



TRAINING  
AND  
TECHNOLOGY  
DEMONSTRATION  
AREA

# Nuclear Energy Safety POWER SYSTEMS TECHNOLOGY



# BRAYTON CYCLE CAN BE APPLIED IN NUMEROUS WAYS



- *Biomass to Electricity*
- *Geothermal*
- *Fossil*
  - Sequestration Ready
- *Solar/Nuclear Electric Propulsion*
- *Concentrated Solar Power*
- *US Department of Energy Advanced Reactors*
  - Gas, Metal, Salt Coolants

# SUPERCRITICAL CO<sub>2</sub> - BRAYTON

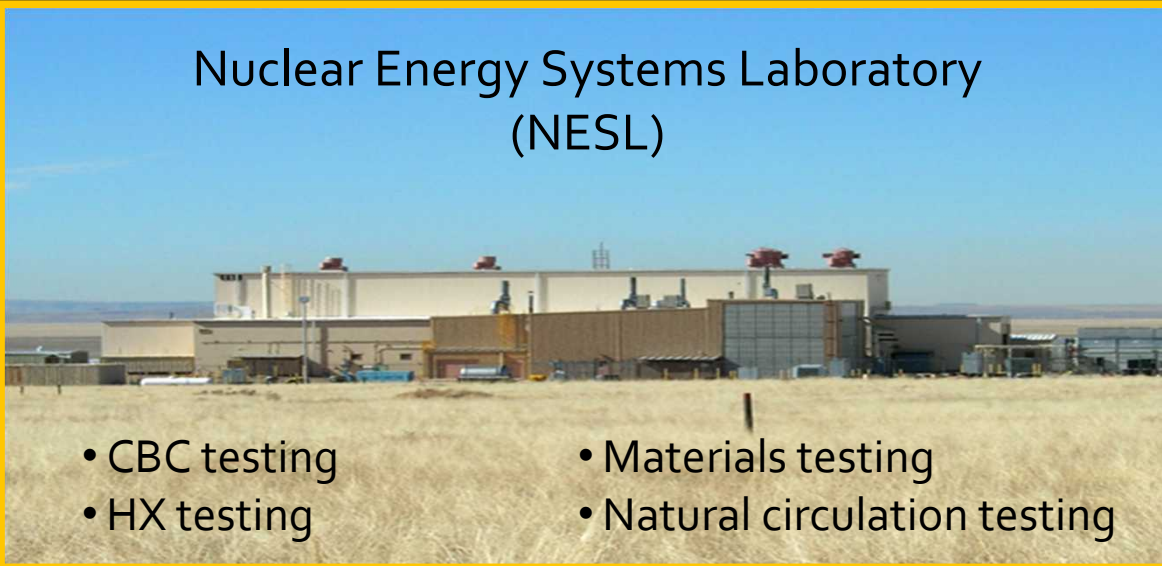
World's first and only operating recompression closed Brayton cycle

- *Demonstrate theoretical performance*
- *Investigate operational characteristics*
- *Test customer cycles with this highly versatile testing platform*



# SUPERCRITICAL CO<sub>2</sub> - BRAYTON

Nuclear Energy Systems Laboratory  
(NESL)



- CBC testing
- HX testing
- Materials testing
- Natural circulation testing

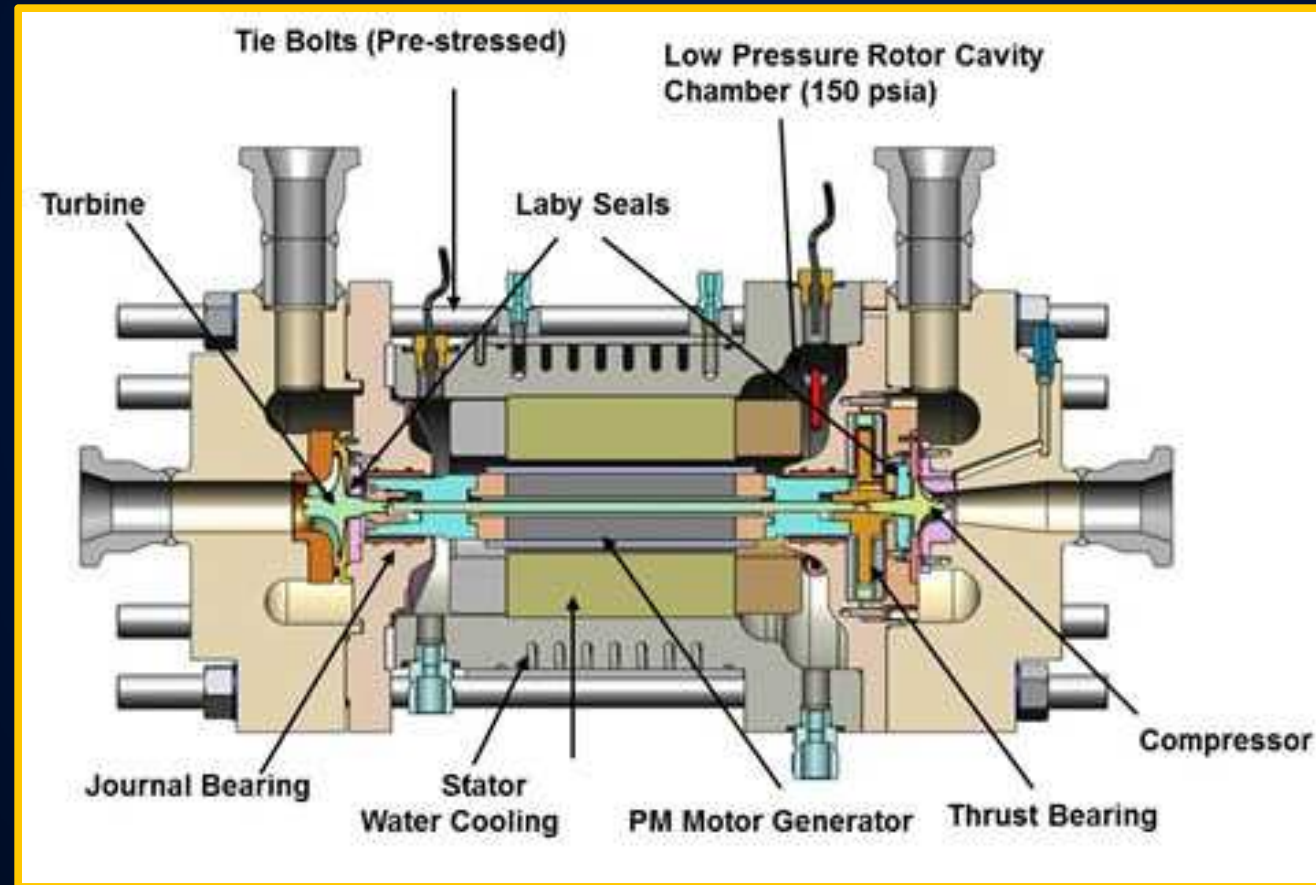


- 780 kW electrical heater
- 1000 °F max T



- 2 Turbine-alternator-compressors
- Mass flow 5.7 kg/s
- Pressure ratio 1.8
- 250 kW electrical generation

# THE HEART OF THE CLOSED BRAYTON CYCLE TURBINE, ALTERNATOR, COMPRESSOR



# POTENTIAL FOR SUPERCRITICAL CO<sub>2</sub> BRAYTON CYCLE TECHNOLOGIES BENEFITS

## Economic advantages

- *Smaller size relative to steam system – reduced capital cost*
- *Increased efficiency – increased electricity production for same thermal input – lower cost of electricity (S/KW hr)*

## Environmental improvement

- *Greenhouse gas reduction*
- *Reduced water consumption*
- *Dry Cooling/suitable for arid environments*

## Commercialization

- *Maturing this technology promotes the U.S. Department of Energy's clean energy strategy*
- *Contributes towards meeting national and energy goals*
- *Promotes domestic industry growth*
- *Facilitates industrial competitiveness*

# SMALL MODULAR REACTORS

Sandia National Laboratories is Contributing to the Assurance of the Economic Competitiveness and Licensability of Small Modular Reactors (SMRs)

Why focus on SMRs?

- *“Right-sized” power output*
- *Lower upfront capital at risk*
- *Leverages conventional reactor infrastructure*

# SANDIA NATIONAL LABORATORIES' CAPABILITIES TO SUPPORT SMRs

## Systems Engineering

- *Integrated Systems Model*
- *System Options Definition*

## Engineering Design

- *Evacuation Planning*
- *Defense-in-Depth Design*
- *Plant Siting Analysis*

## Safety Assessments

- *Physical Protection and Cyber Security Assessments*

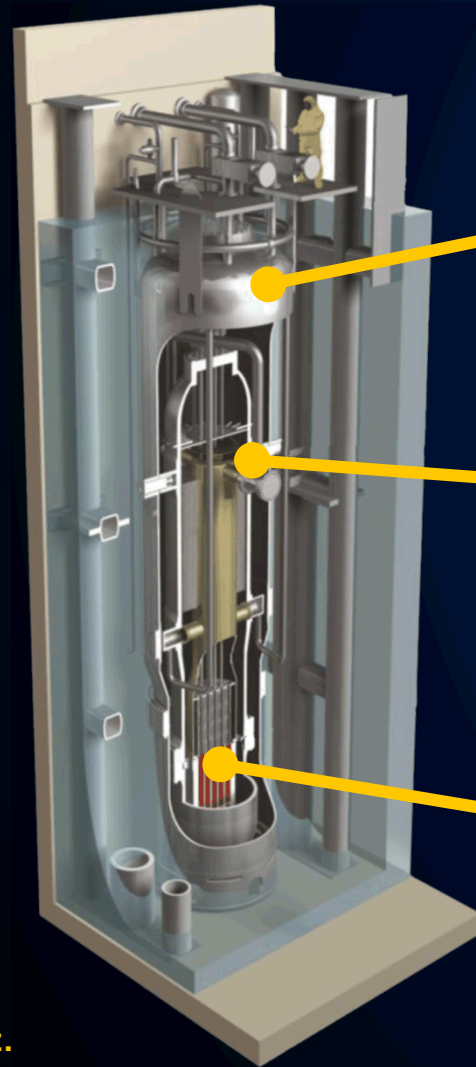
## Security Assessments

- *Vulnerability Analysis*
- *Physical Protection System Design*
- *System and Response Force Modeling*

## Population Characterization

- *Hydrology Characterization*
- *Socioeconomic Analysis*

# NUSCALE SMALL MODULAR REACTORS



High-strength stainless steel containment  
10 times stronger than typical PWR

Water volume to thermal power ratio is 4  
times larger resulting in better cooling

NuScale Reactor core has only 5% of the  
fuel of a large reactor