FPOG Stakeholder Engagement Meeting – Fire Protection Engineering Evaluation (FPEE) Research Update

Flexible Plant Operations and Generation (FPOG)

March 19, 2025

0925 -0940 MST

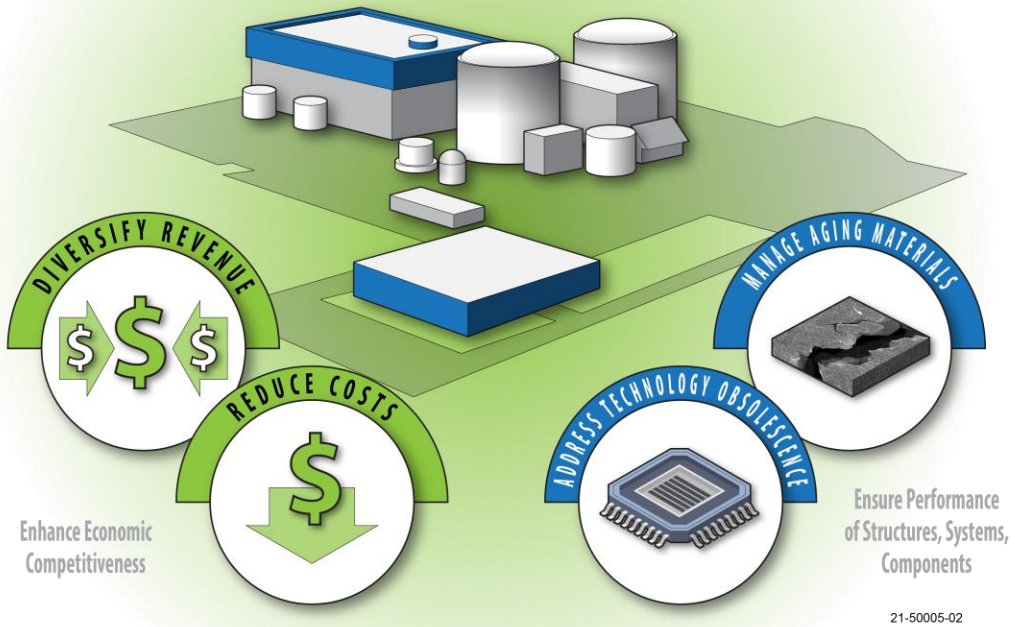
LWRS Project Lead – Jeff Brown

LWRS Pathway Advisor – Jack Cadogan

Meeting Purpose and Objectives

Purpose: In-Process Research Update

- Nuclear-integrated Hydrogen—Code and Licensing Separation Distance Considerations (INL_RPT-24-80476) is under planned revision to:
  - Provide code guidance on utility evaluation of separation distances between co-located high temp electrolysis facilities (HTEF) and NPP SSC's.
  - Obtain expert fire protection engineering review of original code and technical R0 report bases (Jensen Hughes)



Assumed Nuclear Integrated Hydrogen Plant Layout

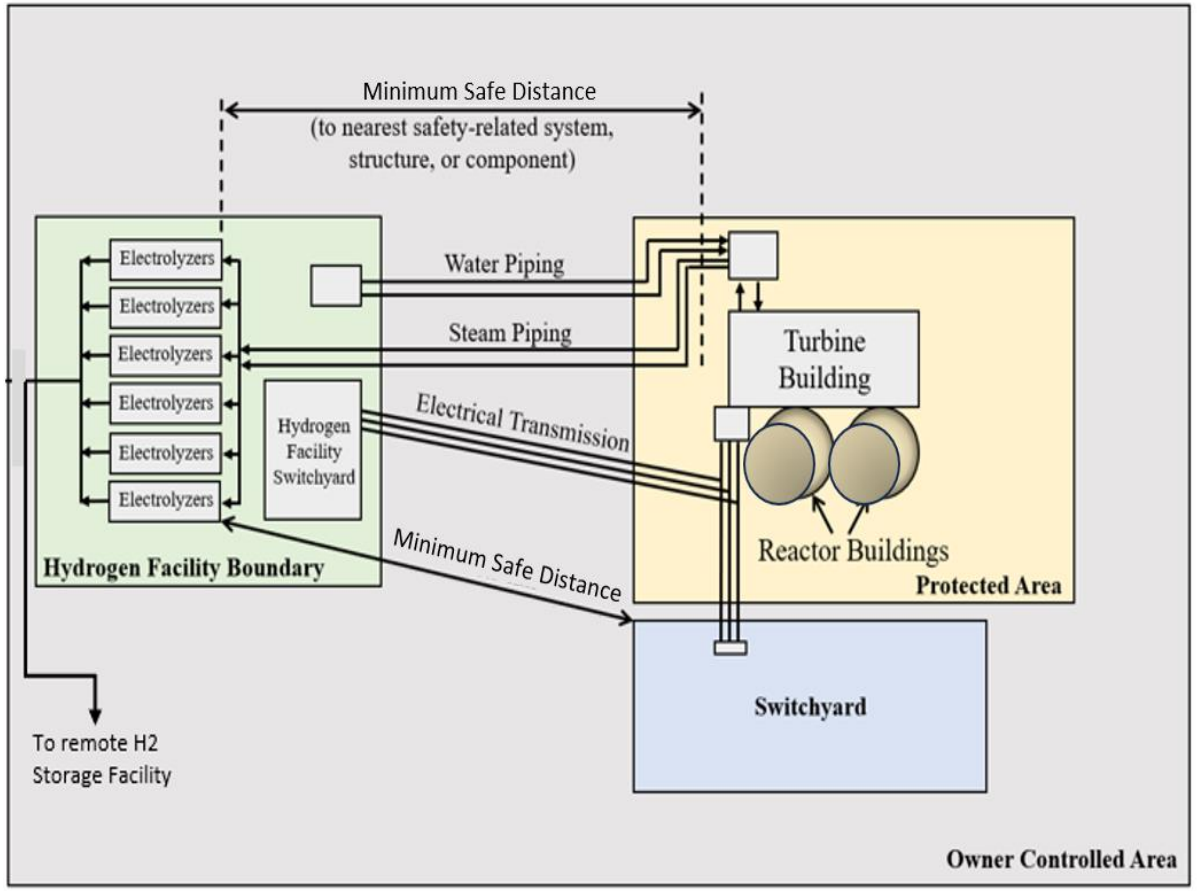
Move this slide to Kurt

Reference Nuclear Plant

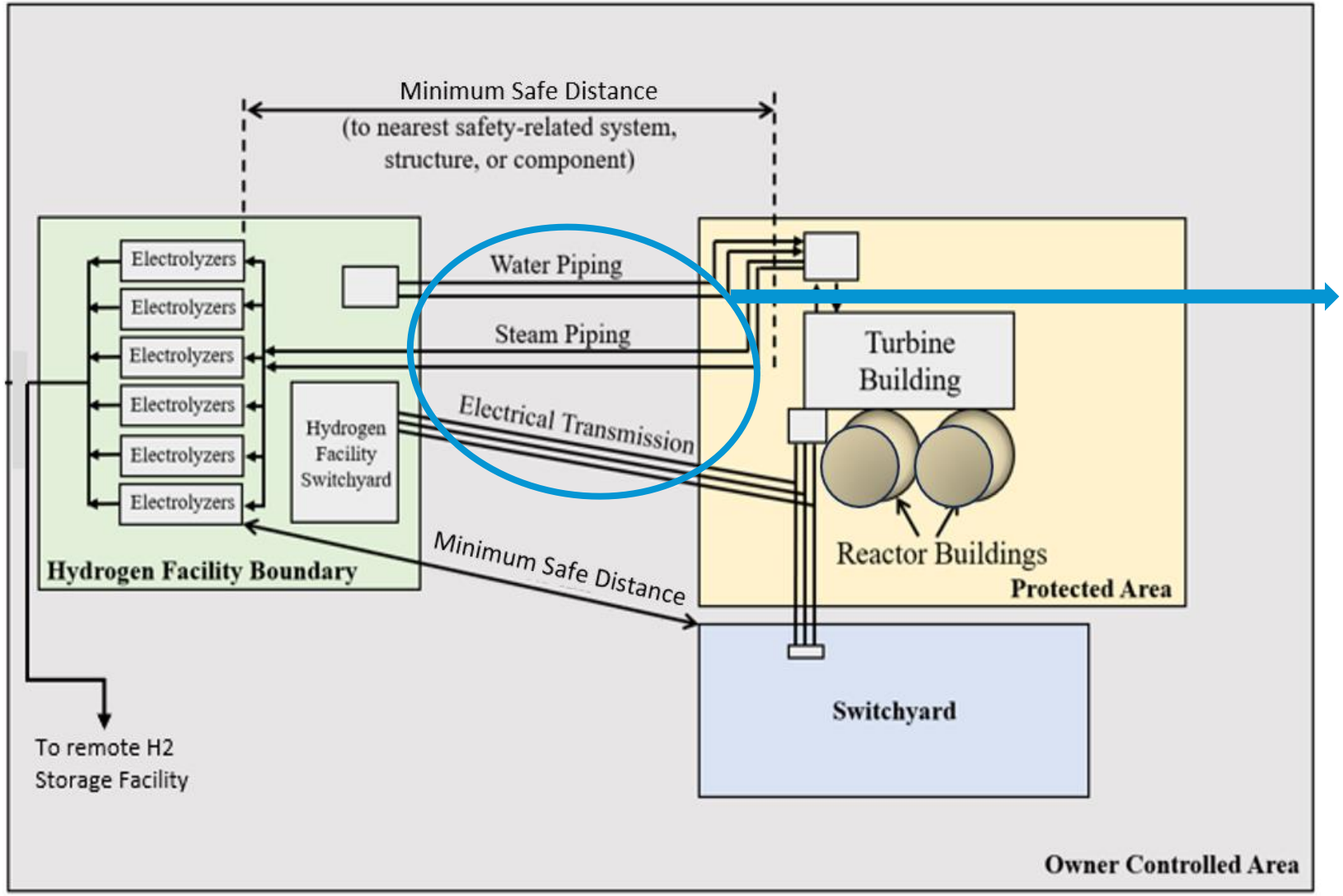
- Westinghouse 4-loop PWR
  - 1200MW$_e$ / 3,700MW$_{th}$ / SWYD: 345kV
  - Typical for 1/3 of operating US NPP Units
- New Hydrogen Steam/Water Supply
- New Behind the Meter Electric

High Temp Electrolysis (HTE) Facility

- 500MW$_{DC}$
- Thermal Load – 100MW$_{th}$
- Hydrogen Production
  - 300+ tons/day @ 1500 psi

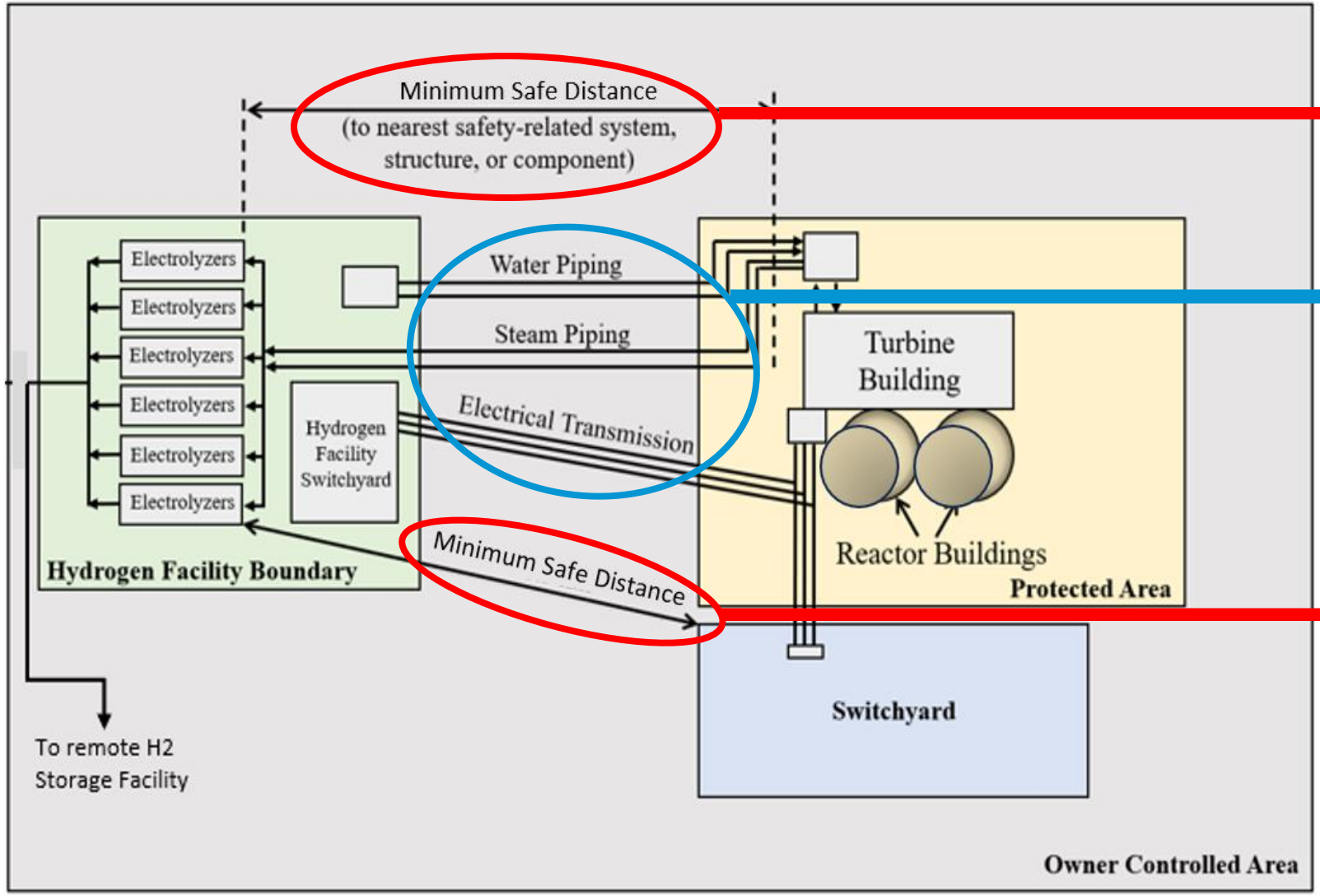


Plant Interfacing Mods -Licensee Evaluation Approach



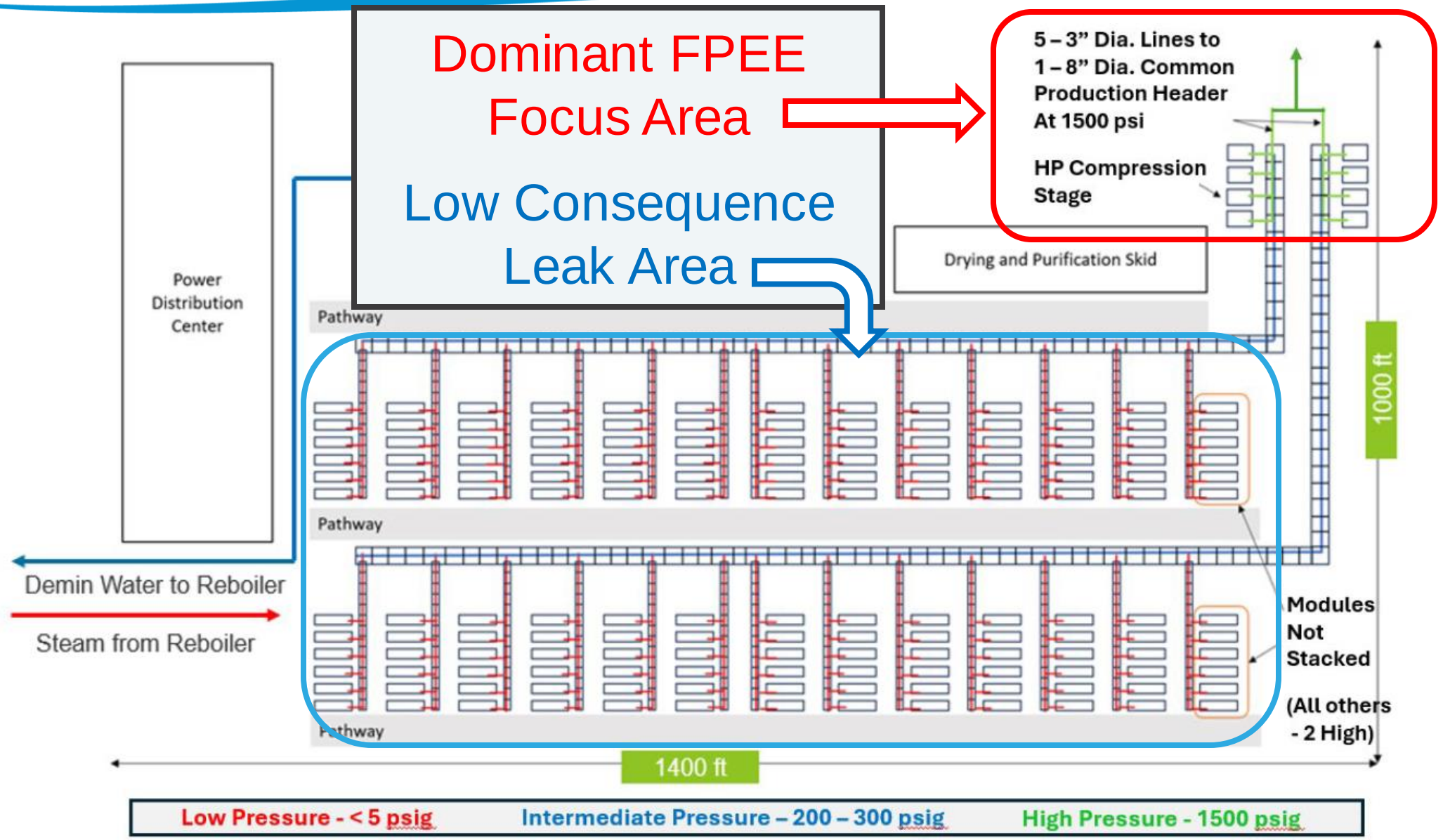
Mechanical and Electrical Interfaces Evaluated under 50.59

Comparative HTEF Licensee Evaluation Approaches



Mechanical and Electrical Interfaces Evaluated under 50.59

Hydrogen Fire and Detonation Separation Evaluated under FPEE


Dominant FPEE Focus Area
Low Consequence Leak Area
5 – 3" Dia. Lines to 1 – 8" Dia. Common Production Header At 1500 psi
HP Compression Stage
Drying and Purification Skid
Power Distribution Center
Pathway
Pathway
Pathway
1000 ft
Demin Water to Reboiler
Steam from Reboiler
Modules Not Stacked
(All others - 2 High)
1400 ft
Low Pressure - < 5 psig
Intermediate Pressure – 200 – 300 psig
High Pressure - 1500 psig

Preliminarily Confirmed Research Conclusions

Nuclear-integrated Hydrogen—Code and Licensing Separation Distance Considerations (INL_RPT-24-80476)

- NFPA 55 & NFPA 2 code-based evaluation may be used for fire protection program evaluation to determine NPP-to-HTEF separation distances
- Applies under both 10 CFR 50.48(a) and 10 CFR 50.48(c) plant licensing bases

Preliminarily Confirmed Research Conclusions

Nuclear-integrated Hydrogen—Code and Licensing Separation Distance Considerations (INL_RPT-24-80476)

- Alternate non-code elective approaches to separation-distance, as described in previous Idaho National Laboratory research reports may also be conservatively applied.

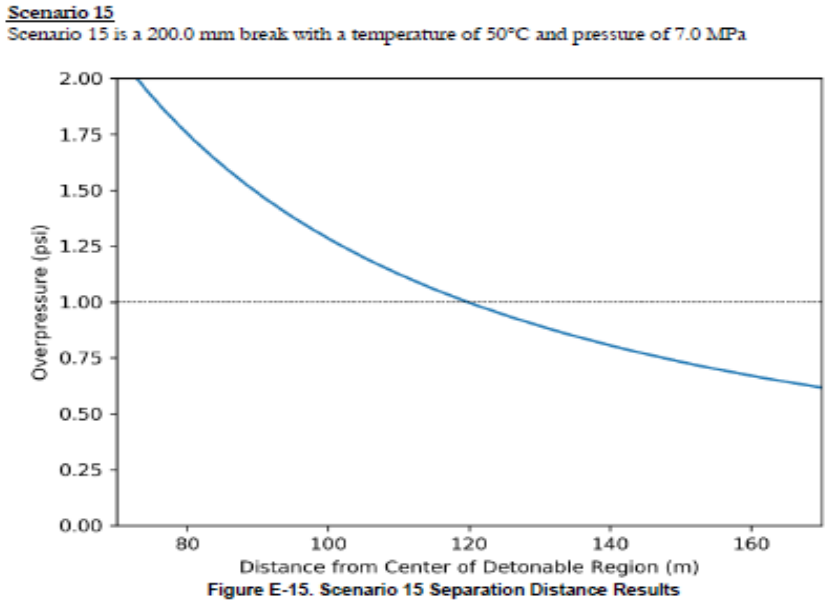
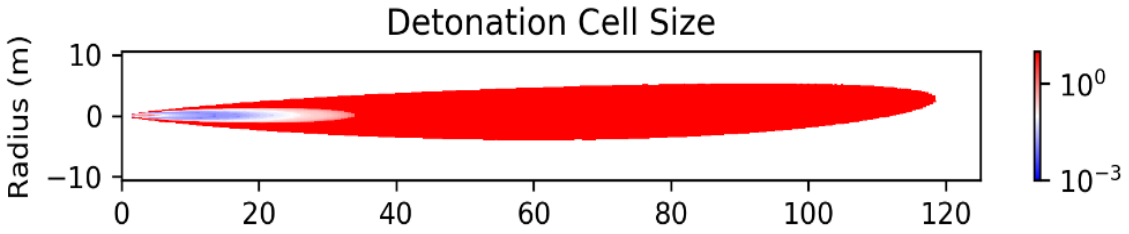
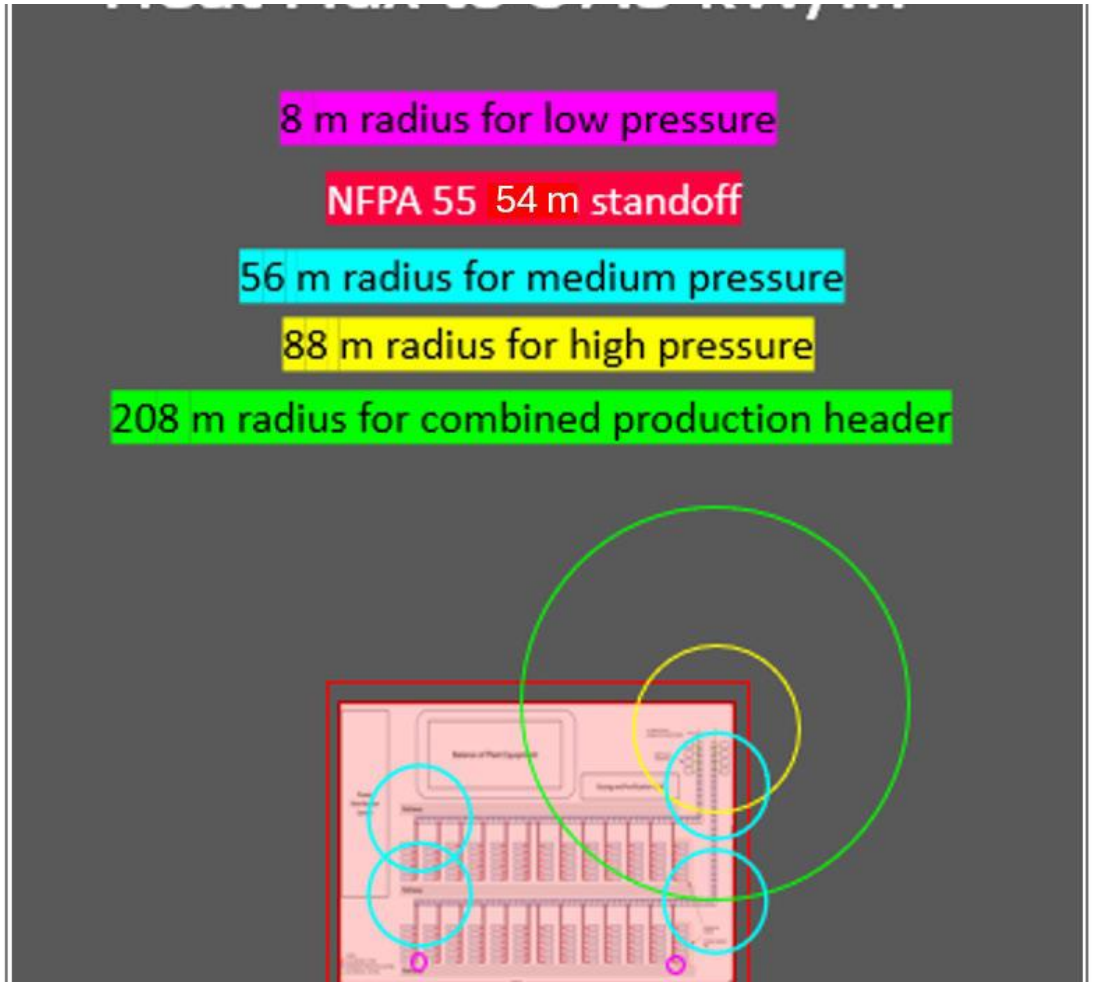


Figure E-15. Scenario 15 Separation Distance Results



NFPA 55 vs HyRAM+ Heat Flux Separation



	HyRAM+ (@ 37.5 kw/m^2)	NFPA 55 (Group 3 Exposure)
Leak Size Assumed	76-mm-diameter orifice Case 6 (3-in. pipe)	7.6 mm diameter orifice
Calculated Separation	88 m	21 meters
Leak Size Assumed	203 mm diameter orifice Case 7 (8-in. pipe)	20.3-mm-diameter orifice
Calculated Separation	208 m	54 meters
Bounding Calculated Separation	208 m	54 meters

HyRAM+ heat flux cases run with assumed full pipe guillotine break vs. NFPA 55 assumed 1% diameter orifice leak.

Bauwens vs. TNT Equiv. O/P Separation

Bauwens

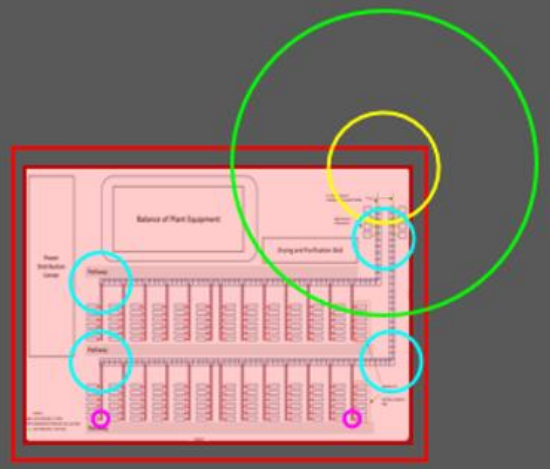
8 m radius for low pressure

NFPA 55 54 m standoff

34 m radius for medium pressure

61 m radius for high pressure

168 m radius for combined production header



TNT Equivalence

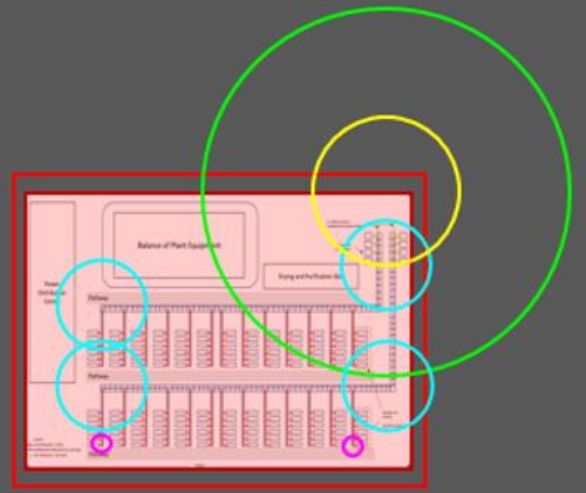
10 m radius for low pressure

NFPA 55 54 m standoff

49 m radius for medium pressure

81 m radius for high pressure

204 m radius for combined production header



Historical Hydrogen Design Bases at NPPs

- 10 CFR 50.48(a) and 10 CFR 50.48(c) fire protection regulatory frameworks support co-located compressed gaseous hydrogen for plant process use
- Safe NPP-to-H2 storage separation distances were historically assessed based on NFPA 55, or earlier NFPA 50A, flammable gas regulation rules, depending on plant license vintage
- NFPA 55 (and emerging H2-specific NFPA 2):
  - Are based on pressurized hydrogen system leakage manifesting in small leaks, rather than gross failures
  - Code approaches contain significant safety margins

LWRS LIGHT WATER REACTOR SUSTAINABILITY

Sustaining National Nuclear Assets

lwrs.inl.gov