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2 April 2010

Subject: 2009 10CFR-50.59 Annual Operating Report for the Kansas State University TRIGA Mark II Nuclear Reactor (Facility License # R-88, Facility Docket # 50-188)

To Whom It May Concern:

This document serves as the annual operating report for the Kansas State University (KSU) nuclear reactor. This document satisfies requirements in facility Technical Specifications (TS) 6.11.e.

The report is divided into paragraphs addressing specific items listed as requirements in the Technical Specifications.

Sincerely,

Jeffrey A. Geuther, Ph.D.
Nuclear Reactor Facility Manager
Kansas State University

Attachments:

1. Kansas State University TRIGA Mark II Reactor Annual Report, CY 2009
2. Final Report of the "Manhattan Thunder" tabletop emergency exercise

Cc: Cindy Montgomery, Project Manager, NRC

A001
NRR

Kansas State University TRIGA Mark II Reactor Annual Report, CY 2009

Introduction

The Kansas State University Nuclear Reactor Technical Specifications (TS) require a routine written report to be transmitted to the US Nuclear Regulatory Commission within 60 days after completion of the first calendar year of operating, and at intervals not to exceed twelve months thereafter, providing the following information:

TS.6.11.e.1 - A brief narrative summary of operating experience (including experiments performed), changes in facility design, performance characteristics, and operating procedures related to reactor safety occurring during the reporting period; and results of surveillance tests and inspections.

TS.6.11.e.2 - A tabulation showing the energy generated by the reactor (in megawatt-hours).

TS.6.11.e.3 - The number of emergency shutdowns and inadvertent scrams, including the reason thereof and corrective action, if any, taken.

TS.6.11.e.4 - Discussion of the major maintenance operations performed during the period, including the effects, if any, on the safe operation of the reactor, and the reasons for any corrective maintenance required.

TS.6.11.e.5 - A summary of each change to the facility or procedures, tests, and experiments carried out under the conditions of 10.CFR.50.59.

TS.6.11.e.6 - A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee as measured at or before the point of such release or discharge.

TS.6.11.e.7 - A description of any environmental surveys performed outside the facility.

TS.6.11.e.8 - A summary of radiation exposures received by facility personnel and visitors, including the dates and time of significant exposure, and a brief summary of the results of radiation and contamination surveys performed within the facilty.

This information is transmitted in this report, in sections separated by TS clause. The previous report from this facility covered April 2008 – March 2009. This report covers January 2009 – December 2009. Therefore, the data from January – March 2009 has already been reported. However, this adjustment to the reporting schedule causes the period covered to fall exactly on the calendar year, and is therefore convenient and intuitive.

TS.6.11.e.1 - A brief narrative summary of operating experience (including experiments performed), changes in facility design, performance characteristics, and operating procedures related to reactor safety occurring during the reporting period; and results of surveillance tests and inspections.

The KSU TRIGA Mark II reactor operates for research, training, and demonstration purposes. The reactor staff consists almost entirely of undergraduate students. The only full-time staff member is the Reactor Manager. For this reason, new operator training is a very important duty of the facility. The demonstration purpose of the reactor is very important as well, and the reactor staff endeavors to make our facility accessible to visitors from K-State and outside organizations. The KSU reactor was host to approximately 2100 visitors through the course of the year.

The reactor facility has benefited from a voluntary security enhancement program. Upgrades were made to security infrastructure including: installation of biometric hand scanners at various doors; upgrades to the security camera system; upgrades to perimeter fences; installation of exterior lighting; and improvements to the University Police Department control console.

The security fence surrounding the facility was moved out in perimeter to envelop the cooling towers, and was increased in height. The security cameras were upgraded to a high-resolution system with digital recording capability. These changes will be documented in a separate 50.59 report.

No significant or unanticipated findings resulted from either the NRC annual facility inspection or the surveillances performed by the reactor staff. There were no changes to performance characteristics or operating procedures related to reactor safety.

A tabletop emergency preparedness exercise was held on May 20, 2009. The exercise was called "Manhattan Thunder," and was designed to assess physical security of the reactor facility during a severe emergency situation. Essentially, the scenario consisted of a Senior Reactor Operator with an accomplice firing an armor-piercing artillery round into the reactor core from a beam port. The scenario involved the collapse of most of Ward Hall (where the reactor is located) and fourteen immediate fatalities. The following organizations took part in the exercise:

- KSU Reactor
- KSU Police Department
- KSU Department of Environmental Safety and Health
- KSU Media Services
- KSU Office of Student Life
- KSU Biosecurity Research Institute
- Nuclear Regulatory Commission
- Kansas Highway Patrol
- Kansas Division of Emergency Management

- Kansas Department of Health and Environment, Radiation Control Program
- Manhattan Fire Department
- Riley County Police Department
- Riley County Emergency Management
- Riley County Emergency Medical Services
- Lafene Health Center

Lessons learned from the exercise are included in the final report (attached).

TS.6.11.e.2 - A tabulation showing the energy generated by the reactor (in megawatt-hours).

The monthly total energy generated by the KSU reactor is recorded in Table 1. The same data is shown as a bar chart in Figure 1.

Table 1 - Energy generated by the KSU Triga Mark II reactor by month for CY 2009.

Month	MWh
January	6.45
February	7.62
March	3.82
April	6.64
May	1.14
June	6.32
July	19.15
August	3.72
September	13.60
October	1.55
November	1.94
December	2.29

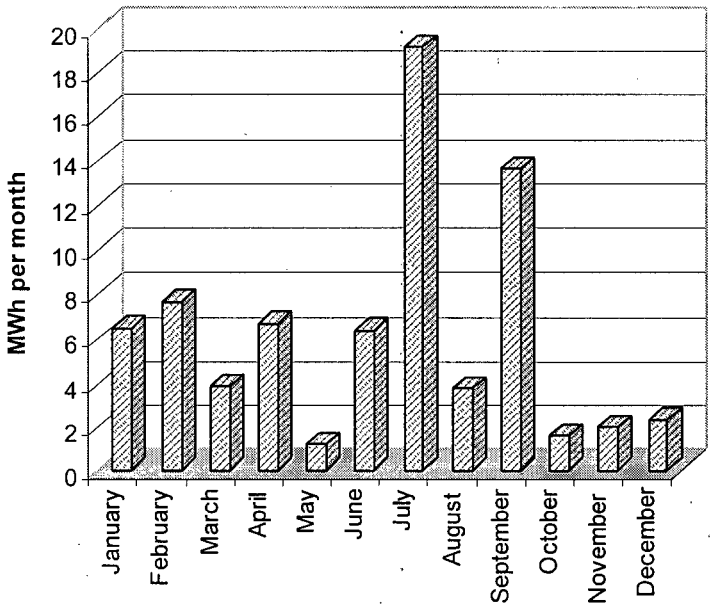

Figure 1 - Energy generated by the KSU Triga Mark II reactor by month for CY 2009.

Figure 2 shows the percentage of hours of reactor operation for various purposes, i.e., research support, training, education, etc. The percentage of hours for training appears small, because operator training was often performed when the reactor was being operated for another purpose, such as research support. The plot demonstrates that the reactor is operated in accordance with our stated primary functions: education; research support (e.g., irradiation); operator training; and demonstration (e.g., tours).

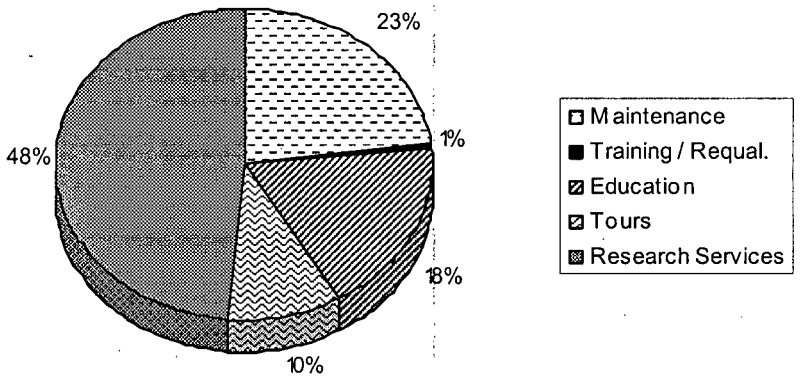

Figure 2 - KSU reactor hours charged, based on purpose of operation. Only billed hours are included.

TS.6.11.e.3 - The number of emergency shutdowns and inadvertent scrams, including the reason thereof and corrective action, if any, taken.

Inadvertent SCRAMS

- Period SCRAM occurred due to operator error. Two occurrences. No corrective action taken.
- Period SCRAM occurred due to insufficient count rate in instrument. One occurrence. No corrective action was taken.
- Linear power SCRAM due to NMP-1000 no being set in auto range (operator error). One occurrence. No corrective action taken.
- Linear power SCRAM occurred with no known cause. One occurrence. The channel was tested and found to be performing as expected. After the channel test, reactor operation was re-commenced.
- SCRAM due to facility power failure. One occurrence. No corrective action taken.

Emergency Shutdowns

- Reactor secured due to console computer hard drive failure (one occurrence). This was not an emergency shutdown, but was a shutdown due to a system failure. The console computer is needed to provide the bulk water temperature alarm required by technical specifications. The reactor was secured from 10/13/09 to 10/15/09 to replace the computer hard drive.

TS.6.11.e.4 - Discussion of the major maintenance operations performed during the period, including the effects, if any, on the safe operation of the reactor, and the reasons for any corrective maintenance required.

No maintenance procedures were performed aside from the security upgrades reported per TS.66.1.5 (next section).

TS.6.11.e.5 - A summary of each change to the facility or procedures, tests, and experiments carried out under the conditions of 10.CFR.50.59.

Two facility changes were carried out under the conditions of 10CFR-50.59. The security camera system was replaced with a high-resolutoin network-based system including a backup server. The fence system was expanded to enclose the cooling towers, and three additional exterior lights were installed. Neither change has a negative impact on the safety analysis, involves an unreviewed safety question, or causes changes to the facility technical specifications.

TS.6.11.e.6 - A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee as measured at or before the point of such release or discharge.

The only liquid discharges conducted in 2009, aside discharges to the facility sump or secondary coolant surge tank, were HVAC condensate discharges to the sanitary sewer. Since the Kansas State University average water usage is 750,000 gallons per day, it is nearly impossible to exceed 10CFR20 limits for effluent concentration at the KSU reactor. The HVAC condensate measured concentration levels were all approximately at background levels, which is expected, since the HVAC condensate water is never circulated through or near the reactor core.

TS.6.11.e.7 - A description of any environmental surveys performed outside the facility.

Monthly radiation surveys are performed within the facility to verify that radiation levels remain safe when at full-power operation. These surveys indicate that the dose rate at the inside surface of the reactor dome are less than a tenth of the public exposure rate limit of 2 mR / h set forth in 10CFR-20. The outside exposure rate can be reasonably expected to be even lower.

Table 2 - Measured radiation exposure rates in mR / hour at locations near the operations boundary, reactor operating at maximum achievable power.

	Exposure Rate (mR / h) at Full Power	
Month	12 foot level, near truck door	Control room door to reactor bay
January	0.03	0.02
February	0.13	0.03
March	0.01	0.01
April	0.02	0.02
May	0.03	0.03
June	0.01	0.01
July	0.02	0.03
August	0.01	0.01
September	0.04	0.03
October	0.01	0.01
November	0.03	0.03
December	0.01	0.01

TS.6.11.e.8 - A summary of radiation exposures received by facility personnel and visitors, including the dates and time of significant exposure, and a brief summary of the results of radiation and contamination surveys performed within the facilty.

There were no instances of significant radiation exposure to KSU reactor staff in 2009. The highest annual dose received by any worker was 210 mrem (deep dose equivalent). A table showing the number of workers receiving given amounts of dose is presented below.

Table 3 - Summary of total occupational dose received by KSU reactor workers from 1/1/2009 - 12/31/2009.

	Number of Workers	
Dose (mrem)	Deep Dose Eq.	Shallow Dose Eq.
[0, 10)	3	2
[10, 20)	1	2
[20, 50)	2	2
[50, 100)	1	1
[100, 175)	3	3
[175, 250)	2	2
>250	0	0

There were three visitor dose records of >= 20 mR for a single visit. Two records of 100 mR were for visitors using the same dosimeter, and the reading is thought to be from the visitors dropping the dosimeter, causing a false reading. As a check, the records for all other visitors from the three day span encompassing that visit were checked, and it was observed that no other reading exceeded 4 mR. A third dosimeter record was 35 mR over a two day span. This dosimeter was assigned to a radiation worker who had not yet received permanent dosimetry. The worker was assigned to work with neutron activation analysis samples, so it is believed that the reading of 35 mR is accurate.

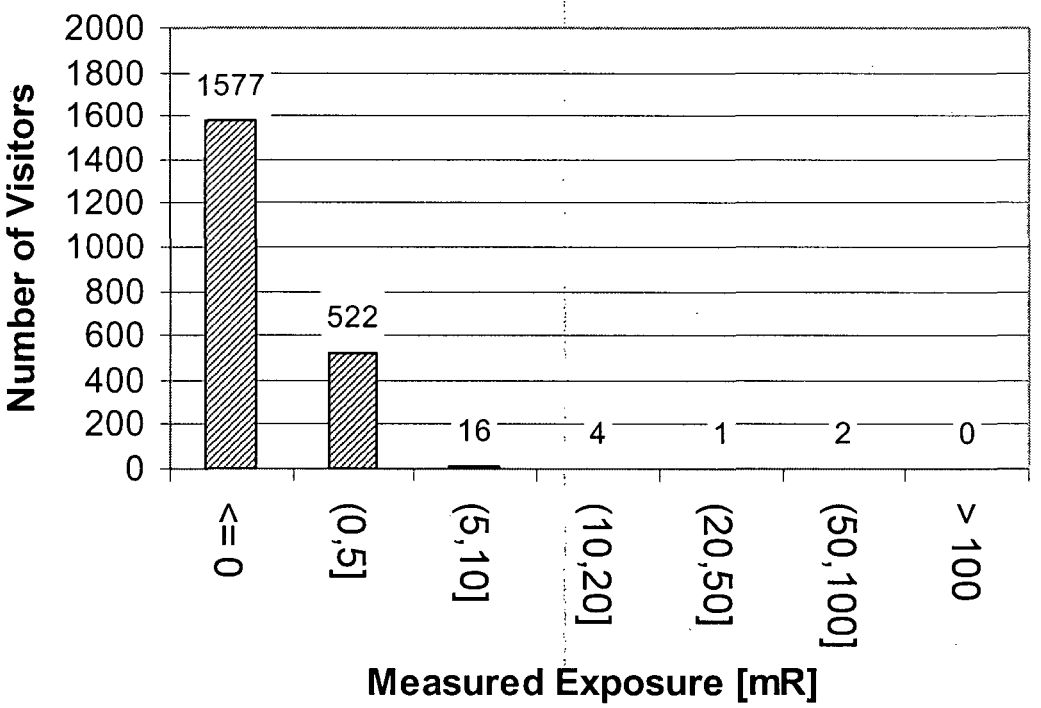

Figure 3 - Histogram of recorded dose for reactor visitors, CY 2009.

This concludes the 2009 Annual Report for the Kansas State University TRIGA Mark II Nuclear Reactor.

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Final Report of the
Manhattan Thunder, Emergency Exercise
May 2009

Background & Introduction

During a Test Research & Training Reactor annual conference in 2008 two Department of Energy programs were discussed, voluntary security enhancements (VSE) and an emergency exercise program designated *Silent Thunder.* The programs are operated by the National Nuclear Security Administration out of the NA-21 Office in the Defense Threat Reduction Agency. VSE program involves an assessment of physical security, identification of areas for improvement, and supporting those improvements identified. The Silent Thunder program develops and conducts a facility-specific table top emergency exercise. The scenario uses facility-specific characteristics (ideally testing the VSE initiatives). In February, the DOE team that developed the scenario visited the K-State campus to gather information (including videotape) and propose logistics. Dr. Galitzer (Director of Environment, Safety & Health) and Alex Meyers (previously a Senior Reactor Operator, currently at Wolf Creek Nuclear Operating Center) worked with the DOE to develop a challenging scenario with as much realism as possible. The exercise occurred as scheduled, on May 20, 2008. This report outlines the scenario, comments generated during the hotwash (standard terminology for immediate debriefing), and potential actions for the KSU reactor. A record of the exercise is maintained at the reactor including:

- This report
- Record of Participants
- "Player's Handbook"
- Exercise "injects" (guidance issued during the exercise)
- Nuclear/Radiological Incident Annex (National Response Framework)
- Terrorism Incident Law Enforcement and Investigation Annex (National Response Plan)
- Dirty Bombs Fact Sheet (United States Regulatory Commission)
- Casualty management after a Deliberate Release of Radioactive Material Fact Sheet (Center for Disease Control)

Scenario

In the week prior to this event, a large quantity of ANFO and detonation cord was stolen from a local quarry. At 1830 hours on May 19, 2009 a Senior Reactor Operator notifies the KSUPD that the reactor will be operating for an experiment. The bollards are lowered to provide access for equipment, which is to be brought into the reactor bay through the truck doors. At approximately 1900 hours, two individuals bring a pickup truck into the paved area behind Ward Hall, open the truck doors, transfer material into the reactor bay, and secure the truck doors. At 2145 hours KSUPD notifies dispatch that the bollards are down, a blue truck is at the truck doors, and the truck doors are open. At 2200 hours the KSUPD Officer notifies dispatch that personnel are in the reactor area, and dispatch verifies the operation is expected. The SRO and another individual load a hyper velocity armor piercing tank round with an improvised timer into the piercing port (north east beam port), replace the inner plug, and secured the beam port. The SRO and his support place improvised explosive devices at strategic locations in the reactor bay including adjacent to the cooling pump skid. The reactor is operated from 2200 hours on May 19 to 0845 hours on May 20 2009.

At approximately 0800 on May 20, 2009 reactor personnel arrive. Two reactor operators are confronted by the SRO and his accomplice armed with automatic weapons. The two reactor operators are flex-cuffed and taken to the dungeon where the accomplice stands guard.

A civil protest was scheduled at the Biosecurity Research Center; in accordance with standard practice for KSUPD, KHP is present in a support role, and the FBI field office (Topeka) is present. At 0815 a press interview is conducted for a representative of the Animal Liberation Front. During the protest a white panel van pulls into the protest site, dumps a large saran wrapped meat-package containing a woman coated in blood. While this operation is underway, 2 gas containers with what appears to be an incendiary device are placed near the gate. KSUPD is notified via 911 and dispatches backup along with MFD, EMS and RCPD bomb squad.

At 0850 the hostages are moved from the dungeon to the northeast SMART lab room (room 1) and the truck door is opened. At 0900 hours 4-5 major explosions occur. The reactor roof and about 2/3 of Ward Hall collapses leaving only NW, SW and SE sections partially standing. The magnitude of the blast causes fatal injuries within a radius that extends to about ½ the distance from the building to the sidewalk on the west, the walkway in front of Cardwell Hall, a section of Burt Hall, the walk on the north edge of Ward Hall, and the drive between Ward Hall and the steam plant. The blast compression wave causes ear and lung damage with a radius from the reactor center to the corner of 17th Street and Claflin Road. Building damage extends through a radius from the center of the reactor to the corner of Dennison and Claflin. Meteorological conditions develop a plume from the reactor building in a south-southeast direction that includes the Holiday Inn, Theodore Roosevelt Elementary School, Manhattan City Hall, Thowe Farms south of Manhattan, and approximately 650 residences. Modeling by NARAC indicates a maximum dose rate on the order of $1X10^{-8}$ rem/h in the plume, with corresponding contamination levels.

The reactor core was breached, the core void of water, cooling pumps destroyed, 42 control rods damaged, control room, destroyed, confinement bay roof and walls destroyed, and all radiation detectors demolished.

From 0925 through 1130, MFD HazMat and EMS respond with rescue and retrieval the principle focus of efforts. As the KHP bomb K-9 squad clears the building of further potential bomb threat, shots are fired from Ward Hall room 1. Victims are provided triage and field decontamination, then evacuated to Mercy Regional Medical Center. As of 1130, casualties included (1) Ward Hall: 40 present, 14 fatalities, 9 missing, 14 with life threatening injuries and 3 with non-life threatening; (2) Cardwell: 100 present, 6 with life threatening injuries and 41 with non-life threatening; (3) power plant: 20 present, 3 with life threatening injuries and 9 with non-life threatening; (4) Leasure Hall: 20 present, 2 with life threatening injuries and 9 with non-life threatening.

DOE National Radiological Response Team is activated to provide the Kansas City FBI Special Agent in Charge support on radiological issues. A Radiological Assistance Program team deploys from Albuquerque, NM. An Aerial Monitoring System is altered

to deploy from Las Vegas, NV and the Federal Radiological Monitoring and Assessment Center assets deploy from Las Vegas and Oak Ridge, TN.

KSUPD dispatch receives a 911 call threatening the lives of reactor staff. The FBI hostage negotiation team attempted to negotiate release of the hostages. One hostage is killed, and the adversaries call out that they removed the sources from the safe in the reactor bay prior to the explosion, and are prepared to detonate a device near these sources to disperse more radioactive materials. At 1130 the Special Agent in Charge authorizes a Deliberate Assault Plan, and the FBI SWAT team takes action. The bomb squad neutralizes the explosive device. An evidence response team secures the scene for forensic analysis.

Hotwash

From personal notes, the following comments occurred during an exit briefing at the end of the meeting:

Lafene –

- This event could overwhelm Lafene, with 30-50 "walking wounded"
- Lafene had not previously considered that some of the incoming wounded might be criminals or terrorists
- Lafene will have difficultly with spectrum of possible problems, and in particular balancing contamination concerns against treatment

EMS –

- EMS will be overwhelmed
- Again concerns of contamination are likely to divert resources and efforts; a better understanding, characterization, and control of contamination would help
- Lafene & Mercy should develop a better understanding of interactions during mass casualties

MFD –

- These two incidents would overwhelm local resources particularly as related to structural collapse and hazardous materials response
- Northeast Kansas has a regional response plan that will help by pulling in required services
- Links and relationships for response have been clarified
- The Incident Command Structure was developed early and was a strength
- Information sharing allows the right use of resources
- MFD has plume modeling capabilities

RCPD –

- The time line on this event was a little skewed to meet objectives; in reality most of the action will have been completed prior to arrival of resource from outside Manhattan

BRI –

- The simulated news stories were alarming, although realistic; the criminals/terrorists are the problem, not the facilities
- The media response needs to be practiced & tuned a little more
- It might be helpful to prepare some standard release material ahead of time
- The BRI will need to develop some memorandum of understanding with some of the agencies present

RECM –

- The measured response with careful evaluation was a good feature
- The Joint Information Center needs to be tested
- Sharing of information by law enforcement might need to be tuned; a large quantity of explosives might complicate emergency response where police are not the lead responder
- The central command post/EOC is essential in making sure all responses are coordinated

Media Services—

- This is a new role for the rep
- News conferences are only one part of media services
- Media services include office and site support, web site, and social media like twitter that might be effectively used in an event
- Media services needs to do a lot of public education and promotion of facilities before an event
- Media services offers training in how to interact with the media

KSU ES&H –

- This was an extremely complicated scenario
- K-State is developing an online inventory of hazardous materials across campus & 1st responders will have access
- This area has an extremely good relationship with emergency responders

KSUPD –

- The nature of this exercise couldn't really test the incident command system
- UPD has very good relations with the Joint Terrorism Task Force
- There are some recognized problems with KSUPD communications systems; too many frequencies & too many organizations

KSURX –

- The lack of knowledge about radiation hazards is surprising
- Before first responders enter an area, it has to be cleared as safe; some confusion remains about how to clear an area as there are multiple concerns grouped or requiring "clearance," including (1) radiological hazards (which would keep out MFD, SWAT or bomb squad) , (2) adversaries (which would keep out everyone except SWAT), (3) bombs (which would keep out everyone but the bomb squad), and (4) building integrity (which would keep out everyone but MFD)
- Planning for the exercise was difficult, and KBI was inadvertently not invited until too late for their participation
- We need to offer 1st responder training to KHP
- The maps in the E-Plan need to have a periodic review and update to make sure the hazards are current

KDHE/KDEM –

- KDHE/KDEM encourages this type of activity
- KDHE/KDEM offers some training, some of it web based

NRC –

- Other than notification, NRC was not involved; NRC has a larger role
- The NRC Ops Center works with the State EOC
- NRC provides dose calculations
- NRC would dispatch a resident inspector from WCNOC

KHP –

- Emphasis on the need to be aware of hazards
- Unified command structure needs to be invoked early, tasks assigned quickly
- Media response needs to be disciplined, one voice from the command post with scripts, vetting information before it gets out, strict adherence to the message
- Local first responders should get orientation tours
- Relationship building & understanding of roles & responsibilities is an important function of this type of exercise
- The State Operations Center relationship to emergency response should be transparent
- A list of individuals should be developed before an exercise
- There should be first responder training for KHP

FBI –

- It is helpful to know names & faces before an event

Potential Followup Actions

1. Revise KSU Reactor Emergency Plan building maps periodically to reflect current hazards

2. Resolve the issue of how to clear a building

3. Evaluate information from the State of Kansas relative to protective actions related to radiological dispersion devices

4. Offer first responder training for KHP