HI-SMUR 140

Presentation to NRC
July 21, 2011

a generation ahead by design

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Agenda

- Introduction / Goal
- Holtec and the Holtec Team
- Design Overview
- SECY-10-0034 and other Licensing Issues
- Licensing Schedule
- Summary

Introduction / Goal

- HI-SMUR stands for Holtec Inherently Safe Modular Underground Reactor
- SMR, LLC is a subsidiary of Holtec International that is the developer of HI-SMUR
- First Meeting with NRC on November 3, 2010
  - Presentation of the principal performance goals
- Detailed design and analyses ongoing
  - Natural convection primary loop
  - Core design
  - Steam generators
  - Passive safety systems
- Goal of today's meeting
  - Present current design status
  - Discuss licensing issues
  - Discuss licensing schedule

One-Page Summary of Holtec International

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- 100% U.S. owned company. America's largest exporter of capital nuclear equipment.
- Customers in four continents: U.S.A., Mexico in North America; Brazil in South America; U.K., Switzerland, Spain, and Ukraine in Europe; China, Korea, Taiwan, and Japan in Asia.
- Over 80% of U.S. nuclear plants have Holtec-engineered systems in use.
- World leader in wet and dry storage of nuclear fuel.
- Excellent credit rating, no long-term debt.
- All manufacturing carried out in the United States.

Holtec as SMR Developer

- Significant experience and capabilities essential to nuclear plant design
  - ASME pressure vessels (Spent Fuel Transport and Storage Systems)
  - Large heat exchangers and steam generators
  - Extensive NRC Licensing Experience (71, 72, 50)
  - Safety Related Analyses
    - Criticality (e.g. fuel burnup)
    - Thermal (e.g. natural convection through fuel assemblies)
    - Structural (e.g. seismic analyses of underground systems)
    - Shielding
  - Manufacturing (Pittsburgh)
  - Operational Experience
  - All in-house
- Vertically integrated
  - Design
  - Licensing
  - Procurement and Manufacturing
  - Installation
- Competent partners to complement the in-house capabilities

Holtec Team for HI-SMUR

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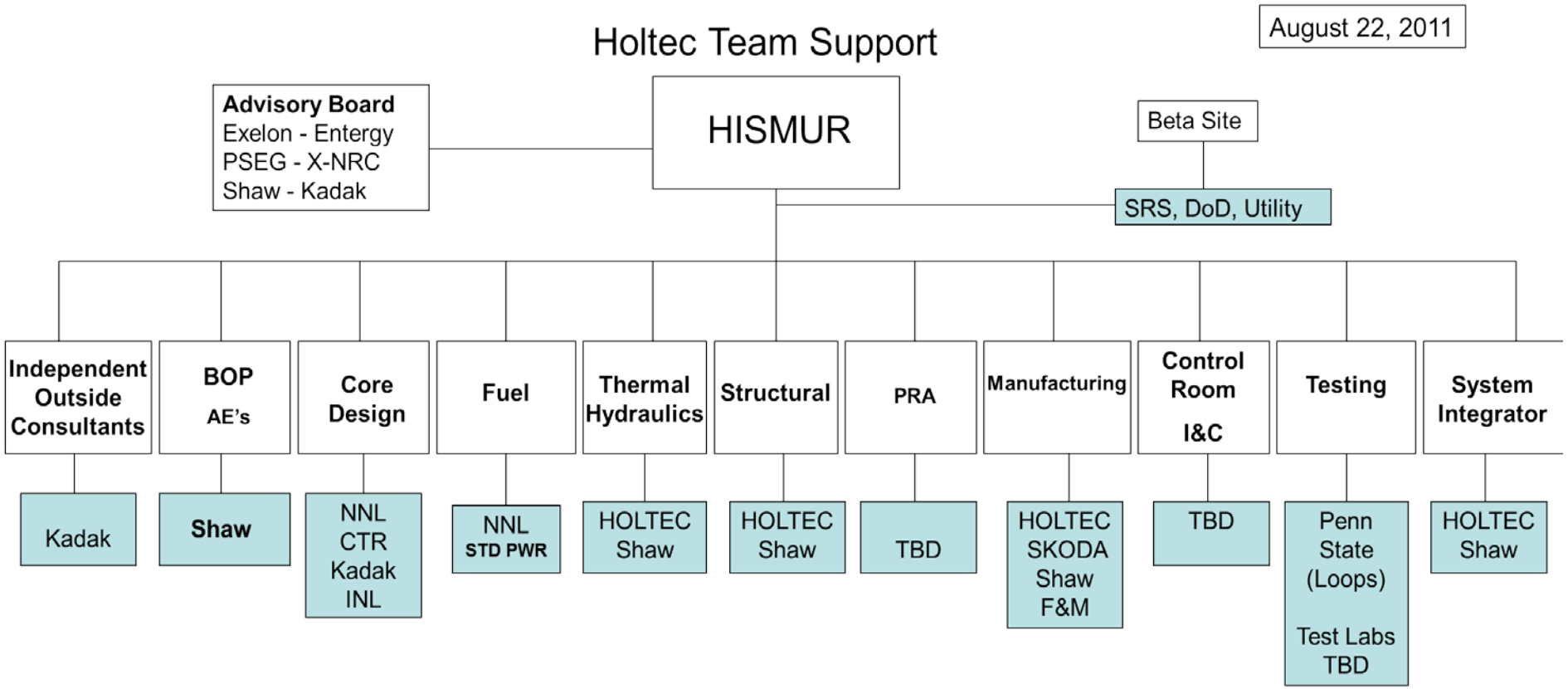

NNL-National Nuclear Laboratory, United Kingdom, old BNFL, made fuel for Sizewell B
CTR-CT Rombaugh, expert on reactor incore detectors (Colorado)Fauske Associates, experts in thermal hydraulics and Probabilistic Risk Analysis (IL)
Shaw- Shaw Group Inc, Power Nuclear

SKODA – Czech Republic manufacturer of incore detectors and control rod drives
Penn State – coolant loops and some nuclear support
Kadak – Andy Kadak (CT)
INL – DOE Lab

Holtec Team for HI-SMUR

- The Shaw Group
  - Conceptual Design Contract, May 2011
- Advisory Board
  - John Herron (Entergy)
  - Andrew Kadak (Previously Yankee Atomic)
  - William Lewis (PSEG)
  - Mike Pacilio (Exelon)
  - Loren Plisco (Previously NRC)
- National Nuclear Laboratory (UK, previously BNFL)
  - Core Design and Fuel Performance reports, July 2011

HI-SMUR 140 Design Overview

- Performance
  - 469 MW Thermal
  - 145 MW Electrical
- Primary Loop
  - Natural Convection
  - 2250 psi
  - RV: 120’ high, 8’ ID, 9’ OD
- Core Design
  - 32 assemblies (exploring 37 assemblies option)
  - Standard 17x17 design, < 5 wt% Enrichment
  - No soluble boron
- SGs
  - Horizontal, integrally connected to RV
  - Two stages with superheaters

Underground structure designed to withstand significant seismic loads

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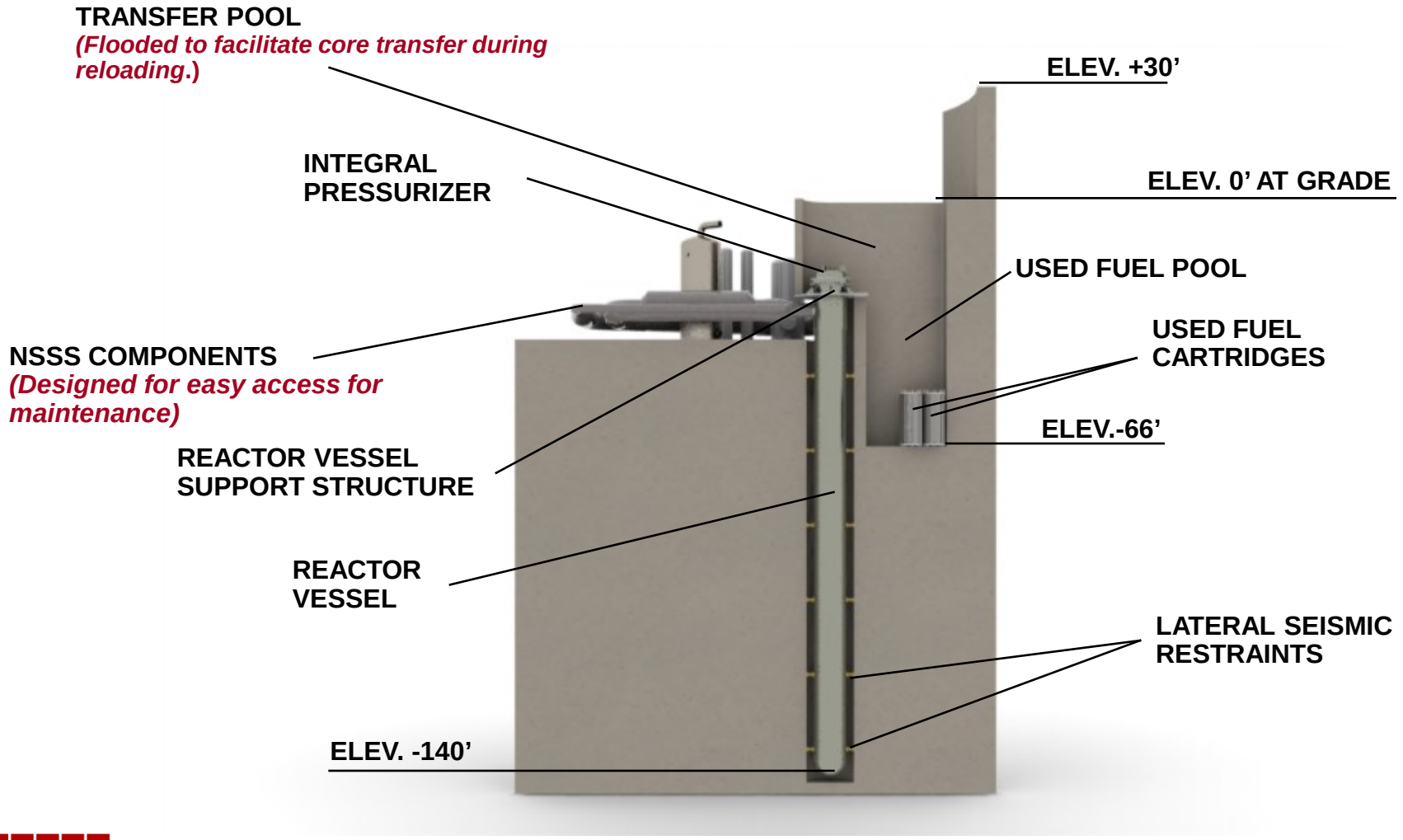

Principal Design Characteristics

- Core deep underground
  - Maximum protection from external natural events and malevolent human intervention
- Gravity-driven circulation of the reactor coolant
  - No pumps in primary loop
- Safety against earthquakes
  - Major equipment underground or horizontally mounted
- Critical components readily accessible
  - Steam generators and CRDMs outside the reactor vessel
- Efficient Steam cycle
  - Two horizontal steam generators with superheaters
- Large water inventory around and above the core
  - No penetrations in the lower 120 ft of the RV
  - Cavity around RV (reactor well) flooded with water

Principal Design Characteristics (cont.)

- Rapid Refueling
  - Entire core loaded and unloaded as a single cartrige
- Long operating cycle
  - 3+ years single cycle core
- Demineralized water
  - Less corrosion, simplified chemical controls
- Extended on-site spent fuel storage (plant life)
  - Wet and dry storage
- Passive safety systems
  - No reliance on off-site power for long term heat removal
- Short construction life cycle
  - Virtually all components shop-fabricated
- Suitable for water-challenged sites
  - Air-cooled condenser option available as main heat sink

Containment Building Plan View

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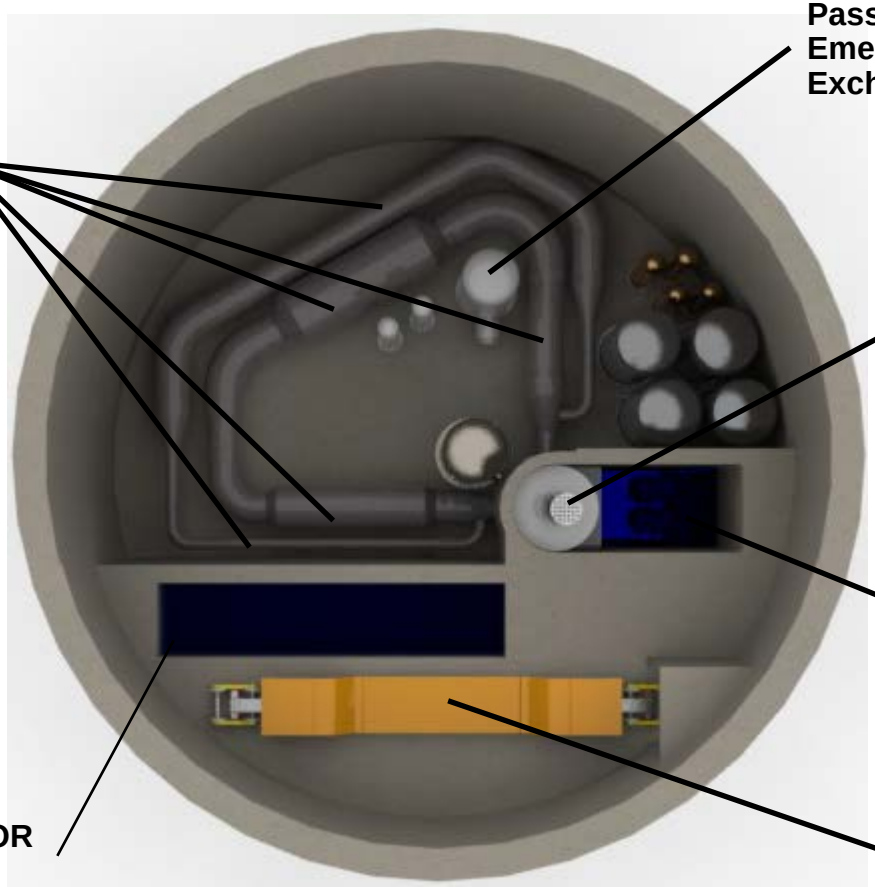

Containment Building Overview: Isometric Cut Away

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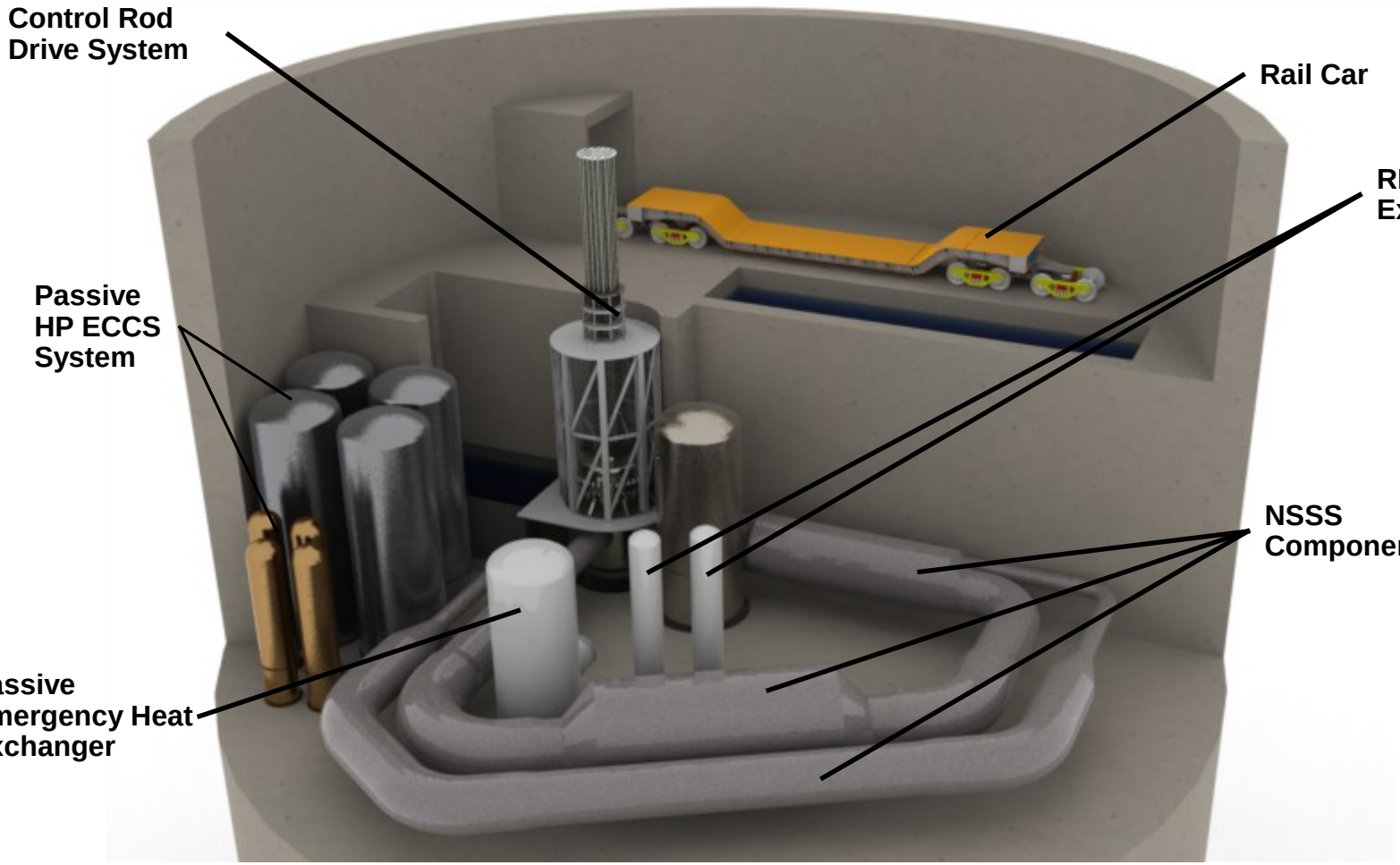
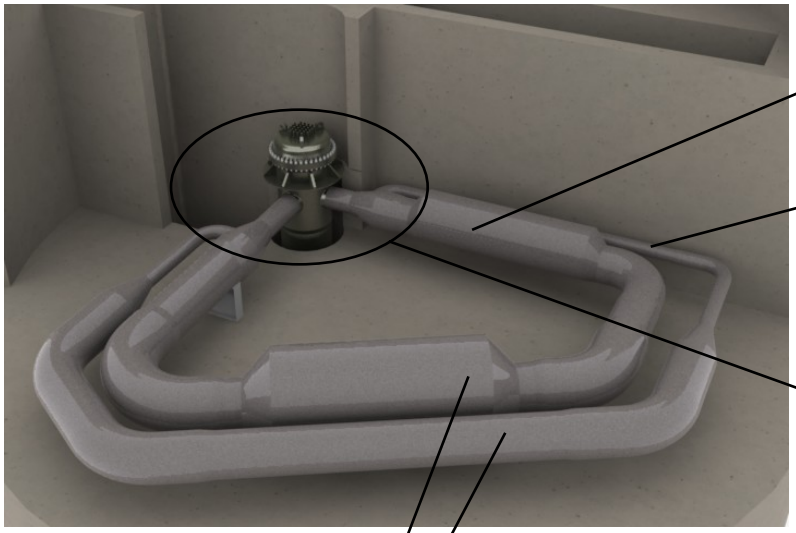


Containment Building Overview: HI-SMUR Power Loop



HP STEAM GENERATOR

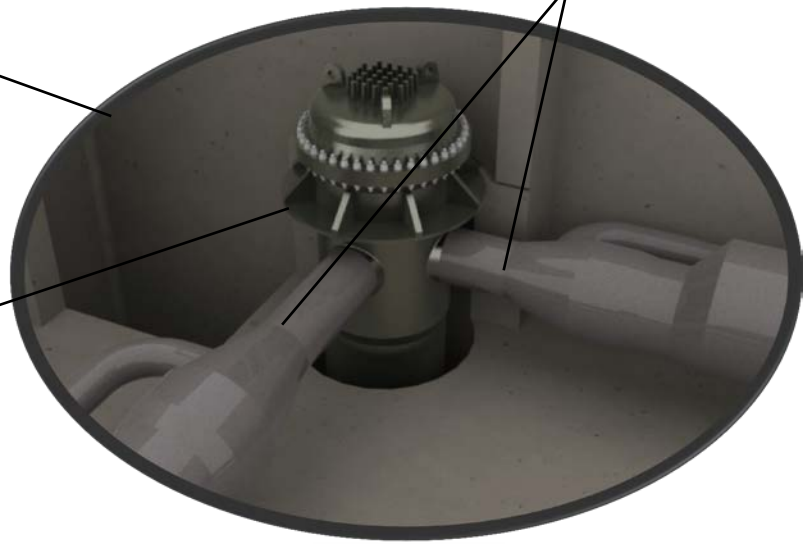
HP SUPER HEATER

LP STEAM GENERATOR

LP SUPPER HEATER

REACTOR VESSEL SUPPORT STRUCTURE

Steam Generators are integrally connected to Reactor Vessel – no interconnecting piping



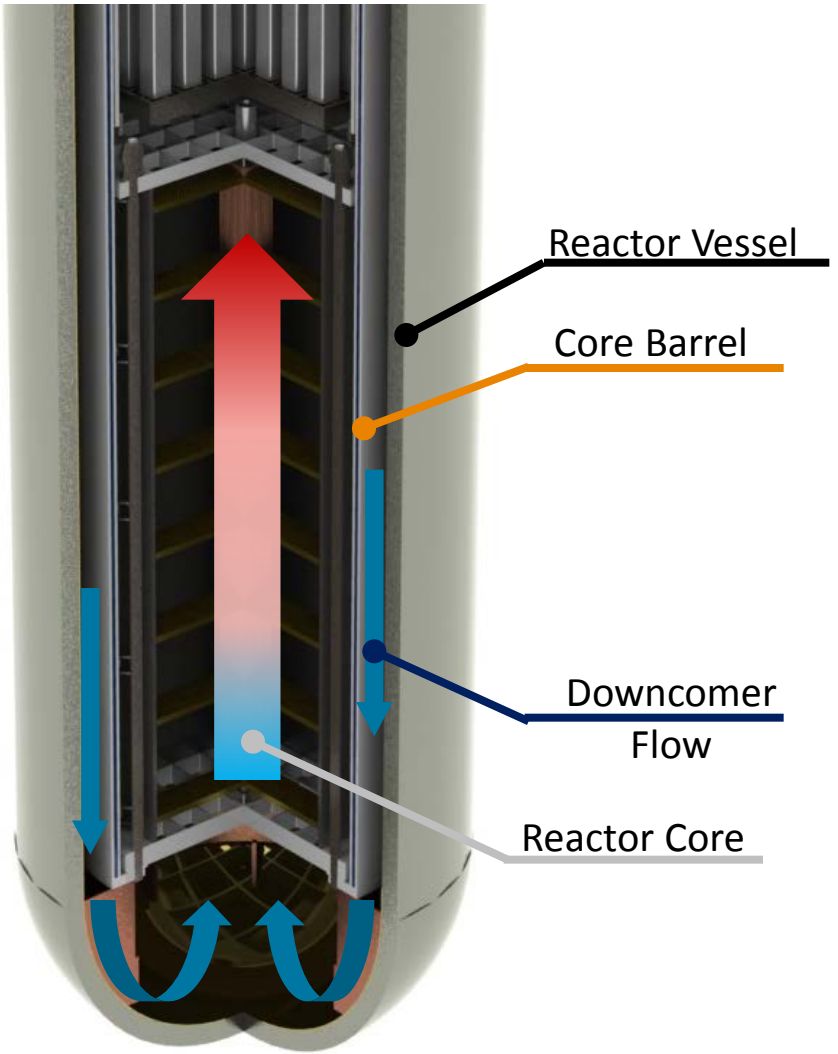
Containment Building Overview: Reactor Vessel At a Glance

Minimal Number Of Large Penetrations into Reactor Vessel to Minimize LOCA Concerns.

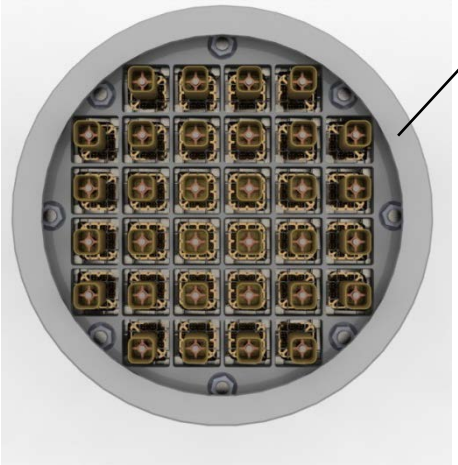
No Penetrations in the Lower 120ft of Reactor Vessel to preclude LOCA

Reactor Coolant Flow Path

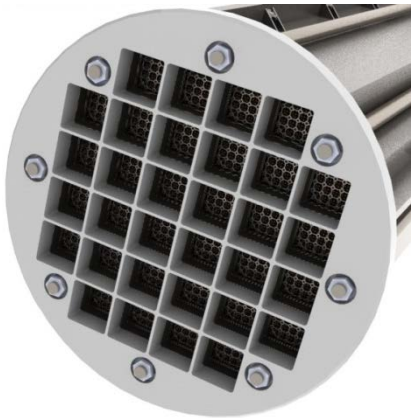
Natural Circulation of Reactor Coolant – No pumps required under normal operation or under accident conditions



Fuel Cartridge Design Features



HI-SMUR FUEL CARTRIDGE
TOP PLAN VIEW

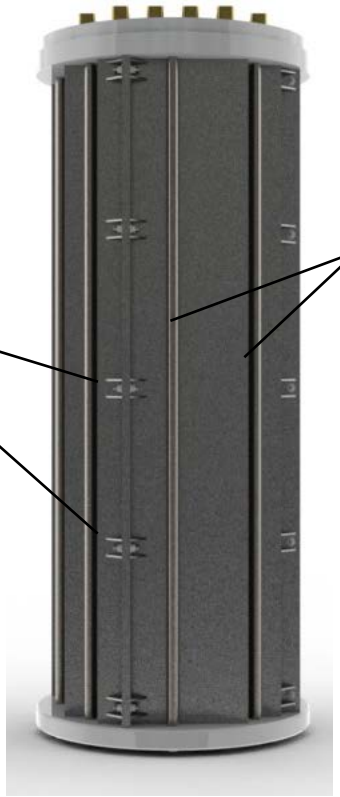


HI-SMUR FUEL CARTRIDGE
BOTTOM VIEW

INTEGRAL LIFTING
RING DESIGNED TO ANSI14.6 TO FACILITATE
INSTALLATION AND REMOVAL
OF THE CORE.

SPECIAL
TOOLS ARE
REQUIRED TO
DISASSEMBLE
CARTRIDGE

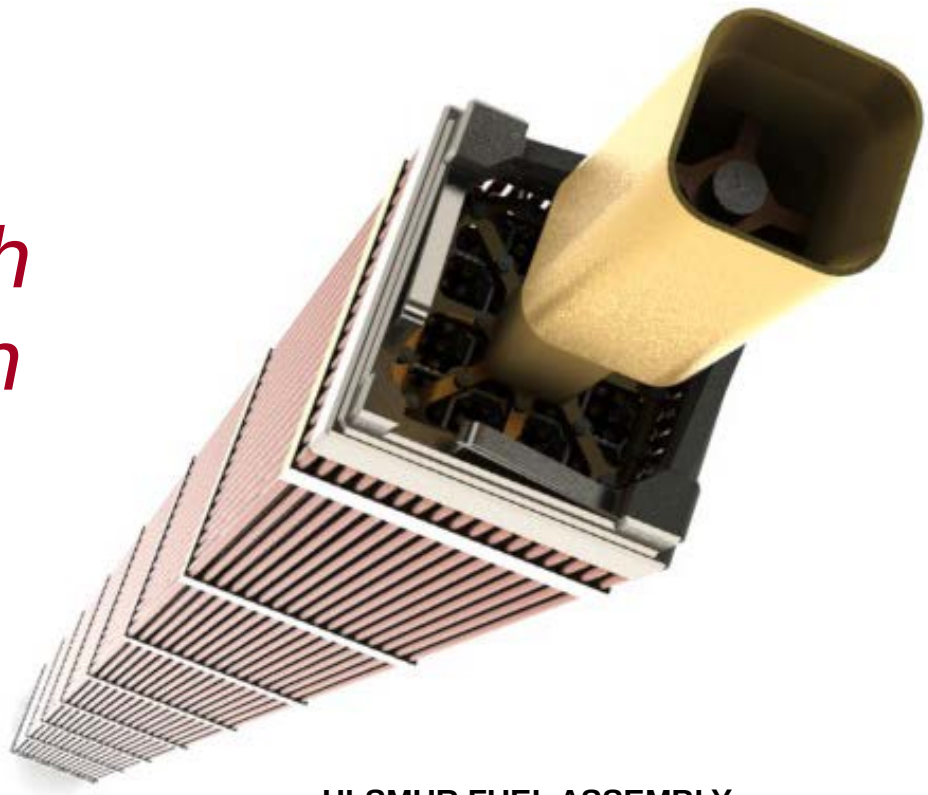
FUEL CARTRIDGE
TIE RODS



HI-SMUR FUEL CARTRIDGE

HI-SMUR Fuel Assembly

Fuel assembly design emulates standard PWR fuel used in the industry to insure high reliability premised on extensive experience



HI-SMUR FUEL ASSEMBLY

Passive Core Cooling System

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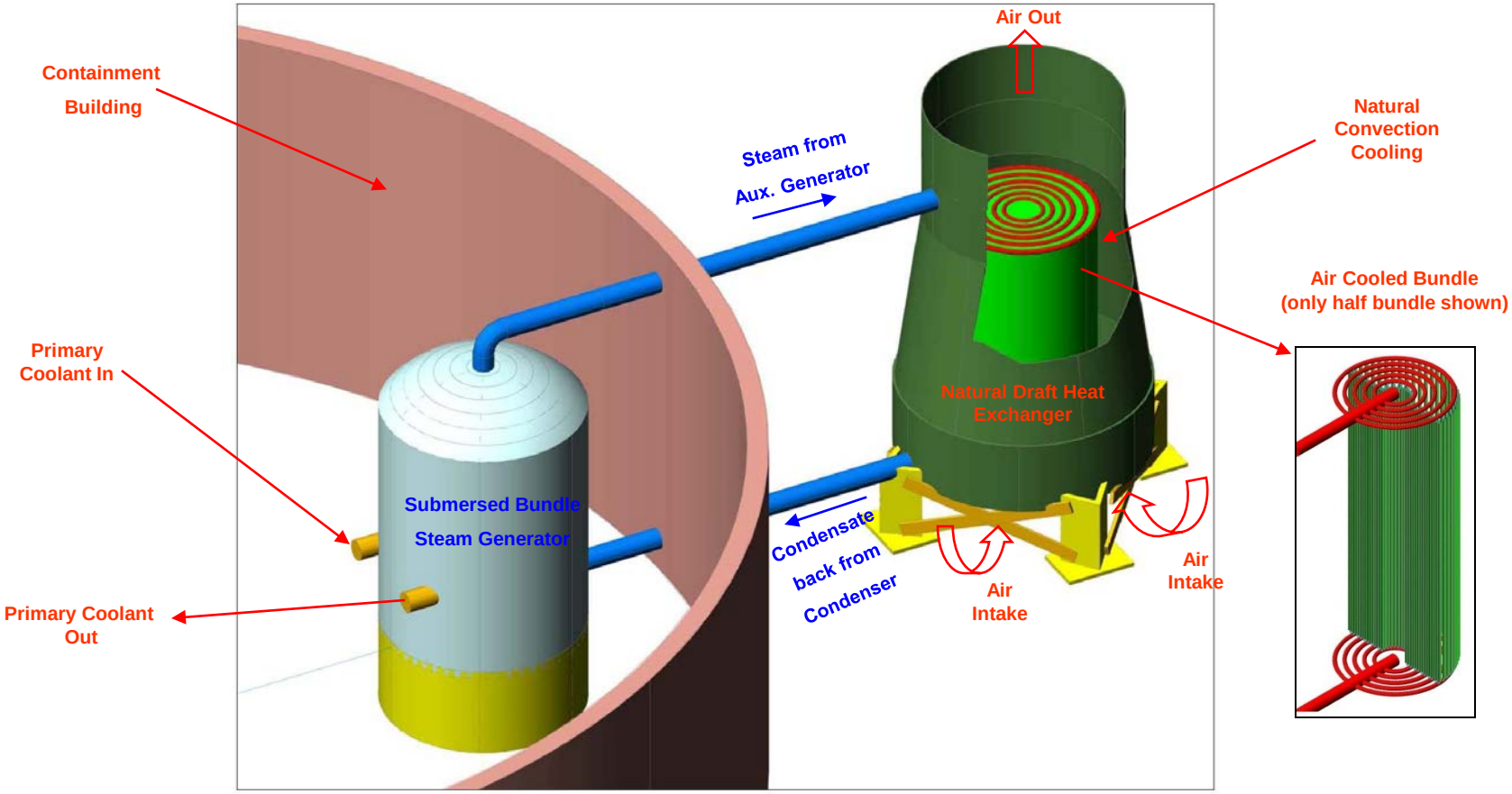

Safety Systems

- Passive Core Cooling System (PCCS)
  - Uses submerged bundle steam generator in the containment, and air-cooled condenser outside of the containment
- Residual Heat Removal System (RHR)
  - Lower pressure system used for normal shutdown in conjunction with the PCCS.
- High Pressure Core Injection System (HPCIS)
  - Injects borated water at high pressure
- Reactor Startup System
  - Heats up reactor after fresh core load. Integrated with RHR
- Passive SFP cooling system
  - Similar to PCCS (lower capacity, lower operating temperature)

Transient and Accident Conditions

- External Initiating Events
  - Earthquake, Hurricane, Tsunami etc.
- Anticipated Operational Occurrences
  - Various pressure and level fluctuations, Turbine trip, Inadvertent valve openings, Power excursions, etc
- Postulated Accidents
  - Stuck CRA, Uncontrolled CRA withdrawal, CRA ejection, CRA drop
  - Main Steam Line Brak
  - SB LOCA
  - LB LOCA (TBD)
  - Anticipated Transient without Scram
- Beyond Design Basis Events
  - Seismic or Flooding events in excess of Design Basis
  - Loss of Emergency Cooling
  - Drop of Fuel Cartridge

Summary of HI-SMUR Design Features that insure utmost safety

A. Minimum number of active components

B. Underground location of safety systems

C. No reliance on off-site power and on-site power for safe shutdown of reactor

D. Robust core design

E. Integrally Connected Reactor and Steam Generator

F. Wet and Dry Storage of Spent Fuel

SECY-10-0034 and other Licensing Issues

- Design — LWR
- Barriers — Clad – RV – Containment
- Accident Sources — TBD (standard LWR or less)
- Module Operation — Independent (no sharing of control room or other safety systems)
- Security/Safeguards — TBD
- Licensing Approach — Part 50 followed by Part 52
Possibly first unit as prototype
- I&C — TBD (analog or digital)
- RHR, SFP cooling — Passive (emergency)
Active (non-emergency)
- Aircraft Impact Protection — Yes

SECY-10-0034 and other Licensing Issues (cont.)

- Loss of offsite power — Indefinite (passive cooling)
- Startup (heatup) — Separate non-nuclear heat source
- LB LOCA
  - "Traditional" LB LOCA analysis and corresponding safety installations
  - LB LOCA not credible per design / risk evaluation
  - Limited-pressure-retaining building

Licensing Schedule

- HI-SMUR Licensing and Project schedule presented in November 2010 meeting
  - Design and Analyses May 2012
  - License Submittal December 2012
  - Full Size Prototype by 2014
- Other designs
  - 5+ years until licensing submittal
  - 10+ years until first operational plant
- HI-SMUR needs an accelerated but achievable schedule
  - What would be the most expedient licensing approach in Part 50 and/or Part 52
  - Impact of building first plant as prototype
  - Impact of Topical Reports and While Papers
  - NRC's role in supporting HI-SMUR's licensing

Summary

- Summary discussions and comments
- Closing statements
- Thank you

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