Full-Scale Hydrogen Mitigation Installation & Testing at Nevada Solar One

National Renewable Energy Laboratory
Acciona Solar Power, Inc.

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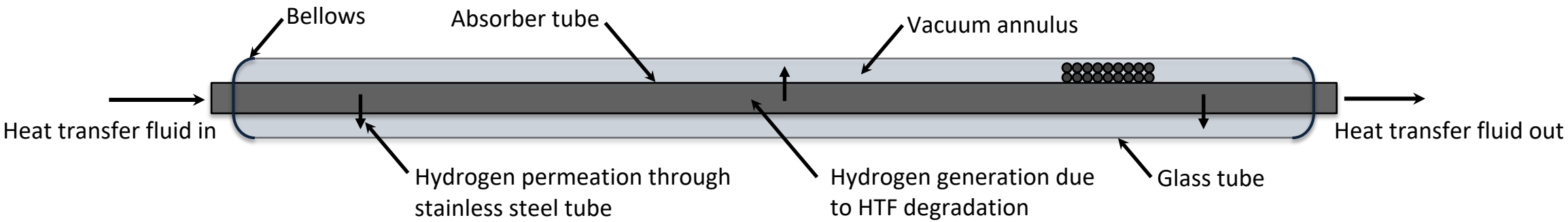
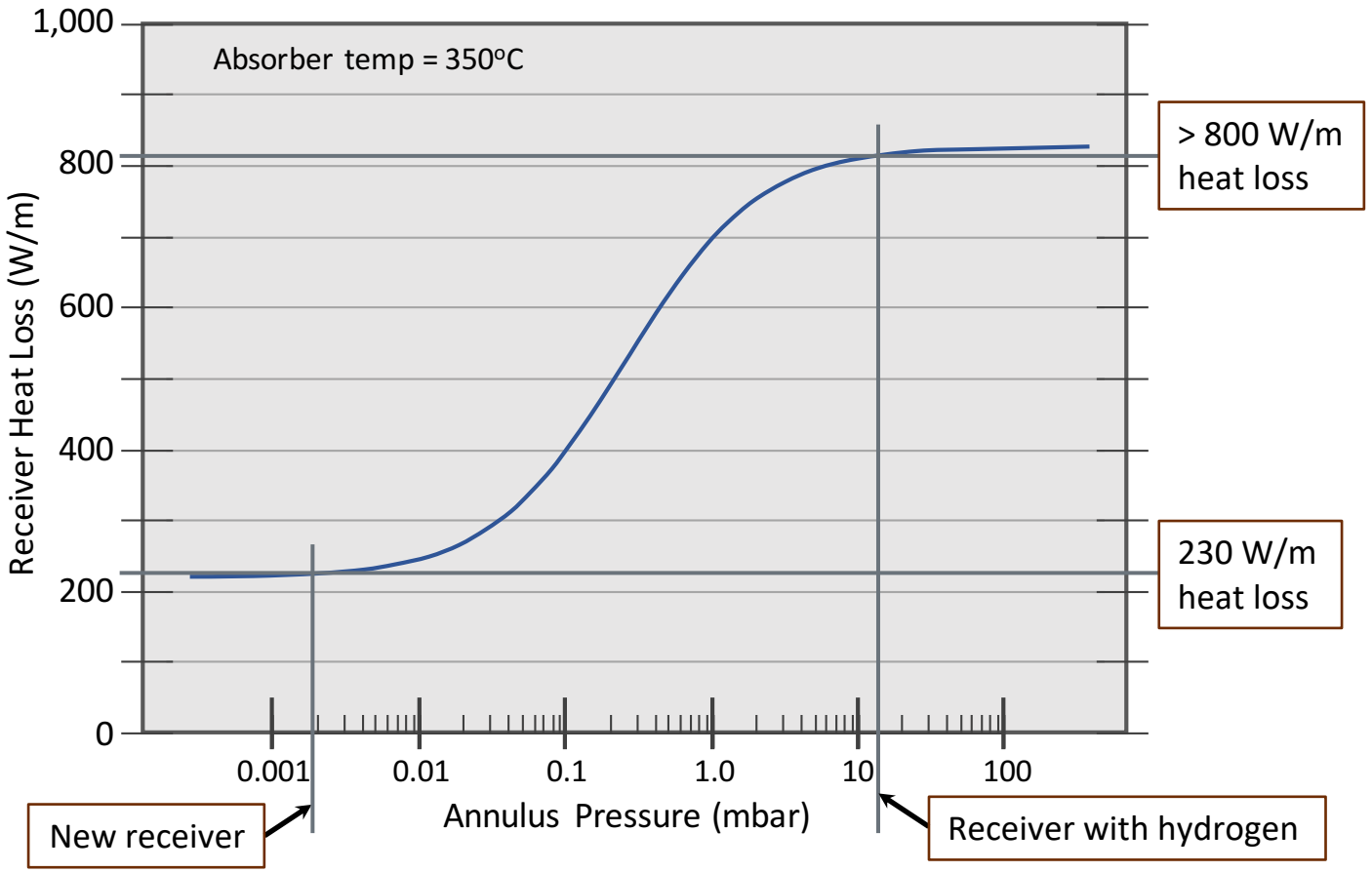
Project Challenge

Heat transfer fluid breakdown generates hydrogen buildup in receivers



Project Challenge

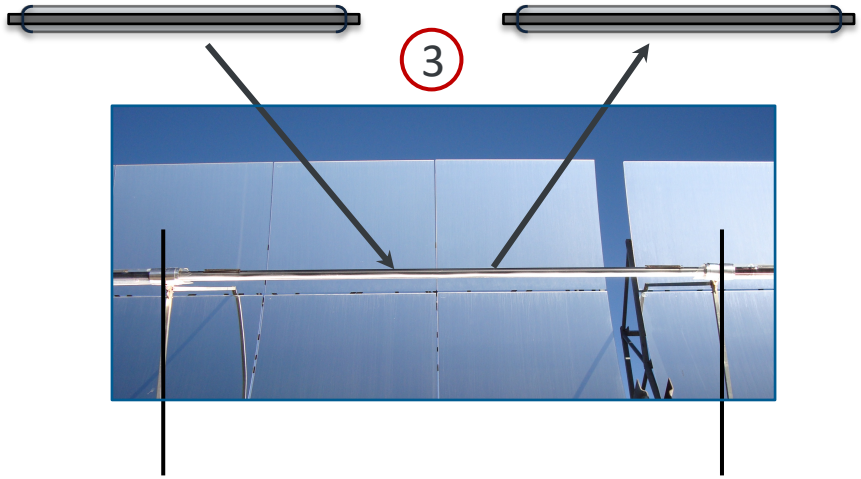
Receiver heat loss versus hydrogen pressure in annulus

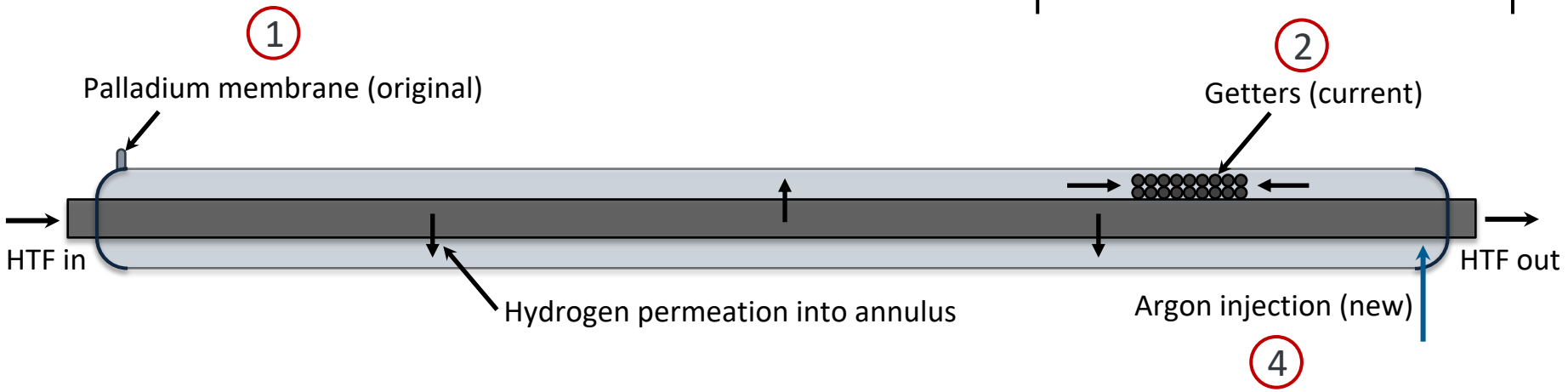


Nevada Solar One Collector Field

Previous & Current Solutions

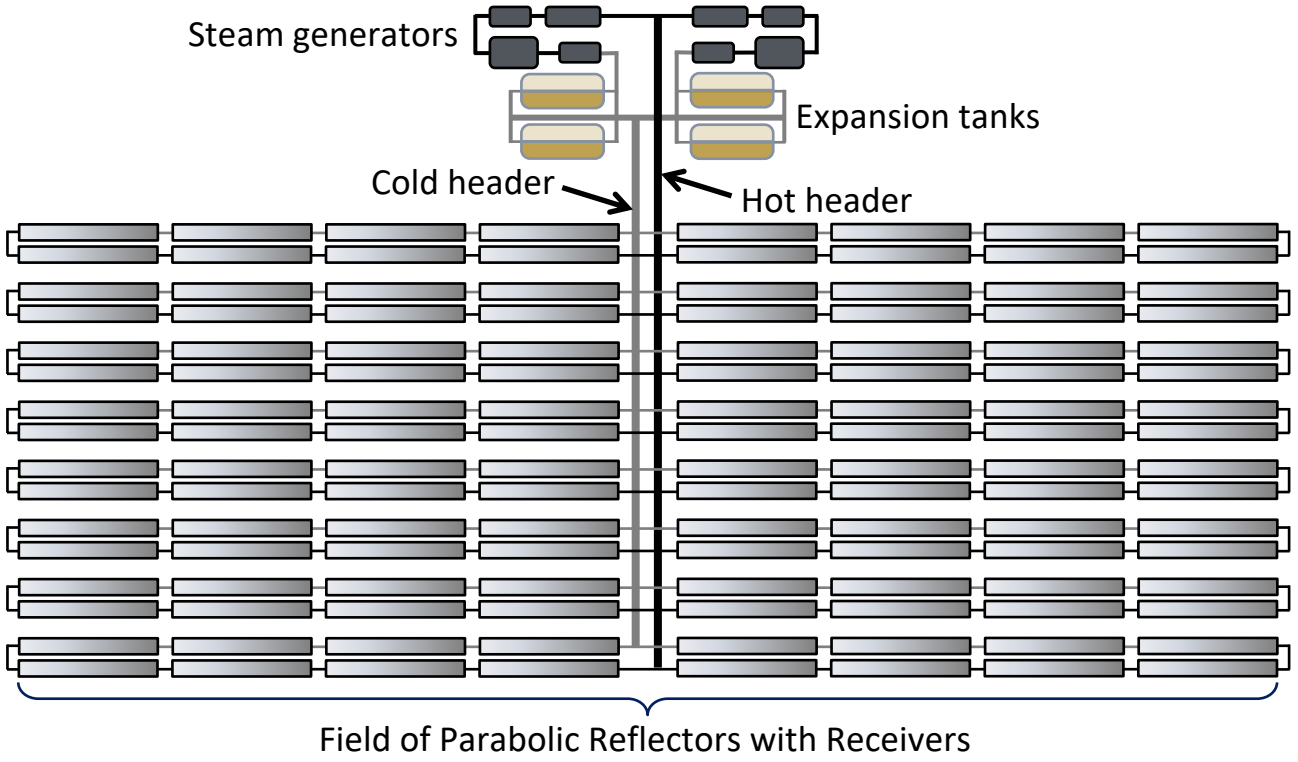
1. Palladium membrane (original)
2. Getters (current)
3. Receiver replacement (current)
4. Argon injection (new)

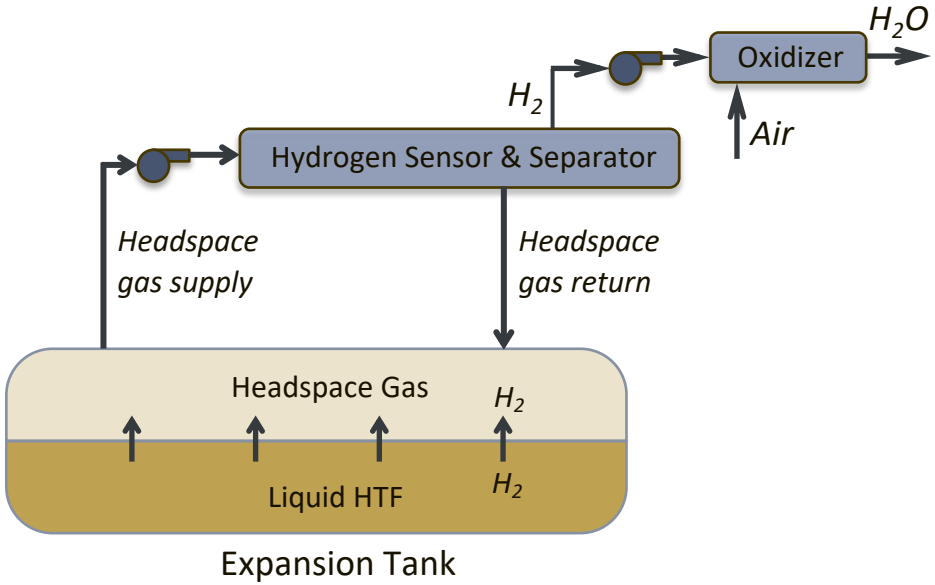




Mitigation Process Approach

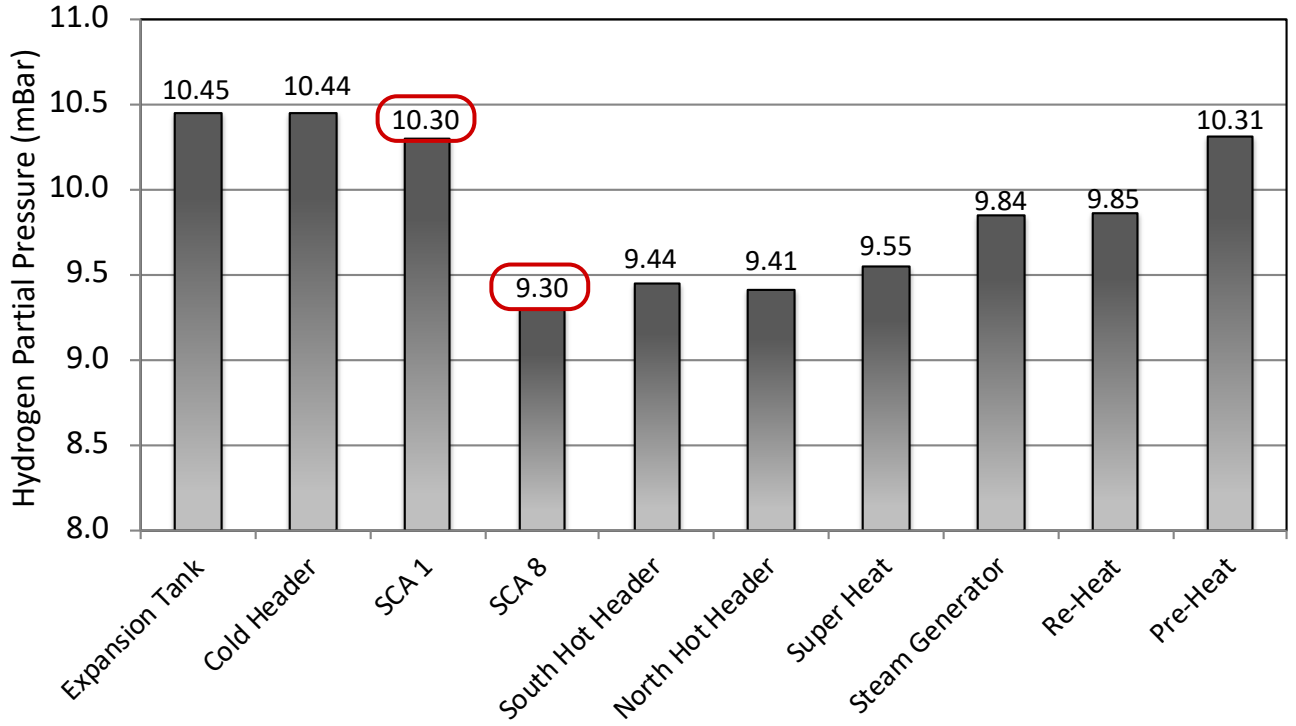
Measure & extract hydrogen from the expansion tanks



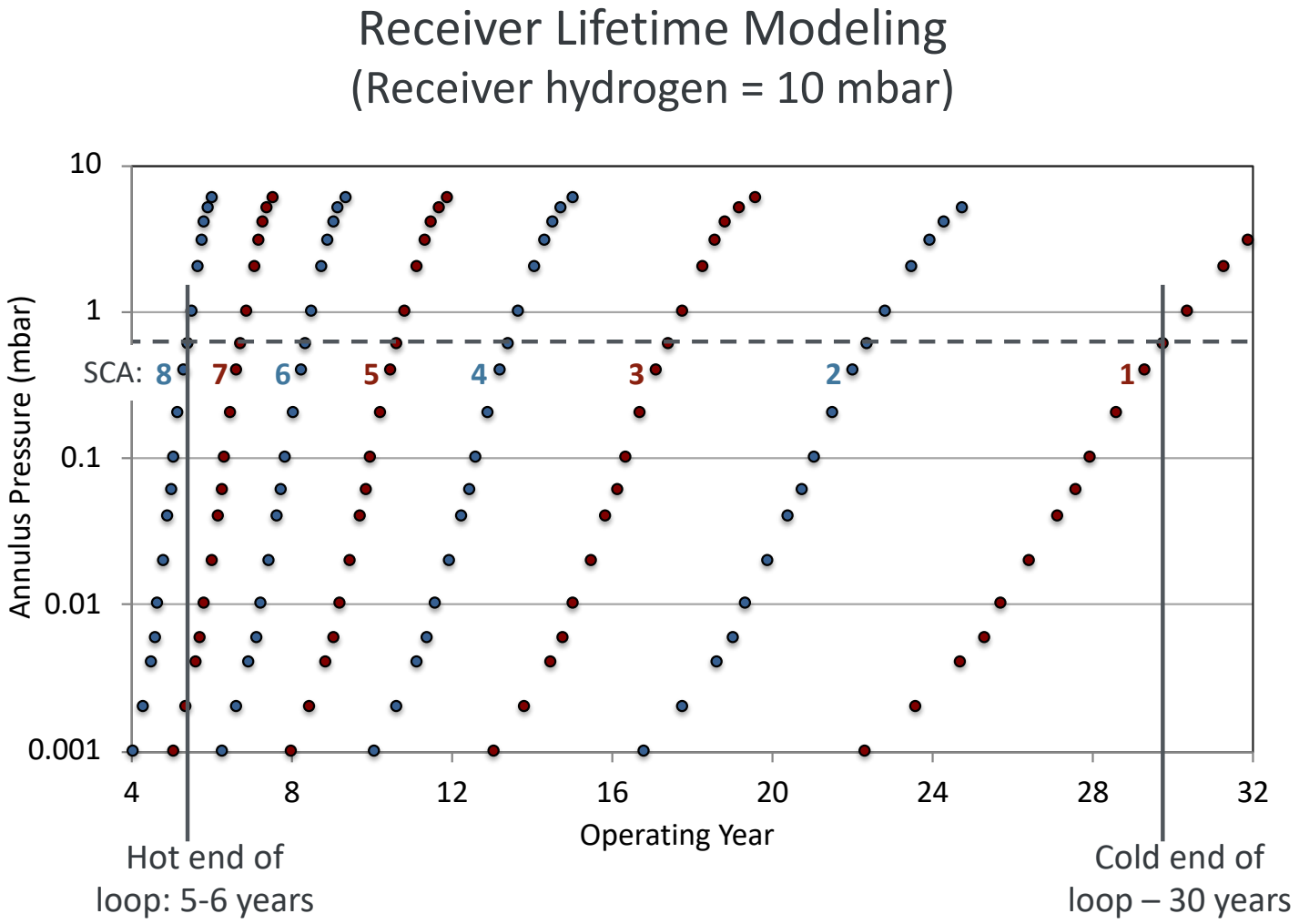


Mitigation Process Approach

Generation & Transport Modeling
(no hydrogen extraction)

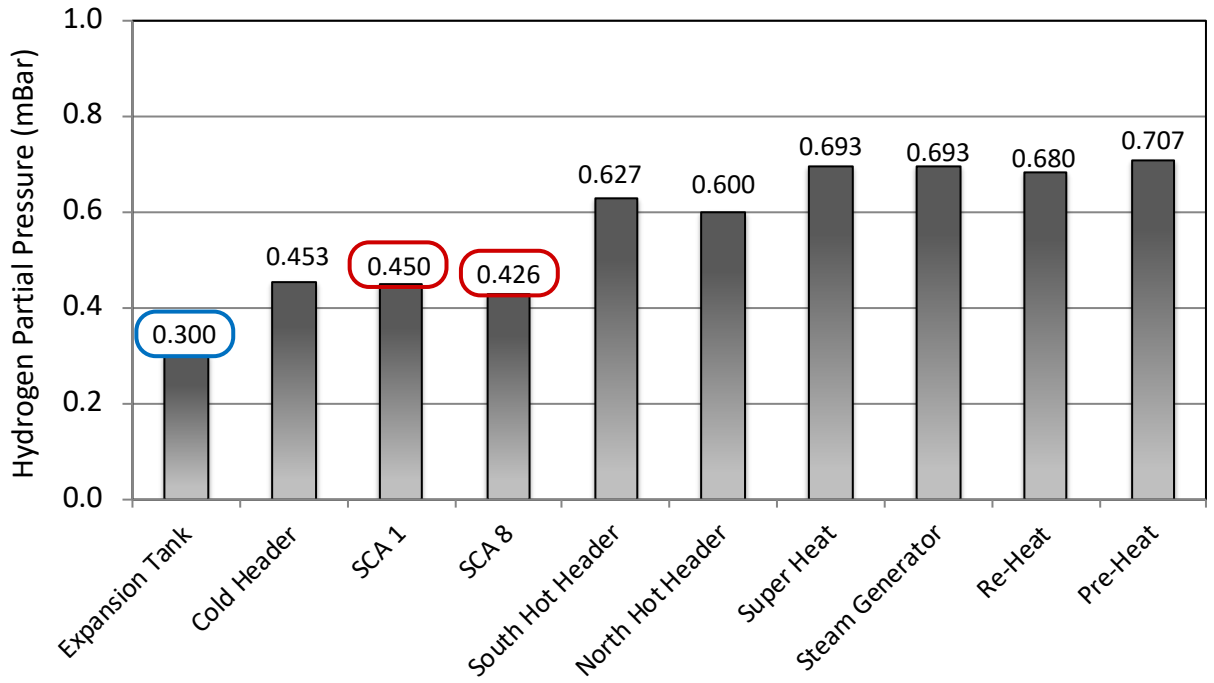


Mitigation Process Approach

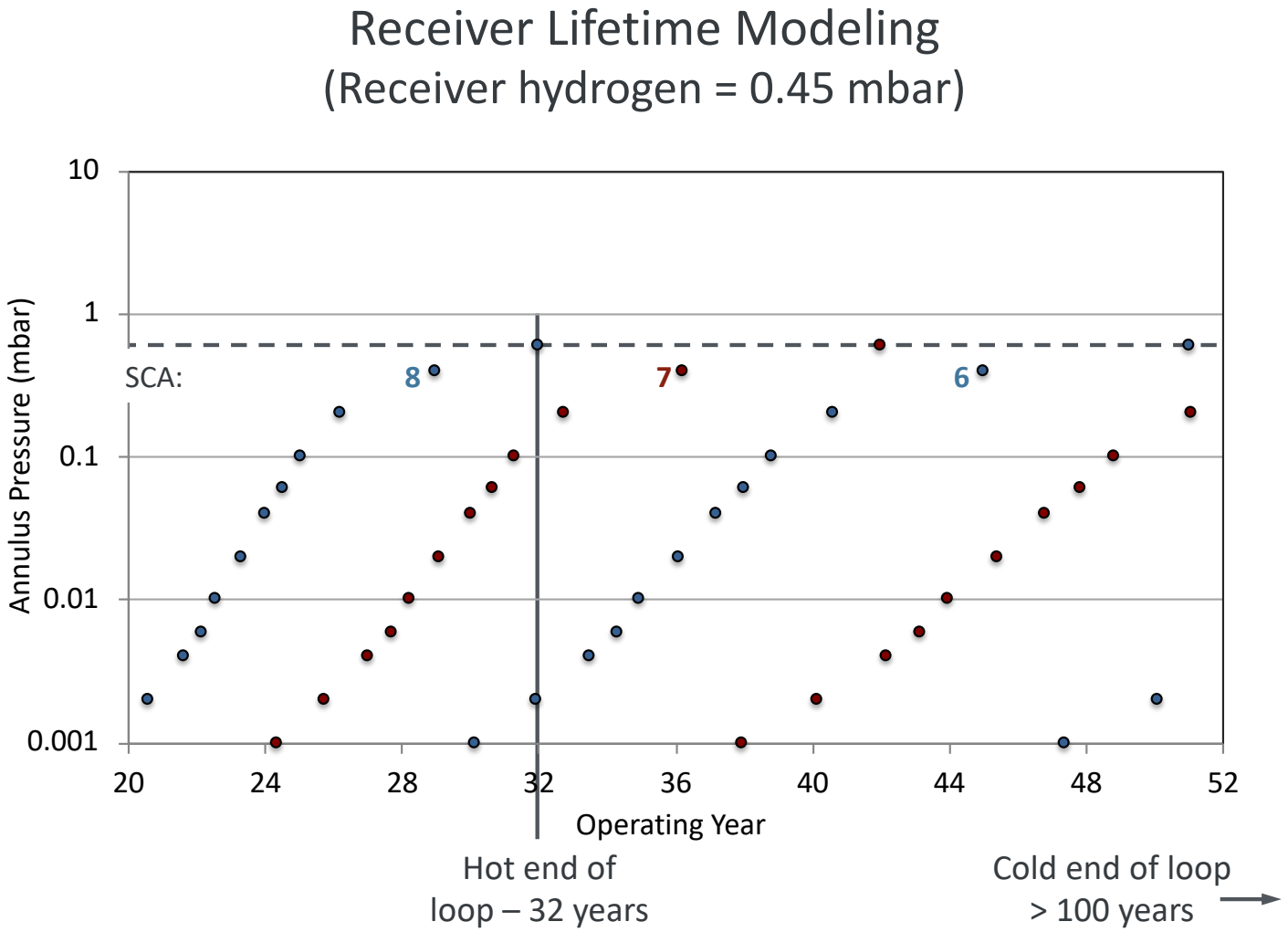


Mitigation Process Approach

Generation & Transport Modeling
(with hydrogen extraction)

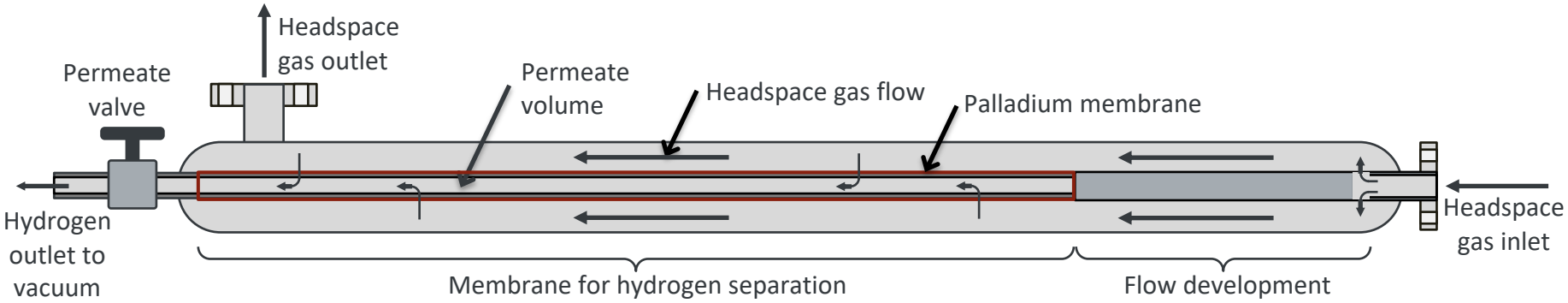


Mitigation Process Approach



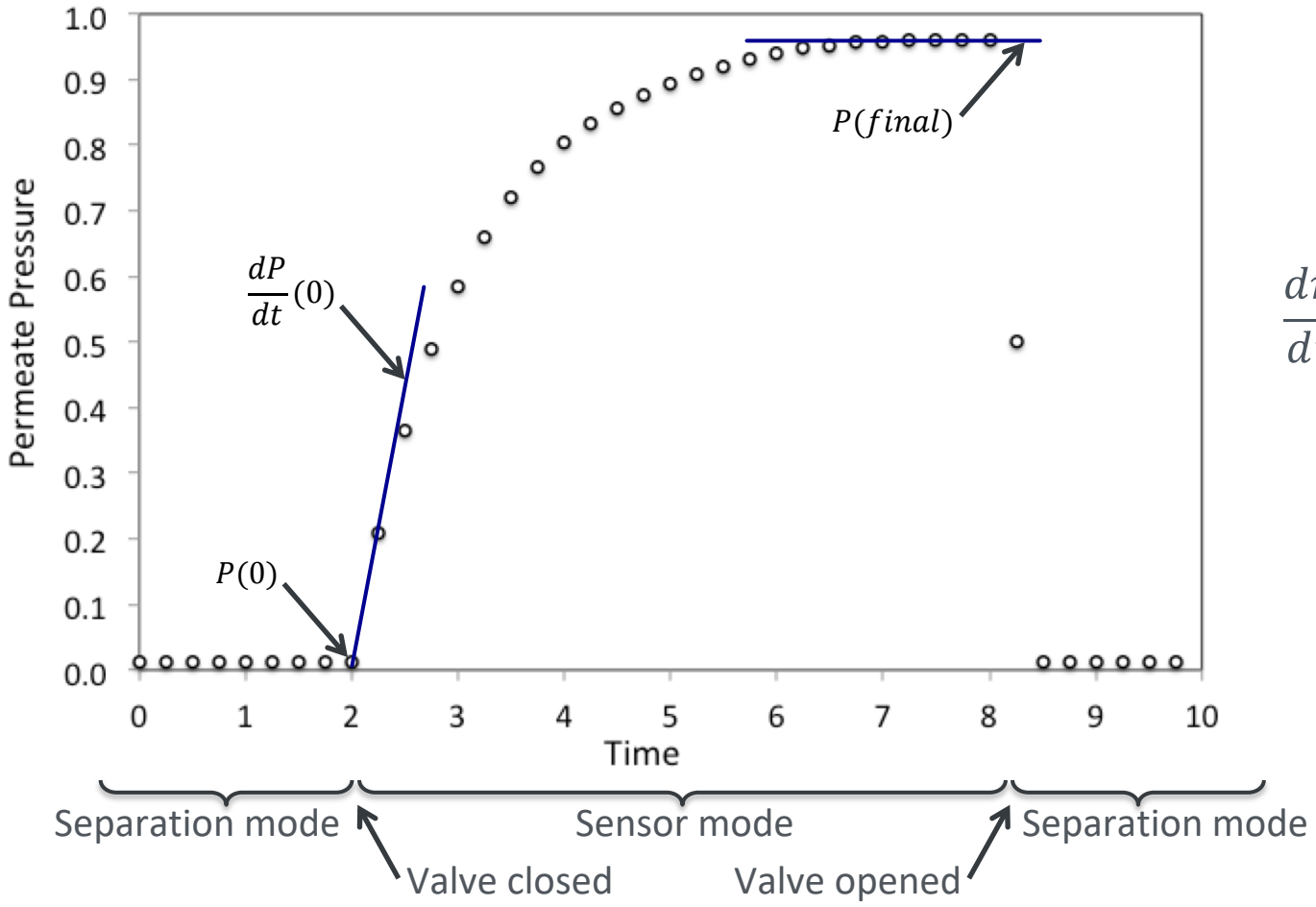
Mitigation Process Approach

Integrated Sensor/Separation Module Design



Mitigation Process Approach

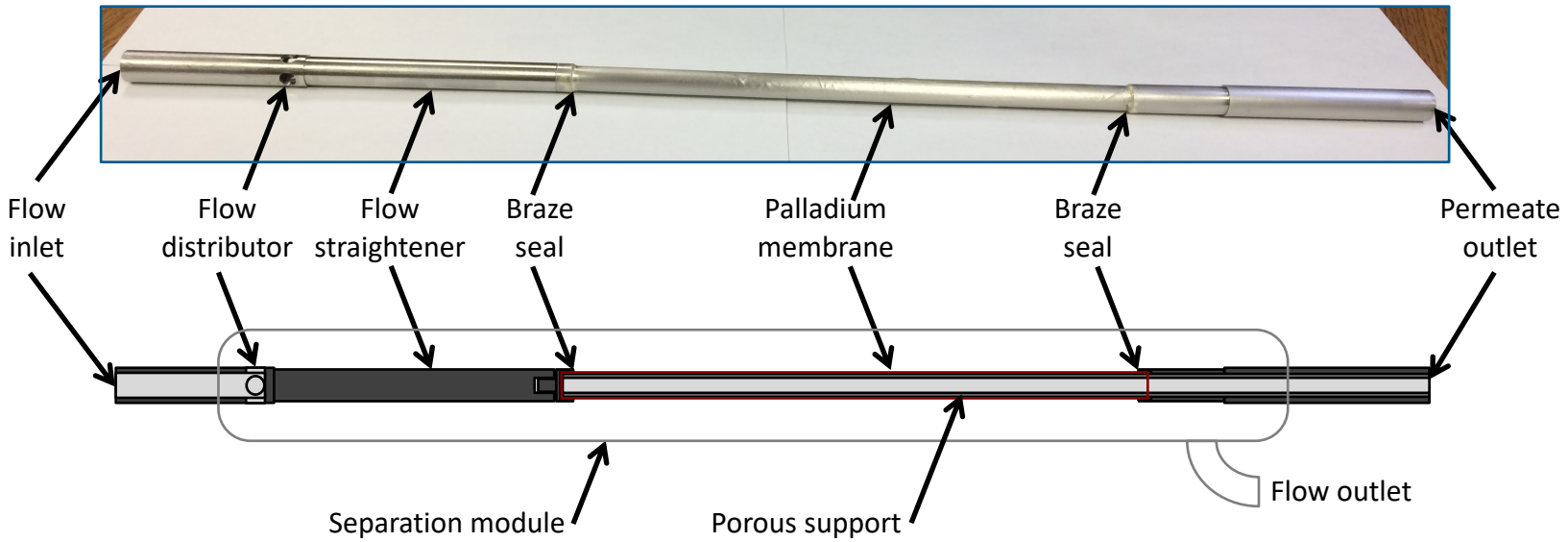
Integrated Sensor/Separation Module Operating Modes

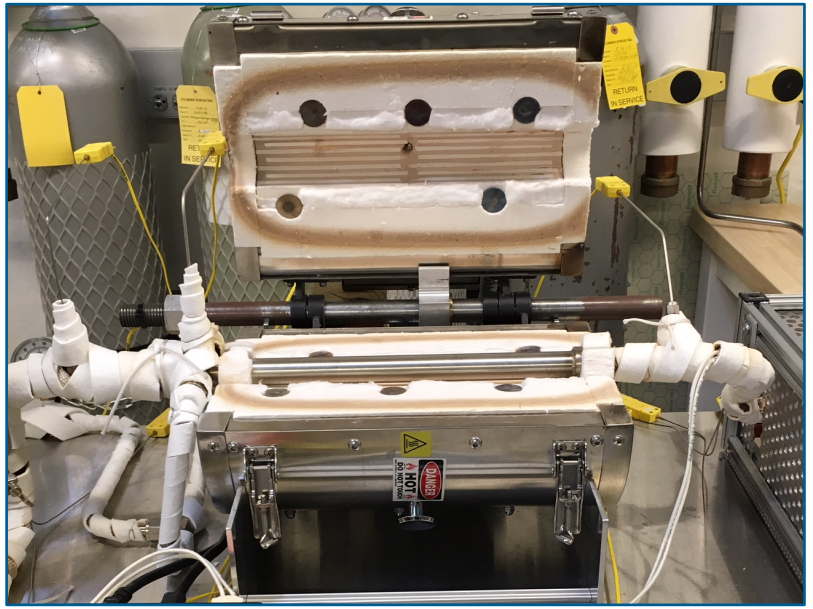


$$\frac{dn}{dt}(0) = \frac{V_p}{RT_p}\frac{dP_p}{dt}(0)$$

Mitigation Process Approach

Integrated Sensor/Separation Module Testing



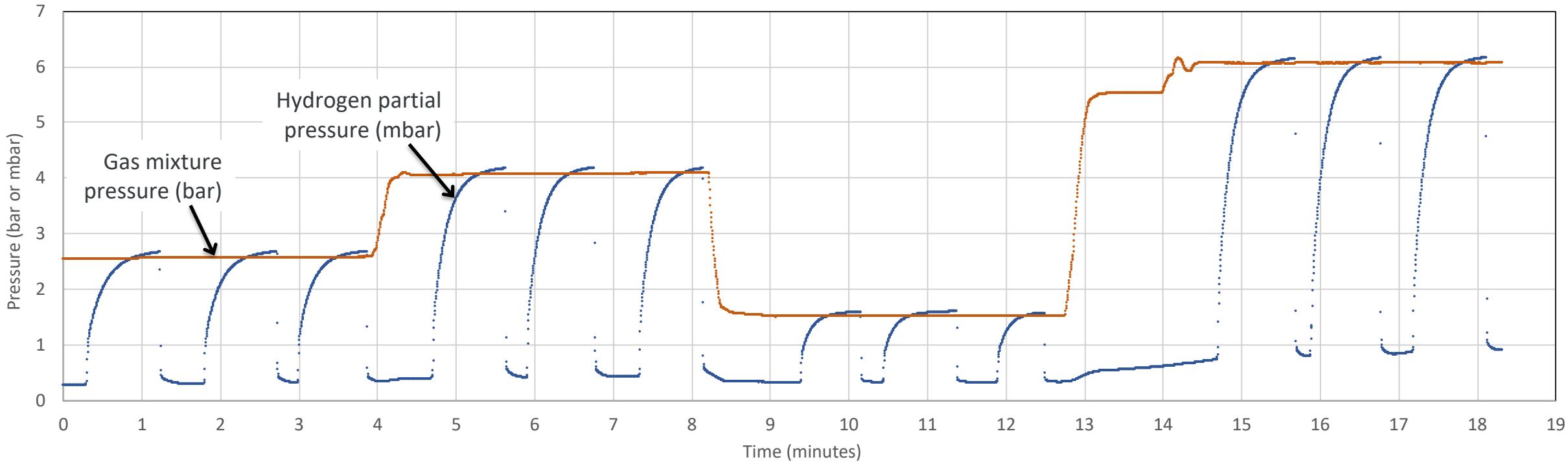


Mitigation Process Approach

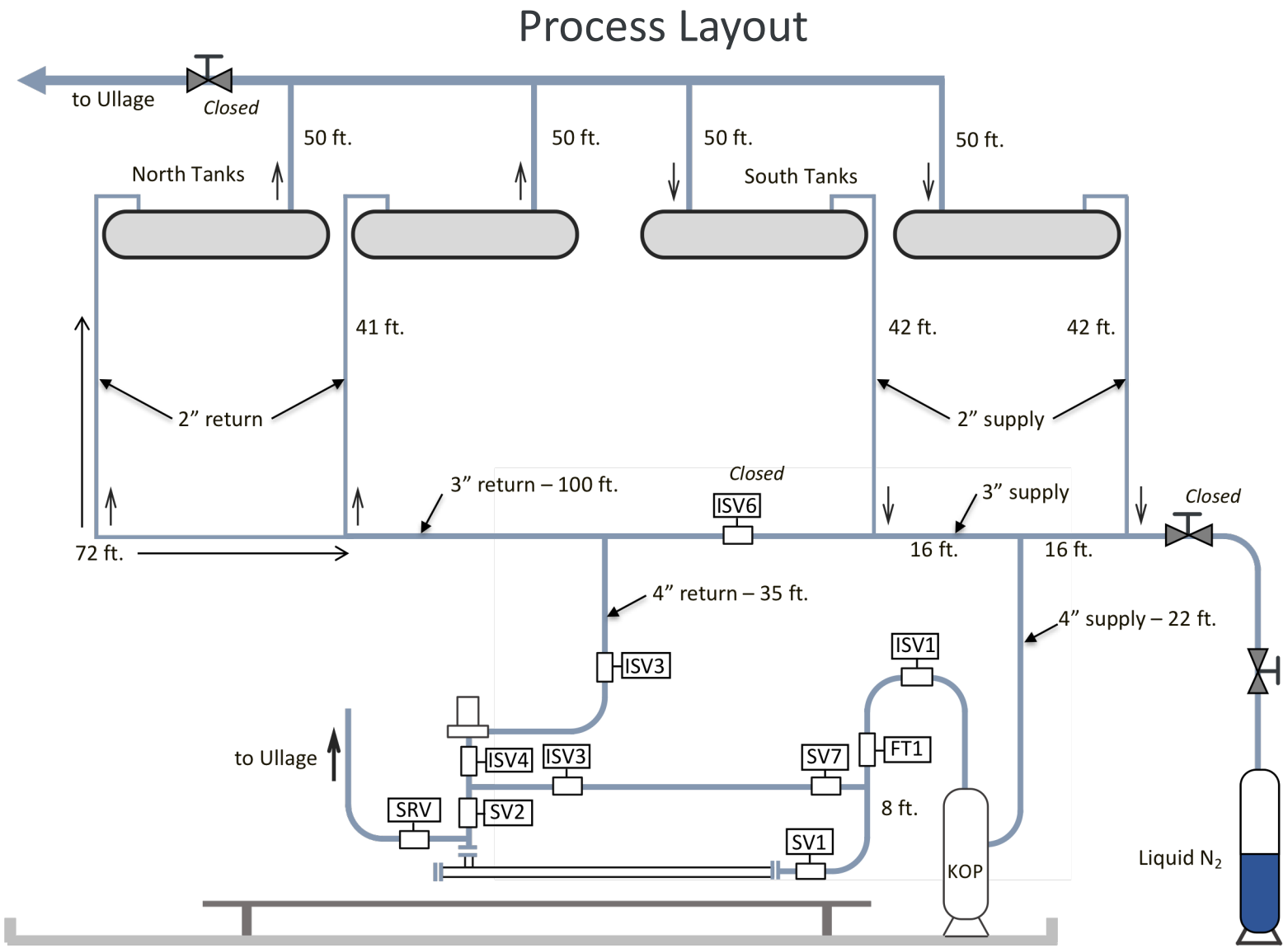
Integrated Sensor/Separation Module Results

- *Accuracy for integrated module is +/-10%.*
- *Real-time measurement takes 1 minute*

Hydrogen concentration = 0.1% in gas mixture



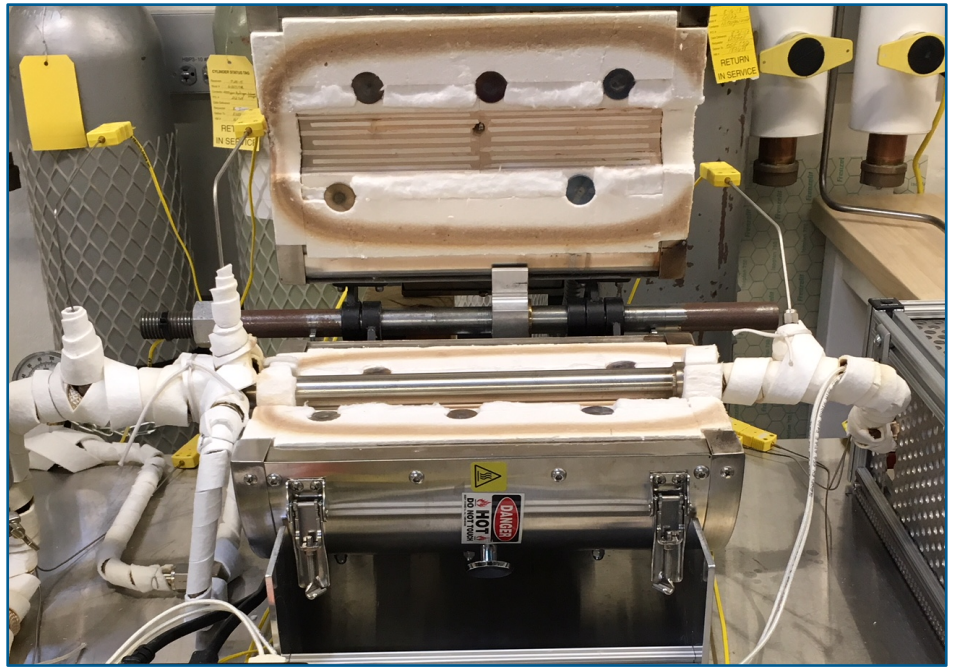
Installation at Nevada Solar One



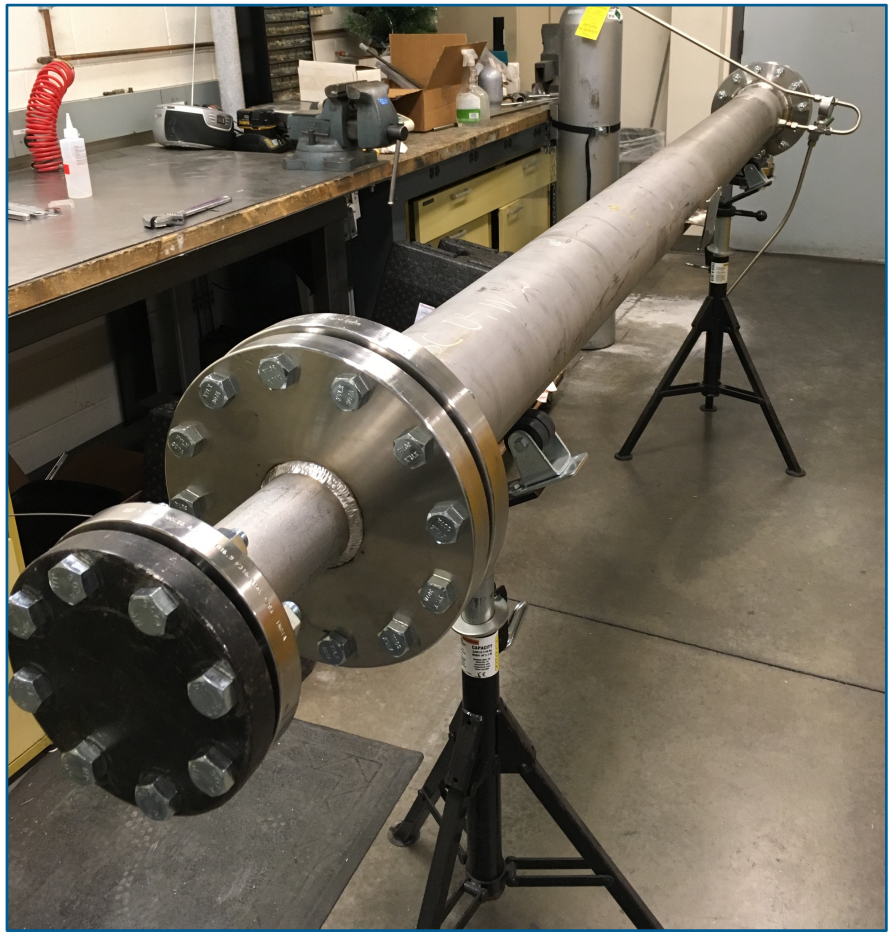
Installation at Nevada Solar One

Process Separation Module

Laboratory Module



NSO Module



Project Impact

Consequences for Parabolic Trough Power Plants Operating Worldwide

- Decreased thermal efficiency reduces electricity output by up to 15%.
- 70 power plants operating worldwide have total generating capacity of 5 GW.
- A 15% thermal efficiency loss corresponds to 750 MW of lost power generating capacity.
- This lost capacity equates to revenue loss of about $200 million per year for these 70 power plants.