

NuScale Power – Safe, Economic, Scalable, Proven Nuclear Technology



**Bruce Landrey
Vice President, International Marketing
10 August 2012**



SMRs – The Perspective Today

“Small Modular Reactors represent the innovation that is the competitive edge for this country.”

***Nicole Y. Lamb-Hale
Assistant Secretary for Manufacturing & Services
U.S. Department of Commerce
Platts Nuclear Conference
16 February 2011***

SMRs – Western Governors’ Policy

SMRs are envisioned to require limited on-site preparation and are expected to essentially be ready to “plug and play” when they arrive from the factory. Those working on SMRs expect them to provide simplicity of design, enhanced safety features, and the economics and quality afforded by factory production. It is envisioned that additional modules can be added incrementally as demand for energy increases.

**Western Governors Association
Policy Paper on Nuclear Power
2011**

Everything Changed Except Business Risk

Old Nuclear	New Nuclear
Every plant is “First of a Kind”	NRC “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 routinely exceed 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

USA Market Driver – Aging Infrastructure

Coal

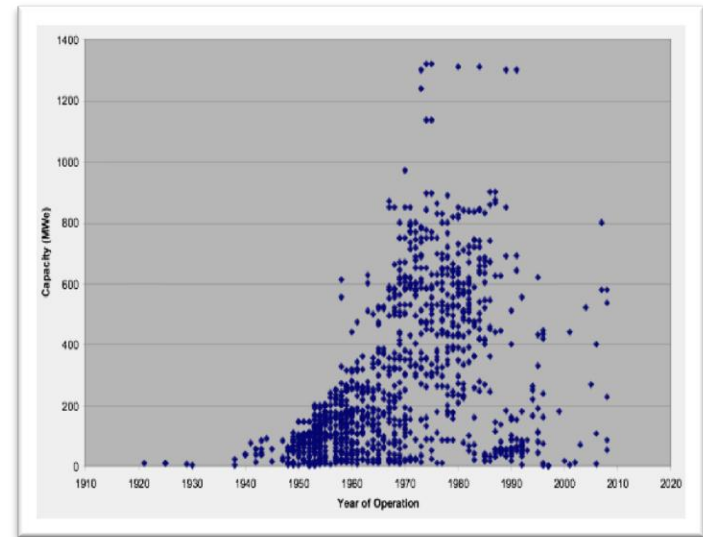
- 330 GWe from 1,112 coal-fired power plants
- 50 percent are more than 40 years old
- 230 plants canceled totaling 104 Gwe

Nuclear

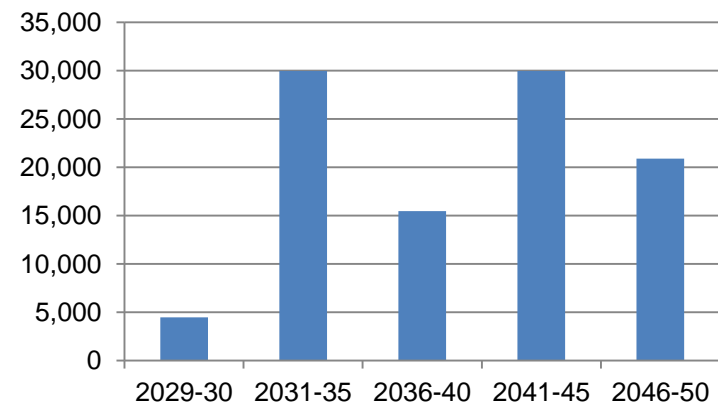
- 100 GWe from 104 plants = 20 percent of total U.S. generation
- NRC licenses expire and retirements begin in 2029. All plants retire by 2050

Renewables

- For wind and solar the best sites are gone
- Intermittency an increasing issue on all grids



Aging US Coal Plants



Nuclear Plant Retirements

Drivers for Small Modular Reactors

Safety

- Smaller size and simplicity of design result in greater opportunities to enhance safety. Not subject to large LWR scenarios – large break LOCA, SBO
- Natural circulation for passive “always-on” cooling

Reduced Business Risk

- Less capital at risk for a shorter period
- No longer a “bet the company” decision

Economies of Small

- Less to design, engineer, license, build, operate, maintain, decommission
- Extensive modularity and off site manufacturing of complex components

Broad Accessible Market

- True scalability – from 45 MWe to 540 MWe in a single nuclear plant
- Multiple applications: commercial power, desalination, district heating.

Capturing the “Economies of Small”



**Nuclear system
construction moved off
site.**



Simplicity = Greater Safety, Lower Costs and Risks

- Proven technology
- Fewer systems and components than traditional plants

- ✓ Less to **Develop**
- ✓ Less to **Design**
- ✓ Less to **License**
- ✓ Less to **Build**
- ✓ Less to **Operate**
- ✓ Less to **Maintain**



NuScale Corporate Overview



NuScale Power History

- Oregon State University builds ¼ scale test facility to support Certification of the AP600 and AP1000 without requiring a “prototype” (1990s)
- OSU, Idaho National Laboratory and Nexant develop MASLWR (NuScale) design and test facility originally developed under DOE funded program in 2000-2003
- OSU refines and develops the design with proprietary improvements (2004-2007)
- NuScale Power Inc. formed in June 2007. Tech-transfer agreement with OSU provides exclusive use of the Integral System Test facility and patents.
- 2008 – 2011
 - Establish Executive Team and staff of world-class engineers. 250 FTE’s currently
 - Gain commitment from US NRC to support licensing
 - Secure support from US Congress and US DOE
 - Secure funding from Fluor Corporation



Fluor Overview

FLUOR[®]

- ◆ Acquired majority interest in NuScale – October 2011.
- ◆ One of the world's leading publicly traded engineering, procurement, construction, maintenance, and project management companies
- ◆ **#124** in the FORTUNE 500 in **2011**
- ◆ More than **1,000** projects annually, serving more than **600** clients in **66** different countries
- ◆ More than **42,000** employees worldwide
- ◆ Offices in more than **28** countries on **6** continents
- ◆ Nearly **100** years of experience

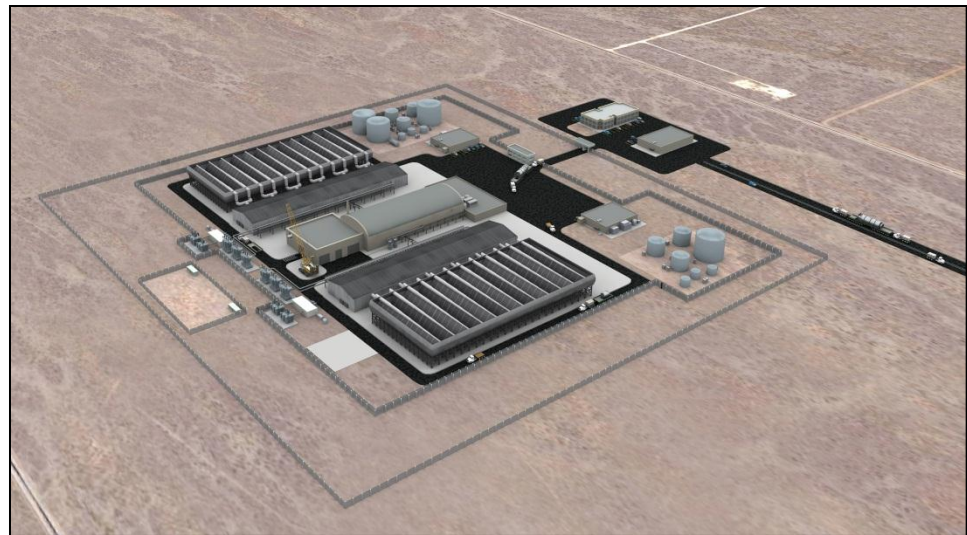


Fluor Corporate Headquarters
Dallas, Texas

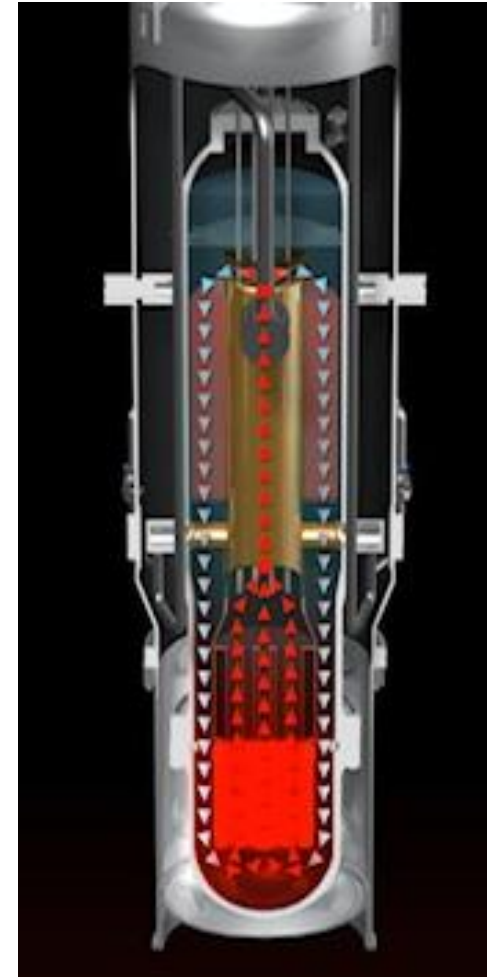
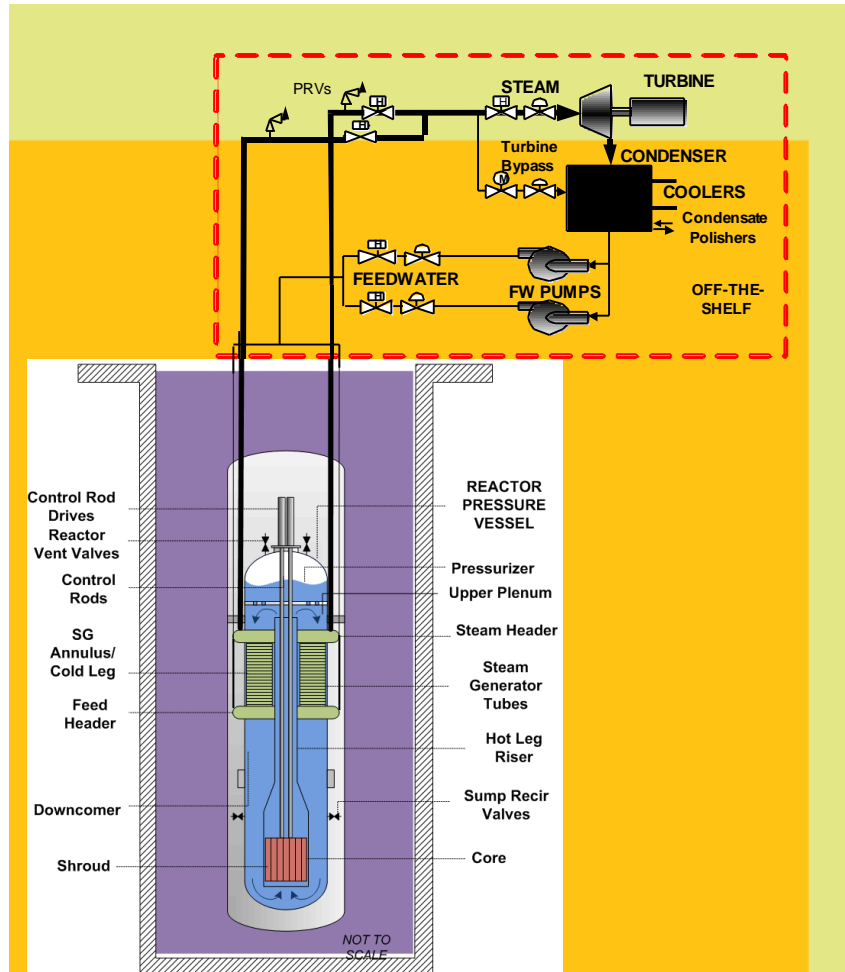
- ◆ Revenue: **\$20.8 billion**
- ◆ New Awards: **\$27.3 billion**
- ◆ Backlog: **\$34.9 billion**
- ◆ Investment Grade Credit Ratings:
S&PA-, Moody's A3, Fitch A-

Modular Scalable Nuclear Power

- NuScale Power is commercializing a 12-Module centralized nuclear power station that can be built in two increments:
 - Up to 270 MWe (1-6 modules)
 - Up to 540 MWe (7-12 modules)
- Sizes that are compatible with most power grids.
- Each power module consists of a 45 MWe Pressurized Water Reactor:
 - Factory Built
 - Natural Circulation
 - Passively Safe

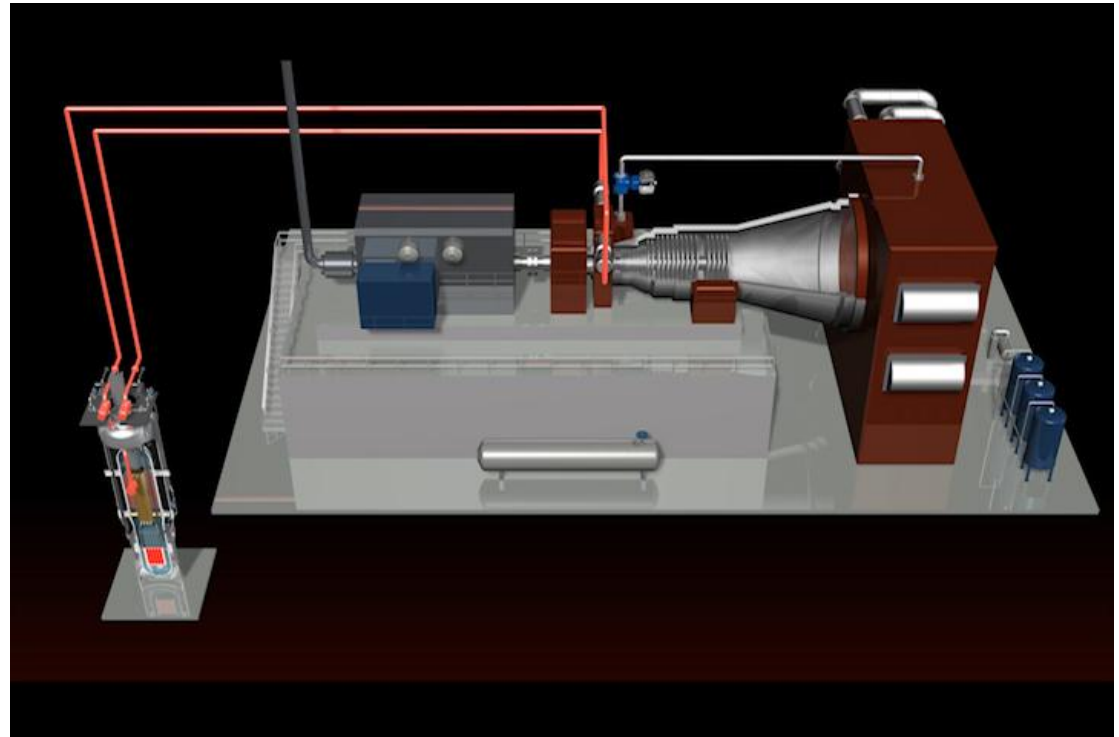


Elegantly Simple Innovative Design

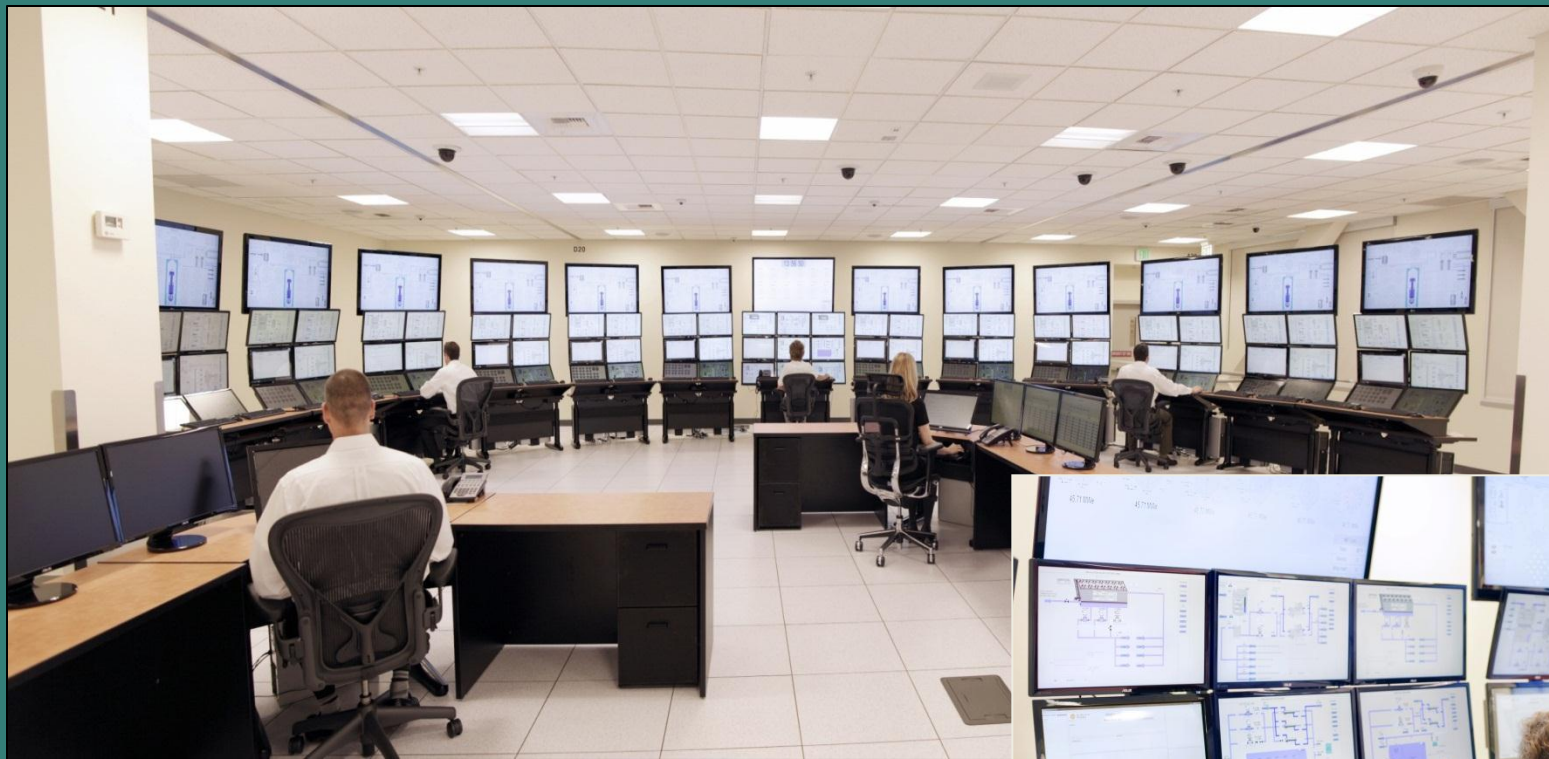


Independent TG Sets for Each Module

- Skid mounted
- Easy to transport
- Controlled fabrication
- Fast onsite installation
- Off-the-shelf models currently available
- Direct coupling to steam turbine, allowing a much safer water- or air-cooled design

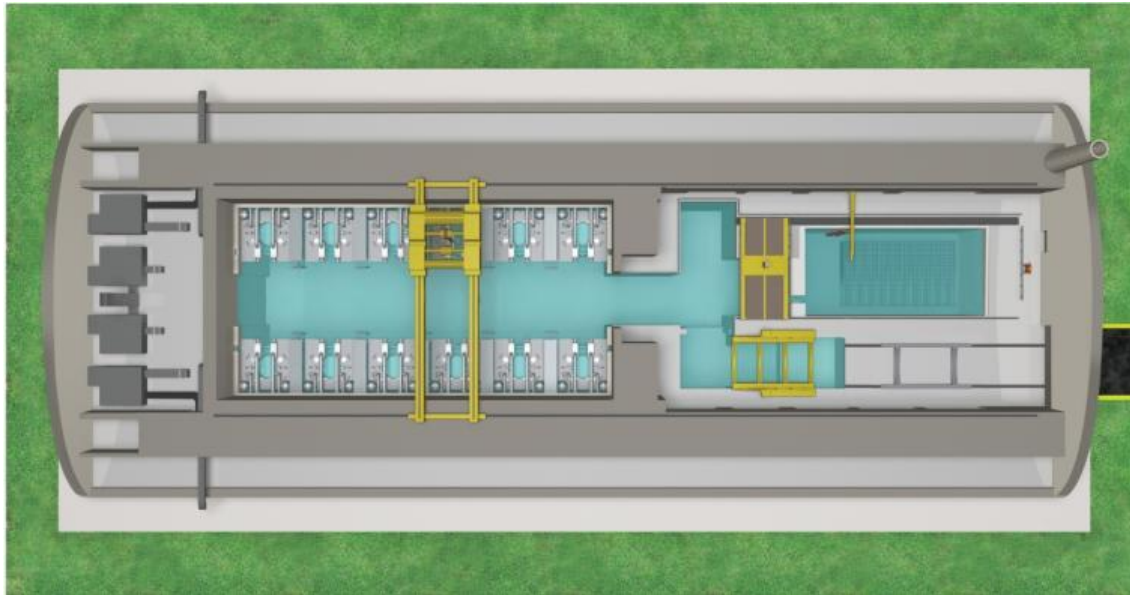


Full-Scale Main Control Room Simulator

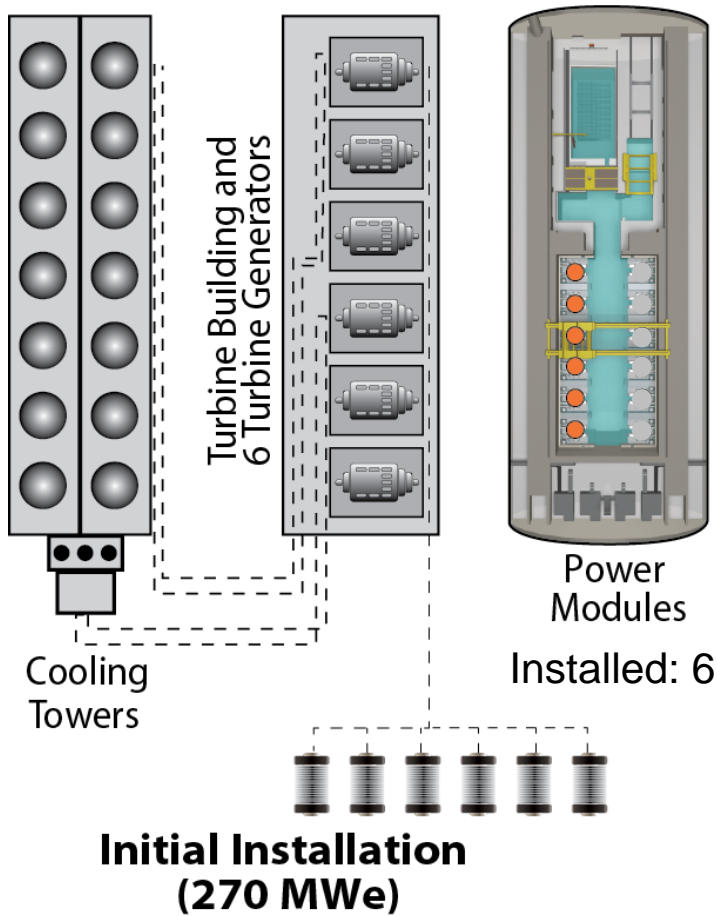


Safe and Scalable

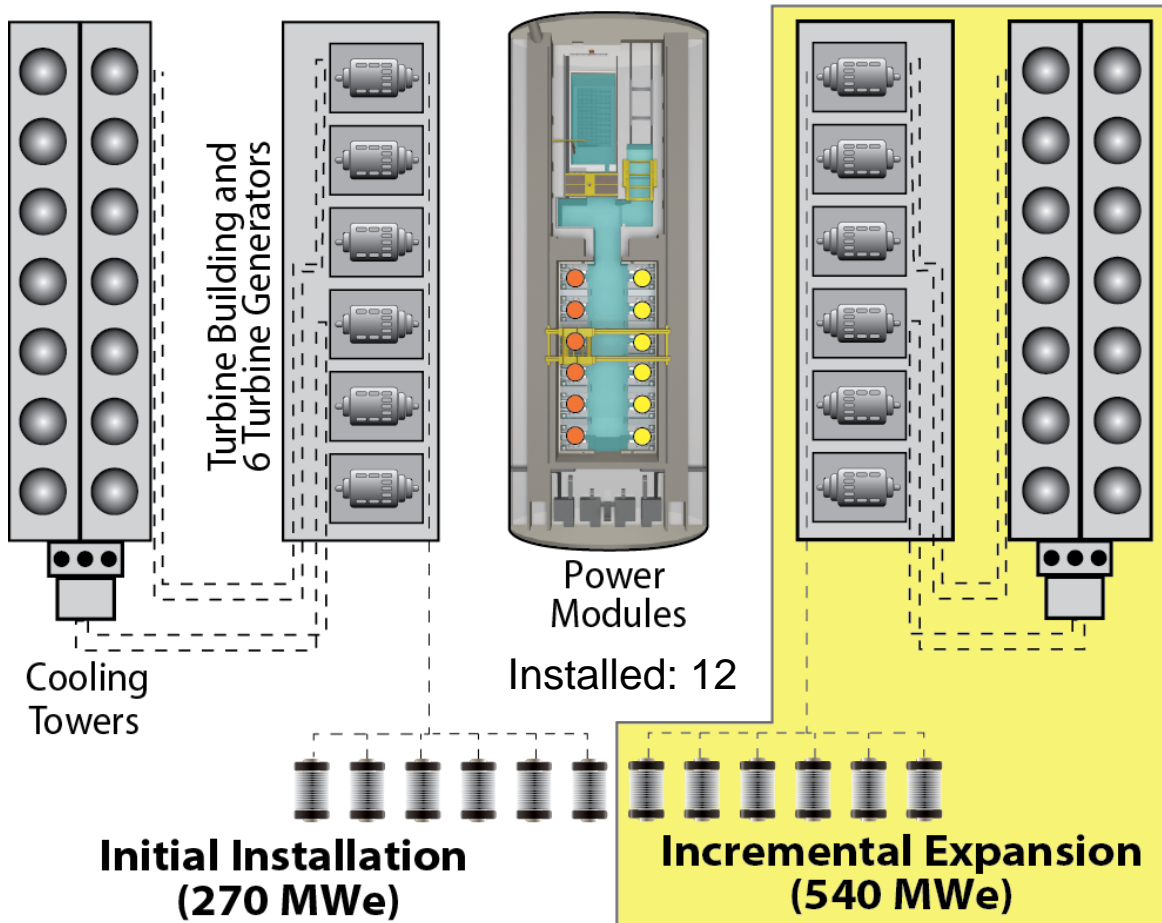
- 12 x 45 MWe Reference Plant = 540 MWe
- Each module is independent, installed and refueled sequentially
- Reactor vessel integrated into steel containment vessel installed below grade in 4 million gallon pool
- Integrated NSSS transported to site by truck, rail or barge



Incremental Build Out



Incremental Build Out



Innovative PWR Technology

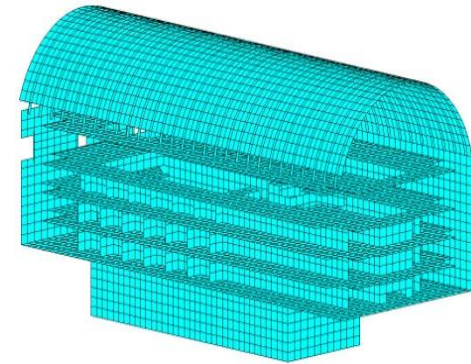
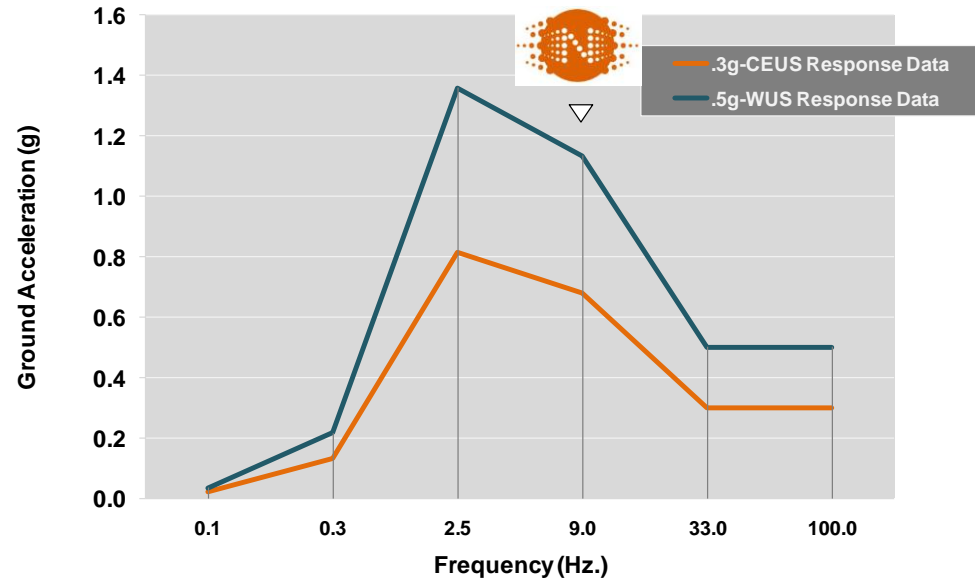


NuScale Offers an Extra Layer of Safety

- No Large Break LOCA
- No Design Basis Accident can cause core to uncover
- Peak Ground Acceleration 0.5g
- Smaller source term per reactor
- Low CDF $\sim 2 \times 10^{-8}$ per reactor year
- 7 Barriers to Fission Product Release
 - Oxide fuel pellet and cladding, reactor vessel, containment, reactor building pool water, underground stainless steel lined concrete bunker, biological shield, filtered seismic category 1 reactor building
- Deeply embedded spent fuel pool with 4 x water volume per MWt of 1000 MWe plant
- Complete Station Blackout protection without pumps, AC power, or external supplies of water
 - Passive cooling of reactor for 30 days with water followed by an unlimited period of air cooling

Extensive Siting Options

- **Robust Seismic Design**
- Designed for potentially higher seismically-active areas
- Structure composed almost entirely out of concrete, with well arranged shear walls and diaphragms which provides for high rigidity
- Significant portion of the structure located below grade partially supported by bedrock
- Large pools filled with water help dampen seismic forces



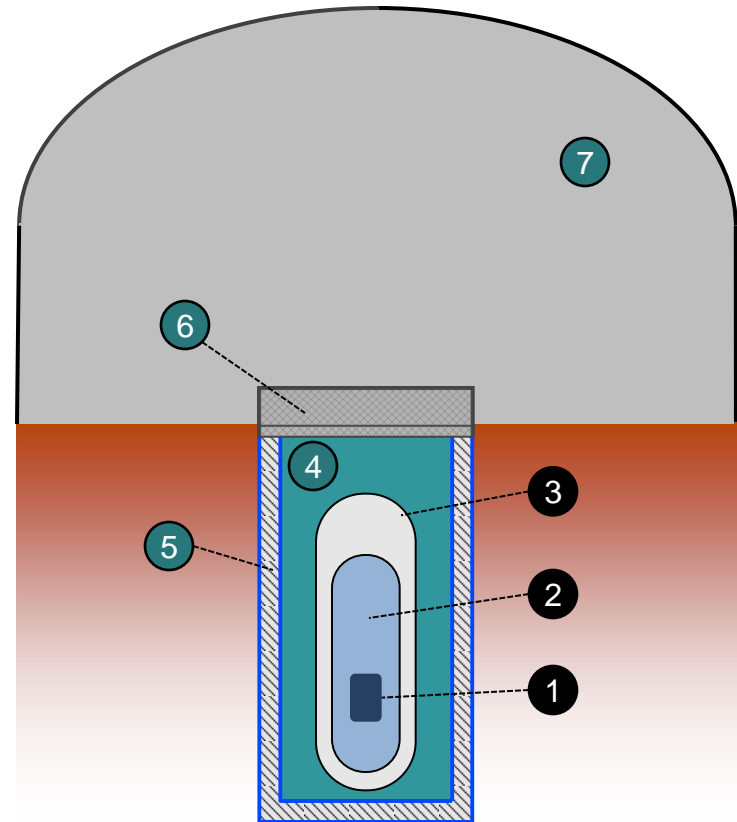
Added Barriers Between Fuel and Environment

Conventional Designs

1. Fuel Pellet and Cladding
2. Reactor Vessel
3. Containment

NuScale's Additional Barriers

4. Water in Reactor Pool (10 million gallons)
5. Stainless Steel Lined Concrete Reactor Pool
6. Biological Shield Covers Each Reactor
7. Reactor Building

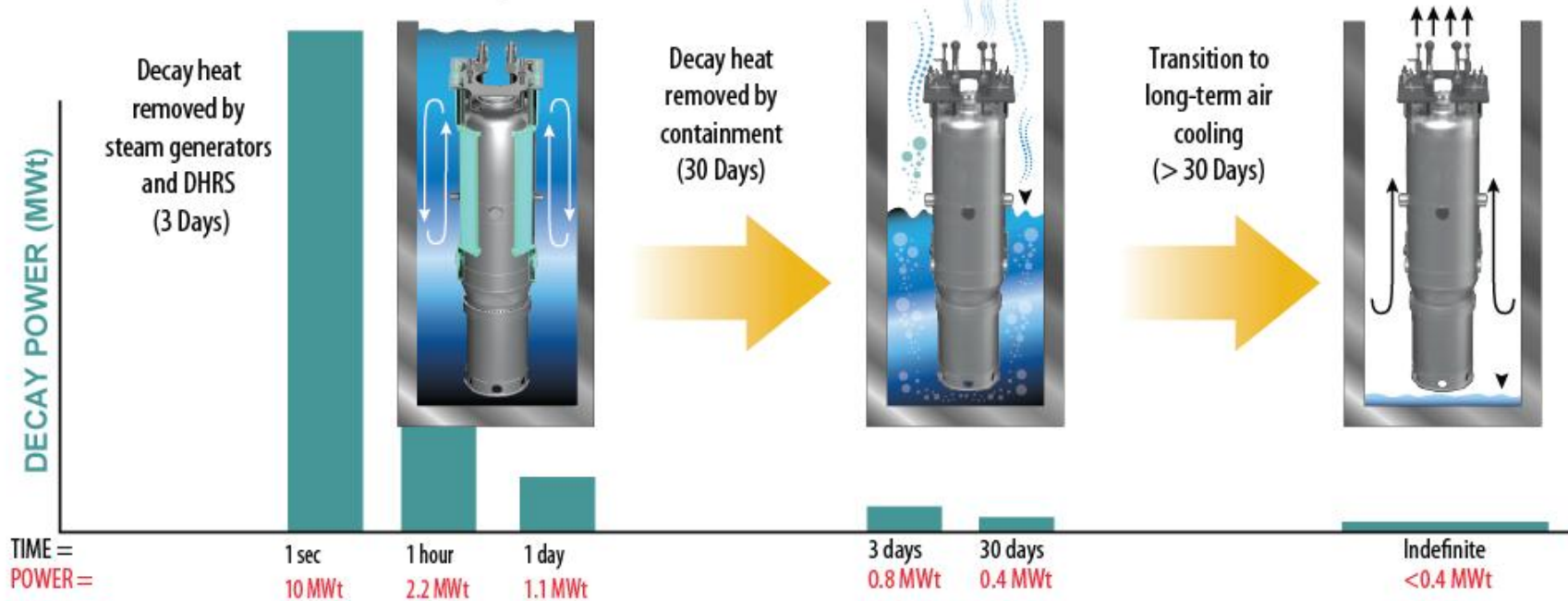


Stable Long Term Cooling

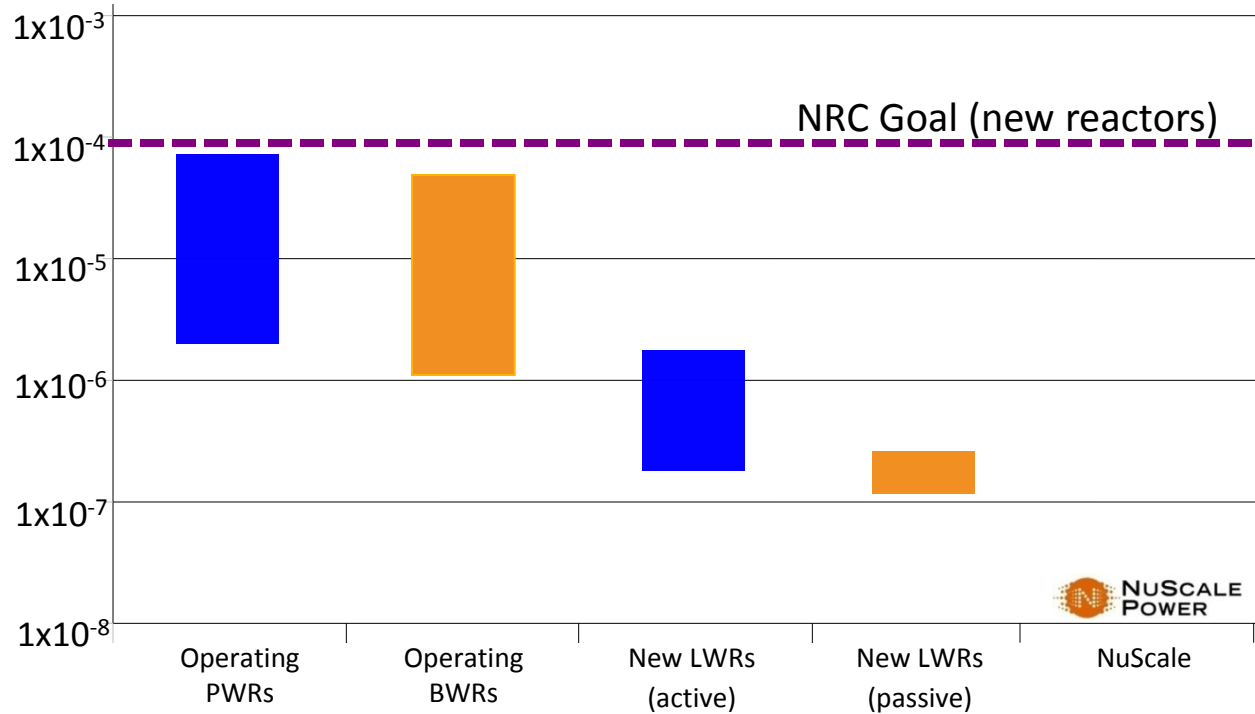
Reactor and nuclear fuel cooled indefinitely without pumps or power



No Pumps • No External Power • No External Water



Reduced Core Damage Frequency



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



Pathway to Commercialization



NuScale / NRC Engagement

- Initiated first formal iPWR NRC pre-application project in April 2008 (Project 0769)
- Conducted 11 meetings to date; 5 meetings remaining in 2012; more in 2013
- Submitted 7 reports to date (2 topical reports, 5 technical reports); 8 additional submittals committed for 2012; more in 2013
- Scheduling NRC observations of extensive testing programs at integral effects facility (OSU) and major separate effects facilities (fuel, HCSG)
- NRC developing Design Specific Review Standards for NuScale and mPower



US DOE Commercialization Program

- **Goal – “expedite the construction and operation of the first-mover SMRs”**
- **\$452 million, five-year program**
- **Starts with ~ \$67 million in FY2012**
- **Maximum 50/50 cost share for:**
 - Design Certification
 - Reference Construction & Operating License
 - First of a kind costs
 - Early site permit
- **Funding Opportunity Announcement decision pending**



Customer Advisory Board



Suppliers and Strategic Partners

NUCLEAR "MODULE" MANUFACTURERS



ENGINEERING DESIGN AND TECHNOLOGY



LICENSING AND REGULATION



NuScale SMR “Value Chain”

Value chain

Design & Technology Development / Licensing	Manufacturing & Equipment Supply	Engineering Procurement Construction	Training & Operations
<ul style="list-style-type: none"> •Engineering •Component development and testing •System development and testing •Safety Analysis •Computer modeling •Software development •Legal 	<ul style="list-style-type: none"> •Engineered Components •NSSS •Turbine-generators •Heat exchangers •Pumps •Piping •Forgings •Valves •Instrumentation •Controls •Wire and cable •Fuels •HVAC •Materials handling •Facility MRO 	<ul style="list-style-type: none"> Skilled craft labor – •Electricians •Welders •Piping •Instrumentation •Quality assurance •Mechanical •Engineering •Excavation, site preparation •Construction materials – concrete, steel •Administrative and Management 	<ul style="list-style-type: none"> •Trainers •Operators •Engineers •Instrument & Control Technicians •Health physics •Security •Administrative and Management



*Bruce Landrey
Vice President, International
Marketing
6650 SW Redwood Lane
Suite 210
Portland, OR 97224*

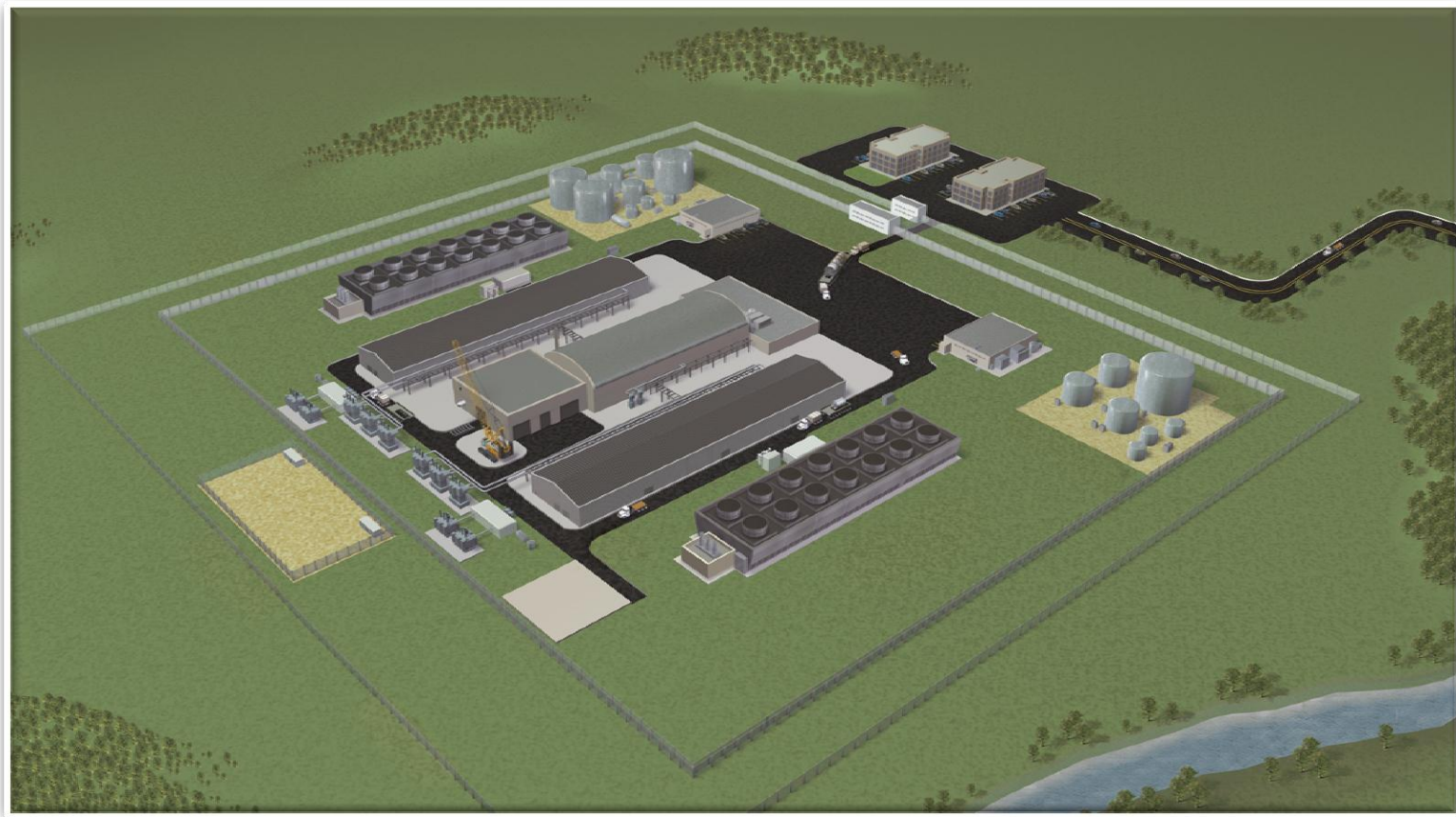
[*blandrey@nuscalepower.com*](mailto:blandrey@nuscalepower.com)

503-715-2230

[*http://www.nuscalepower.com*](http://www.nuscalepower.com)



Compact Site Layout



- **Site boundary is 330 meters x 360 meters (12 hectares) “inside the fence”**
- **All cooling options available.**



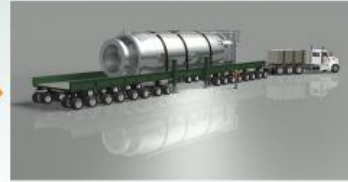
Factory Manufacturing



Module includes Containment and Reactor Vessel



Shipped by Truck, Rail, or Barge

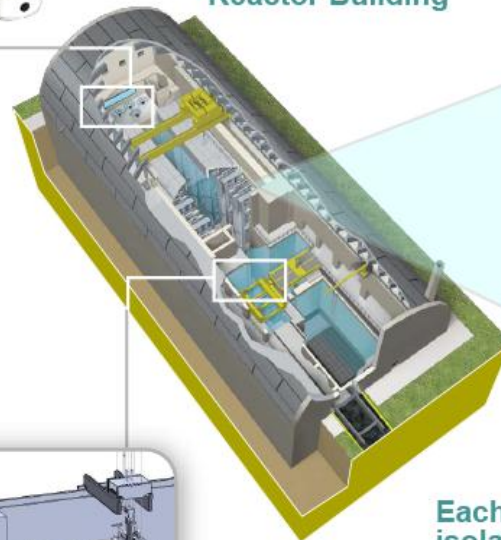


Skid-Mounted Steam Turbine/Generator



Below-Ground Control Room provides enhanced security and state-of-the-art controls

12 Module Reactor Building

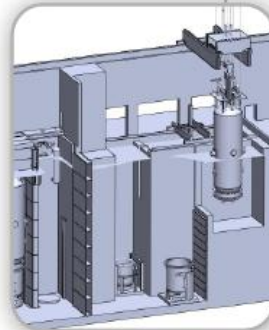


Containment
Reactor Vessel
Steam Generator
Fuel



Each Module is refueled underwater while the remainder of the plant produces power

- Refueled once every 24 months
- 10 Day Refueling Target



Each Module is installed in its own seismically isolated bay

- Natural Circulation (No Reactor Coolant Pumps)
- Standard 17x17 PWR Fuel
- Standard Magnetic Jack Control Rod Drives
- Internal Steam Generator and Pressurizer
- 45 MWe Net Power