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NCSP
NUCLEAR CRITICALITY SAFETY PROGRAM

New NCSP 2 Week Hands-on Course Module: Emergency Response and the Criticality Accident Slide Rule

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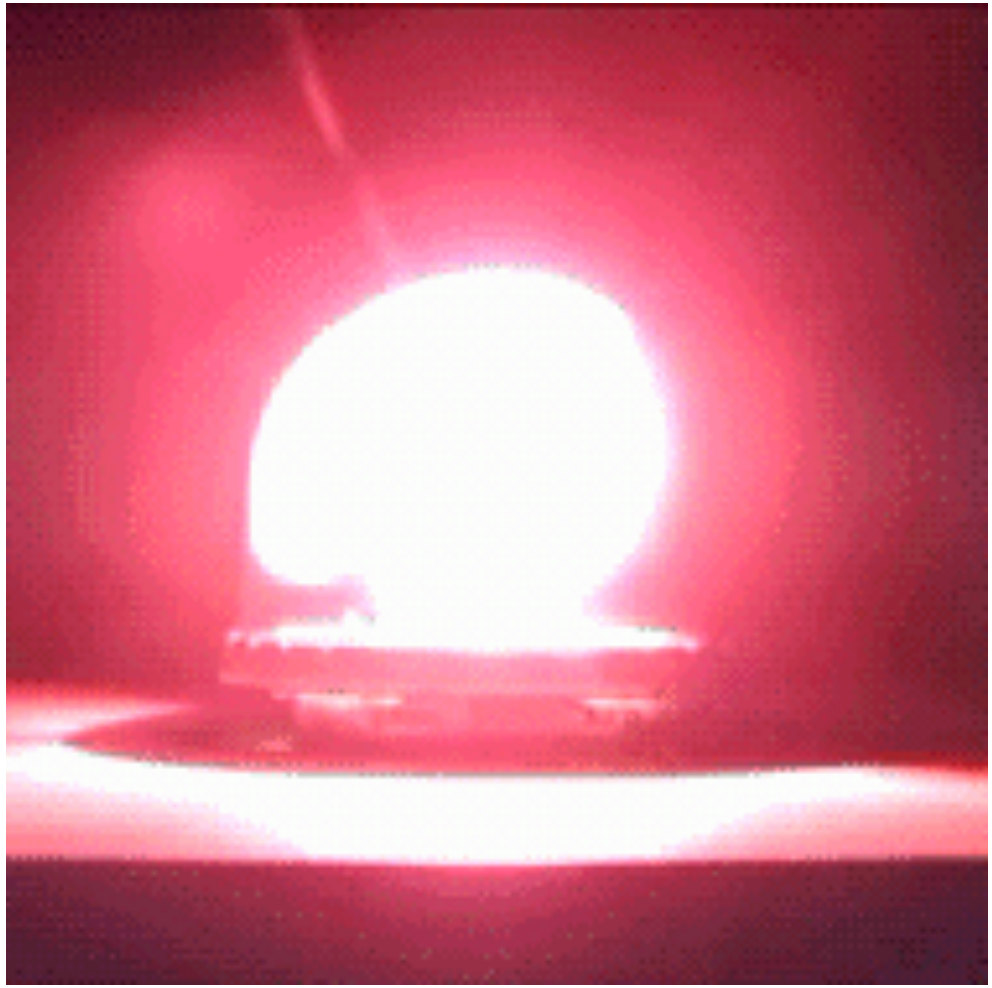
2 Week Hands-on NCSP Class

- Designed for Nuclear Criticality Safety practitioners
- First week provides an overview of ANS and DOE regulations and focuses on developing criticality safety evaluations in a lecture and workshop format
- Based on feedback from the CSSG review of the class, an additional module was developed to provide more training on criticality emergency response
  - Focused on requirements of 8.23
  - Demonstrate the use of the Criticality Accident Slide Rule
- The format of the module was inspired by Neil Harris's emergency response module from the UNM Short Course and the slide rule exercise was based on LLNL Hands-on Training

Criticality Accident Alarm Sounds!



Choose Your Own Criticality Adventure

- You are doing a walk down of an operations area with the Operations Responsible Supervisor. You are both dressed in anti-contamination clothing and you are inspecting the inside of some contaminated equipment to gather process information for an NCSE. The criticality alarm sounds! What do you do?

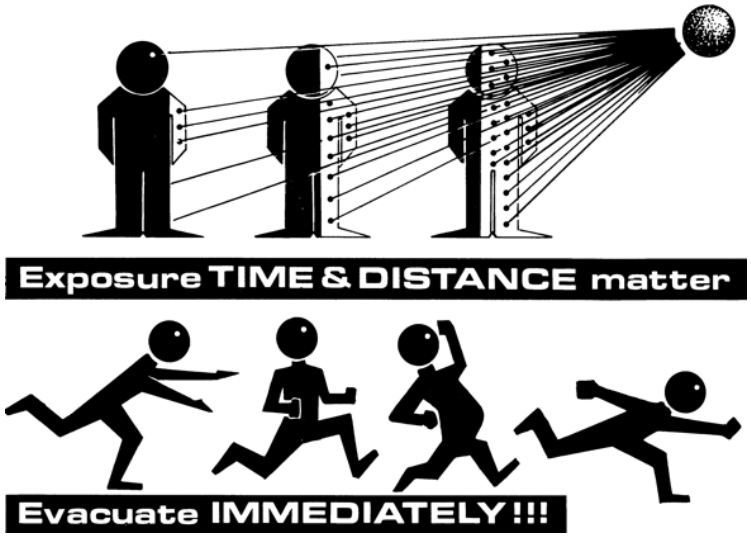
1. Help the operations supervisor close up the contaminated equipment as quickly as possible, doff your anti-cs, and exit the building.

2. Doff your anti-cs and use the hand and shoe contamination monitor as you exit the building as quickly as possible.

3. Exit the building as quickly as possible without stopping to safe equipment and ignoring contamination control procedures.

Soak Up More Dose

- Unfortunately, the criticality happened in the room you were in with your ORS in the adjacent workstation. You were more than a 10 feet away so your dose from the initial criticality would have been survivable. However, since you took so long closing up the equipment and doffing your anti-contamination clothing, you received a much more serious dose from decay of activation products and fission products.

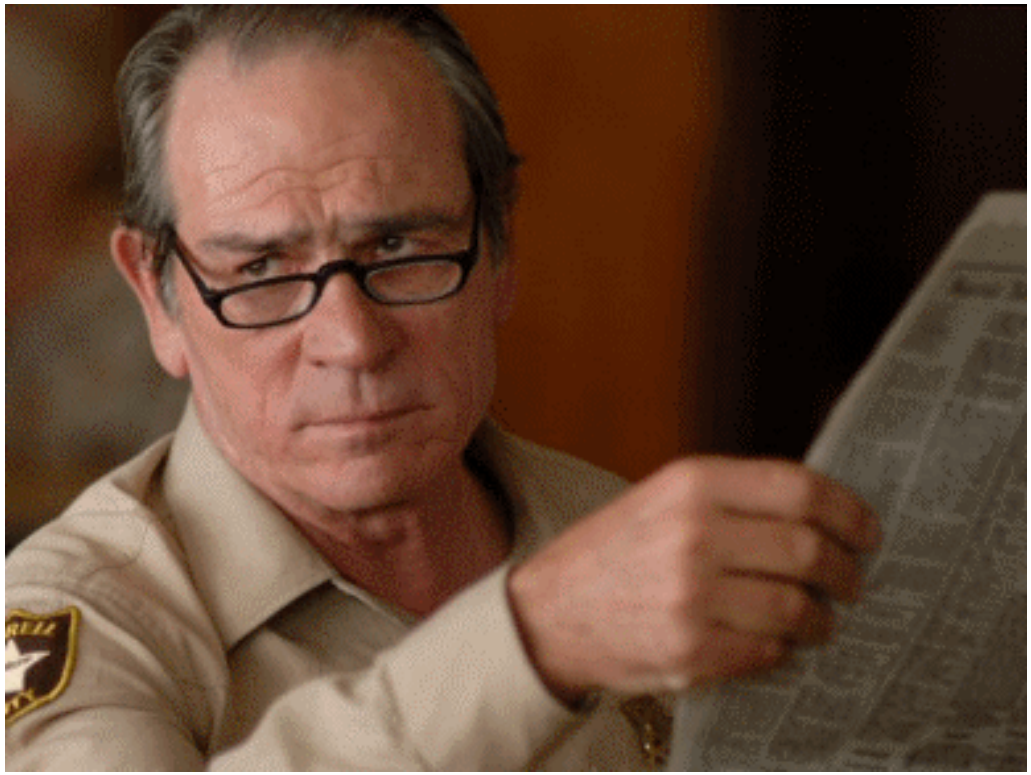


Distance from 10^{17} fission accident	Radiation Dose (Rads)	
	Prompt	Extended Time
1 m	2000	9000
3 m	300	1000
10 m	30	100

Let's make a better choice!

Worrying about Contamination

- Your ORS, Lenny, who has worked in the facility for 30 years, gives you a skeptical look and reminds you that the proper response to the criticality alarm is to exit the building immediately and to heck with contamination control. You try and keep up as he runs down the hallway.



Exit the Building Quickly

- Congratulations! Option 3 is the correct response to the criticality alarm. ANS 8.23 states:

> *When an evacuation is initiated, all personnel within the immediate evacuation zone shall evacuate without hesitation by planned evacuation routes to an established assembly station.*

While everyone is congregating at the assembly station, one of your coworkers from radiation protection runs over to you and asks,

"How do we know this assembly station is safe? If this is a real criticality accident, couldn't this be part of the radiation field? What about gaseous fission products?"

Established Assembly Stations

- ANS 8.23 requires
  - An immediate evacuation zone be pre-established based on a documented evaluation of a predicted accident
  - Evaluation must establish a maximum acceptable value for absorbed dose
  - Requires radiation monitoring of assembly stations and other occupied areas during a real emergency

- 8.23 further requires consequences from an accident, including material releases, must be evaluated
  - Therefore, if gaseous fission products are a concern (large solution criticalities, as one example), prevailing wind conditions should be monitored to determine if the assembly point needs to be relocated

Slide Rule Exercise

- The scenario unfolds similarly to the way a real accident response might, with the students getting to make choices about what to do. Options include:
  - Talking to operations
  - Phoning a supervisor
  - Checking CAAS readings

- There are two exercises the students work through, and they use the electronic slide rule to estimate the size of the criticality accident

Just How Big Was This Accident?

- Incident Command has been transferred to the fire chief, Chief Wiggum. As he sees you approach, he says,

  "Are you the crit guy? It's been about an hour since the accident. They stood up the Emergency Operations Center and the site is fielding calls from the mayor, the governor, the press, and even the president himself."

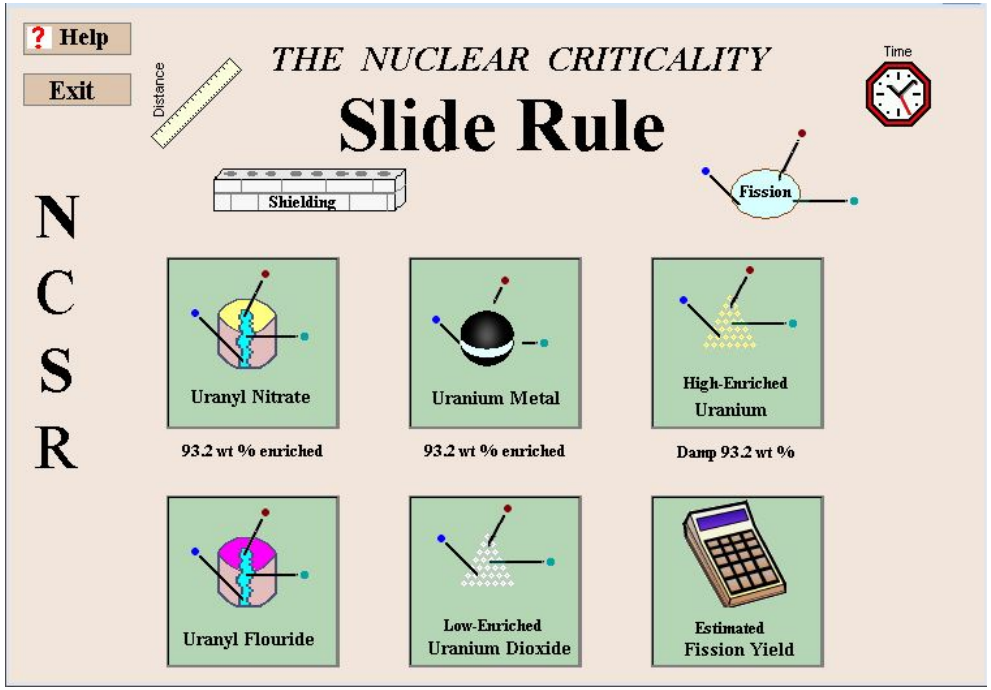
  "We need to know the source term of the accident to figure out the offsite consequences. You guys figured out how big the accident was?"

Discussion:

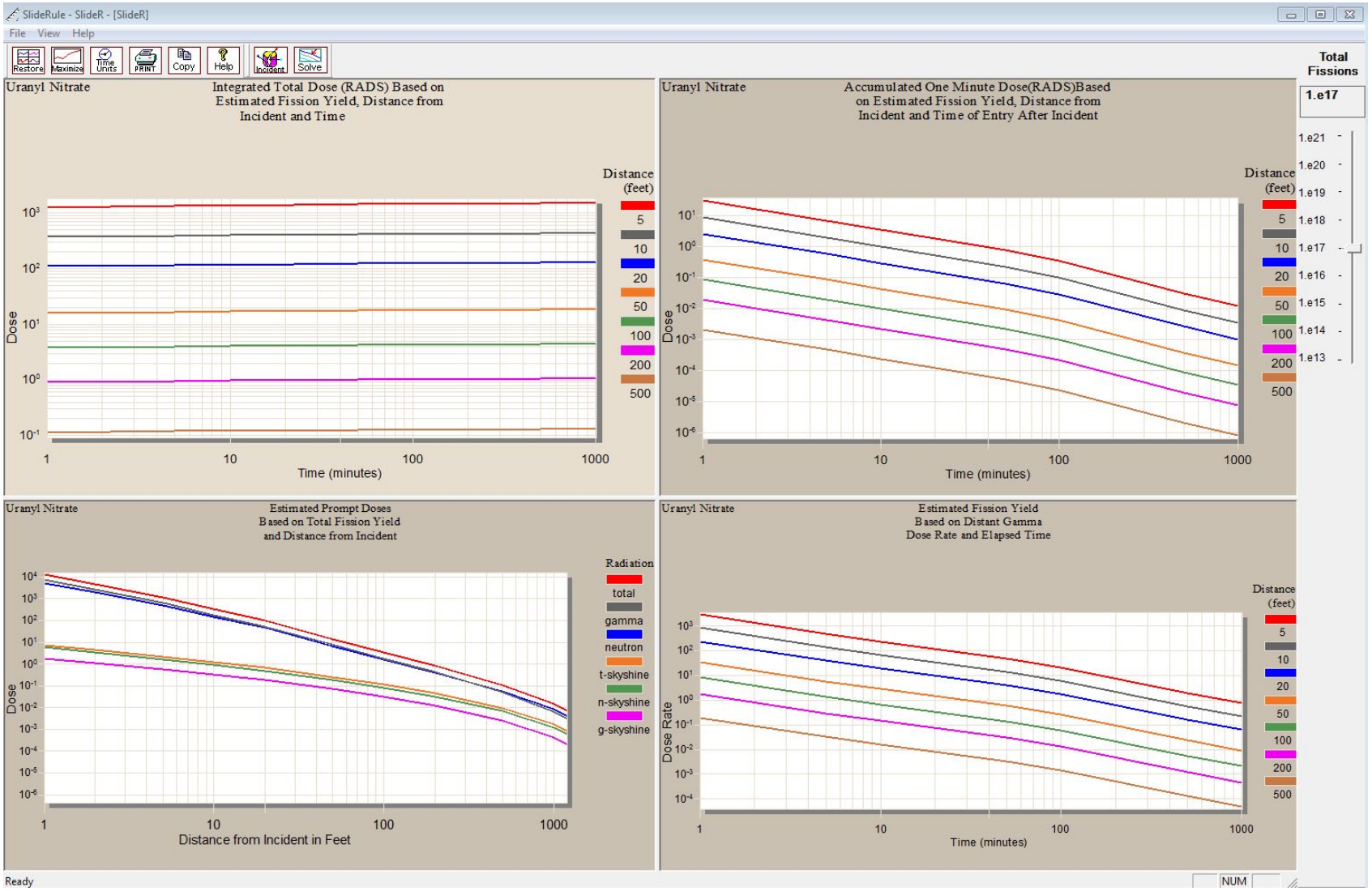
- How could we answer these questions?
- Do we know enough information?

Nuclear Criticality Accident Slide Rule

- First developed in 1974 by Oak Ridge National Laboratory
- Provide a way to quickly estimate fission yield magnitudes and estimate doses for use in emergencies and emergency response planning.
- Updated and converted to a computer executable in 2001

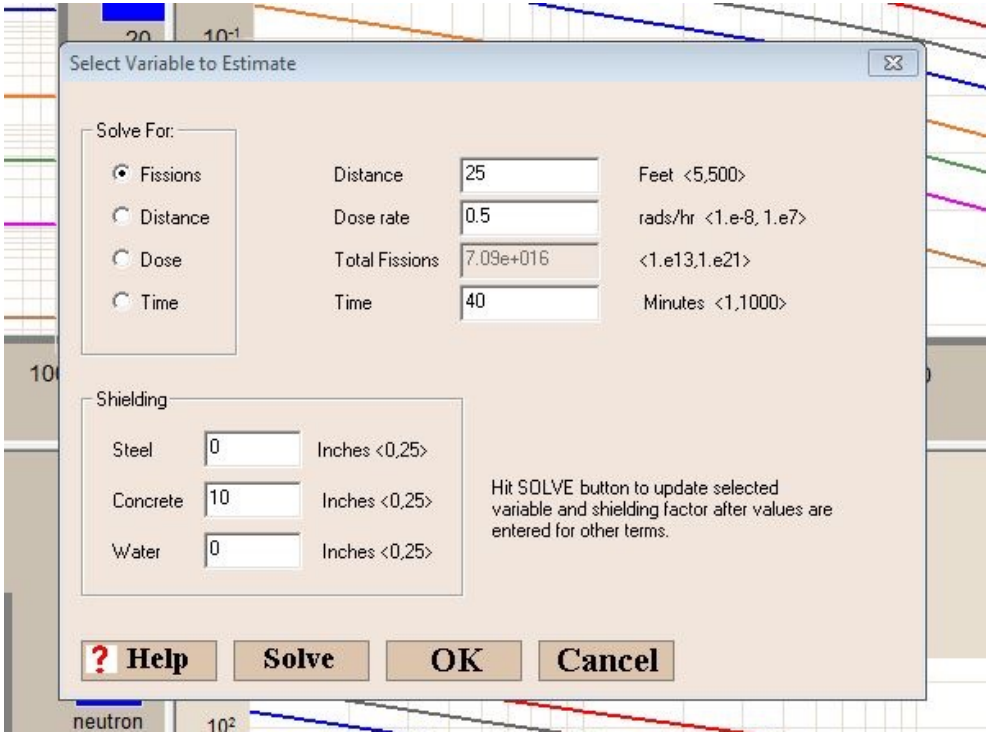


Slide Rule Data is Presented Graphically



Exercise 1: Location and Size of the Accident

- Students use information gathered from interviews, gamma CAAS alarm readings, and a map of a fictitious facility to determine probable location and size of the accident
- During class, we deploy the electronic slide rule and estimate the total number of fissions in the accident



Exercise 2: Determining Recommended Actions

- The students are told a worker is unaccounted for and discuss whether they agree to sending someone back inside

- The initiating event for the accident was an earthquake that ruptured a water line and allowed water to get into an oxide operation, and the students are further asked if they recommend shutting off the water

Positive Feedback from Students

- We deployed this module for the first time in January of 2018, and have given the module 3 times

- Feedback has been very positive from the students and many have commented that learning to use the slide rule was valuable