# Status Update of the Nuclear Criticality Safety Training and Pipeline Program

**Steven Biegalski, Doug Bowen, Alex Lang, Walid Metwally, Pavel Tsvetkov**

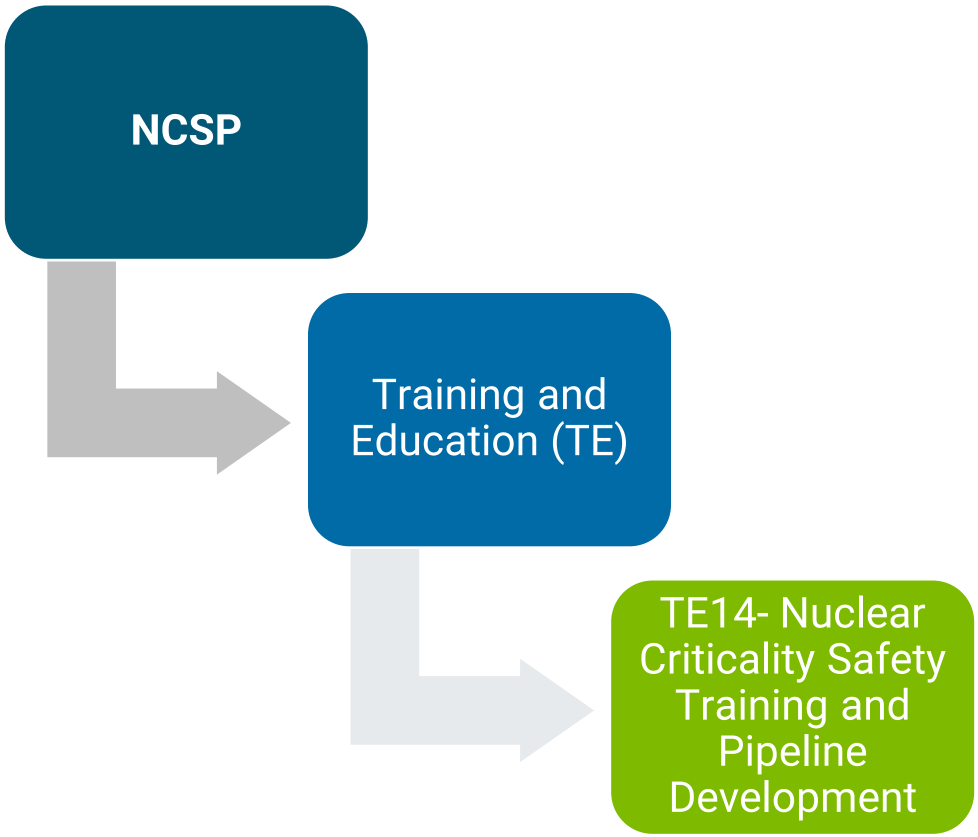
Nuclear Criticality Safety Program (NCSP)

Technical Program Review, December 3-5, 2024

# Outline

- Introduction
- Program overview
- Status update

# Introduction




ORNL TE14

Collaborators:
- Georgia Institute of Technology
- Texas A&M University

# Introduction

- Why
  - Gaps in knowledge of incoming professionals
  - Better preparation of students for NCSP hands-on training courses
- What
  - University-based nuclear criticality training certificate
  - Development of a pipeline of nuclear criticality specialists to feed into the US Department of Energy Laboratory Complex
- Target Audience
  - Undergraduate and graduate engineering, physics, and mathematics students
  - Regional focus on the southeastern United States

# Program overview and certificates

| | |
|---|---|
| Level I certificate | • Video lectures<br>• Exercises |
| Level II certificate | • Hands-on training |

# Program overview

## Phase 1:
### Years 1 and 2

- Develop training material
  - Outline
  - Objectives
  - Training slides
  - Video lectures
  - Exercises
- Develop website

## Phase 2
### Years 3, 4, and 5

- Develop hands-on training session
- Recruit students
- Offer the course (certificate program)

# Content: 1 of 2

| Module # | Title |
|---|---|
| 1 | Course introduction and nuclear criticality safety overview |
| 2 | Nuclear particles and nuclear notation |
| 3 | Nuclear structure and radioactive decay |
| 4 | Atom density, cross-sections, and nuclear data |
| 5 | Radiation interaction with matter and reaction rates |
| 6 | Criticality and 6-factor formula |
| 7 | Neutron flux and Fick's law |
| 8 | Diffusion equation |
| 9 | Critical condition from diffusion equation |
| 10 | Delayed neutrons and pulses |
| 11 | Factors in criticality safety and MAGICMERV |
| 12 | Criticality safety considerations for U and Pu systems |
| 13 | Hand calculations - hand calculation methods for criticality safety |
| 14 | History and lessons learned of process criticality accidents |

# Content: 2 of 2

| Module # | Title |
|---|---|
| 15 | Safety culture, formality of operations, ANS-8 standards, and regulations (NRC/DOE) |
| 16 | Process analysis (Part 1) |
| 17 | Process analysis (Part 2) |
| 18 | Calculation/assessment lecture |
| 19 | Control Implementation, training, maintenance, credible abnormal conditions |
| 20 | Alarms and emergency response - criticality accident alarm systems and emergency preparedness |
| 21 | Validation requirements from ANS-8.1 and ANS-8.24 |
| 22 | Validation approaches and methods |
| 23 | Validation of nuclear criticality safety calculations |
| 24 | Criticality safety evaluation process |
| 25 | Criticality safety evaluations writing and steps - bringing it all together |
| 26 | Criticality safety evaluations for U and Pu systems |
| 27 | Summary and review |

# Status update

## Phase 1: Years 1 and 2

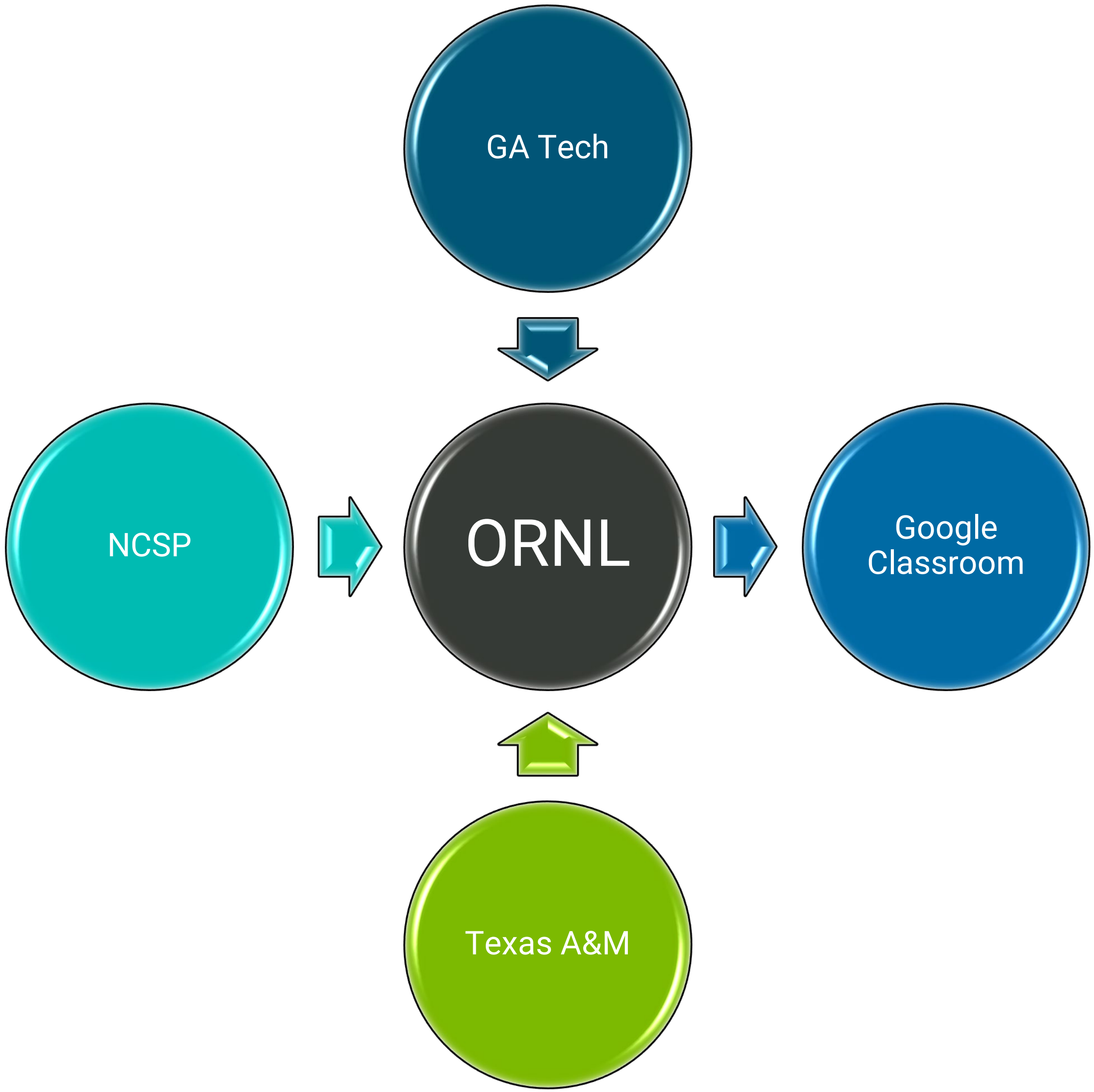
- Develop training material
  - Outline ✓
  - Objectives ✓
  - Training Slides ✓
  - Video lectures ✓
  - Exercises ✓
- Develop website (in process)

## Phase 2: Years 3, 4, and 5

- Develop hands-on training session (in process)
- Recruit students
- Offer the course (certificate program)

Miscellaneous budget challenges slowed progress

# Website structure



# Student engagement

- Two have been recruited
- Another two recruitments are in process
- Recruits will assist in the following:
  - Material finalization
  - Website
  - Google classroom
  - Hands-on exercise

# Moving forward

- Aim to complete Phase 1 within a few months
- Start recruiting for delivery next summer (Level I certificate)
- Complete preparations for the hands-on exercise (Level II certificate)

# Questions / comments / bright ideas?

Oak Ridge National Laboratory