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Work Experience/ Career History

- **Professor, Department of Food, Nutrition & Packaging Sciences, Clemson University, 1999 – Current**
  - Coordinator of Extension Food Manufacturing Program
    - BPC School, Thermal Process Development, Shelf Life Studies, Food Package Testing/Evaluation, Industry Training
  - Originator & Director of Cryovac Flavour Mark Retort Lab (2008)
  - Research focus: Thermal processing of packaged food products, Retort processing technologies, Bio-polymer packaging, Food packaging

Education:

PhD: Food Technology, Clemson University, Clemson, SC (1999)

MS: Agricultural Economics, Clemson University, Clemson, SC (1986)

BS: Ag Mechanization & Business, Clemson University, Clemson, SC (1984)

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Temperature Distribution Performance of New Forced Water Flow Retort System

2023 IFTPS Annual Meeting
February 28, 2023
New Orleans, Louisiana

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Agenda

- Background
- System Overview
- Benefits
- System Process
- Test Set-up
- Results

Background

- Current Batch Retort Systems
- Benefits
  - Overpressure
  - Package Options
- Challenges
  - Uneven temperature distribution
  - Extended CUT with dense packed loads

ImmersaFlow OVERVIEW

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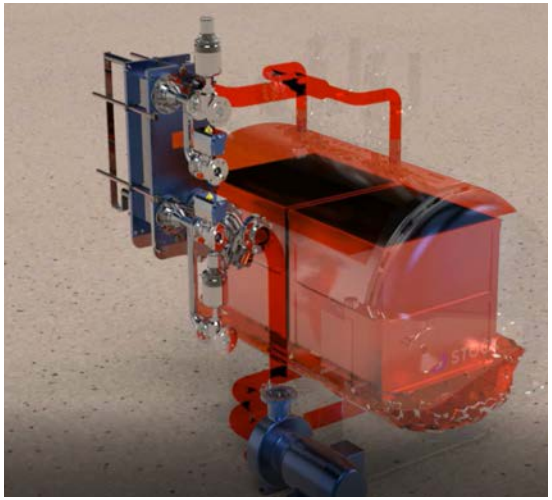
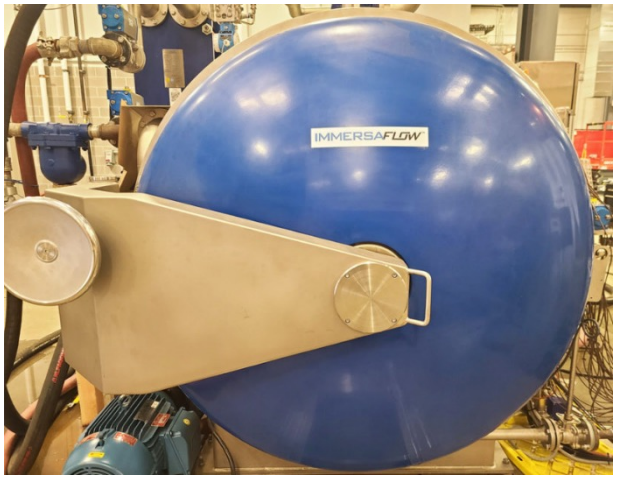
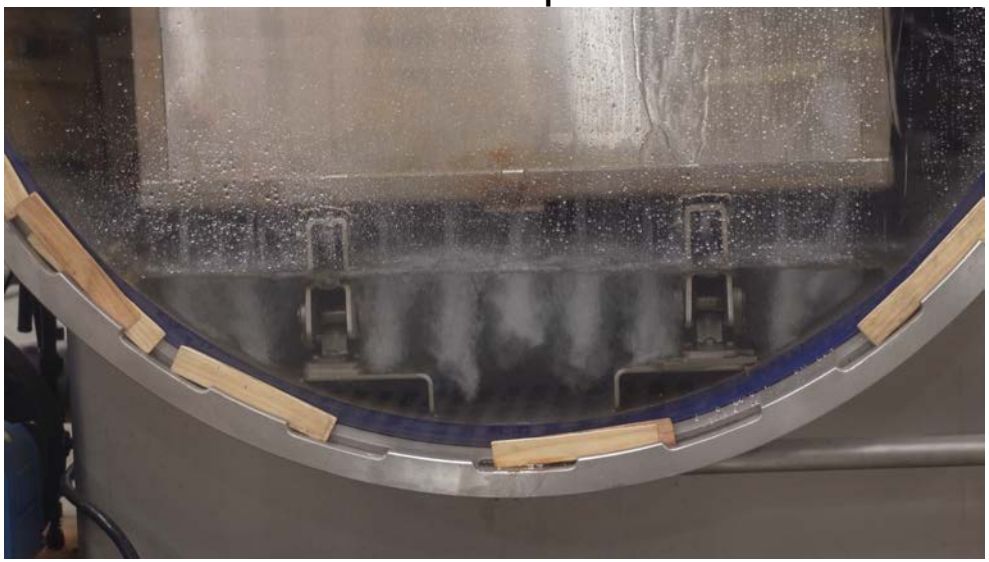
- ImmersaFlow system is a closed loop water immersion process.
- Process is pumped through a distribution plenum, through solid sidewall baskets with a bottom orifice plate and returned through a reservoir for the process medium (water).
- Process water is forced past the product while flow is regulated by pump speed.
- Specifically sized orifices in the basket bottom plate are sized to create full immersion in the basket.
- Controlled water flow allows for even temperature distribution throughout all open areas of the basket load.





Operation

- Preheat reservoir filled and heated to set temperature. Distribution plenum mechanically seals against the basket rim.
- Solid sidewall baskets create a sealed pathway. Flow is regulated by pump speed and the orifices in the bottom of the basket.
- Orifices in the basket bottom are calculated to provide flow sufficient to force the basket to fill completely and remain full during the process .
- Pump creates forced flow of process water within basket and around containers.
- Water exits the basket through the orifices in the bottom to a common reservoir and recirculated to continue the process.



Potential Benefits

- Precise, uniform heating and cooling within each basket due to forced flow design.
- Quick reheating capacity of process water.
- Highly efficient for densely packed loads.
- Potentially higher throughput and greater control of product quality.
- Reduced heating and cooling energy due to less process water when compared to full immersion system.

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Energy Savings

- Faster Come Up Times and Cooling Time reduces Steam and Water usage.
- Over 40% less water used than in a typical Full Immersion sterilizer of comparable size.

				Six position 1400mm Retort				
				Full Water Immersion			Immersaflow	
Water in vessel minus product				1906.98	gallons		812.1348	gallons
Water in plenum							275.8249	
Water below basket							306.33	
water in basket							229.98	
Incoming water temp				60	F		60	F
Retort Processing Temp				251	F		251	F
BTU's to heat water to process temp				3038312	BTU's		1293941	BTU's

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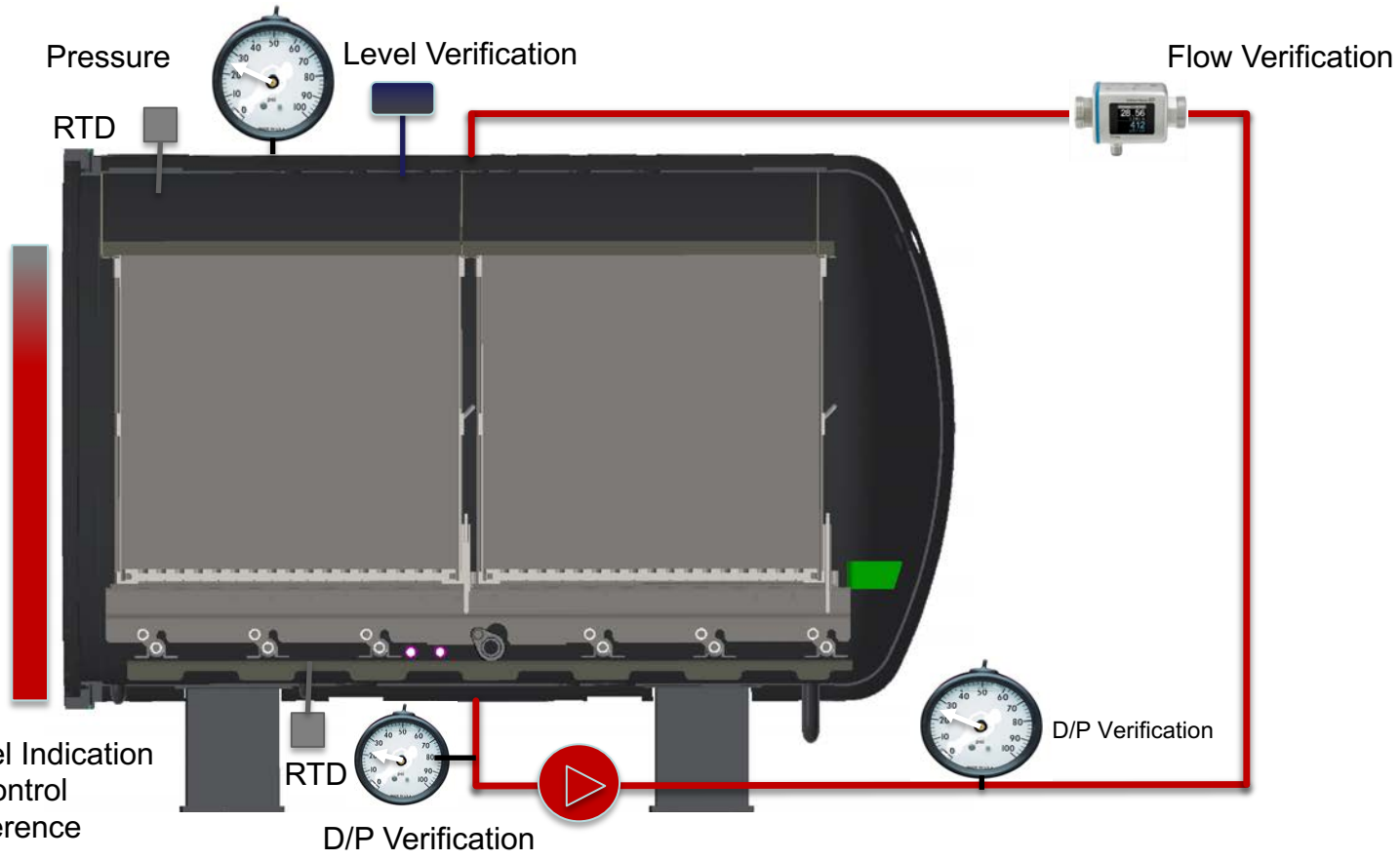
Sensor Overview

- Level TX LO
- Level DI LO
- Pump OVL LO
- Basket In Load Position HI
- Conveyor Motor OVL DI LO
- RTD Plenum in Range
- RTD Reservoir in Range
- Pressure in Plenum in Range
- Pressure in Shell in Range
- Differential Pressure around Pump is DI LO
- Flow Meter is at ZERO



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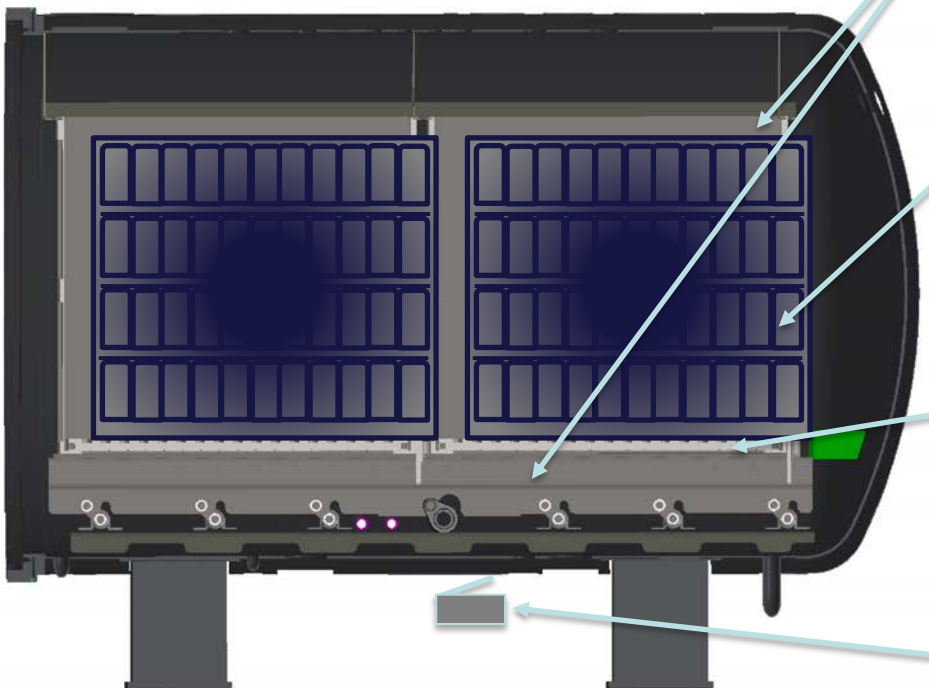
Basket Seal



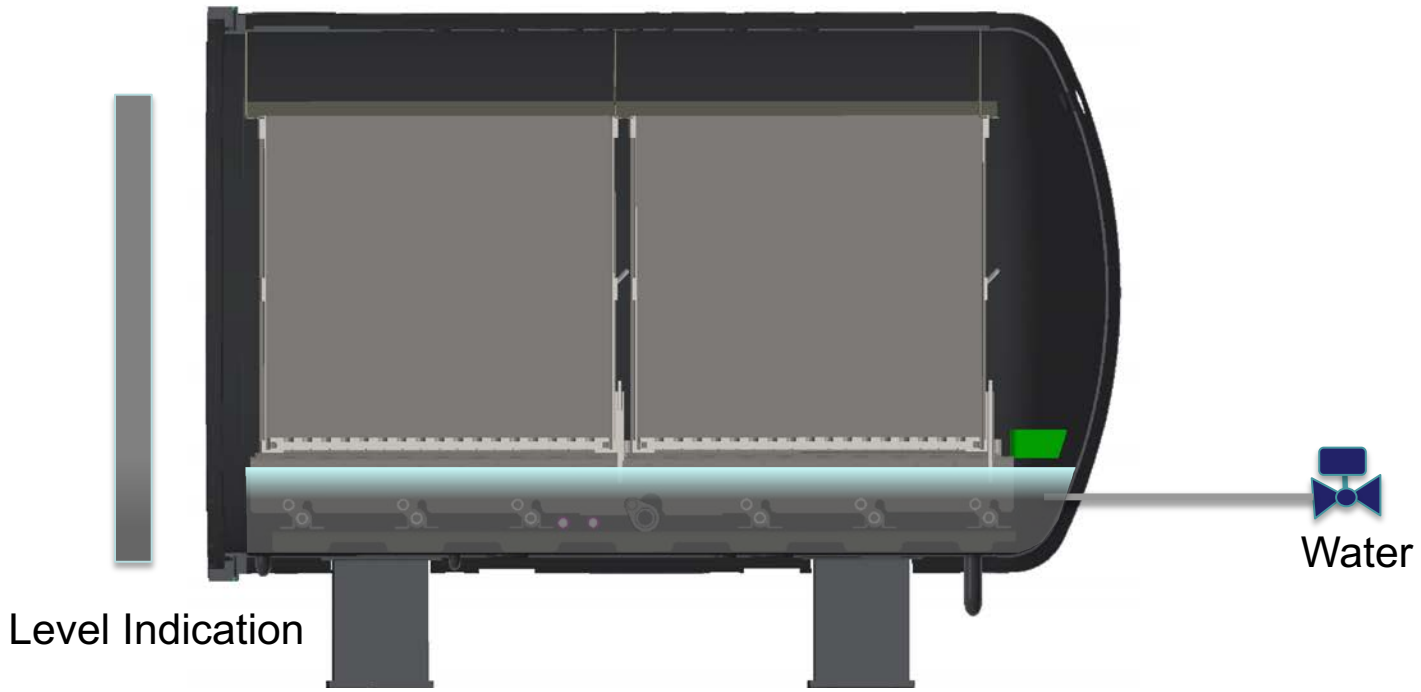
- Roller Rails Lift basket against plenum Face to Create a Water Colum.
- Baskets or Trays have Solid Sides to Force Channeling.
- Perforated False Bottom Ensure a Full Colum of Process Water
- Lift Contact Switch

Fill Step

Logic:
Fill Reservoir to Preheat Level

Sequence:
- Open Water Valve
- Lift Basket to Seal Position

Verify:
- Level at Preheat Position
- Basket In Seal Position

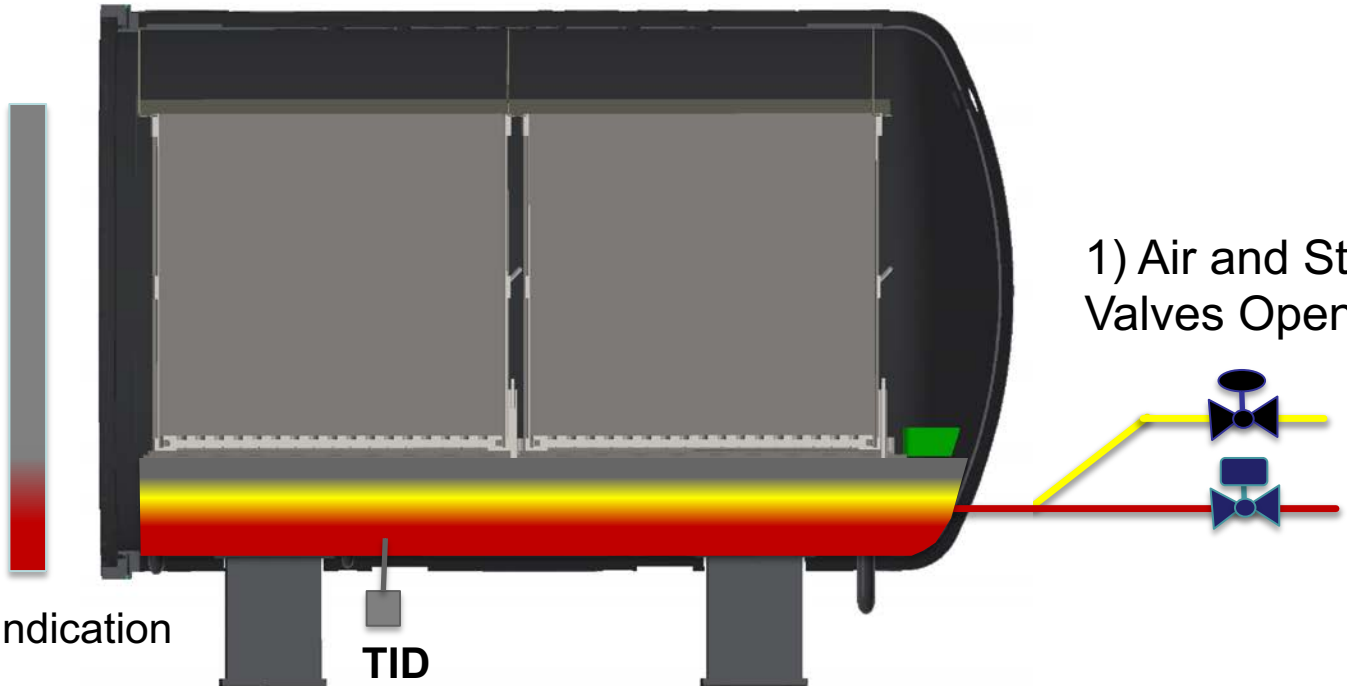


Preheat

Logic:
Preheat Reservoir to a Setpoint higher than Product Initial Temperature.

Sequence:
- Open Steam Boost Valve
- Open Air Control Valve (Agitation)

Verify:
- Level at Preheat Position
- Rise in Temperature on TID
- Basket In Seal Position



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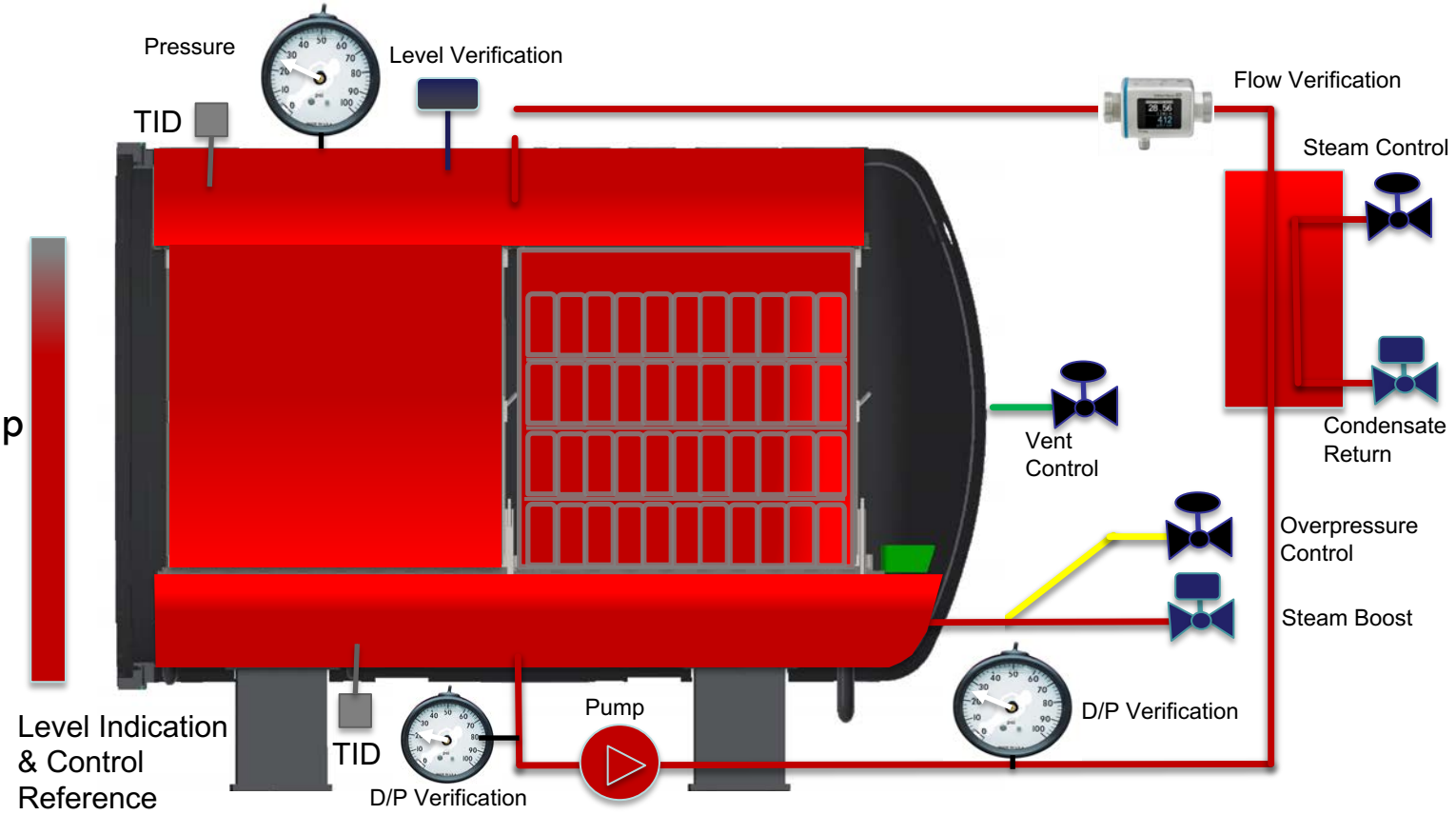
Come Up
Pressurize Plenum & Basket

Logic:
Create Process Water Column by Flooding Each Basket Remaining Vessel Volume Empty

Sequence:
- Start Pump
- Adjust Level
- Start Pressure Ramp
- Start Temp Ramp
- Utilize Steam Boost

Verify:
- Pump D/P
- Plenum Level
- Plenum TID
- Reservoir TID
- Basket In Seal Position



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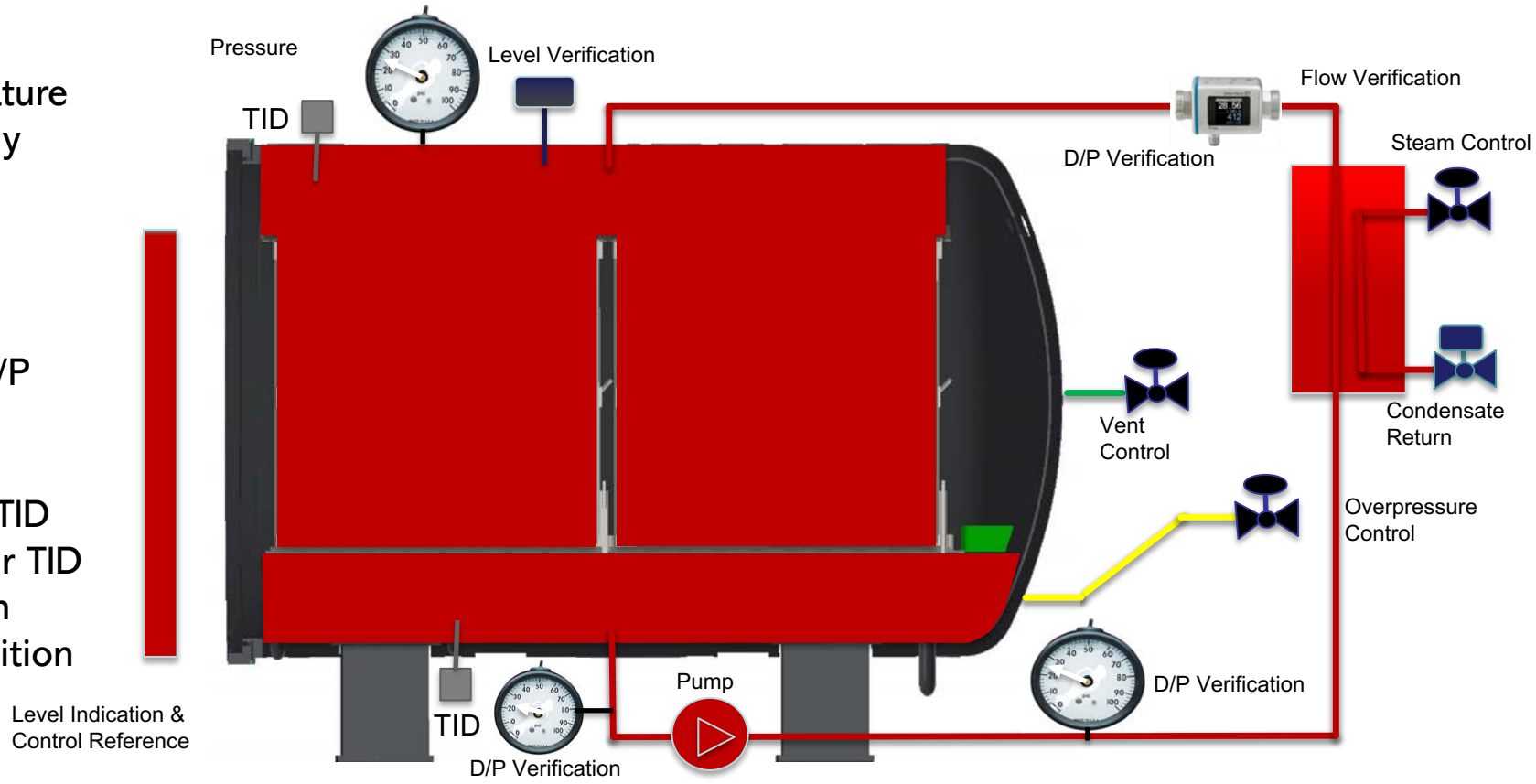
Sterilization

Logic:
Maintain Temp & Pressure

Sequence:
- Control Temperature (Indirectly H/E)
- Control Pressure

Verify:
- Pump D/P
- Level in Plenum
- Plenum TID
- Reservoir TID
- Basket In Seal Position



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Pressure Cooling

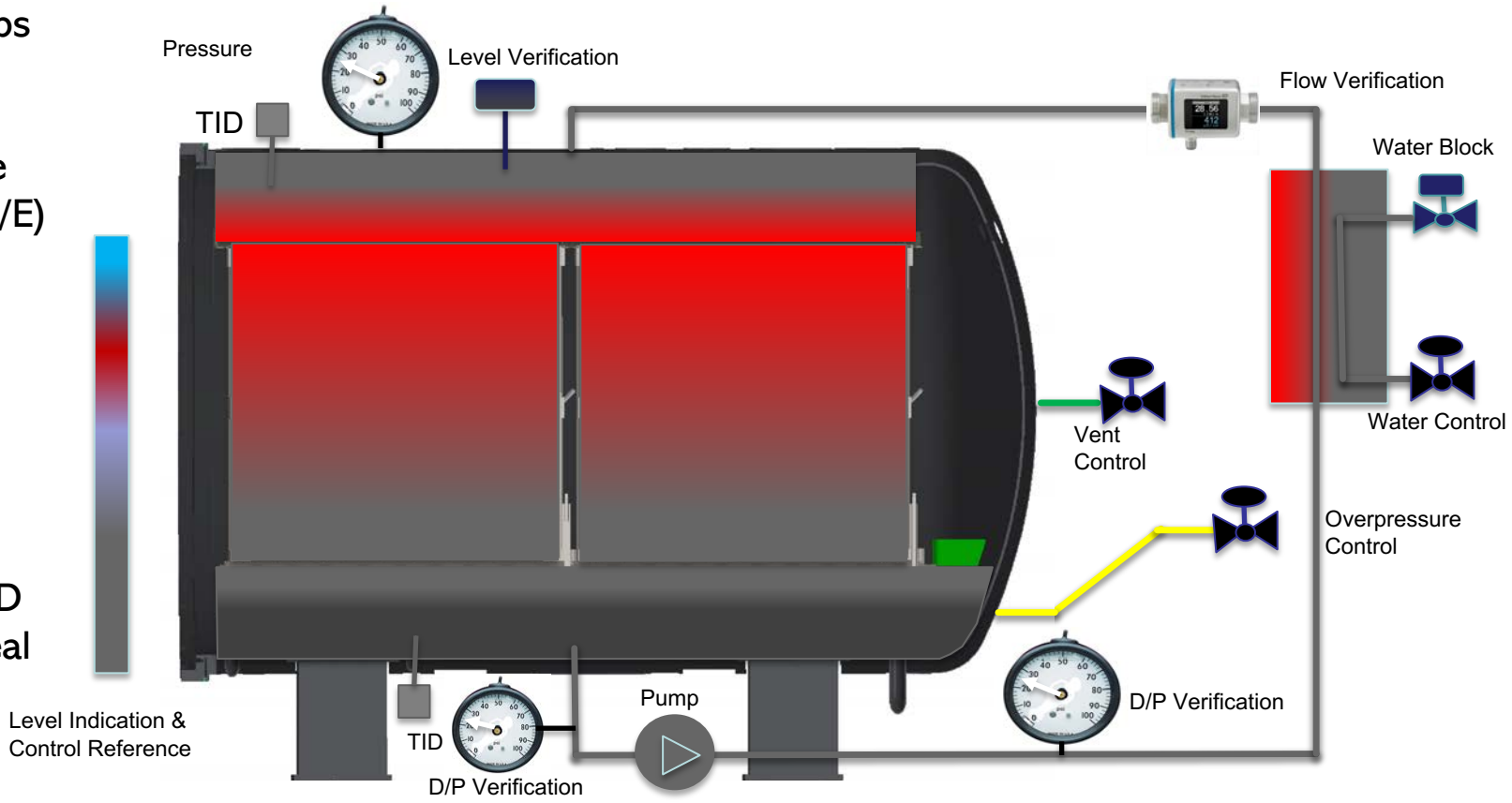
Logic:
Start Cooling
Temp &
Pressure Ramps

Sequence:

- Control Temperature (Indirectly H/E)
- Control Pressure

Verify:

- Pump D/P
- Level in Plenum
- Plenum TID
- Reservoir TID
- Basket In Seal Position

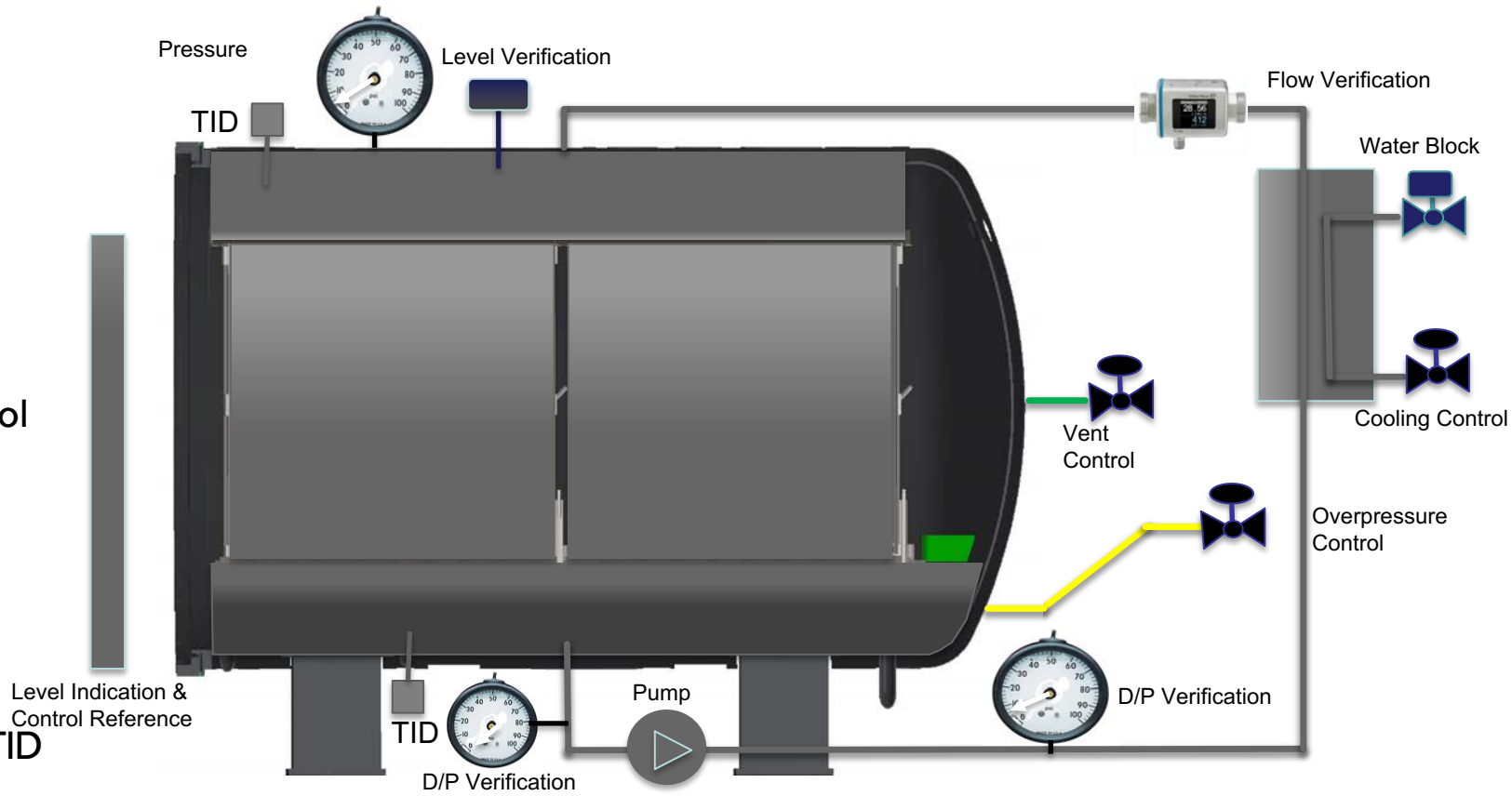


Atmospheric Cooling

Logic:
Cool until desires Exit Temperature

Sequence:
- Cooling Control 100%
- Vent Control 100%

Verify:
- Pump D/P
- Level in Plenum
- Reservoir TID
- Basket in Seal Position

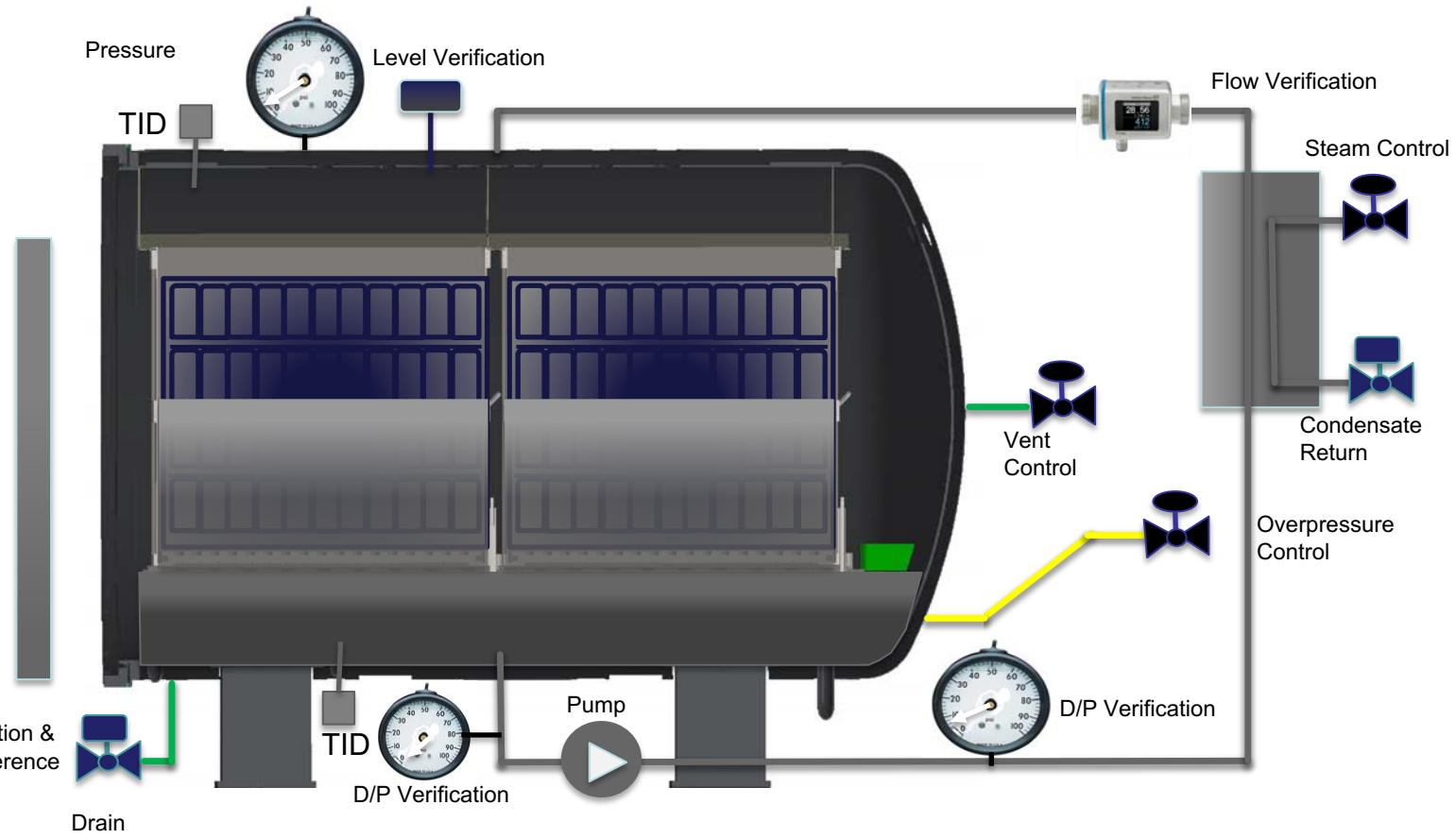


Drain

Logic:
Drain Reservoir to Restart Level (Recipe Dependent)

Sequence:
- Drain Open
- Vent Control 100%
- Retract Basket

Verify:
- Level in Reservoir
- Basket Down



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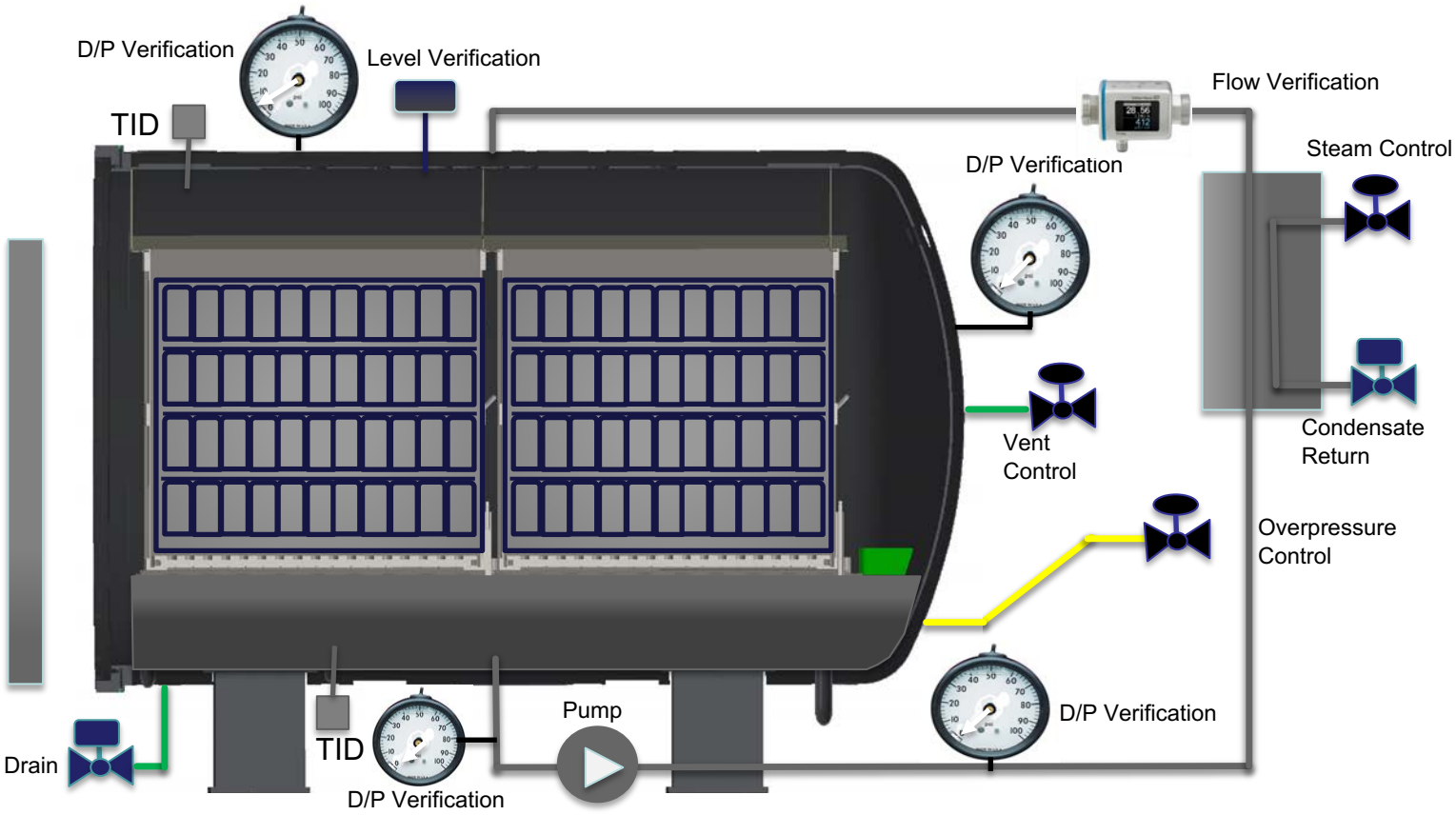
Unload

Logic:
Ready for Unloading

Sequence:
- All Valves Off
- Basket Retracts

Verify:
- Open Pressure
- Open Level
- Low TID Reservoir



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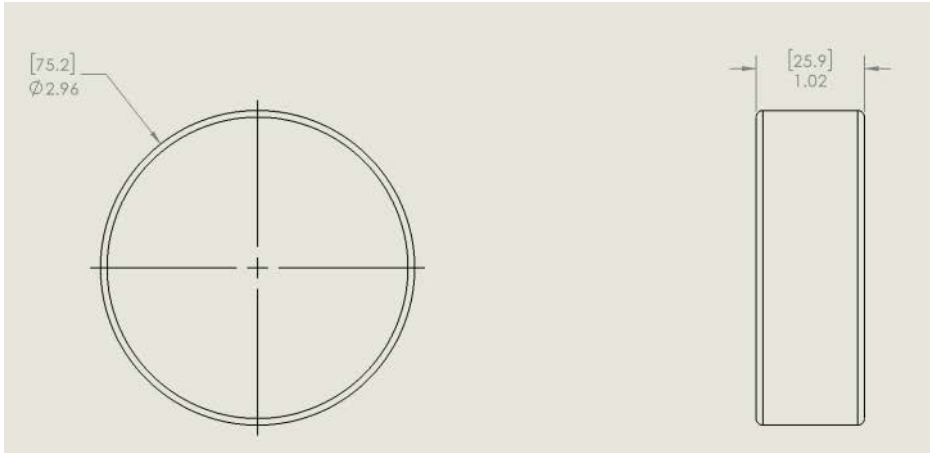
Testing Set-up

- Ballast containers
- “Regulation” Hockey Puck
- Material: Rubber.
- Weight: 0.36 lb (5.7oz); 160g.



Testing Set-up

- 28 Layers.
- 161 Pucks/Layer {(7*12) + (7*11)}.
- 4,508 Pucks/Basket.
- 4mm (.158”) Polypropylene Spacer Mat between each layer.

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Testing Set-up

- CALPlex Data Logger
- 32 Type “T” Lead Wires.
- CALSoft Software.
- 10 Second Scan Rate.

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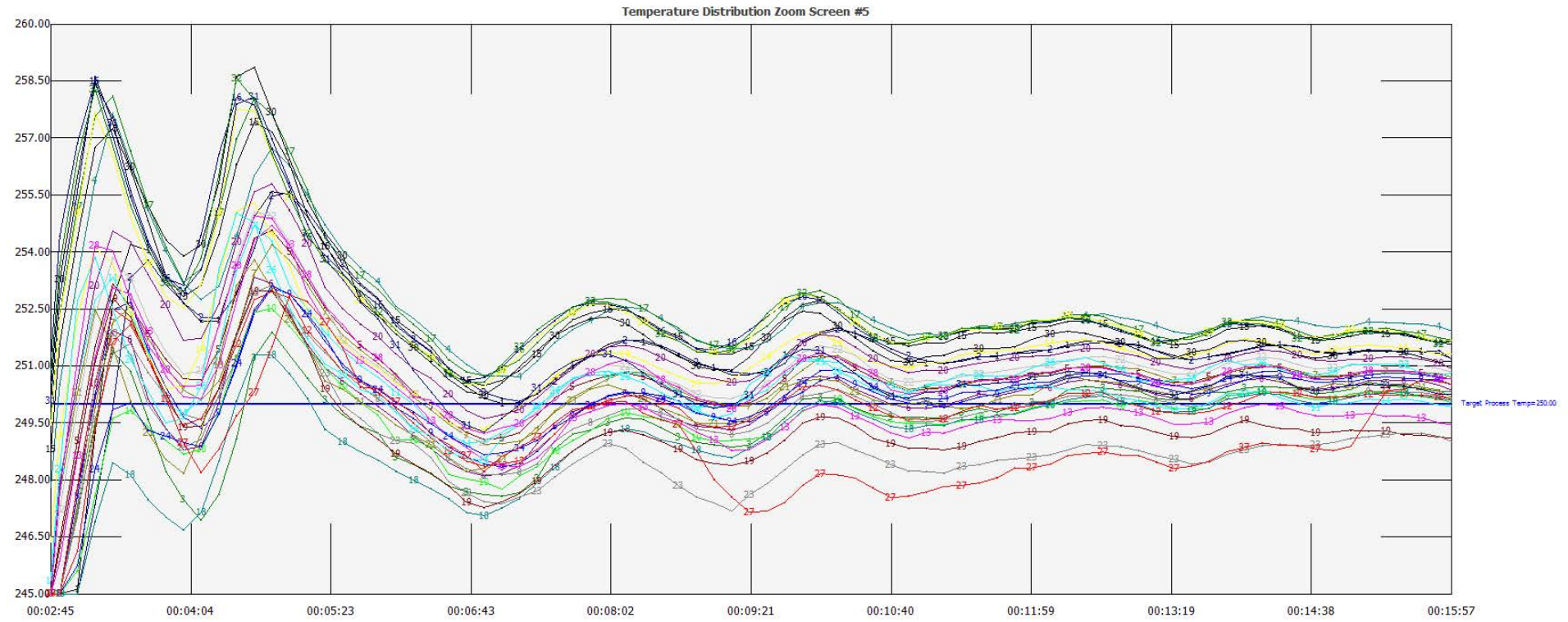
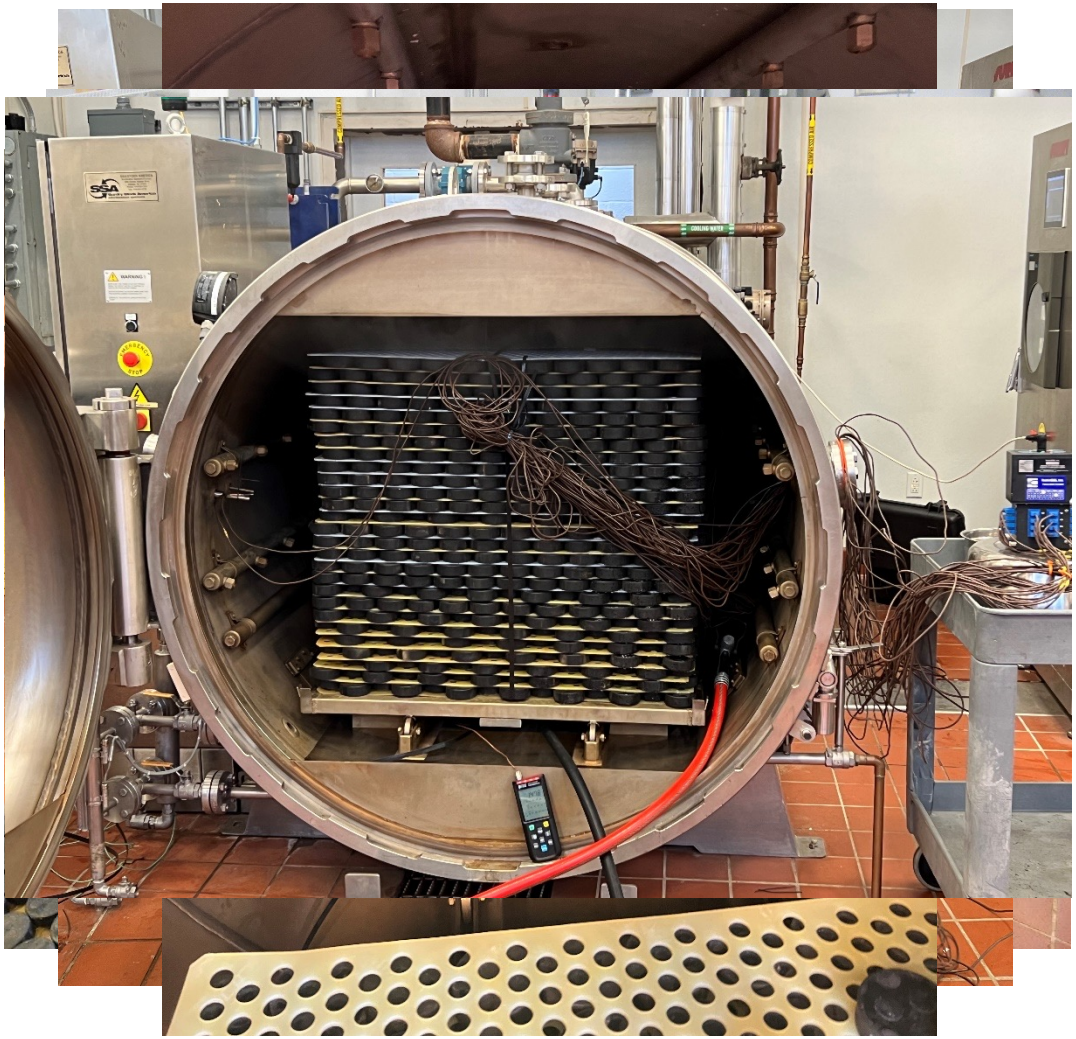
Immersaflow Test Results



Clemson Testing

- Surdry AO-142 Retort
- Steam/Waterspray
- Static
- No Pre-heat
- Same loading pattern as original.
- No Baskets
- 32 TD Lead Wires
- CALSoft Data Logger
- CALSoft Software



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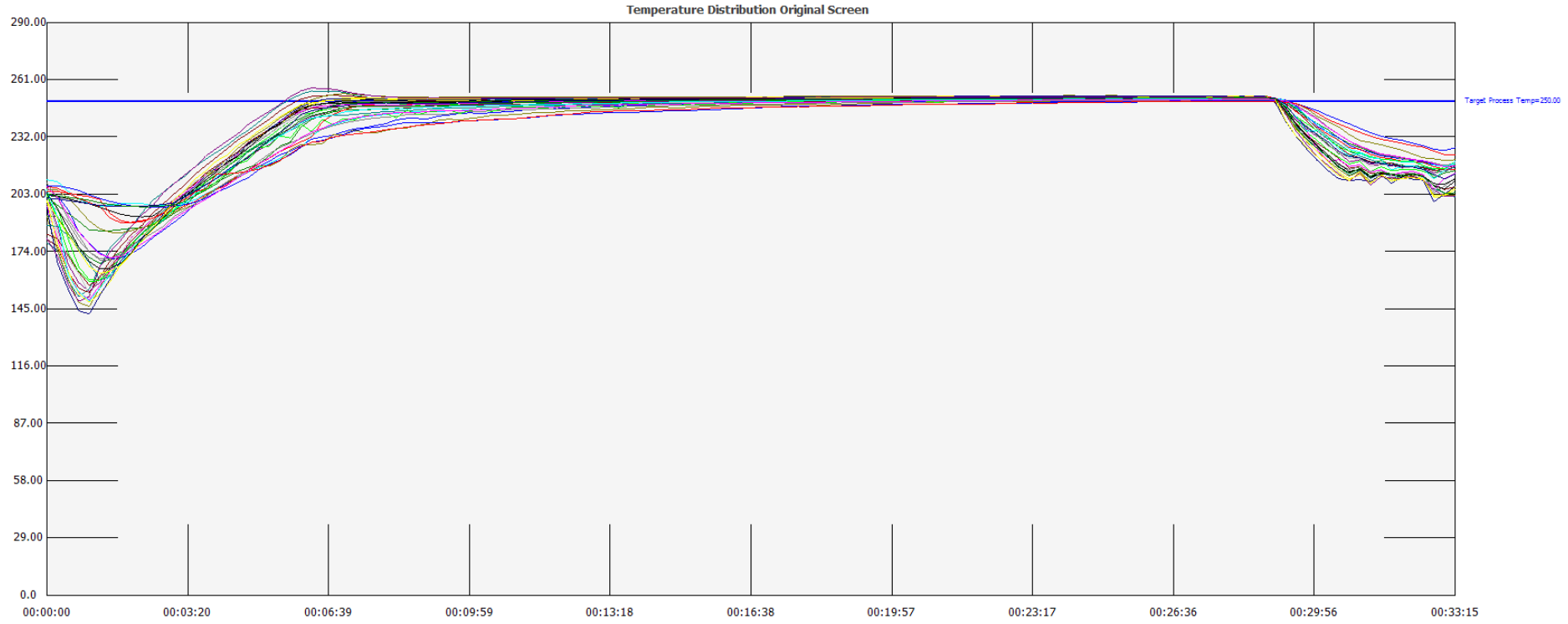
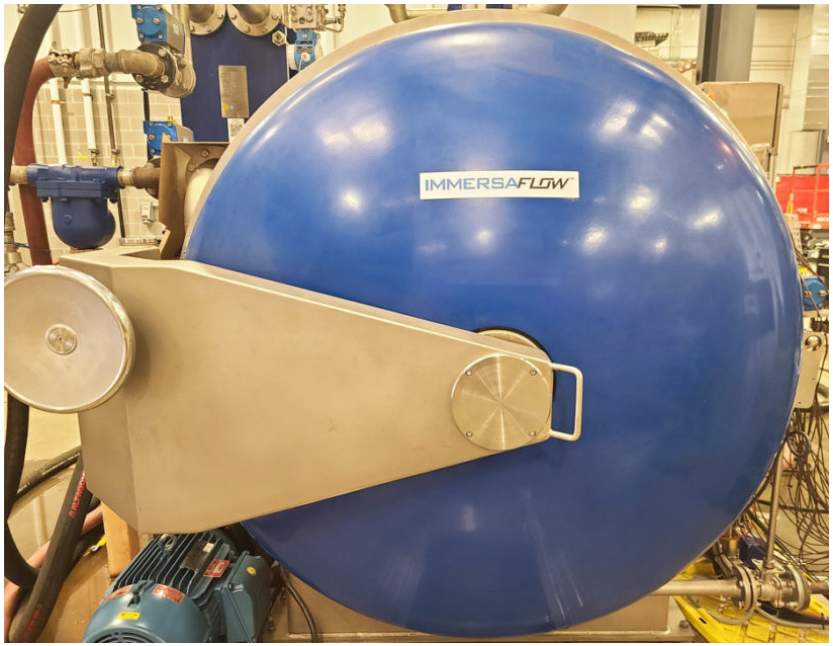
Steam/Water-Spray Test Results



Conclusions

- Rapid CUT
- Uniform TD
  - Greater Control of Product Quality
- Potential for Increased Throughput
- Reduced Energy Usage



Much Appreciation

- Stock America
- TechniCAL
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  - Dr. Sneh Bangar
  - Simoneth Jimenez
  - Charlie Weaver
  - Avery Mustar
  - Cayden Gates

Questions?

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