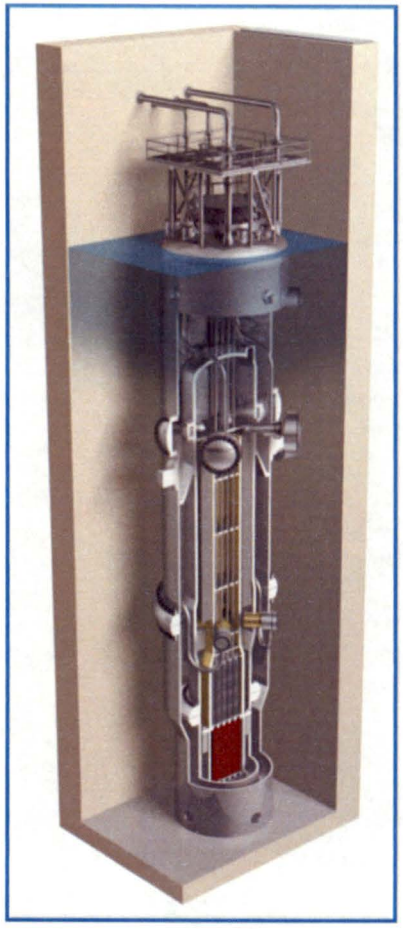
Enclosure 1:

"ACRS Presentation: NuScale Chapter 5, Reactor Coolant System and Connecting Systems Overview," PM-0419-65159, Revision 0

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvallis, Oregon 97330 Office 541.360-0500 Fax 541.207.3928
www.nuscalepower.com

ACRS Presentation: NuScale Chapter 5, Reactor Coolant System and Connecting Systems Overview



PM-0419-65159
Revision: 0

NUSCALE
Power for all humankind

Presentation Team

Derek Noel

Supervisor, NSSS Component Design

Colin Sexton

Chemical Engineer

Hongqing Xu

Materials Engineer

Carrie Fosaaen

Supervisor, Licensing

Zackary Rad

Director, Regulatory Affairs

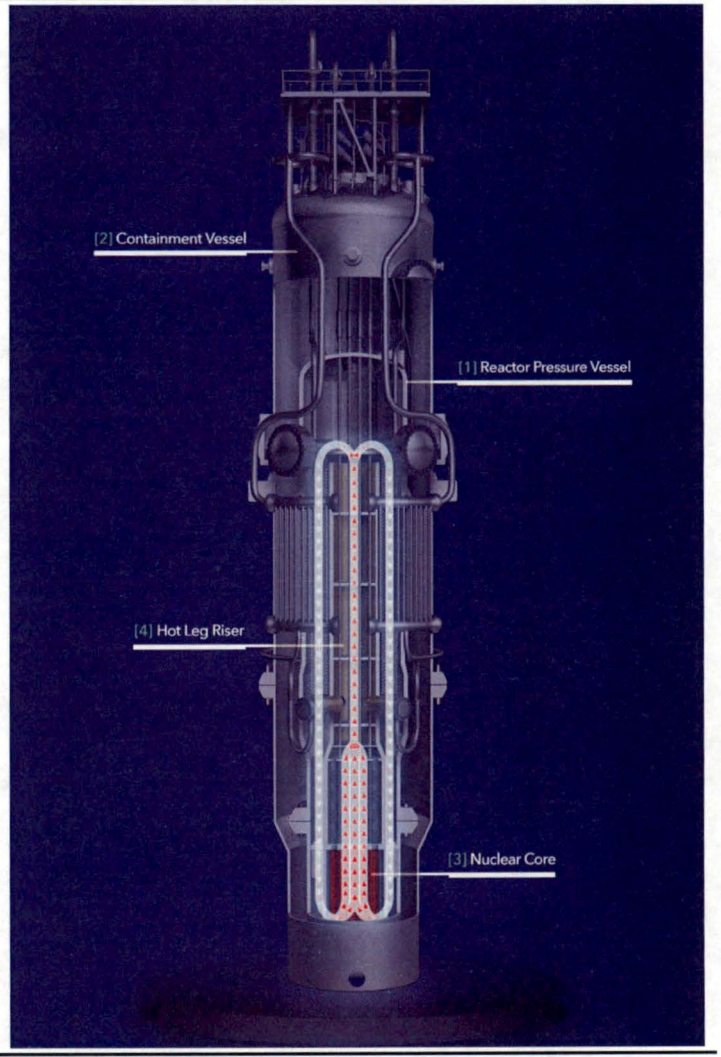
Chapter 5: Reactor Coolant System and Connecting Systems

Section	Title
5.1	Summary Description
5.2	Integrity of Reactor Coolant Boundary
5.3	Reactor Vessel
5.4	Reactor Coolant System Component and Subsystem Design

5.1 – Summary Description

Overview of RCS Components

- Reactor Pressure Vessel
- Integral Pressurizer
- Reactor Vessel Internals
- Reactor Safety Valves
- RCS piping inside the containment vessel



5.1 – Summary Description

RPV Parameters

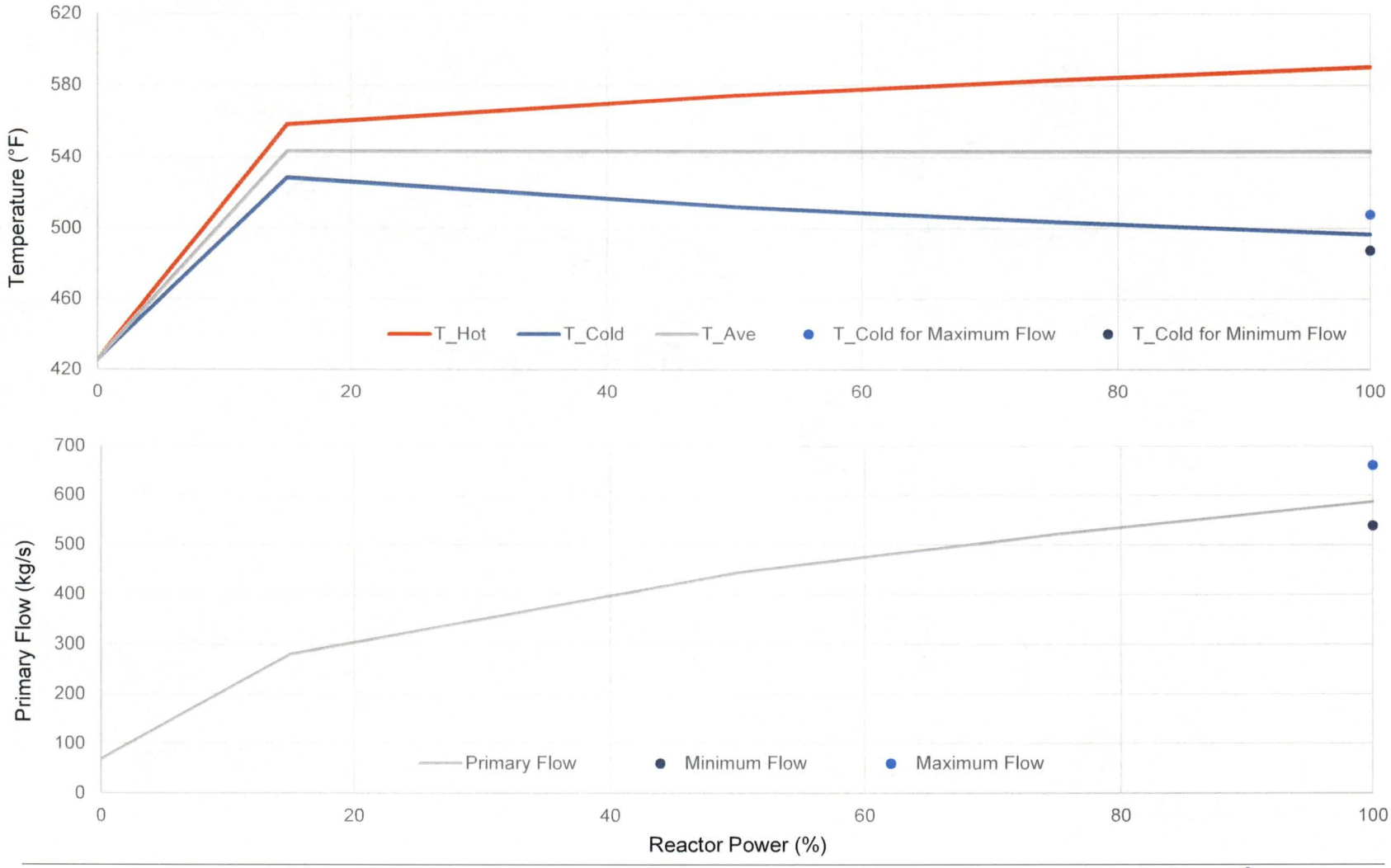
Parameter	Value
Design thermal Power, MWt	160
Design Pressure, psia	2100
Design Temperature, °F	650
Overall Height (ft)	64.83
Inside diameter (excluding clad) (ft)	8.04 – 8.88

RCS Volumes

RCS Region	Nominal Volume (ft^3)
Hot Leg	635
Cold Leg	578
Core Region	89
SG Region	621
PZR Region	578

5.1 – Summary Description

RCS temperature and flow data



5.2 – Integrity of Reactor Coolant Boundary

Section	Title
5.2.1	Compliance with Codes and Code Cases
5.2.2	Overpressure Protection
5.2.3	Reactor Coolant Pressure Boundary Materials (5.3 – Reactor Vessel also discussed here)
5.2.4	Reactor Coolant Pressure Boundary Inservice Inspection and Testing
5.2.5	Reactor Coolant Pressure Boundary Leakage Detection

5.2 - Integrity of Reactor Coolant Boundary

5.2.1

- Code of Record - ASME BPVC, 2013 Edition with No Addenda

5.2.2

- RCPB Overpressure protection provided by RSVs – primary and secondary sides
- LTOP is provided by RVVs

COL Item:

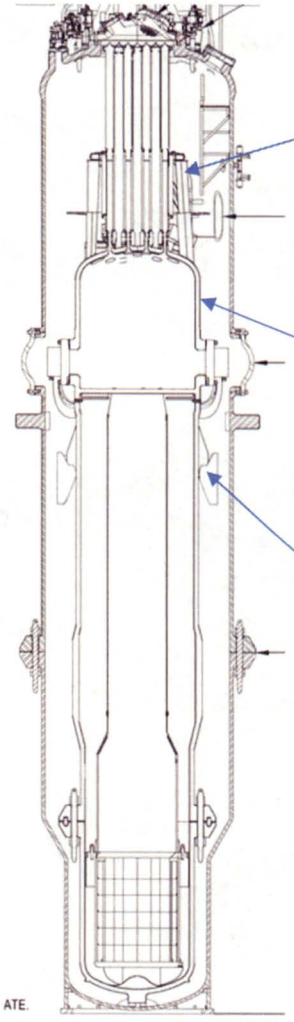
- 5.2-2: Provide a certified Overpressure Protection Report in compliance with ASME BPVC Section III, Subarticles NB-7200 and NC-7200 to demonstrate the RCPB and secondary system are designed with adequate overpressure protection features, including LTOP features.

5.2.3 – Reactor Coolant Pressure Boundary Materials

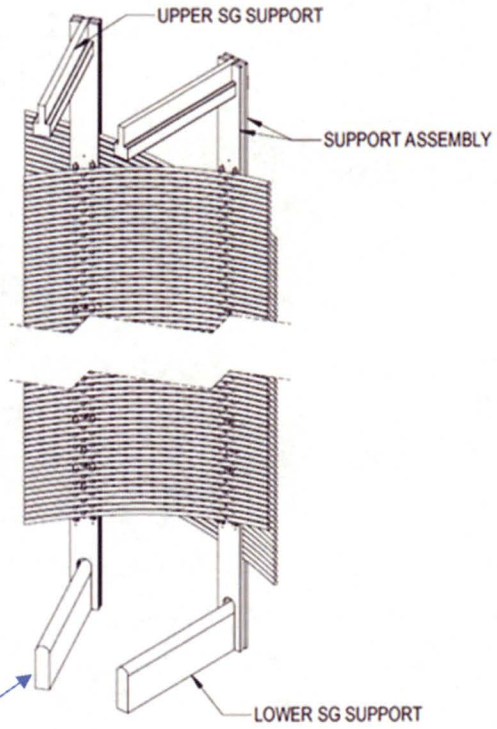
Materials selected, including weld materials, conform to fabrication, construction, and testing requirements of ASME BPVC, Section III, Subsection NB requirements

- RCPB Materials include:
  - SA-508 – base metal for RPV shell components
  - Alloy 690 TT – SG tubes & Safe ends
  - Dual certified 304/304L– RCS piping
  - Austenitic SS and Nickel based (Ni-Cr-Fe) – Cladding
  - Alloy 718 – Threaded Fastener material
- Fabrication follows applicable ASME Code and regulatory requirements

5.3.1 – Reactor Vessel Materials



- CRDM seismic support structure– fabricated per ASME BPVC Section III, NF
- RPV shell is fabricated per requirements of ASME BPVC Section III, NB
- RPV supports – fabricated per ASME BPVC Section III, NF
- SG tube supports – fabricated per ASME BPVC Section III, NG



5.3.1 & 5.3.2– RPV Materials & P/T Limits, Pressurized Thermal Shock, and Charpy Upper-Shelf Energy Data and Analyses

- Fracture Toughness requirements, Material Surveillance requirements, Pressurized Thermal Shock screening, and Upper-Shelf Energy comply with regulatory requirements
- Limit Curves Methodology in TR-1015-18177, "Pressure and Temperature Limits Methodology"
- COL Items:
  - 5.3-1: Establish measures to control the onsite cleaning of the RPV during construction in accordance with RG 1.28
  - 5.3-2: Develop operating procedures to ensure that transients will not be more severe than those for which the reactor design adequacy had been demonstrated. These procedures will be based on material properties of the as-built reactor vessels.
  - 5.3-3: Describe the reactor vessel material surveillance program consistent with NUREG 0800, Section 5.3.1

5.2.3 – Reactor Coolant Pressure Boundary Materials

- Reactor Coolant Chemistry parameters and impurity limitations conform to EPRI PWR Primary Water Chemistry Guidelines and RG 1.44, Revision 1
- COL Items:
  - 5.2-4: Develop and implement a Strategic Water Chemistry Plan consistent with the latest version of the EPRI Pressurized Water Reactor Primary Water Chemistry Guidelines.
  - 5.2-5: Develop and implement a Boric Acid Control Program that includes: inspection elements to ensure the integrity of the RCPB components for subsequent service, monitoring of the containment atmosphere for evidence of RCS leakage, the type of visual or other NDE inspections to be performed, and the required inspection frequency.

5.2.4 – Reactor Coolant Pressure Boundary Inservice Inspection and Testing

Inspections per ASME BPVC, Section XI

- Applicable to ASME BPVC Class I components except for SG tubes
  - ISI of SG tubes covered by SG Program

COL Item:

- 5.2-6: Develop a site-specific preservice examination, inservice inspection, and inservice testing program plans in accordance with Section XI of the ASME BPVC and will establish implementation milestones. Identify the implementation milestone for the augmented inservice inspection program. Identify the applicable edition of the ASME Code utilized in the program plans consistent with the requirements of 10 CFR 50.55a.

5.2.5 – Reactor Coolant Pressure Boundary Leakage Detection

Leakage Detection Methods

- CES collected condensate
- CNV pressure
- Radioactivity Monitoring & Chemistry Analysis
- RCS Inventory Mass Balance

- LBB application to secondary side piping covered in 3.6.3

COL Item:

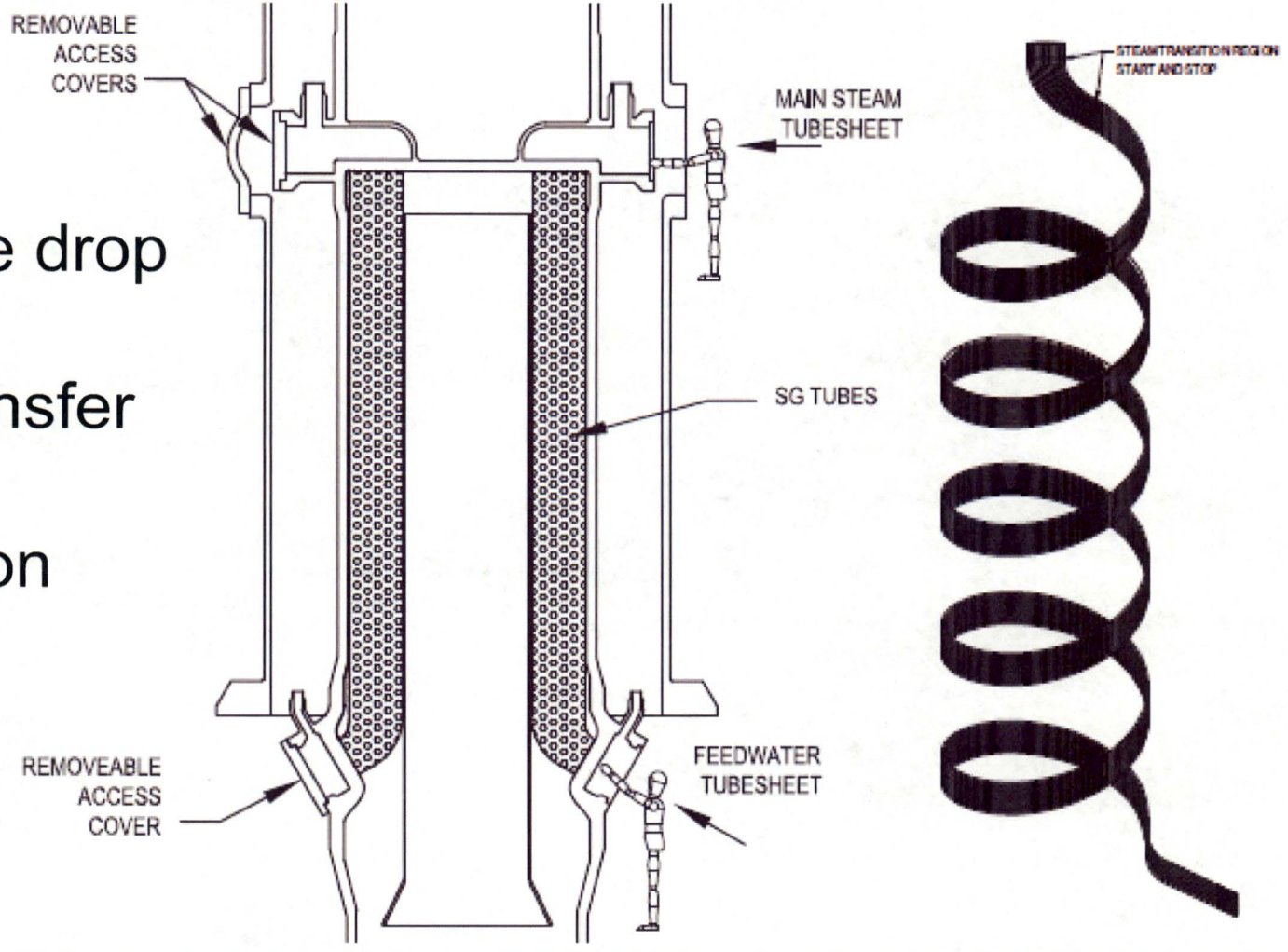
- 5.2-7: Establish plant-specific procedures that specify operator actions for identifying, monitoring, and trending RCS leakage in response to prolonged low leakage conditions that exist above normal leakage rates and below the TS limits. The objective of the methods of detecting and trending the RCPB leak will be to provide the operator sufficient time to take actions before the plant TS limits are reached.

5.4 – Reactor Coolant System Component and Subsystem Design

Section	Title
5.4.1	Steam Generators
5.4.2	Reactor Coolant System Piping
5.4.3	Decay Heat Removal System
5.4.4	Reactor Coolant System High-Point Vents (not discussed)
5.4.5	Pressurizer

5.4.1 – Steam Generators

- Pressure drop
- Heat transfer
- Inspection

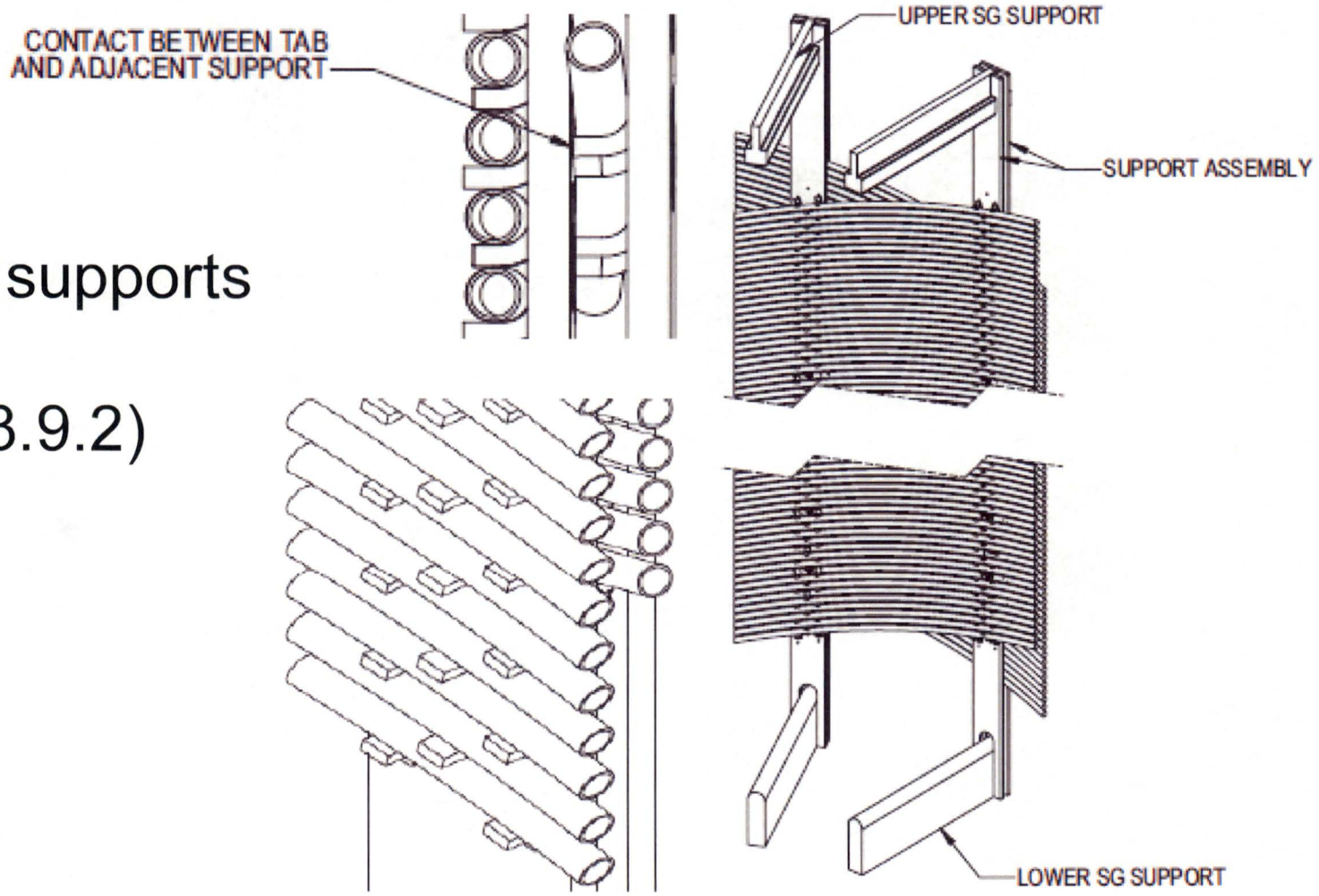


5.4.1 – Steam Generators

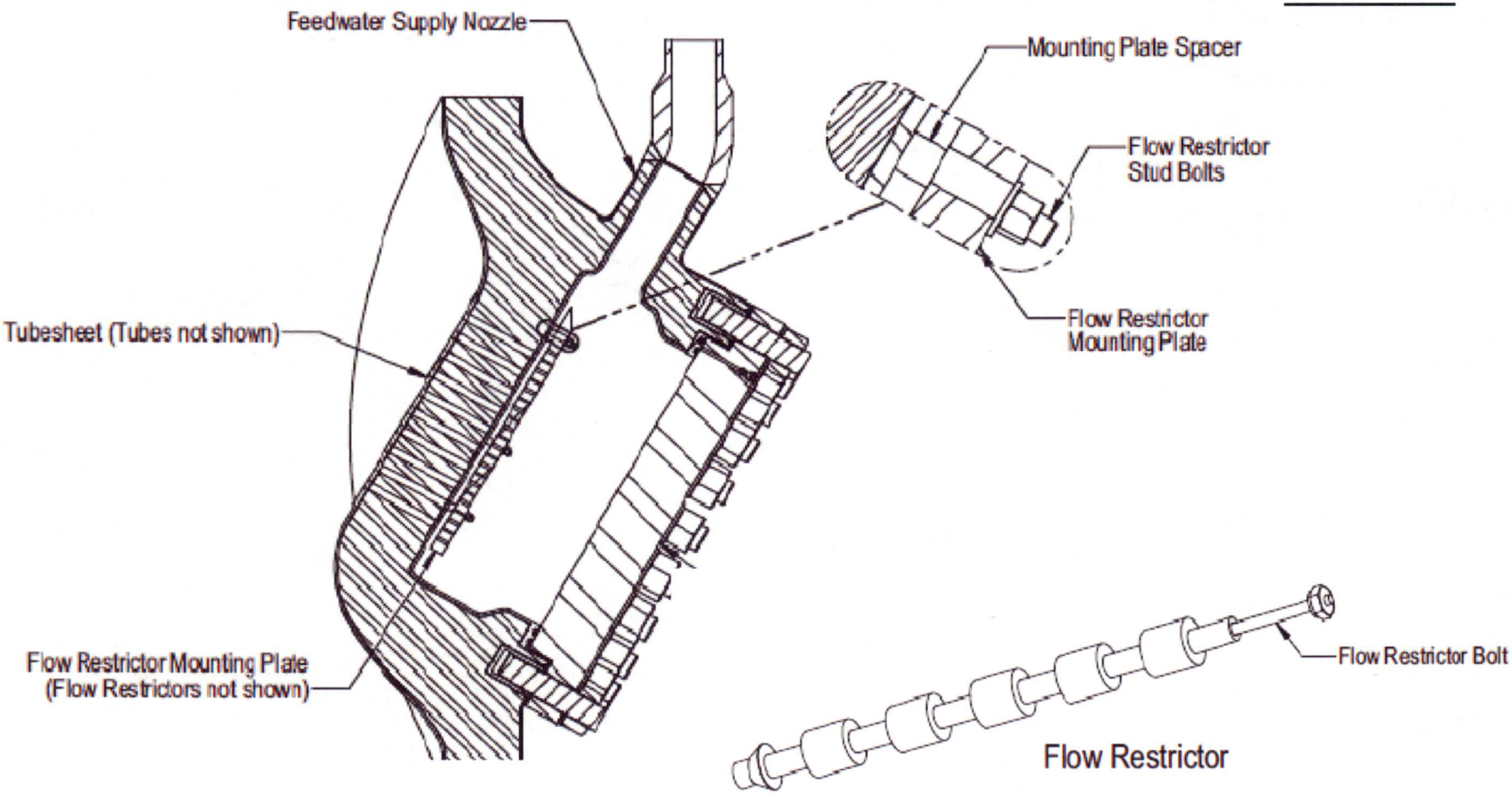
- Integral Helical Coil SG Design features
  - Shell side is primary side - Tube side is secondary side
  - Alloy 690 TT (1380 tubes, 77 - 87ft long, 5/8" OD)
  - Low flow in primary (~1ft/sec)
  - Tube wall degradation allowance (0.010" > ASME min wall)
  - Support 100% volumetric inspection
  - Normal access to shell side of tubes from below during refueling
- Incorporation of OE
  - Follow guidance of NEI 97-06 & EPRI (COL Item 5.4-1: Develop and implement a SG Program)

5.4.1 – Steam Generators

- Tube supports
- FIV (3.9.2)



5.4.1 – Steam Generators



- Limit flow oscillations

5.4.2 – Reactor Coolant System Piping

RCS Piping Design

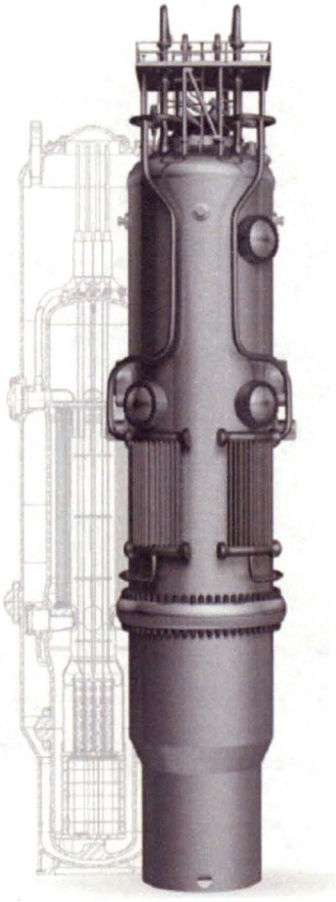
- NPS 2 – Schedule 160
- Austenitic stainless steel – SA-312, Type 304/304L (dual certified)

RCS Piping Includes:

- Pressurizer spray supply
- RCS injection
- RCS discharge
- RPV high-point degasification piping

5.4.3 – Decay Heat Removal System

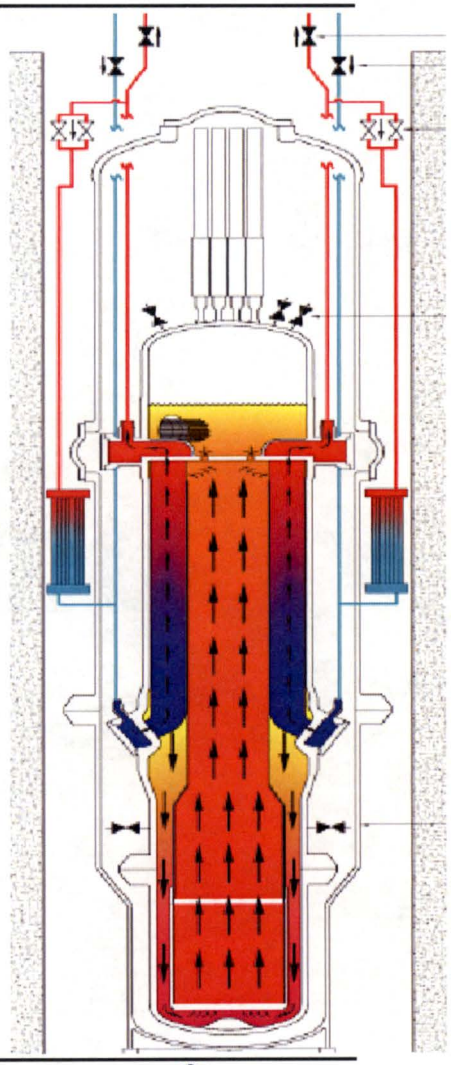
- Two phase Natural circulation system connected to SG
- Condensers submerged in UHS
- Closed loop is established on signal or loss of power by CIV
- Two independent single failure proof trains
- Design pressure matches RCS design pressure



5.4.3 – Decay Heat Removal System

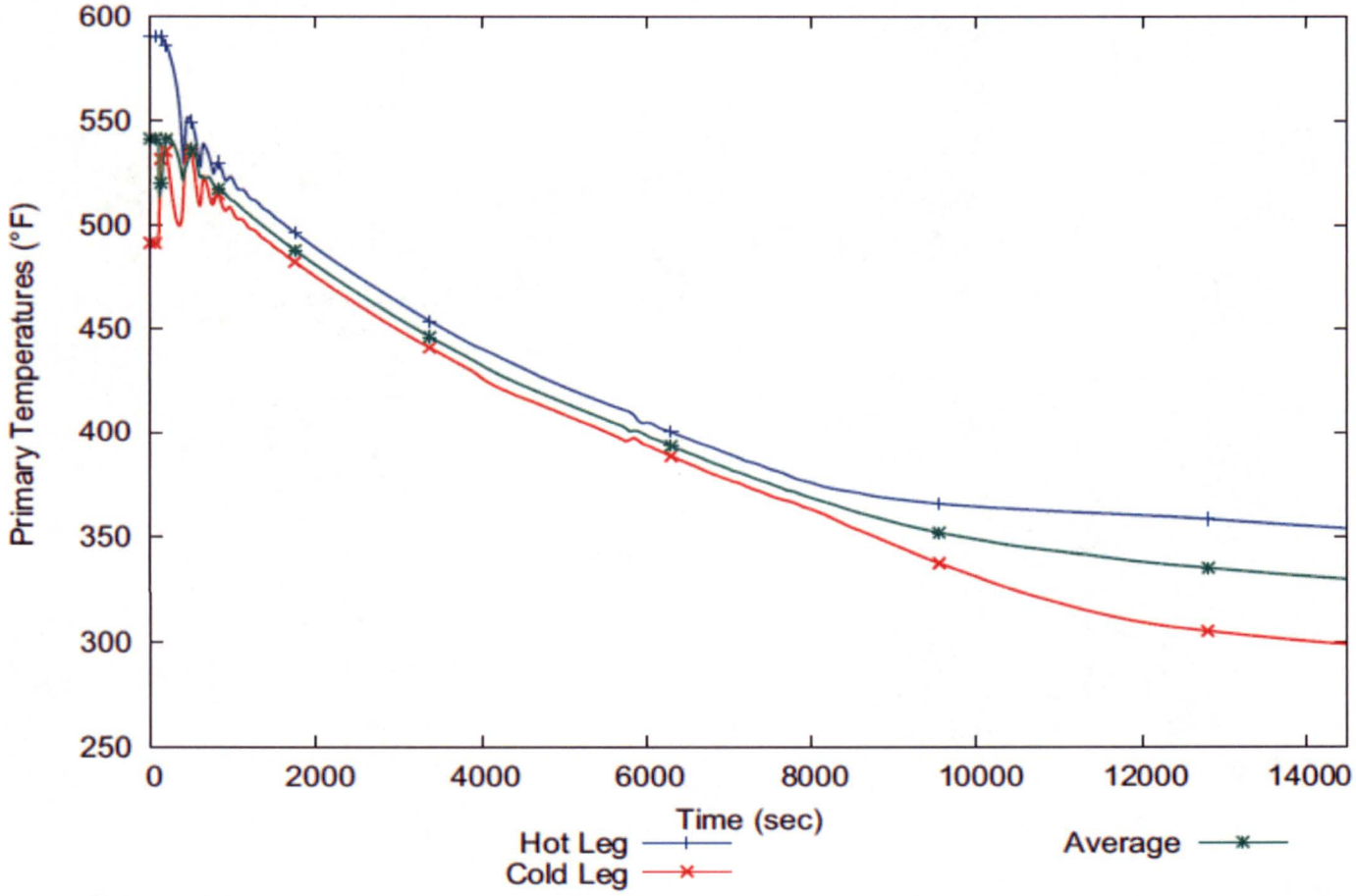
Thermal-Hydraulic Performance dependent on:

- RCS temperature
- Reactor pool water temperature
- Water inventory
- Noncondensable gas accumulation
- Pressure losses
- Driving head



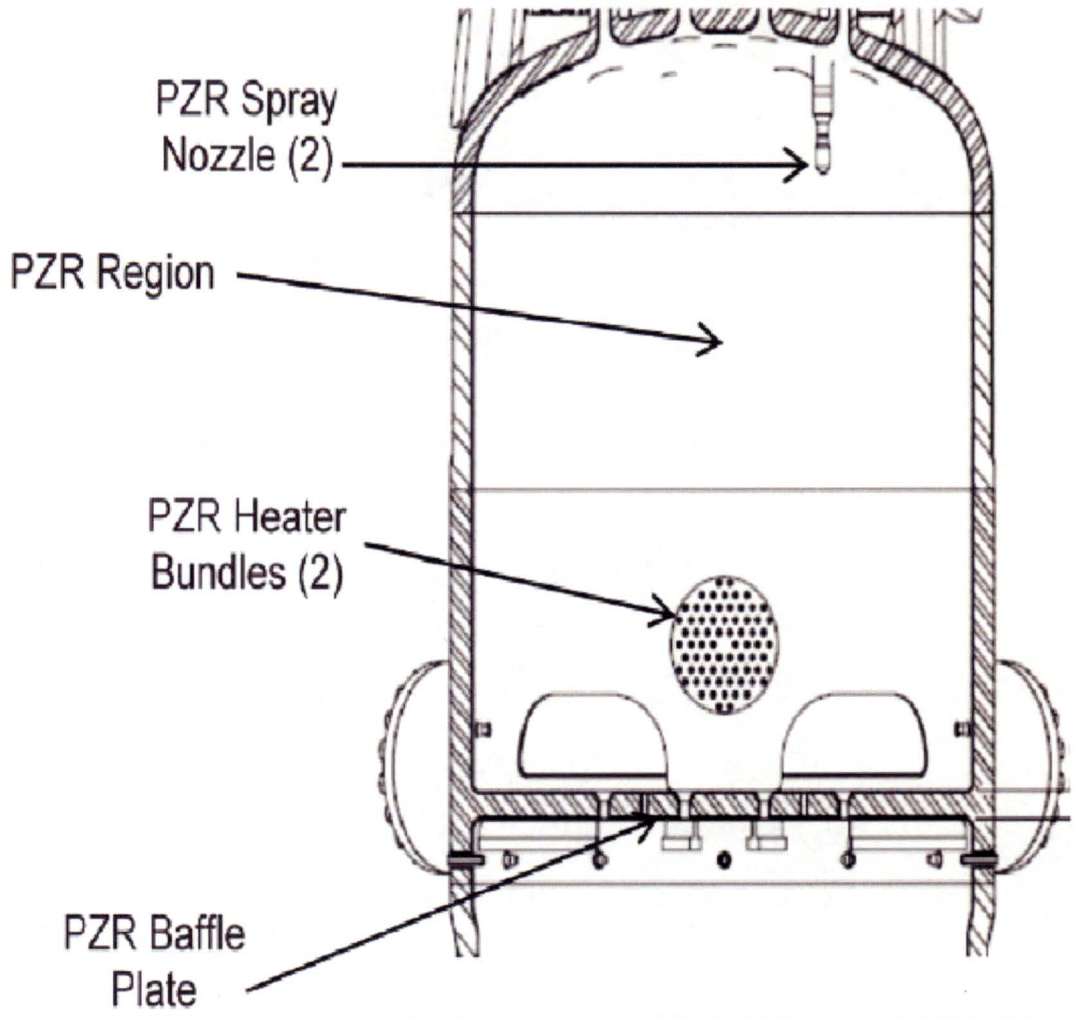
5.4.3 – Decay Heat Removal System

Nominal two train cool down (4 hour duration)



5.4.5 – Pressurizer

- Integral to the Reactor
- Baffle plate separates PZR from RCS
- Pressure controlled by heaters/sprays
- Level controlled by CVCS
- Highpoint degas line can be used during normal operation



Acronyms

- AOO – Anticipated Operational Occurrences
- ASME – American Society of Mechanical Engineers
- ASTM – American Society for Testing and Materials
- BPVC – Boiler Pressure Vessel Code
- CES - Containment Evacuation System
- CIV – Containment Isolation Valve
- CNV - Containment Vessel
- COL - Combined License
- CRDM – Control Rod Drive Mechanism
- CVCS - Chemical and Volume Control System
- DHRS – Decay Heat Removal System
- ECCS – Emergency Core Cooling System
- EFPY – Effective Full Power Years
- EPRI – Electric Power Research Institute
- °F – degrees Fahrenheit
- FIV – Flow Induced Vibration
- FSAR – Final Safety Analysis Report
- ft – feet
- FW - Feedwater
- FWIV – Feedwater Isolation Valve
- HZP – Hot Zero Power
- ISI – Inservice Inspection
- LOCA – Loss of Coolant Accident
- LTOP – Low Temperature Overpressure Protection
- MPS - Module Protection System
- MSIV – Main Steam Isolation Valve
- MSS – Main Steam System
- MWt – Megawatts thermal

Acronyms

- NDE – Non-destructive Examination
- NEI – Nuclear Energy Institute
- NPM - NuScale Power Module
- NPS – Nominal Pipe Size
- OD – Outside Diameter
- OE – Operations Experience
- psia – pounds per square inch absolute
- P-T – Pressure and Temperature
- PTS – Pressurized Thermal Shock
- PWR – Pressurized Water Reactor
- PWSCC – Primary Water Stress-Corrosion Cracking
- PZR – Pressurizer
- RCCWS – Reactor Component Cooling Water System
- RCPB – Reactor Coolant Pressure Boundary
- RCS - Reactor Coolant System
- RG - Regulatory Guide
- RPV – Reactor Pressure Vessel
- RSV – Reactor Safety Valve
- RT_{NDT} – Reference Temperature for nil-ductility transition
- RVV – Reactor Vent Valve
- SG – Steam Generator
- TRV – Thermal Relief Valve
- TS – Technical Specifications
- TT – Thermally Treated
- UHS – Ultimate Heat Sink
- USE – Upper Shelf Energy

Portland Office
6650 SW Redwood Lane,
Suite 210
Portland, OR 97224
971.371.1592

Corvallis Office
1100 NE Circle Blvd., Suite 200
Corvallis, OR 97330
541.360.0500

Rockville Office
11333 Woodglen Ave., Suite 205
Rockville, MD 20852
301.770.0472

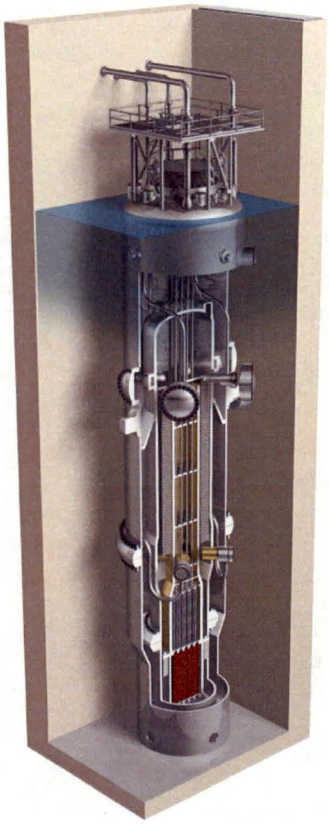
Charlotte Office
2815 Coliseum Centre Drive,
Suite 230
Charlotte, NC 28217
980.349.4804

Richland Office
1933 Jadwin Ave., Suite 130
Richland, WA 99354
541.360.0500

Arlington Office
2300 Clarendon Blvd., Suite 1110
Arlington, VA 22201

London Office
1st Floor Portland House
Bressenden Place
London SW1E 5BH
United Kingdom
+44 (0) 2079 321700

http://www.nuscalepower.com
Twitter: @NuScale_Power



NUSCALE™
Power for all humankind