NuScale Power

Corporate and Technology Overview

Mr. Bruce Landrey
Chief Marketing Officer

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INNOVATIVE. SAFE. ECONOMIC.

NuScale Technology:
A Decade in Development

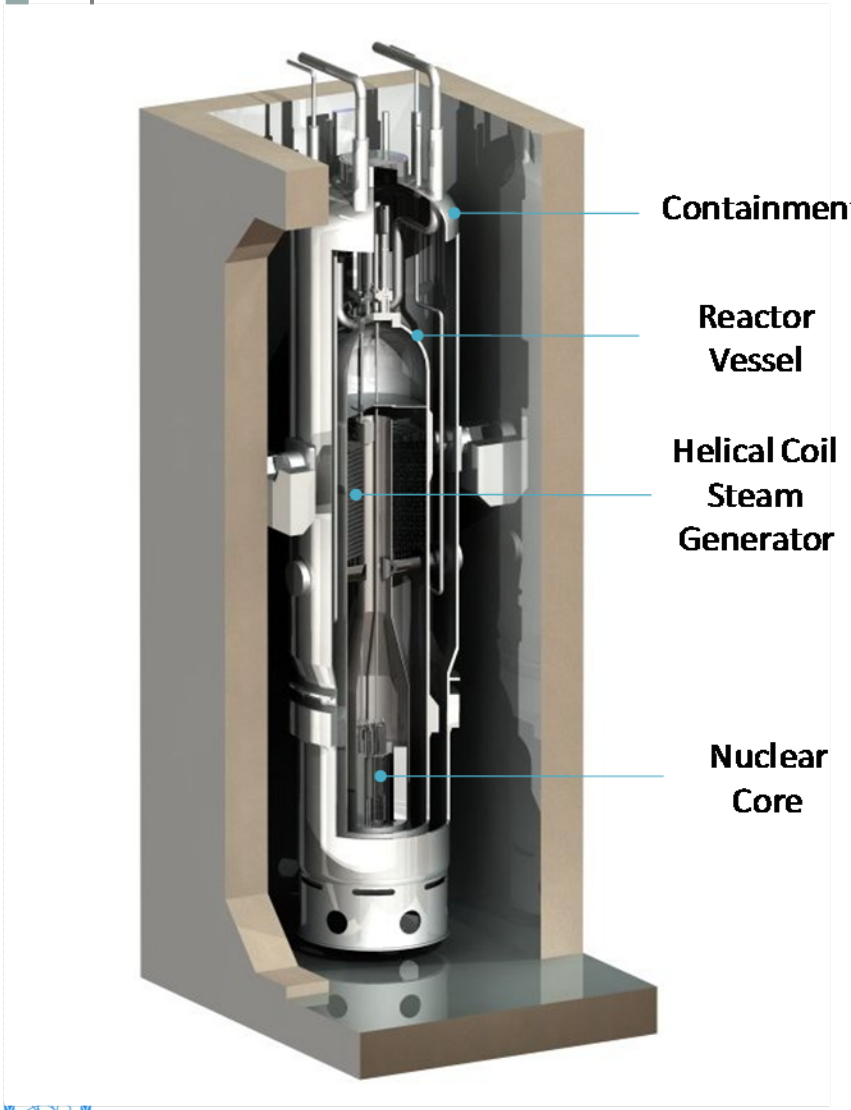
- **Initial Research Funded by U.S.DOE -- 2000-2003**
  - Concept developed for the Multi-Application Small Light Water Reactor (MASLWR)
  - Design concept confirmed in 1/3 scale (electrically-heated) test facility at Oregon State University
- **Design Evolution at Oregon State University -- 2005-2007**
  - Increase in Net Power from 35 MW(e) to 45 MW(e)
  - Passive Feedwater and Decay Heat Removal System
  - Containment vacuum
  - Seismically Isolated trunnion support system
- **NuScale Power, Inc. formed in June 2007**
  - Tech-transfer agreement with OSU - test facility and patents
  - Dr. Paul Lorenzini, CEO, and Dr. Jose Reyes, CTO

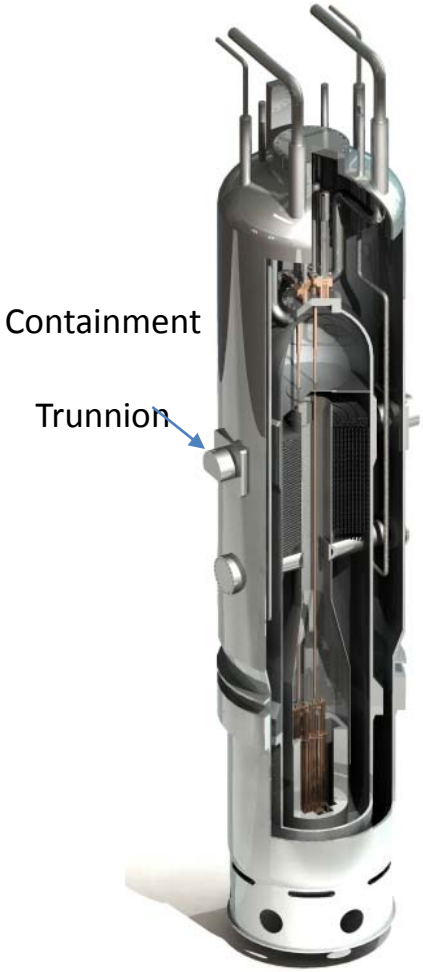
NuScale Power

Changing the Nuclear Power Paradigm

Old Nuclear	New Nuclear
Every plant is different	USNRC “Design Certification” standardizes plant designs for 20 years
Separate licenses for Construction and Operation	Combined Construction & Operating License issued before construction begins
Capacity factors ~70%	Capacity factors average >90%
Active safety systems require emergency power to operate	Passive safety systems rely on natural circulation
All plants > 1000 MWe requiring large financial commitment	All plants > 1000 MWe requiring large financial commitment

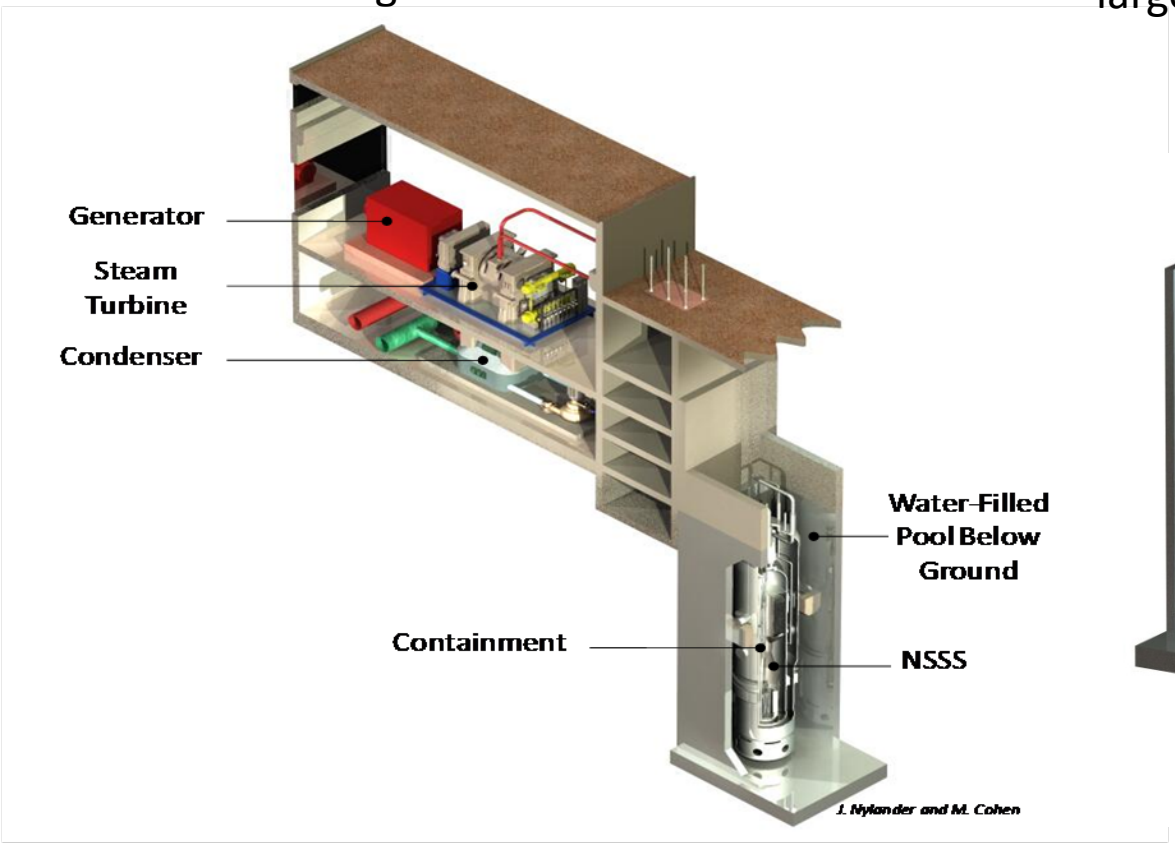
The New Paradigm of Modular, Scalable





Scalable Design Simplifies Development

Each module has a dedicated turbine-generator set



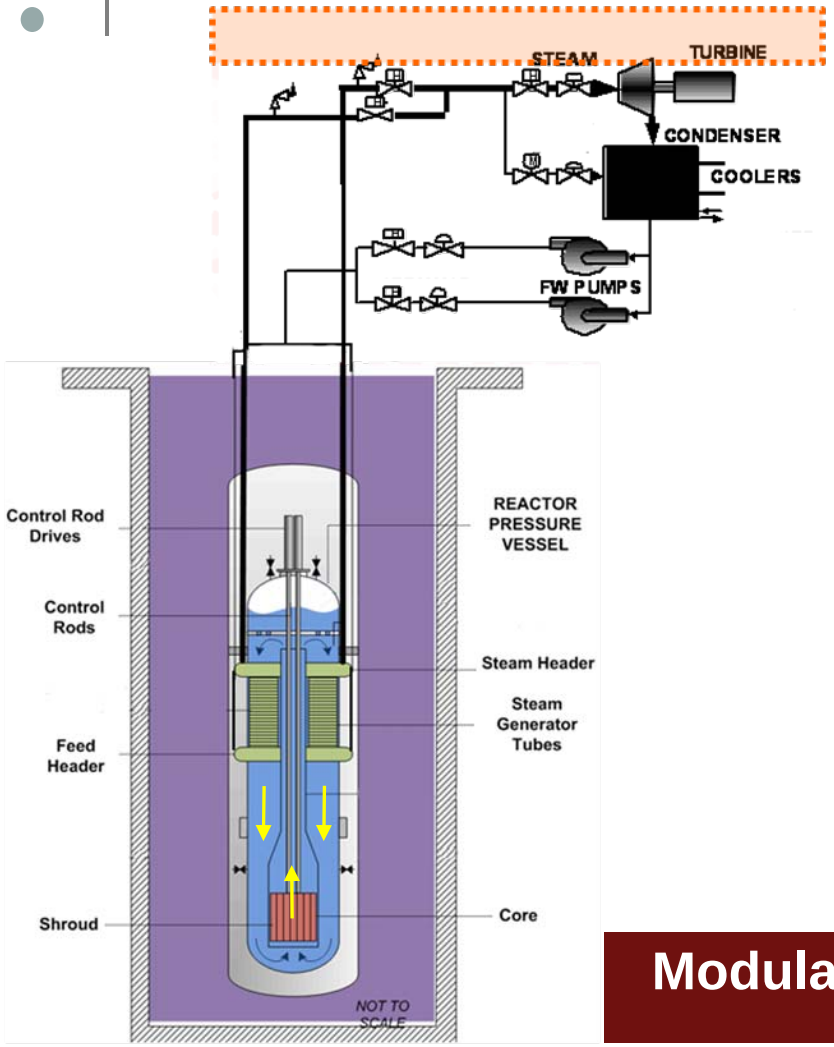
Modules can be scaled to achieve large generation capacities

Basic Plant Parameters

Overall Plant	
• Net Electrical Output	540 MW(e)
• Plant Thermal Efficiency	30%
• Number of Power Generation Units	12 modules
• Nominal Plant Capacity Factor	> 90%
Nuclear Steam Supply System - single module	
• Net Electrical Output	45 MW(e)
• Steam Generator Number	Two independent tube bundles
• Steam Generator Type	Vertical helical tube
• Steam Cycle*	Superheated
• Turbine Throttle Conditions*	3.1 MPa (450 psia)
• Steam Flow *	71.3 kg/s (565,723 lb/hr)
• Feedwater Temperature*	149° C (300° F)
Reactor Core	
• Thermal Power Rating	160 MWt
• Operating Pressure	8.72 MPa (1850 psia)
▪ Fuel	UO_2 (< 4.95% enrichment)
▪ Refueling Intervals	24 months
▪ Fuel Assemblies	37 assemblies - 17 x 17 configuration, 2 meters in length

* Actual Parameters depend on cycle optimization.

NuScale Delivers the "Economies of Small"

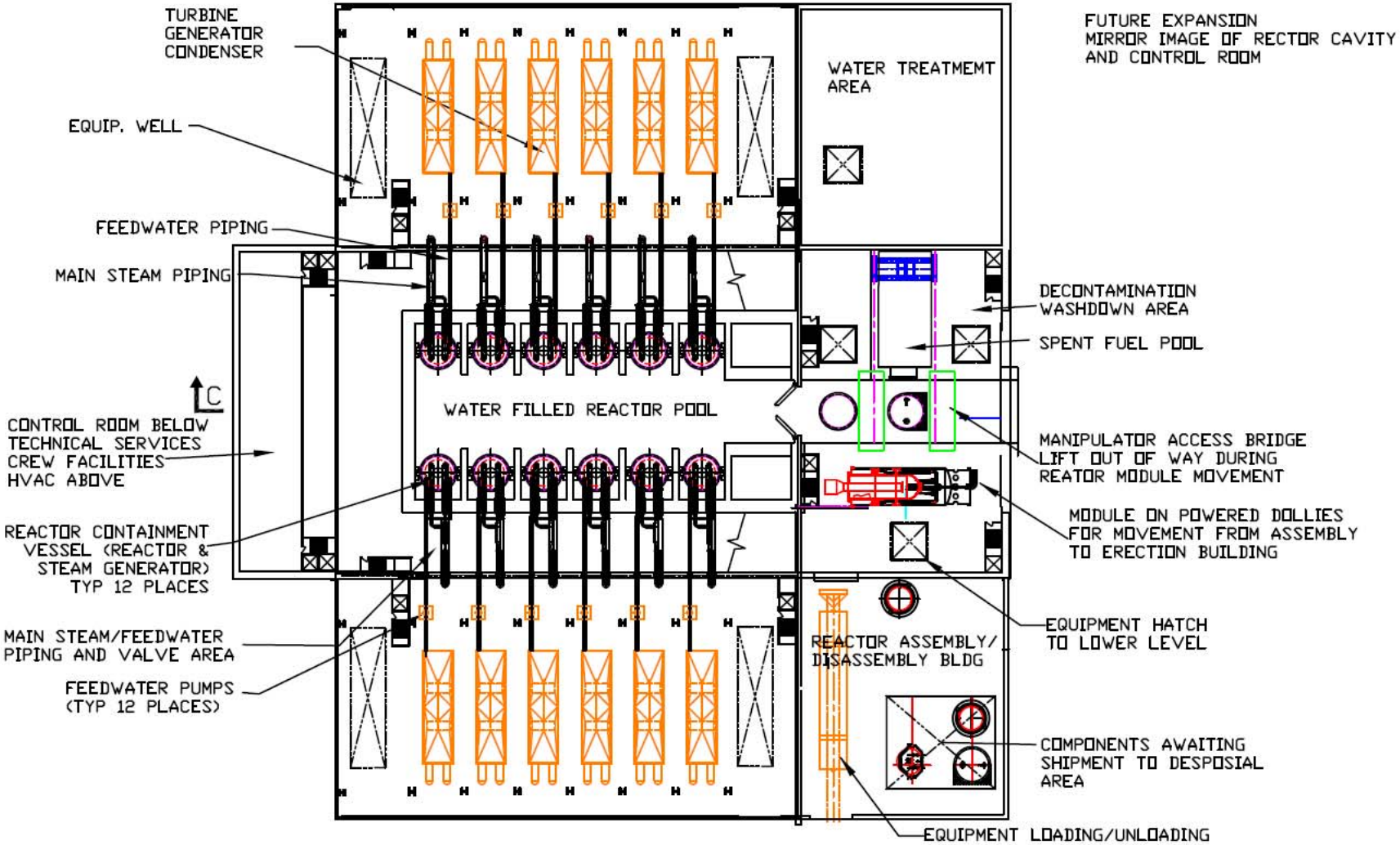


- Construction Simplicity:
  - **Major components prefabricated and shipped by rail, truck or barge** – Entire nuclear system is 60' x 15' / 450 tons
- Natural Circulation Cooling:
  - **Inherently safe** – Eliminates major accident scenarios
  - **Improves economics** – Eliminates pumps, pipes, auxiliary equipment
- Below Ground:
  - **Enhances security and safety** – Critical components - reactor, control room, fuel pool - located below ground

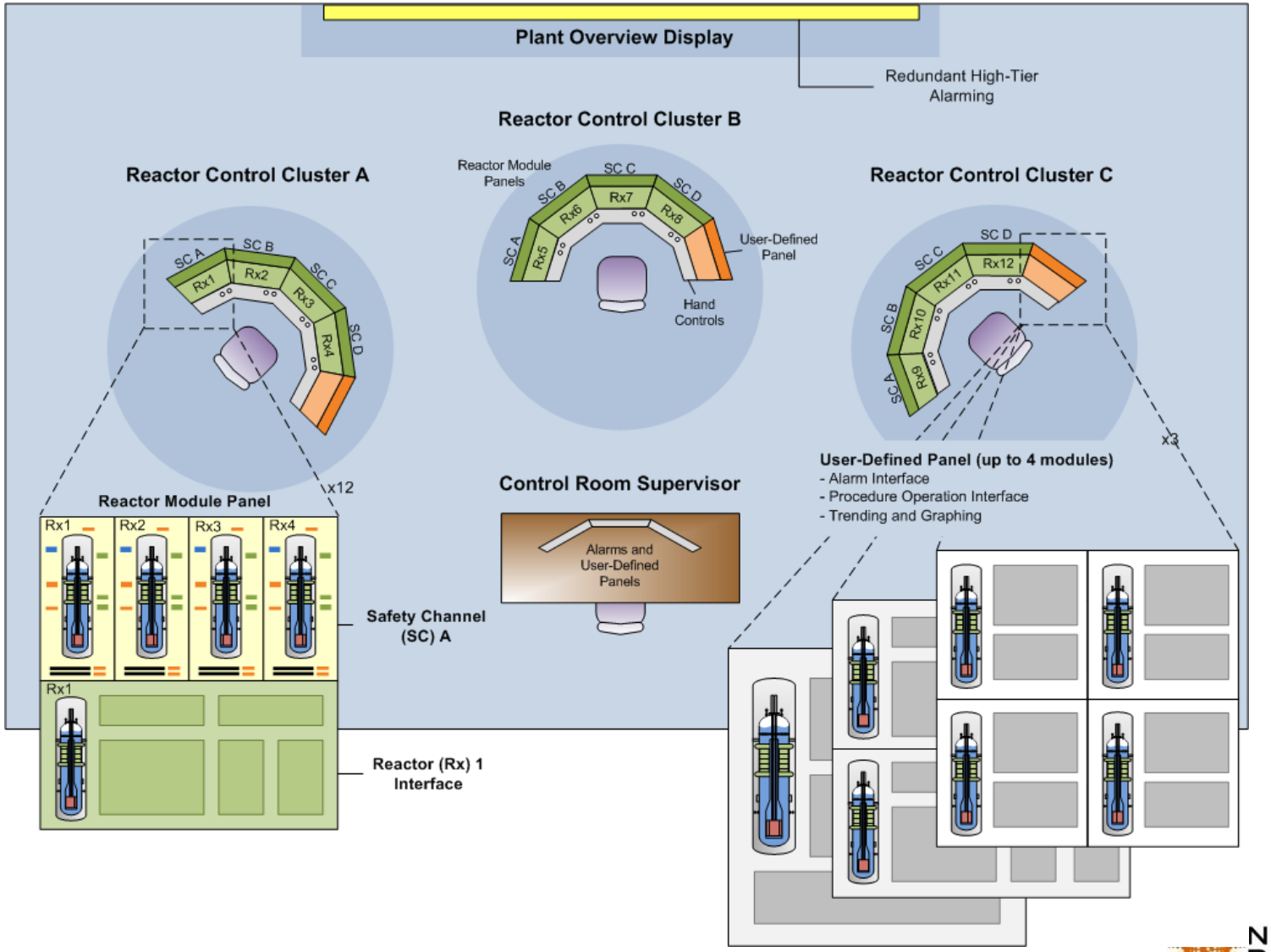
Modular, prefabricated, simple and safe.

Standardized Design = Flexible Capacity

(12 Modules – 540 Mwe)



Multi-Module Control Room



Standard LWR Fuel = Proven Technology

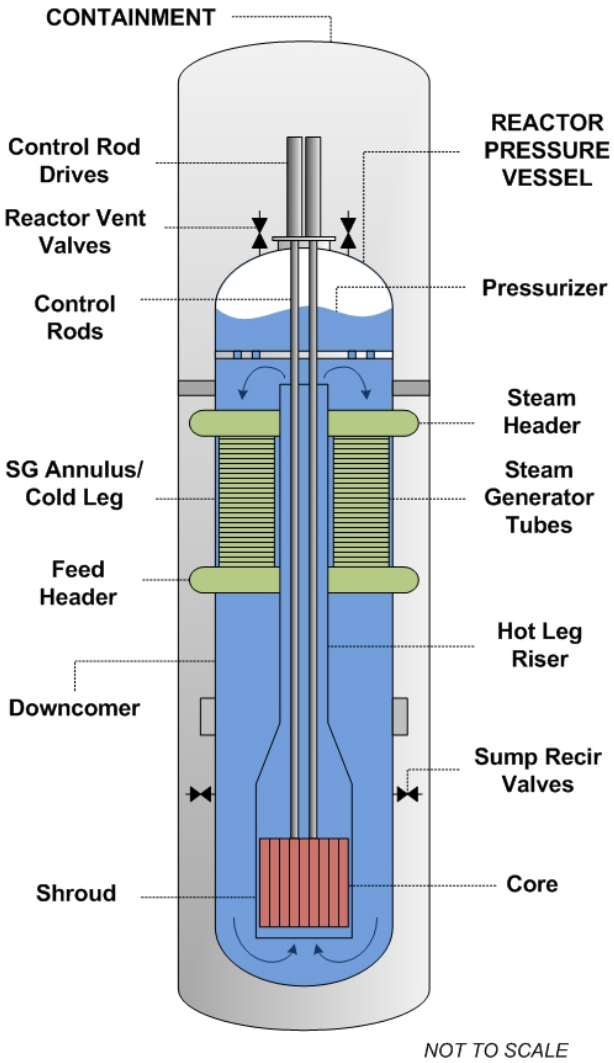
NuScale technology uses the same light water reactor fuel design found in most Pressurized Water Reactors

- 37 fuel assemblies per core
- 17 x 17 rod configuration
- assemblies ~ 2 meters in length
- enrichment ~ 4.95 percent
- 24 month refueling cycle to match required inspections and tests

Simplicity in Motion - Operating Mode

NuScale uses a convection process, or natural circulation, to produce steam

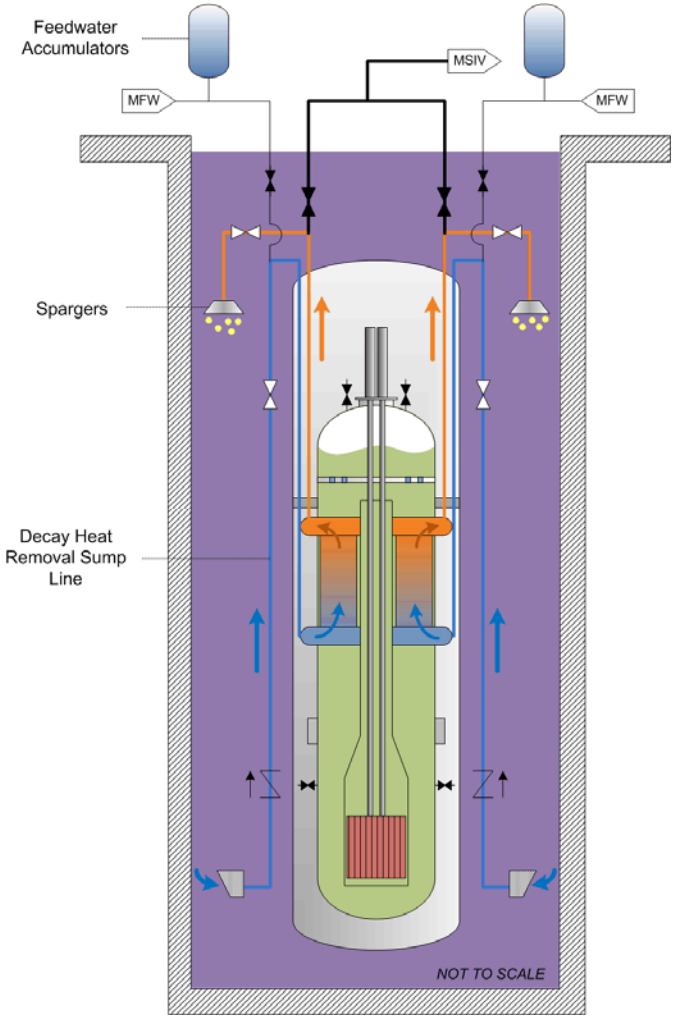
- Water heated in the nuclear core rises inside the hot leg
- At the top of the Riser, water is drawn over the helical coil steam generator inside the Reactor Pressure Vessel
- After the water exchanges its heat to produce steam, it cools and increases in density, falling to the bottom of the reactor
- Cool water is drawn over the fuel and repeats the process



Passive System Offers Inherent Safety

The passive safety system to keep the fuel cooled in shutdown mode is inherently simple and safe.

- Accumulators provide initial uninterrupted flow to the steam generators
- Cold water is then drawn into the SG's from the cooling pool
- Steam is redirected through submerged spargers into the pool
- System operates the same in loss of power scenario



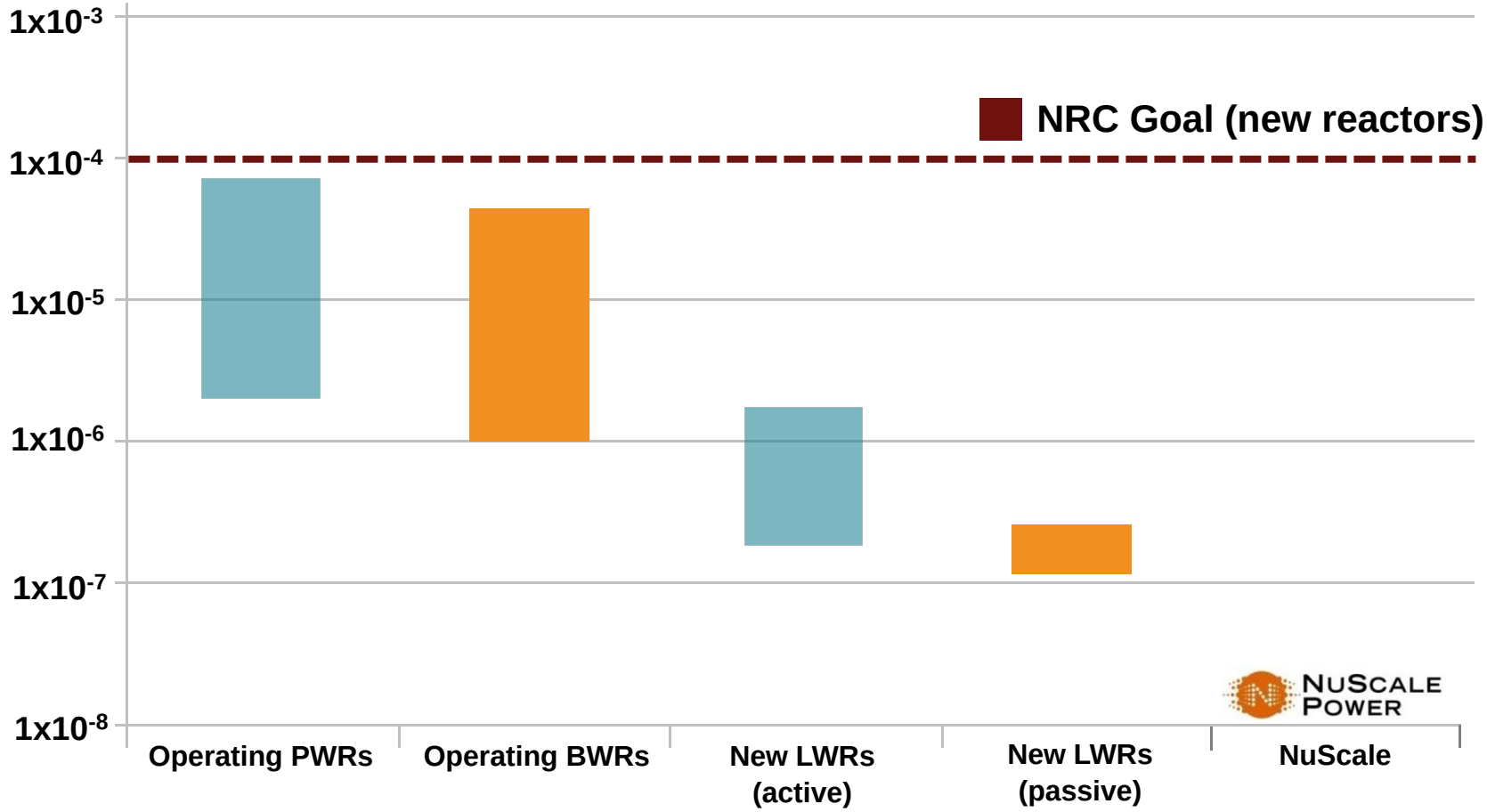
Integral Test Facility Confirms Safety, Design and Performance

- One-third scale, electrically-heated prototype of NuScale plant confirms performance and safety
- Provides benchmark data for NuScale design and safety analysis
- Reduces design and operations risks
- Reduces licensing risk
  - Uses same approach developed to successfully certify the AP600 and AP1000 designs

Independent Review Panel Results

- LOCA Thermal Hydraulic Review
  - Large-break Loss of Cooling Accident (LOCA) **eliminated** by design
  - Small break LOCAs will not uncover the core, thus do not challenge plant safety
- Severe Accident Review
  - Indicated that the PRA is overly conservative with regard to events that lead to core damage
- Preliminary PRA already indicates that the overall Core Damage Frequency is extremely low

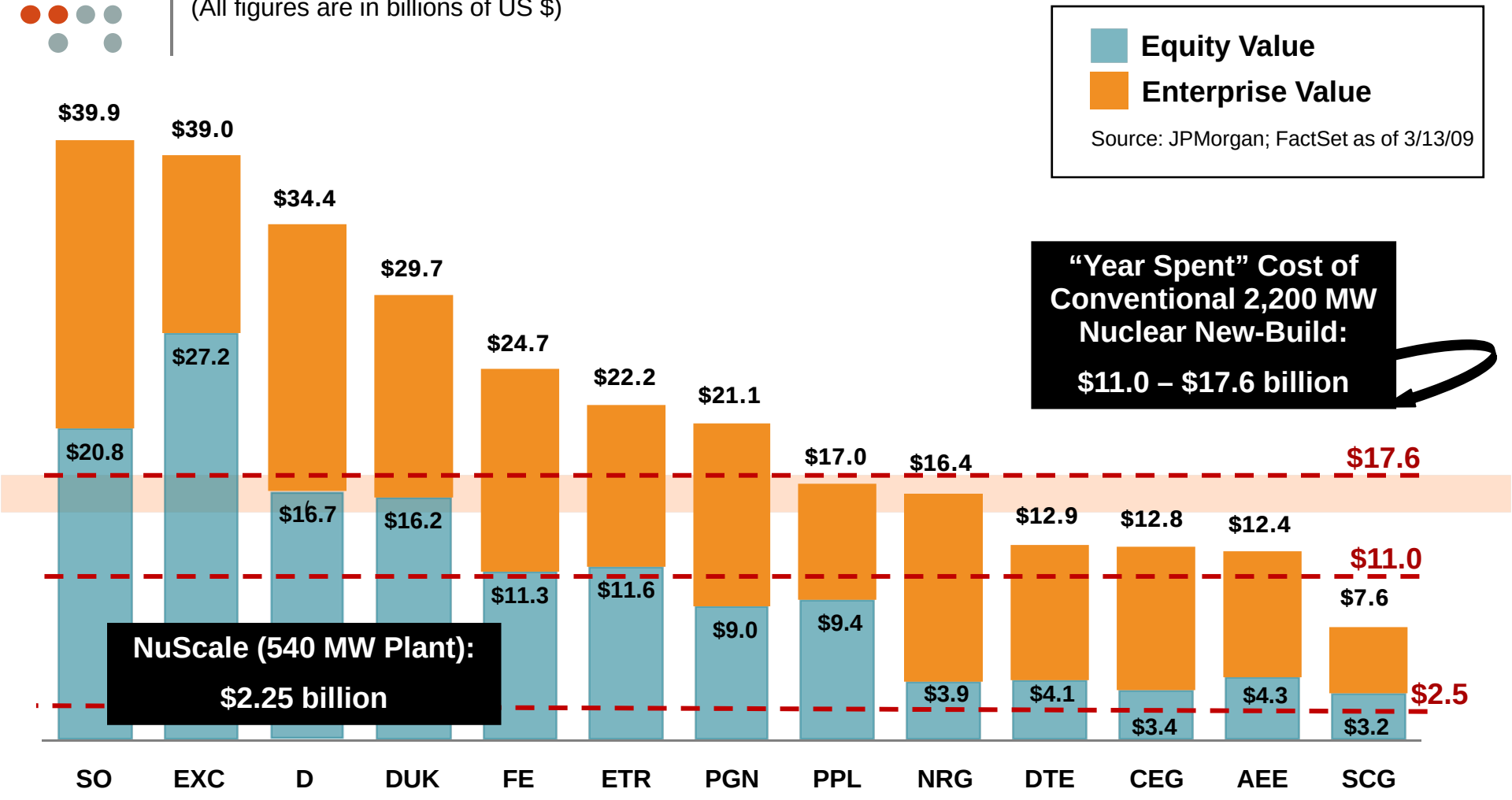
Plant Safety Improved By 10-100x



Source: NRC White Paper, D. Dube; basis for discussion at 2/18/09 public meeting on implementation of risk matrices for new nuclear reactors

Capital Cost is THE Issue for Large Plants

(All figures are in billions of US $)



Why Smaller is Less Expensive

	AP1000	NuScale
NSSS Components	4 Reactor Coolant Pumps	None
	4 Cold Legs	None
	2 Hot Legs	None
	1 Pressurizer Surge Line	None
Passive Safety Systems	2 Core Make-up Tanks and Piping (2000 ft^3 each)	None
	2 Direct Vessel Injection Lines	None
	2 Passive Residual Heat Removal Heat Exchangers	None
	In-Containment Storage Tank	None
	Hydrogen Recombiners	None

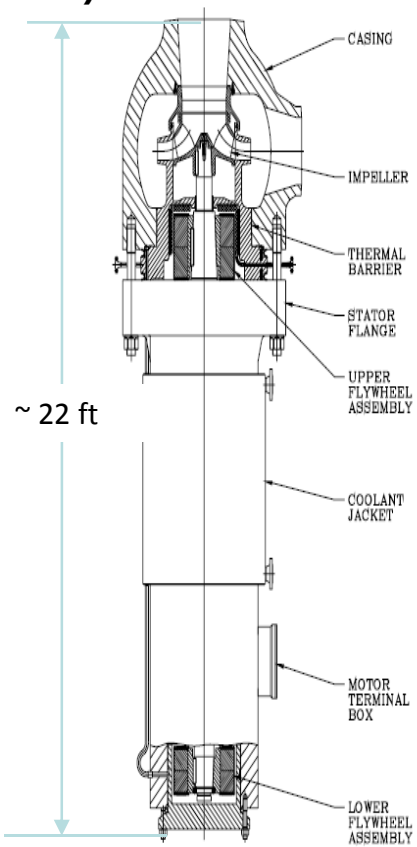
Fewer systems and components.

Fewer Systems and Components

AP1000 vs. NuScale

AP1000 Pump Casing (17 tons)

AP1000 Reactor Coolant Pump
(92 tons each)

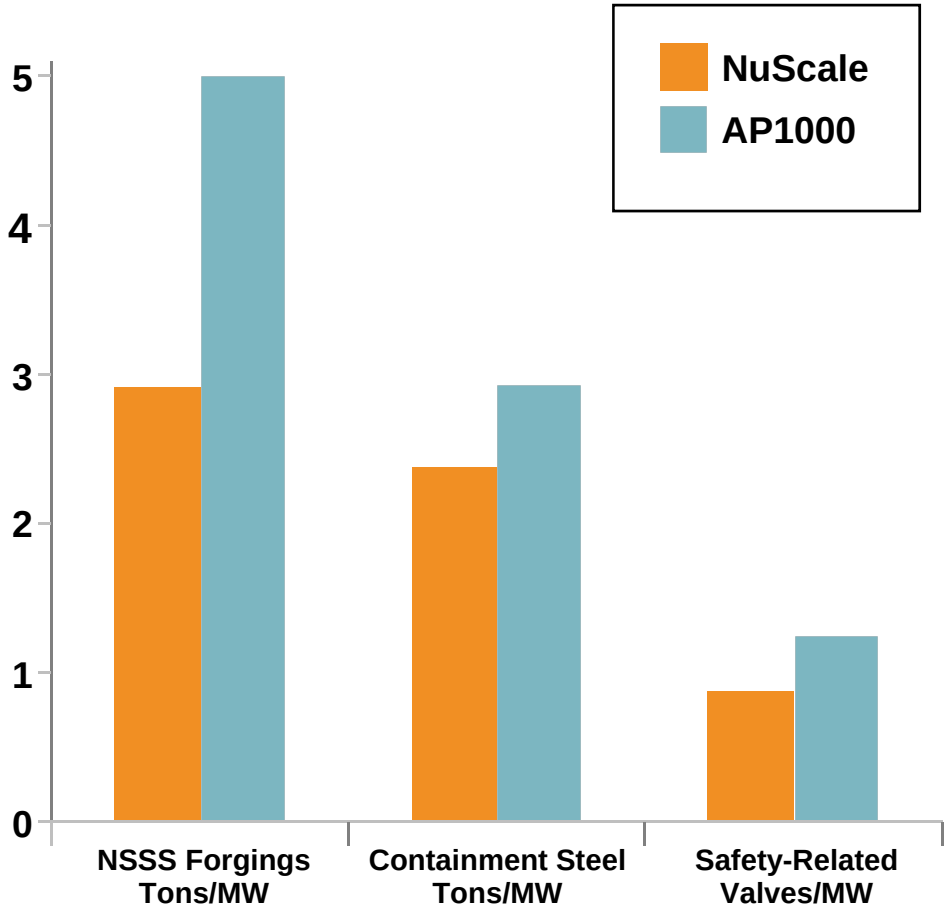


AP1000 Pumps	NuScale Pumps
Four Reactor Coolant Pumps per plant	None
Cost per RC pump: $15.8 Million	**Cost of all RC pumps per plant: $0**

Fewer systems and components: Lower Cost

Why Small, Modular Costs Less

- ✓ Less complexity = less equipment
- ✓ Modular manufacturing off-site reduces costs, simplifies construction
- ✓ Overall reduction in every aspect of training, operations, maintenance



Key U.S. Partners and Suppliers

NuScale Power

Nuclear Vendor

- Design and engineering (NSSS)
- Licensing (Certification)
- Support services

Utility / Owner-Operator

(Current Nuclear Utility

- Site selection
- Licensing (ESP/COL)
- Operations

General Dynamics Electric Boat

Oregon Iron Works, Inc.

Curtiss Wright

Suppliers

- Fabricate Modules
- Steam Generator
- Forgings
- CRDMs

Kiewit

A/E Constructor

- Design & Engineering (BOP)
- Project Management
- Site Preparation & Construction

Kiewit Corp.
Engineer Procure Construct

- 125-year history
- Owned entirely by active employees
- $8 billion in 2008 revenue
- *Engineering News-Record* (*ENR*)
  - One of *ENR's* Top 10 Contractors since 1995
  - 2nd Power
  - 1st Domestic Heavy Contractors
  - 1st Bridges
  - 2nd Offshore and underwater facilities
  - 3rd Highway
  - 2nd Transportation
  - 5th Overall
- 25,000 employees
- Corporate headquarters: Omaha, Nebraska

Kiewit: Committed to being the best contractor on earth.

Integrated Approach

Drives Costs Down

Kiewit

Reduced capital costs and shortened construction schedule

Increased Pre-Fab

Constructability Structures

Ongoing Estimate Validation

Initial ROM Cost and Schedule Estimates

Cost and Schedule Targets

Increased Thermal Power (160 MWt)

T-G Matched to Steam Conditions

Improved Heat Cycle Efficiency

Increased electric generation per module

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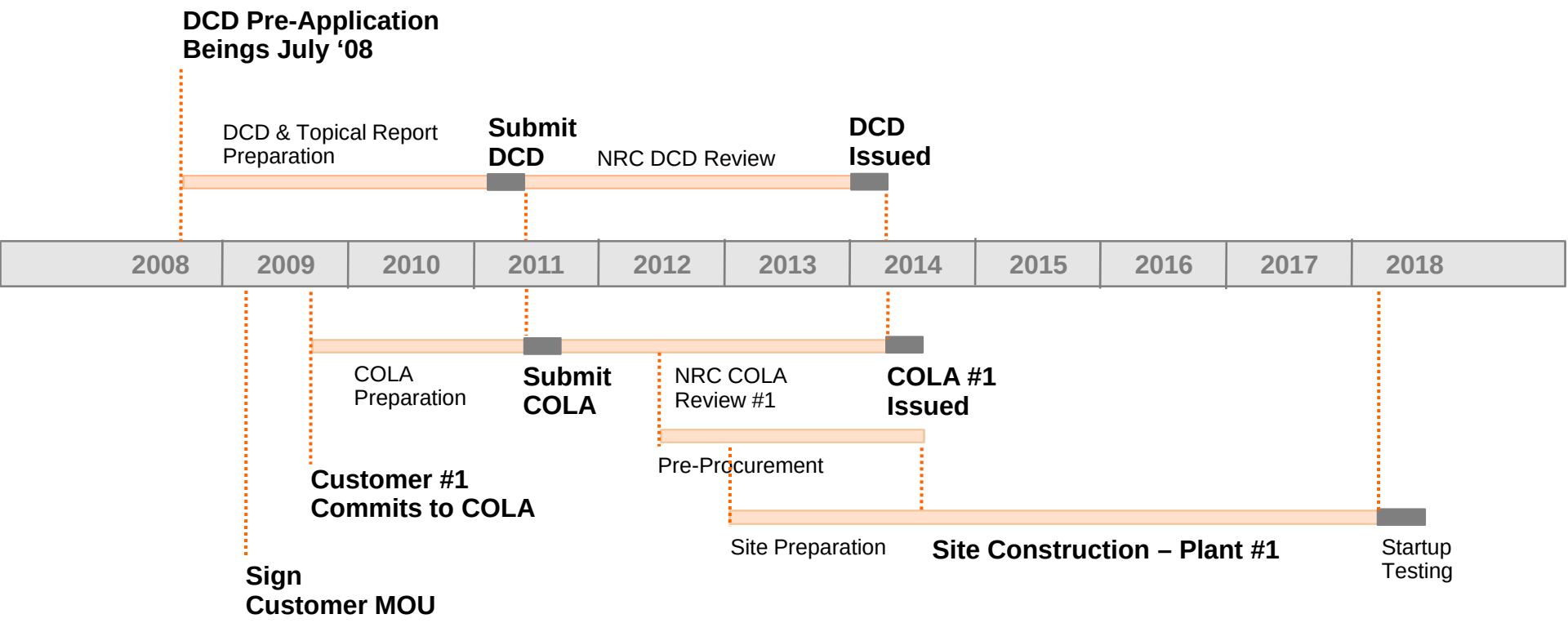
Safety and Licensability

- NSSS supplier applies for Design Certification
  - certifies standardized design for all plants
  - valid for 15 years after issuance
- Owner-Operator has two paths
  - Early Site Permit
    - technology neutral with all site issues addressed and adjudicated
  - Construction & Operating License
    - combined license reduces risk and limits later intervention
- NRC has singular focus on safety

Projected Timeline



NuScale Advantages

- Passive cooling and lack of complexity enhance safety and simplify construction, operations and maintenance
- Prefabricates the entire NSSS including containment as a single unit off site – no on-site NSSS construction
- Fully utilizes proven LWR technology systems
- Prototype test facility validates safety, performance and facilitates licensing
- Maximizes refueling flexibility
- Business risk reduced by early utilization and integration of
  - PIRT and PRA to inform the design and validate safety
  - The A/E contractor early in the design process

NuScale Advantages: Safety / Economics / Schedule / Licensing Certainty

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Learn More

- Updates at www.nuscalepower.com
- Send e-mail to info@nuscalepower.com to be added to electronic mailing list
- Follow licensing at www.usnrc.gov
- Dr. Jose Reyes, NuScale CTO, will make the keynote address at the IAEA International Conference on Water Cooled Reactors, Vienna, 27-30 October 2009
- Visit NuScale in Corvallis, OR, and tour prototype / test facility at Oregon State University