RE-IMAGINED EMERGENCY PLAN DEVELOPMENT AND TRAINING FOR RESEARCH REACTORS

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ABSTRACT

The Utah Nuclear Engineering Program (UNEP) is home to a 100 kW TRIGA Reactor, which has been in operation since 1975. Research reactor emergency plan requirements and expectations have changed quite drastically over the last 40 years of operation. Since 2009, the UNEP has implemented new educational and training programs that have not only resulted in better trained operators but have also improved and strengthened the current reactor emergency plans. The core driver for improving the emergency plan at UNEP has been newly established engineering safety culture. It provided a new paradigm for organized and systematic facility operation, students training, events tracking and reporting. Importantly, this new culture has allowed and encouraged the students and staff members to freely report issues and give recommendations for improvement. As part of this process, UNEP has developed new U.S. Nuclear Regulatory Commission (NRC) licensed reactor operator training sequence in the past five years. Part of the revamped training tasks is for new trainee reactor operators to contemplate and formulate possible faults and other emergency scenarios. This allows UNEP to benefit from a constant scrutiny of new issues or problems that could arise and become an issue for the facility and then see how a possible scenario might play out. It also allows new thoughts and ideas to be constantly refreshed on what could possibly go wrong or be an issue in the facility. The students and trainees benefit from this program by studying the emergency plan on their own and then demonstrating a competent understanding of the plan by developing emergency scenario drills to be conducted by the students and trainees. The students and trainees prove to have much stronger knowledge of the emergency plan after participating in this training. This process has also allowed outside agencies such as bomb squads and the FBI to conduct training exercises for their personnel as well. The revamping of the emergency training program at UNEP has resulted in an improved and tested emergency plan and better responses to such emergencies from staff and students.

1. Introduction

The Utah Nuclear Engineering Program (UNEP) manages the only nuclear engineering and science laboratory and research reactor training facility in the State of Utah. A key component of the program is the University of Utah TRIGA Reactor (UUTR). The UUTR reached its first criticality in 1975 and has accumulated almost 4,000 hours of operation since that time. It is licensed by the US Nuclear Regulatory Commission (NRC) for 100 kW-th power of operation. In the past eight years, the facility and program has undergone a major overhaul and revitalization. A major part of the revitalization has been the implementation and development of a strong nuclear engineering safety culture [1], [2], [3], [4]. As part of the improvement of UNEP's nuclear safety culture, the emergency planning and the training on emergency planning was targeted as an area to be enhanced and bolstered. The UNEP faculty and staff determined in evaluations of the facilities nuclear safety culture that a re-imagined method for the conduct of training and emergency plan evaluations would be a major area for improvement.

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2. Research Reactor Emergency Planning in the US

In the United States, federal law requires nuclear operating companies to develop and maintain emergency preparedness plans for their nuclear power facilities to protect the public. An emergency plan provides an additional level of protection by stipulating response actions that may be taken in the event of a serious accident or event. The independent U.S. NRC approves each facility's plan, while approval of the associated state and local community plans are coordinated between the NRC and the Federal Emergency Management Agency (FEMA) [5].

Effective emergency response results from mutually supportive planning and preparedness among the operators/licensees and the emergency support agencies, i.e., police, firefighters, paramedics, etc. Emergency plans continually evolve as they are tested and implemented during drills, exercises, and actual emergency scenarios.

Research and test reactors in the United States must also follow the NRC regulations like Nuclear Power Plants [6]. However, additional guidance is given to test and research reactors in regulatory guides and American National Standards from the American Nuclear Society [7], [8]. Where commercial nuclear power plants have 16 planning standards, research and test reactors contain 10 planning standards, which are the following:

1. Introduction
2. Definitions
3. Organization and Responsibilities
4. Emergency Classification System
5. Emergency Action Levels
6. Emergency Planning Zones
7. Emergency Response
8. Emergency Facilities and Equipment
9. Recovery
10. Maintaining Emergency Preparedness

Due to the low power level, small amount of radioactivity in the core and required safety features, the risk from research and test reactors are small. The regulations also require the facilities to train personnel and perform emergency preparedness exercises in order to ensure the feasibility of the emergency preparedness plan.

3. Re-Imagined Emergency Planning Training Method

UNEP has recently developed training classes for licensed operators of the UUTR. As part of this process, the Emergency Plan training needed improvement and enhancement. For many of the early years of the facility, faculty, staff, and students were trained on the emergency plan and emergency response actions by the traditional lecture method. This entailed one of the staff members putting together training and getting up in front of the class and lecturing on the various definitions, emergency planning zones (EPZs), protective action guides (PAGs), and actions to be taken. Unfortunately, this resulted in limited knowledge and comprehension of the Emergency Plan and its implementation.

An active learning strategy for training on the UNEP Emergency Plan was formulated. This training strategy employs the Bloom's taxonomy of the cognitive domain [9], [10]. The six levels in Bloom's taxonomy and examples are shown in Figure 1.

Remember	Understand	Apply	Analyze	Evaluate	Create
•Describe	•Explain	•Complete	•Compare	•Justify	•Plan
•Name	•Compare	•Use	•Examine	•Assess	•Invent
•Find	•Discuss	•Examine	•Explain	•Prioritize	•Compose
•List	•Predict	•Illustrate	•Identify	•Recommend	•Design
•Relate	•Outline	•Classify	•Categorize	•Rate	•Construct
•Write	•Restate	•Solve	•Investigate	•Decide	•Imagine

Fig 1: Six Levels in Bloom's Taxonomy [9, 10]

Figure 1 demonstrates that students or staff can 'know' about a topic such as the Emergency Plan and how to respond to emergencies in different ways and at different levels. While the common written tests on the emergency plan still test at the lower levels at the taxonomy, research has shown that the students and staff remember more when they have learned to handle the topic at the higher levels of the taxonomy [11].

Combining the above inputs, it was determined that the students would first have an introductory lecture on the UNEP Emergency Plan. Once the students had the introduction to the plan, they were each tasked with designing, constructing, and composing an Emergency Plan Drill that would assess the Emergency Plan and students' abilities to implement and utilize the Emergency Plan. This method of training moved the students from the 'remember' taxonomy into the 'analyze', 'evaluate', and 'create' taxonomies.

4. UNEP Emergency Plan Training

The actual implementation of the new method of training first begins with the Reactor Supervisor giving a classroom lecture and presentation on UNEP's Emergency Plan. This introduction allows students to see and hear the terms that are used and to ask clarifying questions. After the lecture, students are given a blank drill guide scenario that includes the following sections:

1. Initial Conditions
2. Pre-Drill Notifications
3. Precautions and Limitations
4. Operational Limits
5. Technical Safety Requirements
6. Drill Team Duties
7. Evaluators
8. Safety Monitors
9. Drill Initiation
10. Expected Response
11. Evaluation Criteria
12. Termination and Restoration

They are then tasked with creating a new emergency scenario drill guide. An example of portions of a student developed drill guide is shown in Figures 2 and 3.

Title: Fuel Failure at UNEP Drill

Drill Number: 2017-01 Revision Number: 0

Initial Conditions:

The Biennial fuel inspection is being conducted in the reactor facility using UNEP-002 (Biennial Fuel/Tank/Control Rod/Reflector Element Inspection). The staff has determined that one of the fuel elements from the core must be transferred to the storage pits due to a bent end pin. A licensed operator is manning the control panel and the Reactor Supervisor and other staff members are in the reactor room participating in the fuel transfer.

Pre-Drill Notifications:

- ☐ Director of UNEP
- ☐ Radiation Safety Officer (RSO)

Precautions and Limitations:

The drill will be terminated if any real emergency takes place.

Operational Limits:

The reactor will be in a shutdown and secure condition during the conduct of the drill.

Technical Safety Requirements:

N/A

Drill Team Duties:

- Monitor Operational Staff, Student's responses to the scenario.
- Ensure participants respond safely.

Evaluator:

Ensure all individuals and activities are conducted in safe manner and evaluate the staff member's response.
Prevent participants from notifying individuals outside the drill (do no evacuate the second floor of the MEB or sound the Fire alarm).

Fig 2: First Page of Student Developed Drill Scenario for Fuel Element Failure

Title: Fuel Failure at UNEP Drill Drill Number: 2017-01 Revision Number: 0

Safety Monitor: N/A
Drill Initiation: While moving the fuel element from the reactor tank to the storage pit area, the fuel handling tool malfunctions and the reactor fuel element is dropped in the AGN museum area. It can be seen visually that the fuel element has fractured. Radiation levels in the room will be above 100 mR/hr over a 10 minute period.
Expected Response/Evaluation Criteria: The operational staff have 4 different Emergency Response Procedures they could enter for response to this procedure. Depending on which order they enter the procedures will impact the exact details of how they respond. The following is the list of emergency procedures they could enter with their associated actions: #5 – High Level Radiation Alarm In the event of a high-level radiation alarm from the Area Radiation Monitors, the ventilation system will switch to limited intake mode. The actions for this alarm are the following: ➢ If a high-level alarm should occur, evacuate non-essential personnel from the UNEF and the second floor of the Merrill Engineering Building directly above the reactor room (MEB 2120B, MEB 2130C, MEB 2125, and MEB 2126B). ➢ Leave the UNEF area as soon as possible and sound the building fire alarm box located at the South entrance of the Merrill Engineering Building, i.e. 12 ft from the UNEF entrance door. ➢ Reactor operator (Senior Reactor Operator) shall carry a portable gamma detector from the control room and the Emergency Plan located on the bookshelf near the front desk in MEB 1206. ➢ All staff personnel should meet at the designated assembly area, 50 meters south of the southwest corner of the Merrill Engineering Building. ➢ Contact Reactor Supervisor. ➢ Complete Radiological Emergency Classification Checklist (UNEP-037)

Fig 3: Second Page of Student Developed Drill Scenario for Fuel Element Failure

In this method of teaching and learning the student must not only become familiar with the Emergency Plan but must also understand how it is implemented and utilized. The completed drill plan is then reviewed and approved by the UNEP leaders and staff. The drills are then carried out on the other students in the class. This active learning has been much more effective and the knowledge of the emergency plan has been a strength for those students taking the NRC license exam.

5. Lessons Learned and Conclusion

The staff and students have taken careful precision in making the drill guides as realistic as possible and the program has found areas where the Emergency Plan and response actions could be improved while conducting the drills. Some examples of the drill guide scenarios are fuel element failure, suspicious package, hostile action against operators and injured/contaminated individual. Outside agencies also get to participate and practice their ability to respond and assist in UNEP emergencies. Recent groups that have been able to participate in the drill scenarios are local police officers, US FBI agents, bomb squad officers, Radiological Health Department technicians, firefighters, and emergency medical technicians. This also test the communication abilities between different agencies which is a common weakness for emergencies.

The implementation of the re-imagined active learning process with UNEP's Emergency Plan has improved the facilities personnel response to emergency situations, has raised the level of understanding and implementing the emergency plan, and has also resulted in improvements being found in UNEP's Emergency Plan. This active learning method is now being evaluated for implementation into other areas for reactor operator training.

6. Acknowledgement

This project is supported by the US NRC Fellowship Award through the University of Utah Nuclear Engineering Program.

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