Study Nuclear Engineering: Save the World
UT has the first NE department in the US

- Offer BS, MS, PhD degrees in two tracks
  - Traditional nuclear power engineering
  - Radiological engineering
- Relevant BS minors
  - Reliability and Maintenance Engineering
  - Cybersecurity
  - Decommissioning and Environmental Management
- Close collaborations with ORNL, Y-12, Thompson Cancer Center
- Strategic Plan and Annual Report are online at ne.utk.edu
High Impact Practices
(National Survey of Student Engagement--NSSE)

Q: Where are the high-impact practices located?
A: Experiential co-curricular

George Kuh, *High Impact Practices: What are they, who has access to them, and why they matter.* (AAC&U, 2008)
Nuclear Engineering-Related Minors

Earn a Minor with your BS in Nuclear Engineering and increase your knowledge, expertise, and employability. The following minors are desired by nuclear engineering utilities and industry.

### Concepts of Cybersecurity Minor
- ECE 461 - Introduction to Computer Security
- ECE 462 - Cyber-Physical Systems Security
- NE 362 - Numerical Methods and Fortran*
- STAT 251 - Probability and Statistics for Scientists and Engineers*
- NE 351 - Nuclear System Dynamics, Instrumentation, and Controls*

### Nuclear Decommissioning and Environmental Management
- NE 404 Nuclear Fuel Cycle
- NE 433 or NE 233 Principles of Health Physics*
- CE 340 Construction Engineering and Management I
- NE 406 Radiation Shielding*
- NE 542 Management of Radioactive Materials

### Reliability and Maintainability Engineering Minor
- NE 401 - Radiological Engineering Laboratory*
- NE 483 - Introduction to Reliability Engineering
- NE 484 - Introduction to Maintainability Engineering
- STAT 251 - Probability and Statistics for Scientists and Engineers*
- NE 351 - Nuclear System Dynamics, Instrumentation, and Controls*

### Nuclear Safety Minor
- NE 360 - Reactor Systems and Safety
- NE 402 - Nuclear Engineering Laboratory*
- NE 485 - Process System Reliability and Safety
- NE 486 - Nuclear Licensing
- NE 421 - Introduction to Nuclear Criticality Safety

*Required for radiological track
Opportunities for Nuclear Abound

EAST TENNESSEE’S NUCLEAR INDUSTRY

STATE OF TENNESSEE TRENDS:
$3.275 BILLION IN REVENUE
8,969 JOBS IN WORKFORCE

DATA COMPILED BY THE EAST TENNESSEE ECONOMIC COUNCIL - 2015
2019 NE Placement and Salary Data

- **Employment Status for**
  - Employed full time: 50% 33% 27%
  - Graduate school: 39% 59% 46%
  - Still Seeking: 8% 8% 24%
  - Not Looking: 3% 0% 6%

- **Mean GPAs**
  - Graduate School: 3.6 3.6 3.7
  - Employment: 3.5 3.2 3.5
  - Still Looking: 2.9 3.2 3.1

- **Salary Data (2018)**
  - BS: $71,000 [56k – 101k]
  - MS (2017): $120,000 [120K]
  - PhD: $93,500 [70k – 117k]

Top Employers: Southern Co. (3), NN Shipyard: HII (3), US Navy (3), Dominion (3)
Salary Growth

<table>
<thead>
<tr>
<th>Years</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>+1.1%</td>
</tr>
<tr>
<td>3-5</td>
<td>+7.7%</td>
</tr>
<tr>
<td>6-7</td>
<td>+7.5%</td>
</tr>
<tr>
<td>8-10</td>
<td>+13.9%</td>
</tr>
<tr>
<td>10+</td>
<td>+0.8%</td>
</tr>
</tbody>
</table>

*Less than 10 respondents in this category*
New Engineering Complex
Current Status

https://tickle.utk.edu/new-engineering-complex/
Analysis and design to enhance the safety, sustainability, and flexibility of nuclear energy
What we do!

- Reducing the burden of nuclear waste for future generations
- Exploring new missions for advanced nuclear energy

**ORNL/TM Identification of LR**

The lower core support structure incorporates flow distribution plates to maintain the vessel at minimum coolant temperatures. A technology testbed, the FHR DR, is expected to recover less than 50% of chemical process heat from the intermediate salt, which can be shared with a system similar to the Mk1 PB-FHR concept. Heat from the intermediate salt reservoir can be coupled to an open-air Brayton power conversion system.

The baseline design of the FHR DR is to have independent intermediate loops each carrying transport systems, with heat exchange to independent sumps and covered with removable top hatches. The primary heat core, flows downward along the vessel wall into a lower plenum, resistant materials. Primary coolant flows into the vessel above the immersed in salt within a cylindrical vessel fabricated of corrosion-resistant materials. Primary coolant flows into the vessel above the immersed in salt within a cylindrical vessel fabricated of corrosion-resistant materials.

The geometry of the core structure allows simplified construction, the ability to move and replace fuel structures within the core is useful to inform and accelerate the development and deployment of advanced reactor applications. The FHR DR is a 100 MWt salt-cooled reactor that uses TRISO fuel form for deployment within 10 years. The fuel form is based on the well-developed TRISO technology and scalable to other candidate salt coolants.

The AGR is a representative system with sufficient detail to provide data to evaluate several tools were used to perform thermal-hydraulic design, core and system analysis. Heat generation in the graphite was found to be significant, with graphite temperatures increasing as the power level of the SmAHTR design (125 MWt). This power level represents more than 70% of the power of DOE’s operating reactors, the High Flux Isotope Reactor (HFIR) at ORNL (85 MWt) and the Advanced Test Reactor (ATR) at Nevada Lawrence Livermore National Laboratory (70 MWt). The flexibility in core configuration is a key feature of the FHR DR concept. It also represents a near-term option with excellent high-temperature strength, but otherwise be achieved.

Several tools were used to perform thermal-hydraulic design and core analysis: the RELAP5-3D code was used to perform overall system calculations. In addition, assembly-level fuel and graphite temperatures, and the RELAP5-3D nuclear core analysis results in an expected availability of approximately 85–90%.

### Accident Tolerant Nuclear Fuel and Cladding:
Enhancing the safety of existing nuclear reactors

- Zircaloy (0.572 mm)
- SiC (0.572 mm)
- SiC (0.762 mm)
- FeCrAl (0.419 mm)
- FeCrAl (0.300 mm)

**FeCrAl**

**Zr & SiC**

http://dx.doi.org/10.1016/j.anucene.2016.11.021

http://dx.doi.org/10.1016/j.anucene.2016.09.033
Opportunities for Fuel Safety Research

How do advanced fuel and cladding materials behave in design basis accidents and beyond?

SATS and Modified Burst Test (ORNL)
Nuclear System Analysis and Safety

- My groups studies accidents and accident progression in nuclear systems
  - Overpower events
  - Undercooling events
