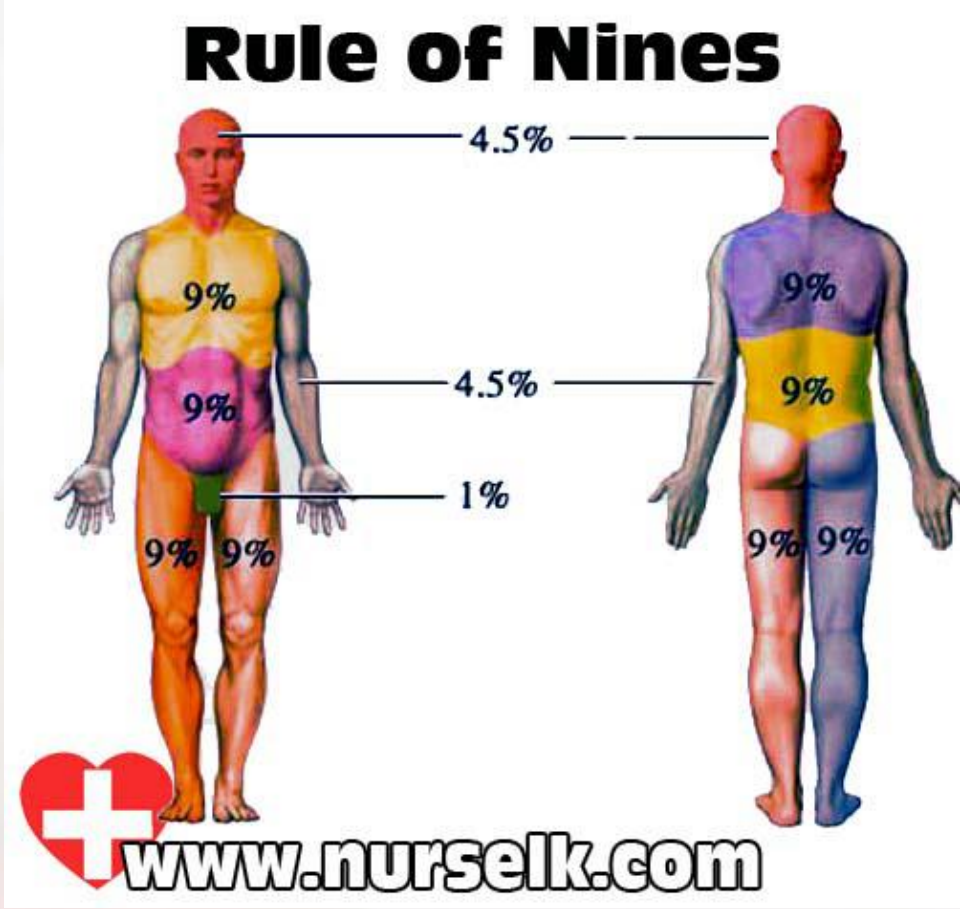




- Skin is the largest organ of the body
- 10% burn will land you in the burn unit
- Over 30% puts your life at risk
- Children and elderly are at higher risk
- Third-degree burns: 1 second at 155F; 2 seconds at 148F; 5 seconds at 140F; instantaneous at wort boilover temps

What to do

- immediately get the person away from the heat source
- remove any clothing or jewelry in the affected area
- cool the burn with cool or lukewarm running water for 10-20 minutes – do not use ice, iced water, or any creams or greasy substances like butter
- make sure the person keeps warm while you seek medical attention



- Head: 9%
- Genitalia: 1%
- Arm: 9%
- Leg: 18%
- Torso: 36%

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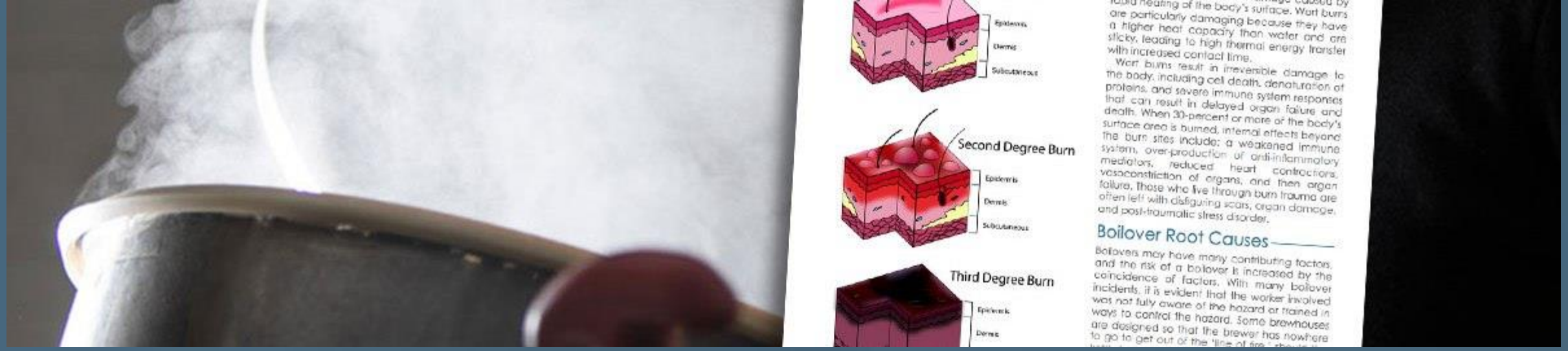

Preventing Kettle Boilovers

Boilover safety systems are critical, but prevention is worth a pound of cure.

1. Fill kettle with the proper volume – reduce recipe volume if you routinely boilover the kettle
2. Trim heat until hot break occurs or when adding hops
3. Consider first wort hopping
4. Consider food grade foam inhibitor
5. Beer must be filtered when certain silicone based antifoam is used

1. Proper staff training
2. Never ever open the manway without elbow length heat resistant gloves and sprayer hose in one hand.
3. Consider installing a dedicated sprayer hose within easy reach **on** the brewer's platform.
4. Long work pants over the outside of their chemical boots

Best Management Practice For Preventing Kettle Boilovers

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Coopersmith's Case Study: Retrofitting a manually-controlled steam kettle

- 8.5 bbl total capacity with approximately 6" of space between high liquid level and edge of manway
- 2 steam jackets – bottom and side, currently controlled by individual 1.5" 304 SS ball valves
- 480,000 BTU @ 15 PSI gas-fired boiler, shared with kitchen
- Currently does not have a boilover protection sensor and shutoff valve installed

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Coopersmith's Case Study: Retrofitting a manually-controlled steam kettle

Current SOP:

- 50 mL of food-grade antifoam added to every brew
- Cold-water hose hung nearby to rinse down foam if necessary
- Personal Protective Equipment (PPE) requirements
  - Long, insulated Neoprene gloves on whenever checking boil or making additions
  - Long pants over steel-toe boots on at all times, even on hot days
  - Safety glasses
- Side steam valve closed and boil allowed to subside before any hop or finings additions are made

Coopersmith's Case Study: Retrofitting a manually-controlled steam kettle

Proposed Solution:

- Design and install a boilover prevention system using a capacitive probe, relay and electrically-actuated solenoid to close the side steam jacket valve when foam is detected.
    - Because of the manual design of the existing brewhouse, the decision was made to go with a capacitive probe with a trip/reset circuit. When foam hits the probe, a signal is sent to close the side jacket steam supply valve, and a visual strobe light is activated communicating the alarm to the brewer on shift. Once the boilover has been mitigated, a reset button can be pushed that will actuate the solenoid valve and allow steam to the jacket once again.
- In addition, develop an SOP describing how to clean, maintain and test the probe.

Engineering Considerations:
Defining the Problem & Clarifying the Solutions

PROBLEM – wort needs boiled, tends to boil-over for numerous reasons

SOLUTIONS :

Level 0 – MIM (Monkey In the Middle)

1. Someone's senses detect boil-over
2. Their hands turn off energy source
3. They wave and scream at those nearby to warn them
4. They re-apply energy to boil again when ready

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Level 1 – Boil-over Protection System (Automated MIM)

1. Sensor used to detect foam from impending boil-over
2. Relay, solenoid, or valve used to turn off energy source
3. Alarm light and/or horn used to alert operators
4. Automatic or manual reset to re-apply energy

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Level 2 – Proper Safety Instrumented System (SIS)

1. Hire Professional Engineer / Certified Safety Professional (PE/CSP)
2. Professionals follow ISA 84.01/IEC 61508 Standards to quantify the risk, design an appropriate SIS, implement it, and verify its operation
3. You sleep soundly knowing you're safe, they sleep soundly on a pile of your $$$

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THIS SYSTEM IS DESIGNED TO MOVE YOU FROM LEVEL 0 TO LEVEL 1 – BUT LEVEL 2 MAY BE WARRANTED!

Real kicker…you don't know if it's warranted until you hire the professionals to tell you it is or isn't.

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Engineering Considerations:
Defining the Problem & Clarifying the Solutions

IMPORTANT NOTE ABOUT LANGUAGE – DETAILS MATTER HERE!

SOLUTIONS :

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THIS IS A MANUAL SYSTEM

Level 1 – Boil-over Protection System (Automated MIM)

1. Sensor used to detect foam from impending boil-over
2. Relay, solenoid, or valve used to turn off energy source
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4. Automatic or manual reset to re-apply energy

THIS IS A PROCESS CONTROL SYSTEM, INTERLOCK SYSTEM, OR PROTECTION SYSTEM

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THIS IS AN EMERGENCY STOP SYSTEM OR SAFETY SYSTEM

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Engineering Considerations:
Defining the Problem & Clarifying the Solutions

“It is better to do something than to do nothing while waiting to do everything”
~Winston Churchill

Even in a “Level 2” SIS, it is very likely that most if not all of the components for our proposed “Level 1” Automated MIM approach will be usable.

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Engineering Considerations:
Level 1 Solution Details

Level 1 – Boil-over Protection System (automate the MIM)

1. Sensor used to detect foam from impending boil-over

Considerations for selection…

- Reliable (triggers when it should, doesn't when it shouldn't)
- Repeatable from best-case to worst-case scenario (from new/clean to covered in Shmoo™)
- Cleanable / sanitary / chemical resistant
- Can handle process and location temperatures (saturated steam is ABOVE 212 °F)
- Easily integrated with existing controls if present (i.e. supply voltage)
- Fail-safe capabilities (N.O.H.C. vs. N.C.) – MORE ON NEXT SLIDE
- Necessary rating for area (combustible dust, natural gas, etc. may require IS or XP)
- Process connection – ideally above liquid level, do you need tri-clamp or is NPT OK?
- Location in kettle – needs to be BELOW manway, ABOVE fluid level – NO OVERFILLING!!!

Technologies that work well in foam…

- Thermal dispersion (typically slower response time)
- Microwave (expensive, large, we don't need continuous level)
- Vibratory / Tuning Fork (fast response, relatively low cost)
- Capacitive Rod (fast response, low cost, base must be kept clean)

Engineering Considerations:
Level 1 Solution Details

What do I mean by “fail-safe”…

- We want majority, or at least most-common, failure modes of our sensor AND system to result in a LACK of energy
- In this case lack of power, faulted device, cut wire to device, etc. all need to kill our boil

What is “Normally Open (N.O.)”, “Normally Closed (N.C.)”, and “Normally-Open-Held-Closed (N.O.H.C.)”?

- All types of sensor or relay contacts
- “Normal” means a lack of voltage on coil (relay) or lack of process activation (sensor)
- “Open” means contacts open, not passing power, off
- “Closed” means contacts closed, passing power, on
- “Open Held-closed” means an open set of contacts, but the control of the coil is reversed
  - For example, when everything’s working, these are identical…
    - N.C. contacts, relay is energized when there is foam
    - N.O. contacts, relay is energized when there is NOT foam (hence “held closed”, to denote that the “normal” process state energizes the relay)
  - Device faults and broken wires prevent relay from actuating, so with N.O.H.C. contacts they would be equivalent to foam being detected

Engineering Considerations:
Level 1 Solution Details

Technologies that work well in foam…

- ~~Thermal dispersion (typically slower response time)~~
- ~~Microwave (expensive, large, we don't need continuous level)~~
- Vibratory / Tuning Fork (fast response, relatively low cost, good ones have good soil resistance)
  - Example – E+H FTL-series (CooperSmith's Pub & Brewing)

  - Other Examples
    - AutomationDirect VFL series
    - Rosemount 2130 series
    - SICK LFV200 series

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Engineering Considerations:
Level 1 Solution Details

Technologies that work well in foam…

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- Capacitive Rod (fast response, relatively low cost, base must be kept clean)
  - Examples – E+H FMI-series (Great Lakes Brewing Company)

  - Other Examples
    - Anderson-Negele (CPE) NVS-345

  - Point of caution – numerous manufacturers have foam-suppression capabilities built-in, meaning they are built to IGNORE foam. Always discuss application with supplier and ideally the manufacturer before buying!

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Engineering Considerations:
Level 1 Solution Details

Level 1 – Boil-over Protection System (automate the MIM)

1. Sensor used to detect foam from impending boil-over
2. Relay, solenoid, or valve used to turn off energy source

Considerations for energy control device selection…

- Involve expert in your energy source – i.e. electrician or pipe fitter/plumber
- Find a device that is fail off/closed (spring close, air to open valves for instance)
- Verify device is rated for full energy load (involve supplier, manufacturer's sales engineers if needed)
- For steam, remember up-stream should be properly trapped to avoid condensate build-up/hammer
- Don't simply assume valve size matches pipe size – may restrict flow, create too much pressure drop!

Engineering Considerations: Level 1 Solution Details

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3. Alarm light and/or horn used to alert operators

Considerations for alarm light/horn selection…

- Horn should be distinct, only loud enough to be heard above background at required distance
- If used, horn should be capable of being silenced electrically (or else people use a hammer)
- Lights should conform to NFPA 79 color requirements

Table 10.3.3 Machine Indicator Lights and Icons

Color	Purposes		
	Safety of Persons or Environment	Condition of Process	State of Equipment
RED	Danger	Emergency	Faulty
YELLOW (AMBER)	Warning/ Caution	Abnormal	Abnormal
GREEN	Safe	Normal	Normal
BLUE	Mandatory action		
CLEAR WHITE GRAY BLACK	No specific meaning assigned		

Engineering Considerations: Level 1 Solution Details

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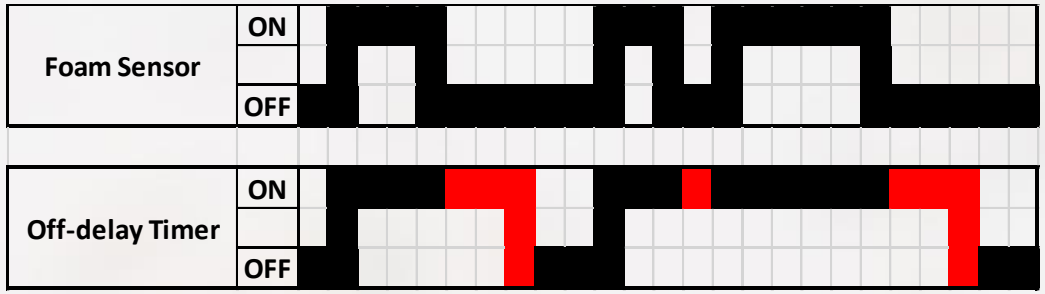
Considerations for reset…

- REGARDLESS of manual or auto, Off-delay timer should be utilized to prevent “short cycling” – guarantees a minimum off time before energy re-applied!
- Manual reset preferred, but not required for a Level 1 system
- Reset button should be located AWAY from hazard, but in view



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<u>General engineering considerations</u>

- Adding anything electrical to your kettle (like a level probe) requires that it be bonded to earth ground per NFPA 79
- Low-voltage controls outside the panel doesn't make the panel safe to open – ANY high voltage terminals makes it a high voltage control panel

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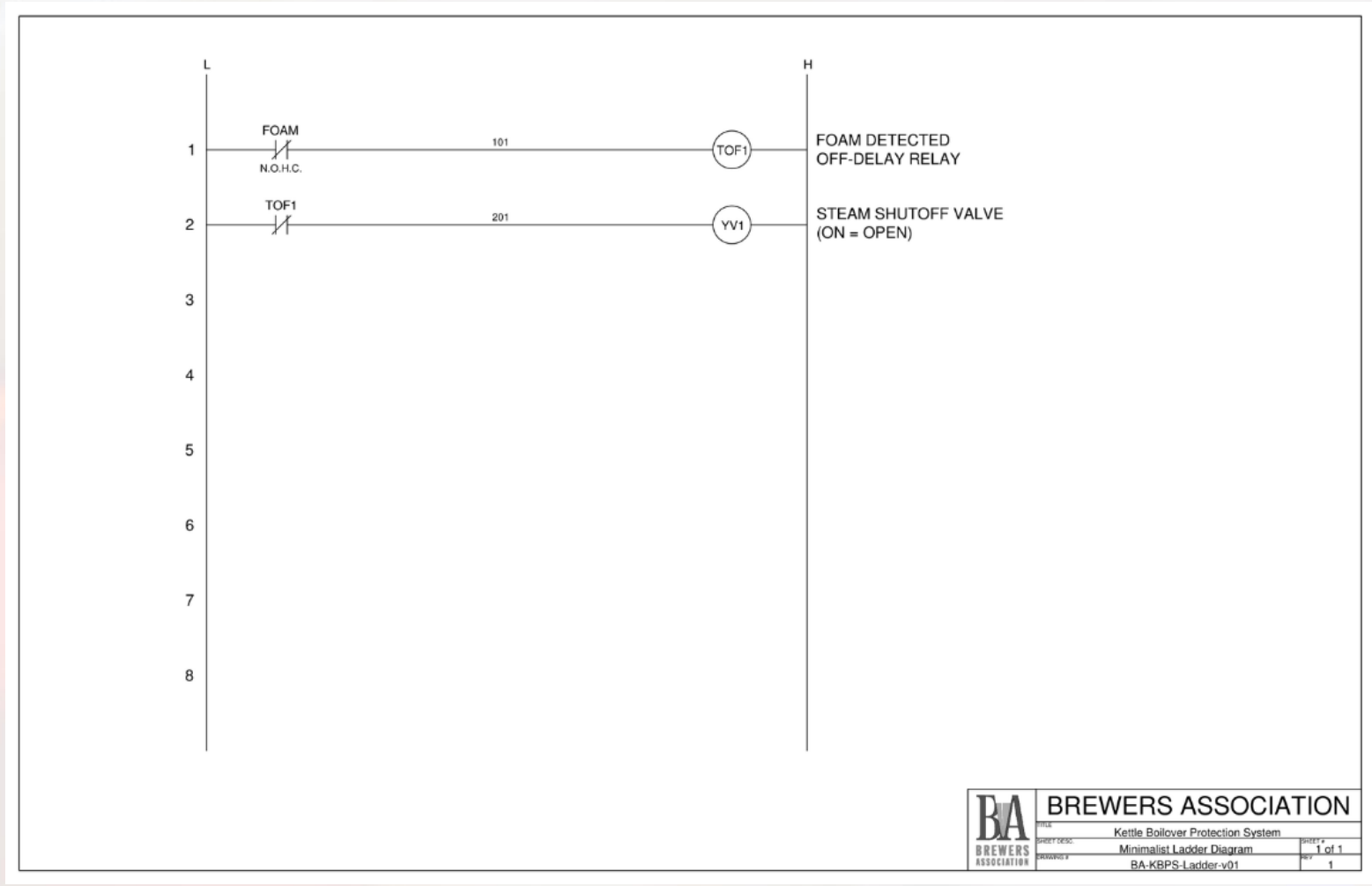
Engineering Considerations:
Level 1 Example “Basic” System

- **Auto-resets after foam switch cleared plus TOF delay time**
- **Absolute minimal implementation**
- **Mimics GLBC’s PLC-based solution**



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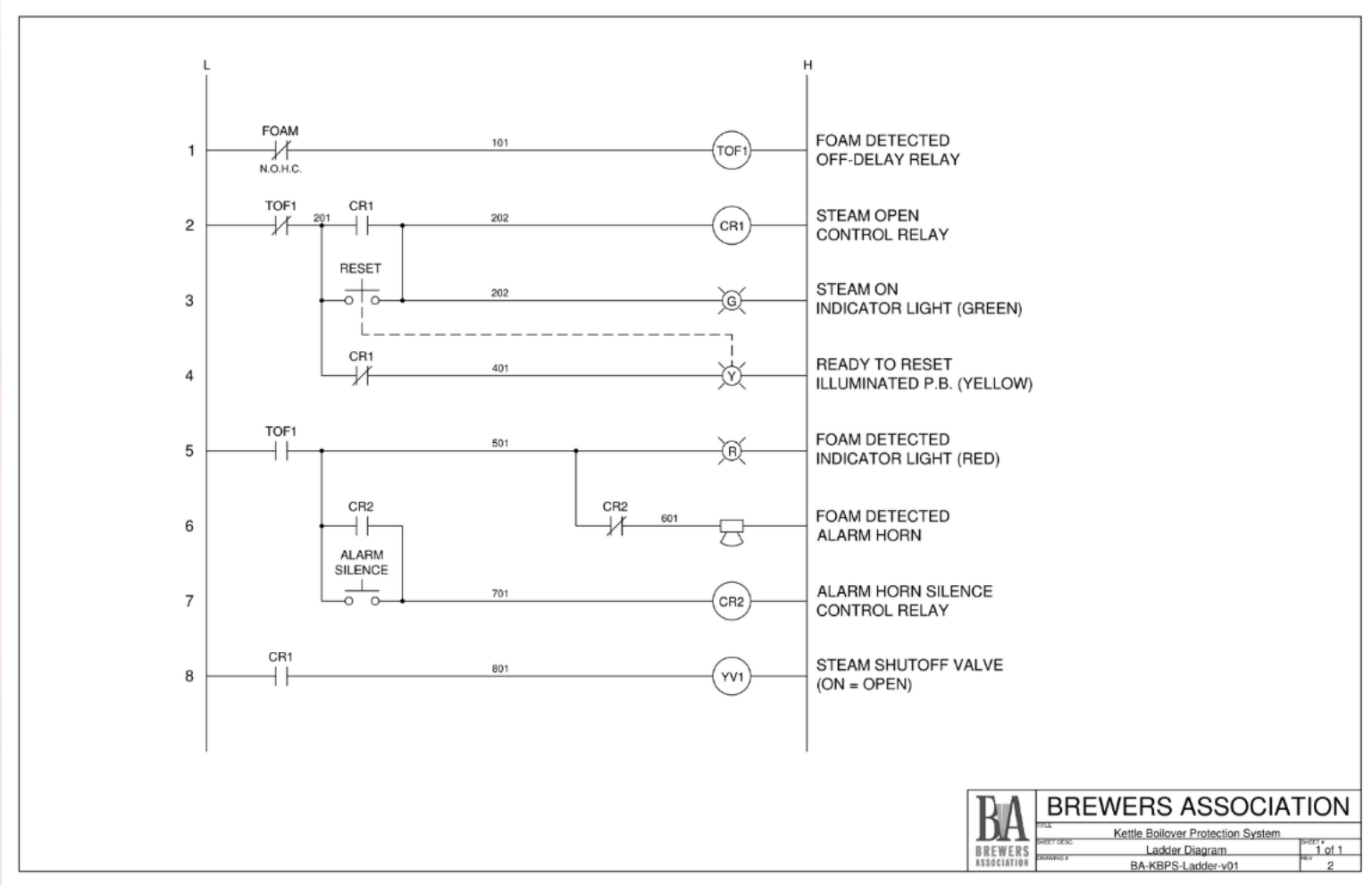
Engineering Considerations:
Level 1 Example “Full-featured” System

- TOF present to prevent short-cycling
- Foam detection turns off steam, turns on red light, turns on alarm horn
- Alarm horn silencable
- Once foam cleared, yellow reset PB illuminates
- Once reset, green light turns on and steam valve opens



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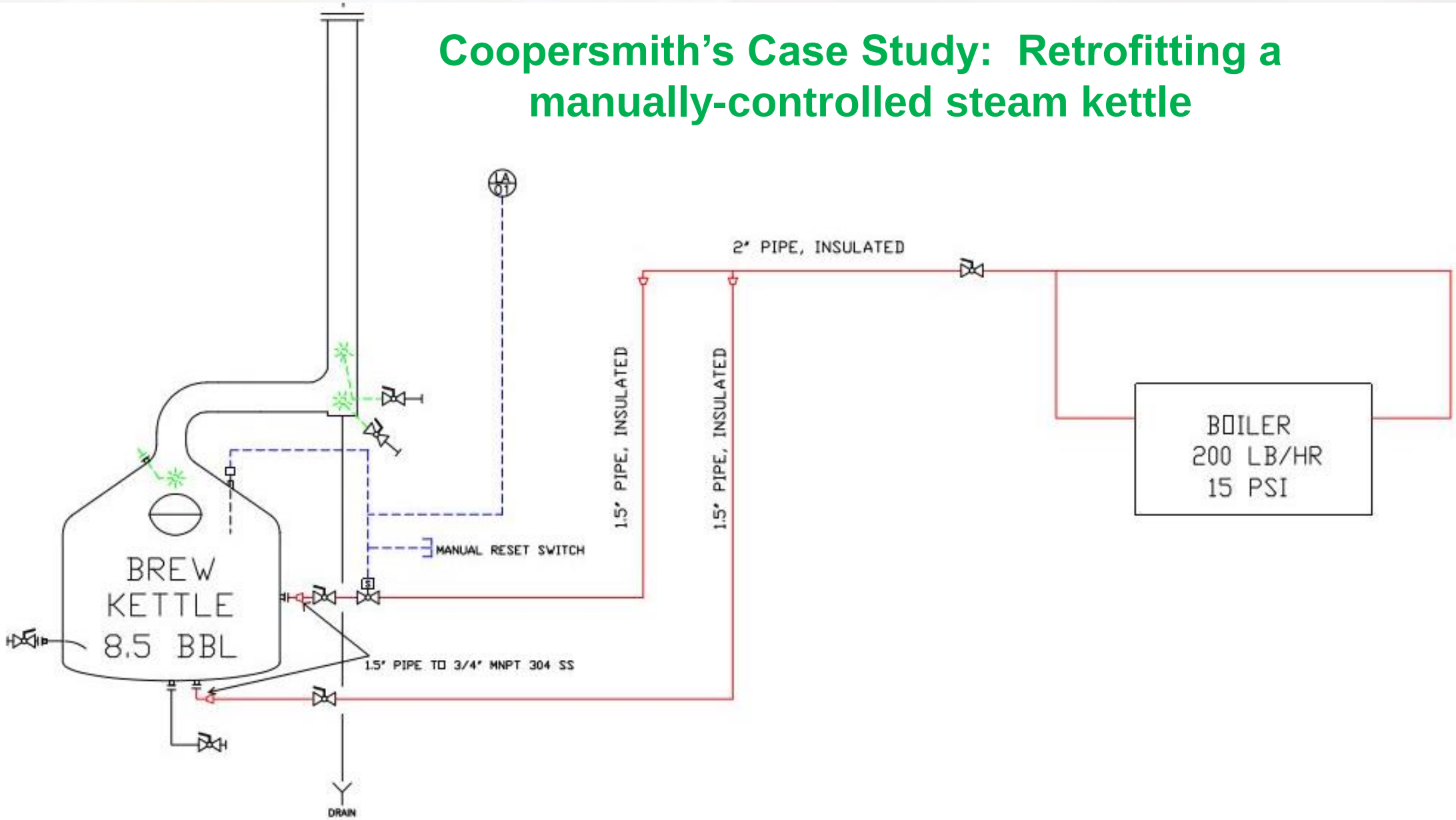
Coopersmith's Case Study: Retrofitting a manually-controlled steam kettle



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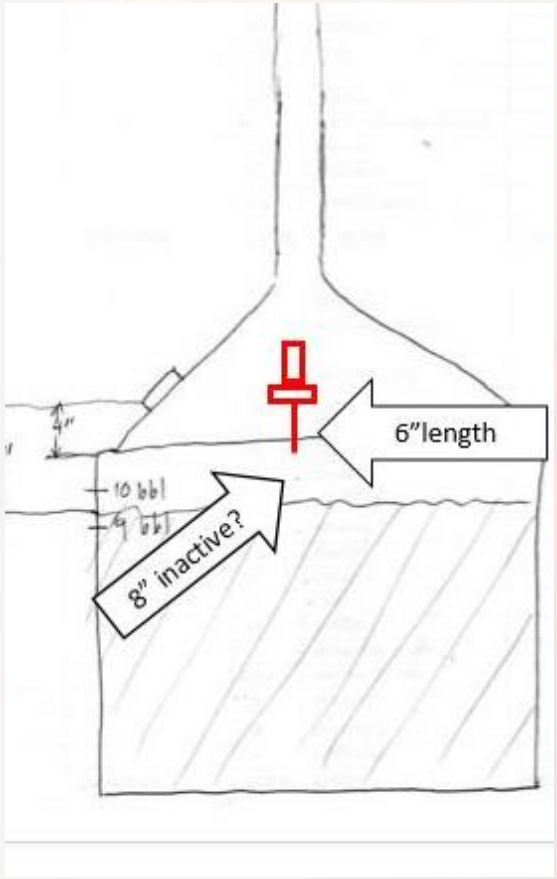

Design Considerations:

•Capacitive probes can not be cut to length, therefore it is important to specify the correct distance between the surface of the wort and the end of the probe

•Existing ball valves may or may not be able to be fit with actuators

- Pneumatic or electric actuators are options, however this brewery does not have enough compressed air capacity for pneumatic
- Replacing with a whole new actuated valve will increase the cost

•Both audible and visual alarm strobe lights are preferred

•No PLC or control cabinet, therefore a push-button reset is preferred

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Coopersmith's Case Study: Retrofitting a manually-controlled steam kettle

Progress Update:

- Pricing for the probe + relay, horn/strobe + actuator for side steam valve + mechanical and electrical installation = $3,350.00
    - +Bottom zone valve shutoff = $850.00
- Work In-Progress

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THANKS!