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Nuclear Security Culture Assessment of Nonnuclear Facilities

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Nuclear Security Culture Assessment of Nonnuclear Facilities

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Presentation Outline

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- Introduction
- Risk
- Risk Index
- Methods
- Results/Discussion
- Conclusions

Introduction

- Radioactive material and radiation generating device use at nonnuclear facilities, such as academic institutions and hospitals, are common practice.
- Securing radioactive sources has become increasingly important given the rising threat of radiological terrorism.
- While radiation safety has long been established in most applicable industries, the importance of nuclear and radiological source security has lagged behind in nonnuclear material specific industries, such as academic institutions and medical facilities.
- Nuclear security culture, strong or weak, helps determine protection against malicious acts leading to unacceptable radiological conditions or other adverse situations.
- **The purpose of this project is to develop a nuclear security potential risk index (PRI) for nonnuclear (radiological) facilities.**

Risk

RISK – PROBABLE FREQUENCY AND PROBABLE MAGNITUDE OF FUTURE LOSS!

IN OTHER WORDS, HOW FREQUENTLY SOMETHING BAD IS LIKELY TO HAPPEN AND HOW MUCH LOSS IS LIKELY TO RESULT.

RISK ANALYZED WITHIN OTHER PROFESSIONS BUT NOT MUCH HAS BEEN DONE IN THE SECURITY OF RADIOACTIVE MATERIALS!!

DECOMPOSITION OF RISK INTO ITS COMPONENTS ->REASONABLE JUDGEMENT

Risk Component Landscape

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- Assets
  - Radioactive sources have a wide range of characteristics (such as activity) that make them attractive in varying degrees to adversaries.
  - Sources are categorized based on the potential to cause harm if used for malicious purposes.
    - CAT 1 : Teletherapy, irradiator, Gamma knife ~6000Ci
    - CAT 2: HDR brachytherapy sources
    - CAT 3: LDR brachytherapy sources
    - CAT4: High activity sources, check sources
    - CAT 5: Nuclear medicine, PET short half-life sources

Risk Component Landscape

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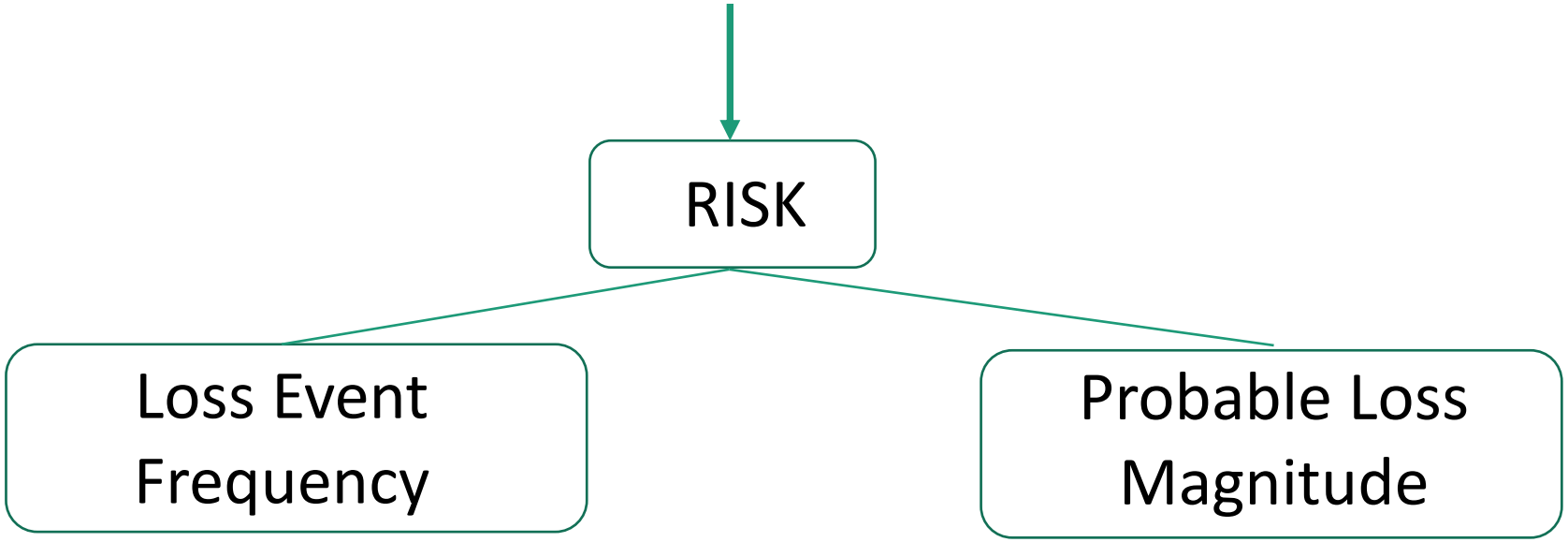
- Threats
  - Suspected or actual theft of a radioactive source
  - Unauthorized intrusion into a source storage area
  - Unauthorized access to or unauthorized use of a source
  - Sabotage of the device
  - Theft during transport of radioactive material
  - Failure or loss of security systems that are essential to the protection of radioactive sources.
  - Security breach.

Decomposing Risk

R = P *C

where R= Risk, P=Probability, C= Consequences



Decomposing Risk

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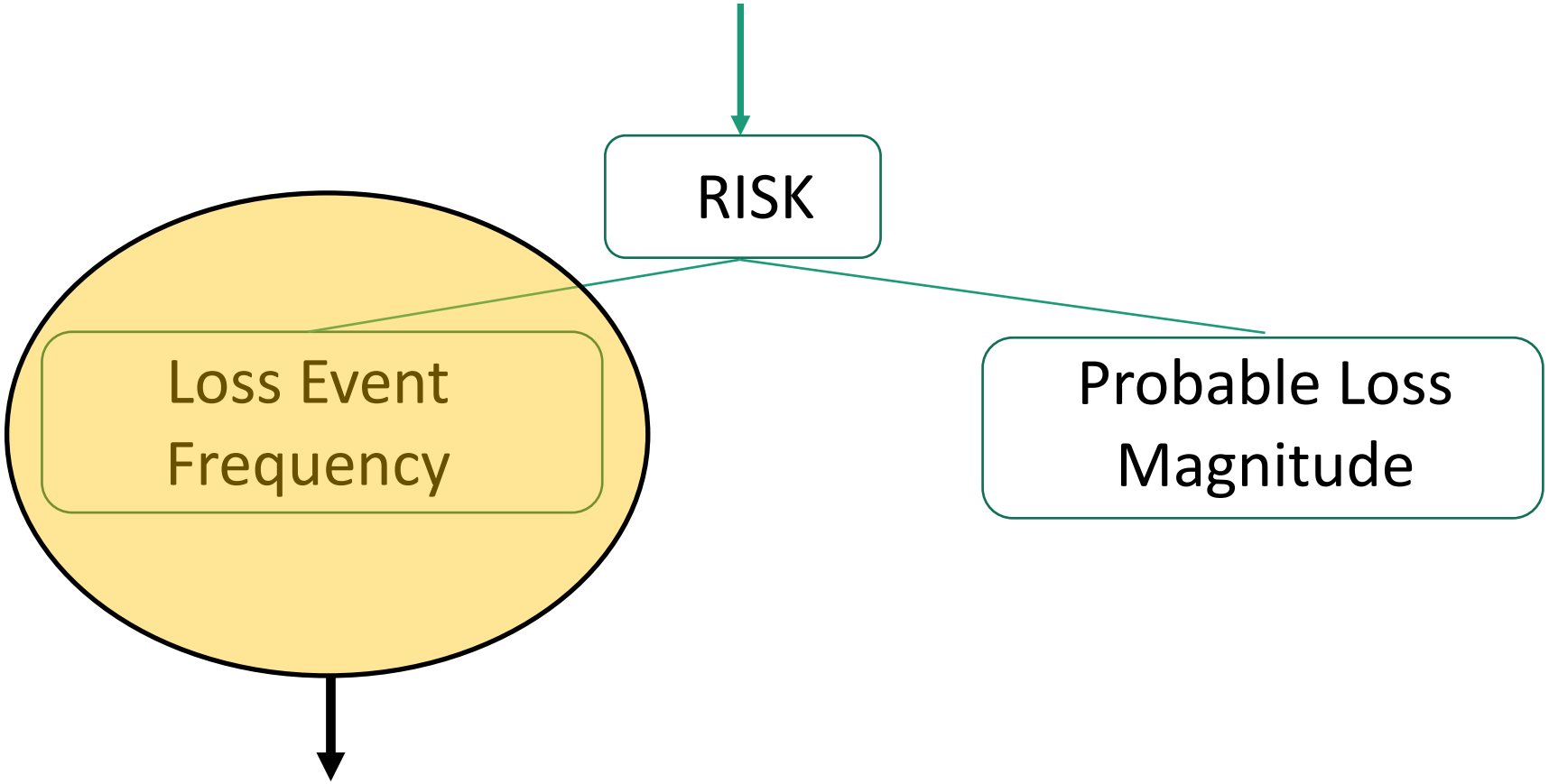
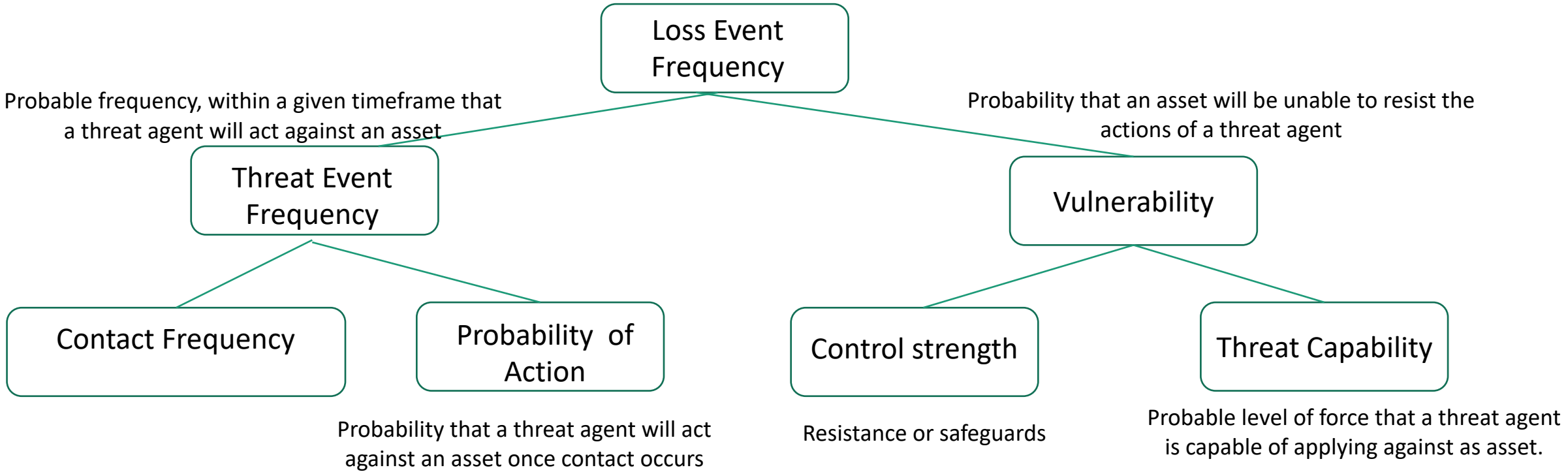
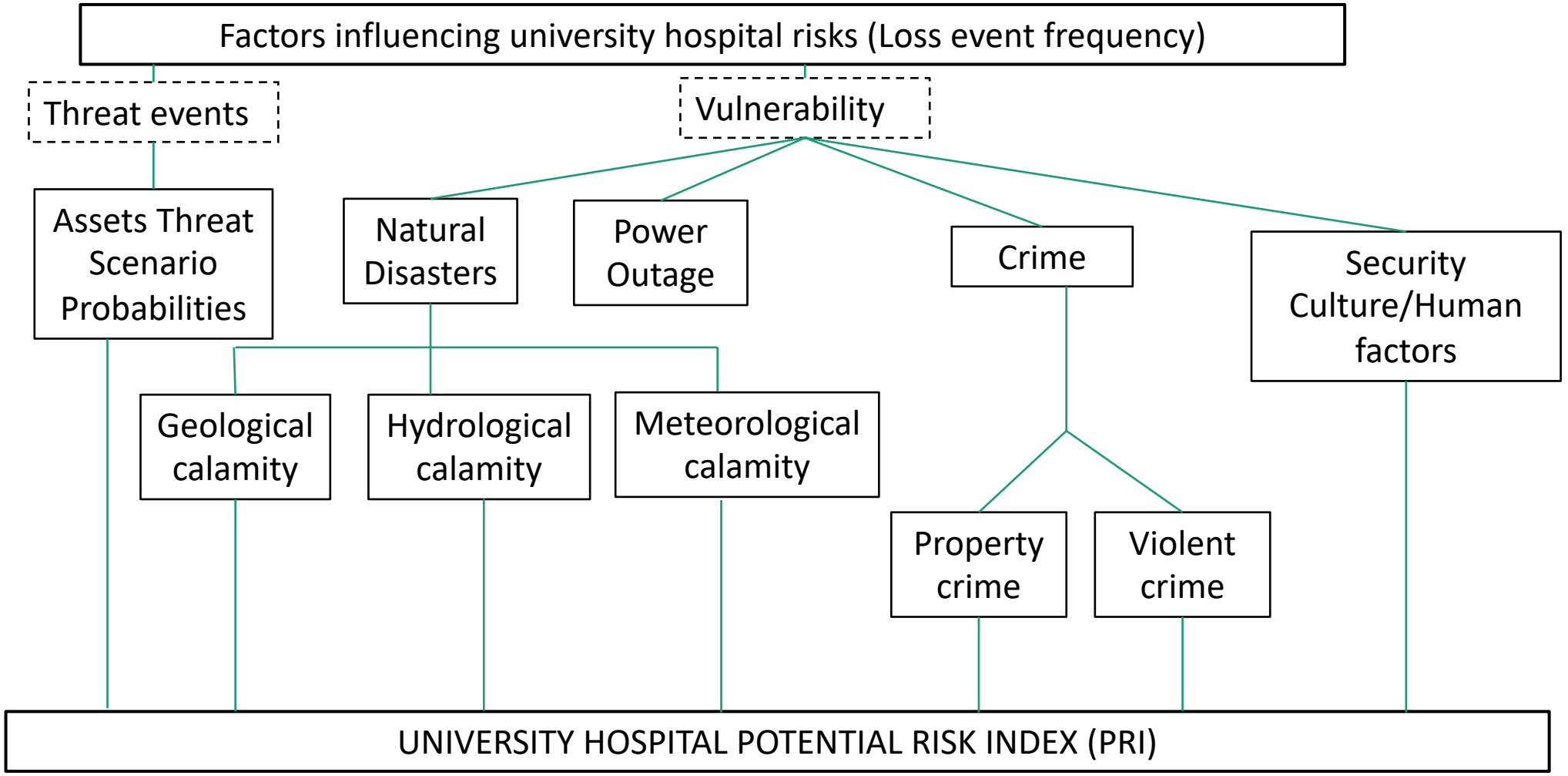


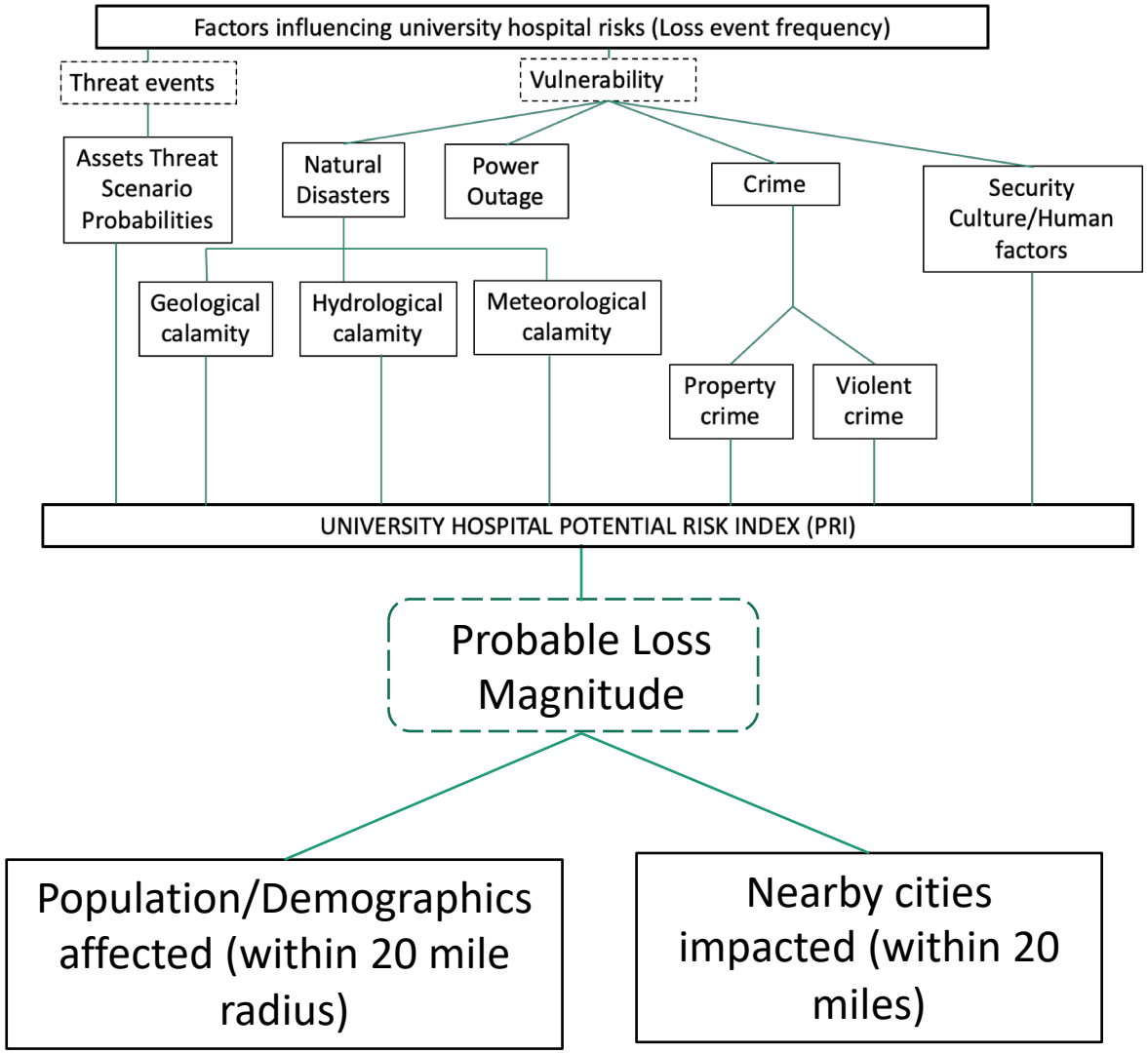
Risk Taxonomy



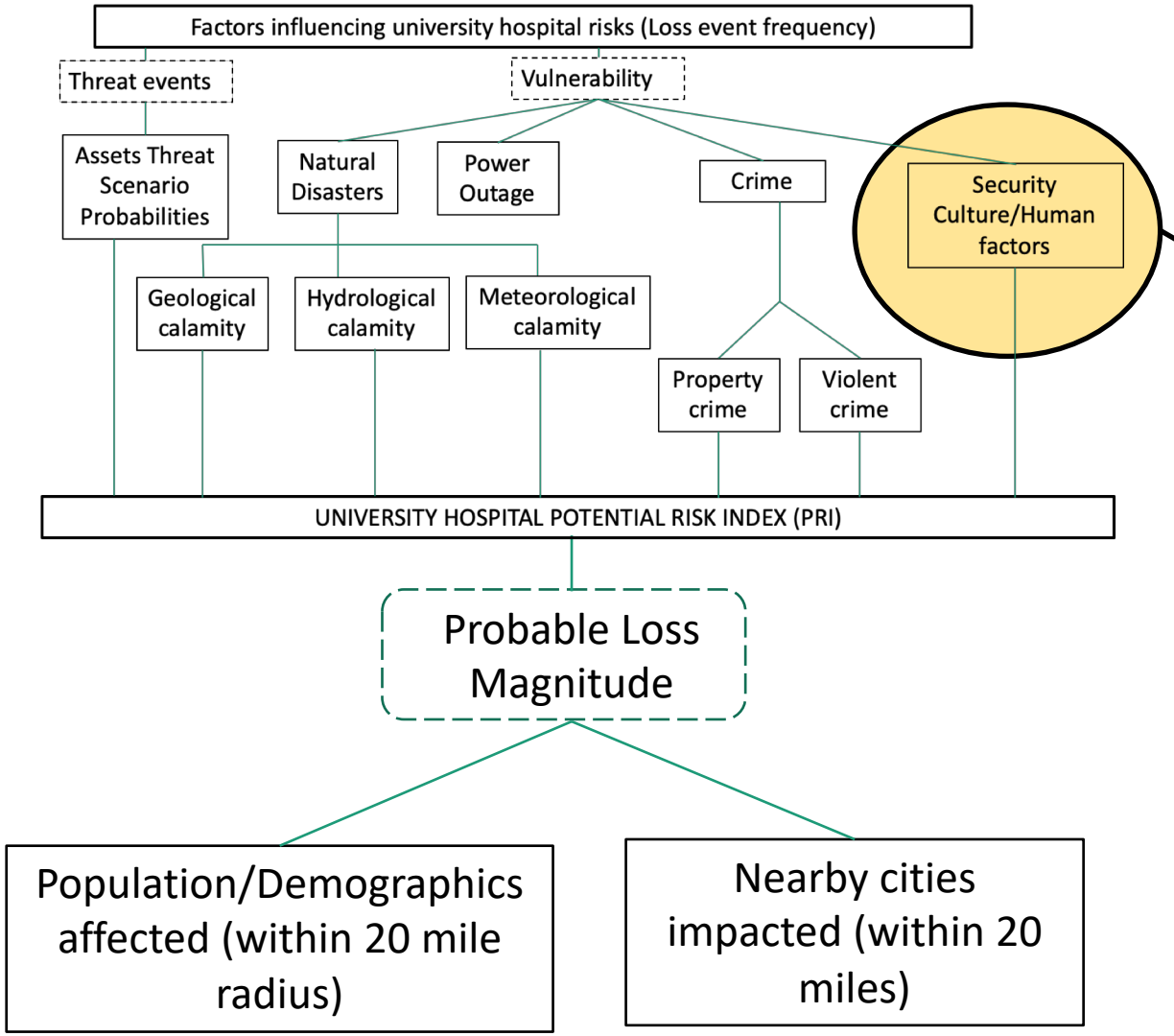
Conceptual Framework for Risk Index



Conceptual Framework for Risk Index



Conceptual Framework for Risk Index



- **Difficult to quantify**
- **Requires assessment**
- **Results used to develop a quantifiable input (scaling factor) for the model**

Methods

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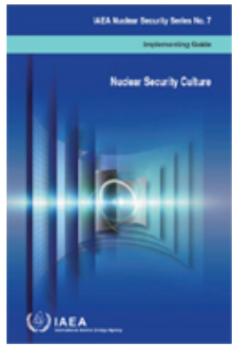
- Surveys and interviews are the primary tools used for initially assessing nuclear security culture.
  - "The assembly of characteristics, attitudes and behaviors of individuals, organizations and institutions, which serve as a means to support and enhance nuclear security"
- Focus of this presentation on nuclear security culture assessment at a comprehensive university (also performed at a medical center)
- Developed survey tools and interview questions
- Two surveys conducted - one for radiation users and one for entire campus
  - Radiation users
    - Questions segregated into five categories: awareness, policy, enforcement, leadership, and behavior (39 questions plus demographics)
      - 16% response rate
  - Campus
    - Questions primarily focused on general awareness of safety and security (14 questions plus demographics)
      - 15% response rate

Methods

- Surveys developed from the following guidance documents:



Nuclear Security Culture

Implementing Guide

IAEA Nuclear Security Series No. 7

Subject Classification: 0503-Tracers

English STI/PUB/1347; (ISBN:978-92-0-107808-7); 37 pp.; 2 figures; € 30.00; Date Published: 2008

Download PDF (0.50 MB)

This book is also available in:

Arabic Chinese French Spanish

Description Keywords Rights and permissions

This publication defines the basic concepts and elements of nuclear security culture, with the aim of providing Member States with international consensus guidance on planning and implementing a programme to improve nuclear security culture. Particular emphasis is placed on areas such as regulation, government institutions and general public awareness. The report provides an overview of the necessary attributes of an effective nuclear security culture and emphasizes that its success is ultimately dependent on individuals: policy makers, regulators, managers, individual employees and, to a certain extent, members of the general public. Practical methods to assess and improve the effectiveness of security culture are also included.

Self-assessment of Nuclear Security Culture in Facilities and Activities

Technical Guidance

IAEA Nuclear Security Series No. 28-T

Subject Classification: 0600-Nuclear and Radiological Safety

English STI/PUB/1761; (ISBN:978-92-0-111616-1); 107 pp.; 8 figures; € 55.00; Date Published: 2017

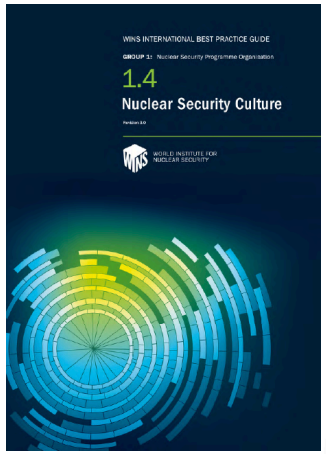
Download PDF (0.86 MB)

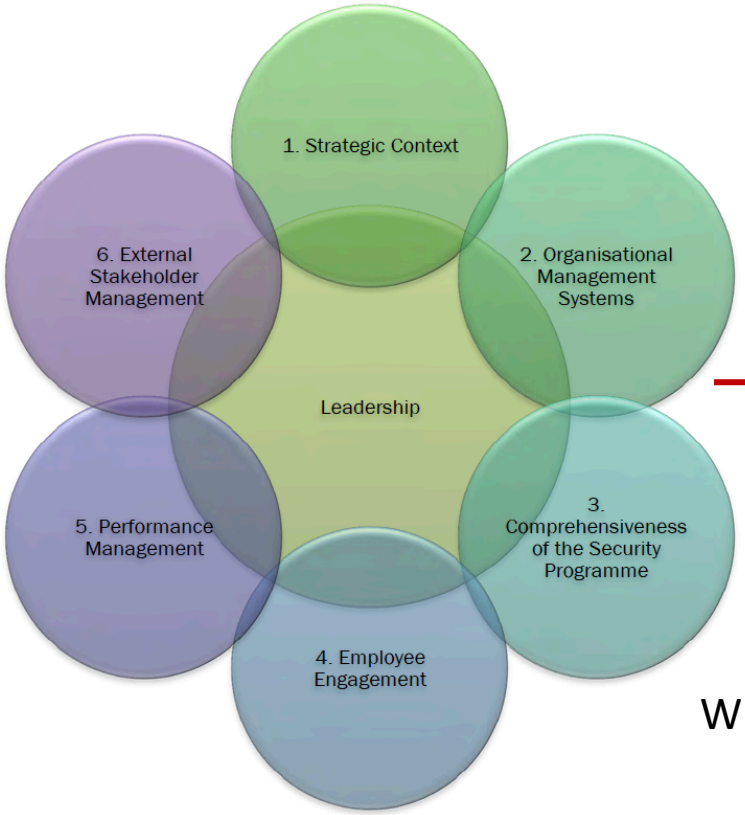
Description Keywords Rights and permissions

The IAEA has developed a comprehensive methodology for evaluating nuclear security culture. When implemented by a State, this methodology will help to make nuclear security culture sustainable. It will also promote cooperation and the sharing of good practices related to nuclear security culture. This publication is the first guidance for assessing nuclear security culture and analysing its strengths and weaknesses within a facility or activity, or an organization. It reflects, within the context of assessment, the nuclear security culture model, principles and criteria set out in the Implementing Guide, IAEA Nuclear Security Series No. 7. This guidance will be useful for organizations and operating facilities in conducting the self-assessment of nuclear security culture by providing practical methods and tools. It will also help regulatory bodies and other competent authorities to understand the self-assessment methodology used by operators, encourage operators to start the self-assessment process or, if appropriate, conduct independent assessments of nuclear security culture.

Methods

- Surveys developed from the following guidance documents:





LEVEL	CHARACTERISTICS
1 WORLD CLASS	Leadership has defined and documented a comprehensive Security Policy that is overseen by the Board of Directors and sets organisational expectations and requirements. The maintenance of an effective, performance-based, performance-tested security programme is seen as a core company value. Leading indicators for security preparedness are used extensively throughout the organisation. There is no sense of security complacency in any part of the organisation. All staff give security the same high priority they give nuclear safety. All employees share the belief that security is a critical aspect of their job and that they share responsibility for preventing security incidents. Employee engagement is excellent, with multiple opportunities for feedback and learning from experience.
2 HIGHLY EFFECTIVE	The majority of staff in the organisation believe that security is important. Therefore, they lead by example. Managers and frontline staff understand that security vulnerabilities can be caused by a variety of events and that managerial behaviour needs to constantly reinforce the importance of effective security arrangements. Frontline staff accept personal responsibility for security and take appropriate action when security weaknesses are identified. The organisation puts significant effort into proactive measures to prevent security weaknesses, including employee engagement and the testing of arrangements. Security performance is measured using all data available, including leading indicators.
3 GOOD	Security is recognised as an important business risk and is overseen by a senior management committee. The organisation believes that security threats are real and that staff at all levels should be involved in helping to achieve an effective security culture. The Security Programme is understood and endorsed by the organisation's senior management. The majority of staff are prepared to support the security objectives and to take personal responsibility for their own security and those around them. Employee engagement is developing, and security briefings allow feedback from staff. Security performance is monitored, and some leading security indicators are being used.
4 DEVELOPING	Security is seen in terms of regulatory compliance and the adherence to rules and procedures that have been set by the regulator. Security is reluctantly seen as a business risk; senior management view it as an unavoidable financial overhead and believe the risk of an incident is extremely small. The Security Department owns the security programme and provides only general, periodic reports to senior management. Employee engagement is limited to periodic briefings about security rules. Security performance is measured by lagging indicators, such as the number of occasions when the regulator has identified security non-compliances. Senior managers are reactive to their involvement in security. Staff comply with security rules, but they consider them to be intrusive.
5 INEFFECTIVE	Security is defined and thought about only in terms of compliance with regulations at minimum cost. Security is not seen as a key business risk, and the postulated threats are not considered to be real. Security is seen as the sole responsibility of the Security Department and/or guard force. Excessive and unnecessary secrecy prevent employee engagement with the security arrangements. Security violations and shortcuts in procedures are not considered serious. Most frontline staff are uninterested in security and see it as an obstacle to getting their work done.

WINS – Security Culture Maturity Scale

Methods

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Awareness Questions	Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree
Purdue University has in place written policies, rules, or procedures for termination of employment as they pertain to security.	1	2	3	4	5	6	7
Action is taken by Purdue University when nuclear and radioactive material security performance does not meet expectations.	1	2	3	4	5	6	7
I know how the security aspects of my work/research fit into the broader picture of security at Purdue University.	1	2	3	4	5	6	7
Processes are in place to identify the mandatory security requirements applicable to me.	1	2	3	4	5	6	7
I clearly know the difference between safety and nuclear and radioactive material security.	1	2	3	4	5	6	7
Nuclear and radioactive material security is as important as safety.	1	2	3	4	5	6	7
Threats on nuclear and radioactive material security are increasing domestically and globally.	1	2	3	4	5	6	7
Purdue University is ready to respond appropriately to nuclear and radioactive material security threats.	1	2	3	4	5	6	7

Awareness category survey questions used for university nuclear security culture assessment.

Methods

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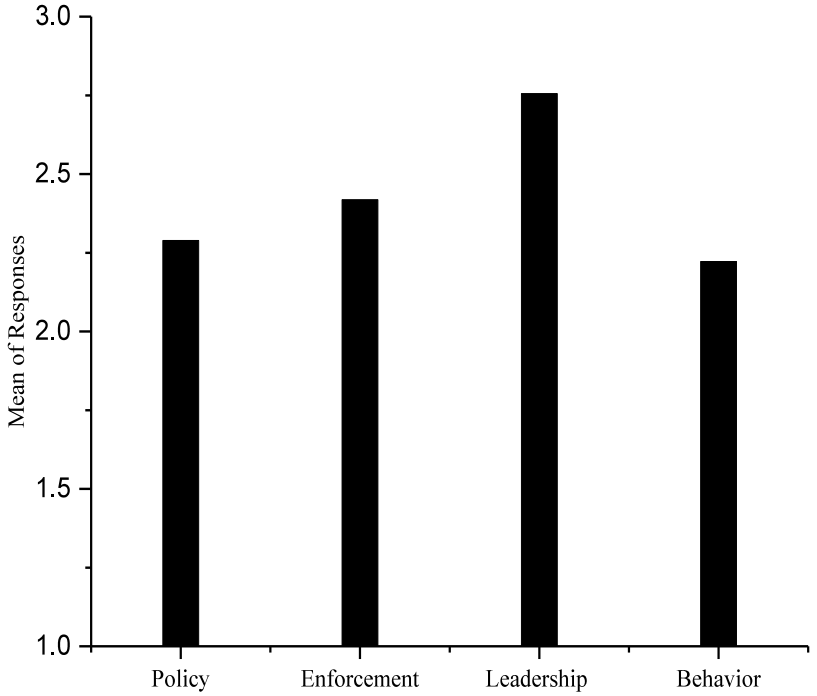
Awareness Questions	Responses						
	Strongly Agree	Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Disagree	Strongly Disagree
The University has in place written policies, rules, or procedures for termination of employment as they pertain to security.	— 1 —	— 2 —	— 3 —	— 4 —	— 5 —	— 6 —	— 7 —
Action is taken by the University when nuclear and radioactive material security performance does not meet expectations.	— 1 —	— 2 —	— 3 —	— 4 —	— 5 —	— 6 —	— 7 —
I know how the security aspects of my work/research fit into the broader picture of security at University.	— 1 —	— 2 —	— 3 —	— 4 —	— 5 —	— 6 —	— 7 —
Processes are in place to identify the mandatory security requirements applicable to me.	— 1 —	— 2 —	— 3 —	— 4 —	— 5 —	— 6 —	— 7 —
I clearly know the difference between safety and nuclear and radioactive material security.	— 1 —	— 2 —	— 3 —	— 4 —	— 5 —	— 6 —	— 7 —
Nuclear and radioactive material security is as important as safety.	— 1 —	— 2 —	— 3 —	— 4 —	— 5 —	— 6 —	— 7 —
Threats on nuclear and radioactive material security are increasing domestically and globally.	— 1 —	— 2 —	— 3 —	— 4 —	— 5 —	— 6 —	— 7 —
The University is ready to respond appropriately to nuclear and radioactive material security threats.	— 1 —	— 2 —	— 3 —	— 4 —	— 5 —	— 6 —	— 7 —

Awareness category survey questions used for university nuclear security culture assessment (radiation users).

Results – Radiation Users

- Overall, the survey responses were in consensus among all four categories of the nuclear security survey assessment.
  - The range of response in all four areas varied between 2 and 3
  - Leadership category questionnaire statements ($\bar{x}$= 2.75, “somewhat agreement)

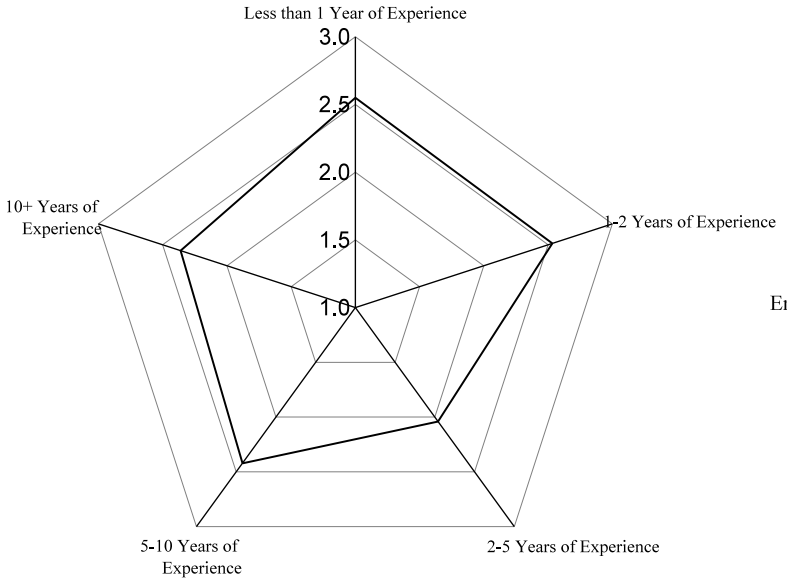


Response mean by nuclear security category

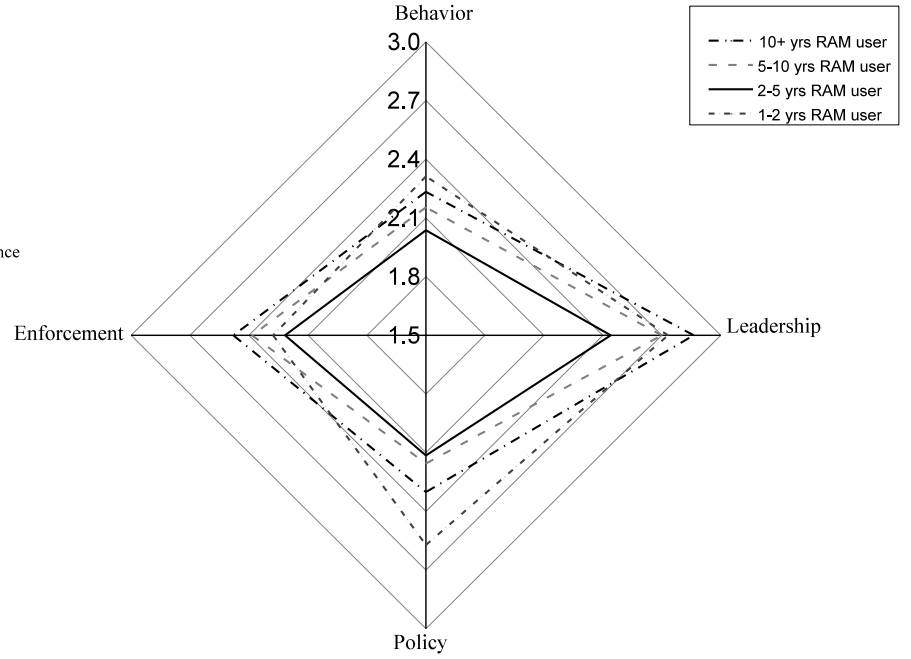
RANE, S., HARRIS, J., FOSS, E. and SHEFFIELD, C. Nuclear and Radiological Source Security Culture Assessment of Radiation Users at a University. Health Phys 115 4 (2018) 637-645.

Results - Radiation Users

- 2 to 5 y of experience in handling radioactive material appeared to have the highest level of nuclear security awareness, as evidenced by their attitudes toward the difference between nuclear security and safety, written policies and procedures related to security, and the overall importance of security-related threat and response.
- Radioactive material users with more experience felt the need to strengthen the overall assembly of characteristics in all four categories of nuclear security to enhance awareness in the university setting



Nuclear Security awareness by years of experience



Nuclear security category response by years of experience

Results - Radiation Users

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- Correlation
  - Absence of expected trend of increased nuclear security awareness with an increase in work classification, age, or years of experience as a radioactive material user.
  - Mean response results between all four categories showed a strong positive correlation with each other, followed by a moderate-to-strong correlation between age and work classification and age and years of experience as a radioactive material user, as expected.
  - No linear relationship found between the individual's response to a series of nuclear security questions and the associated cross section of experience, work position, and skills.

	Enforcement	Policy	Behavior	Leadership	Age	Degree	Sex	Work classification	Experience as a RAM[a] user
Enforcement	1.00	–	–	–	–	–	–	–	–
Policy	0.72	1.00	–	–	–	–	–	–	–
Behavior	0.70	0.67	1.00	–	–	–	–	–	–
Leadership	0.66	0.69	0.79	1.00	–	–	–	–	–
Age	0.04	−0.04	0.07	0.07	1.00	–	–	–	–
Degree	0.03	−0.12	−0.08	−0.08	0.58	1.00	–	–	–
Sex	0.10	0.12	0.05	−0.03	0.21	0.21	1.00	–	–
Work classification	0.11	−0.03	0.01	0.04	0.74	0.43	0.27	1.00	–
Experience as a RAM user	0.13	0.03	0.02	0.08	0.68	0.47	0.10	0.57	1.00

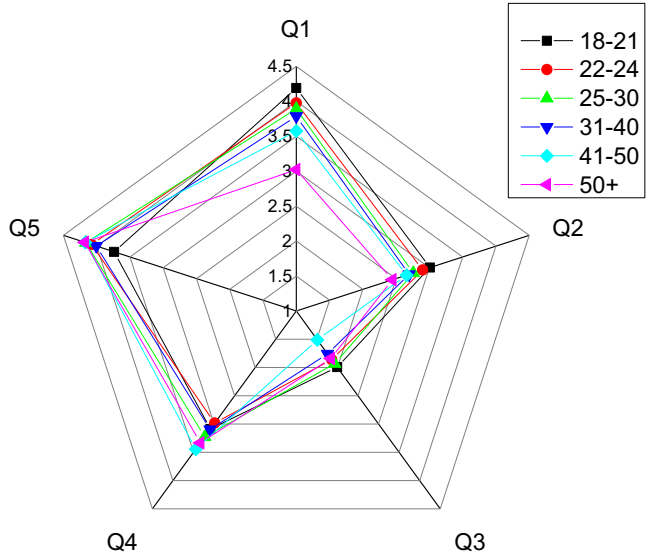
[a]RAM: radioactive material

Results - Radiation Users

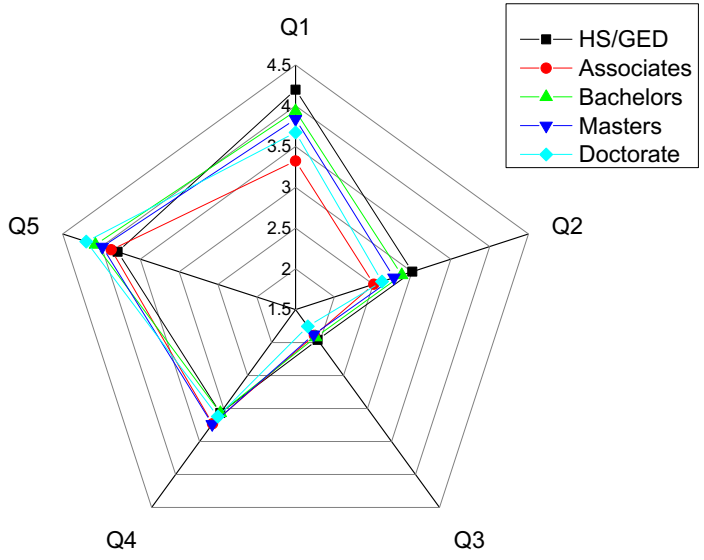
- Interviews
  - 10% of survey respondents participated
  - Most student participants struggled to distinguish nuclear security from nuclear safety.
  - Faculty interviewee responses aligned with the surveys
  - Senior management personnel considered nuclear security secondary to safety
  - Overall knowledge of nuclear security was very superficial.
- Cumulative response findings from surveys and interviews identified personnel, especially those with a well-developed knowledge of and practice in radiation safety, have taken nuclear security for granted.

Results - Campus

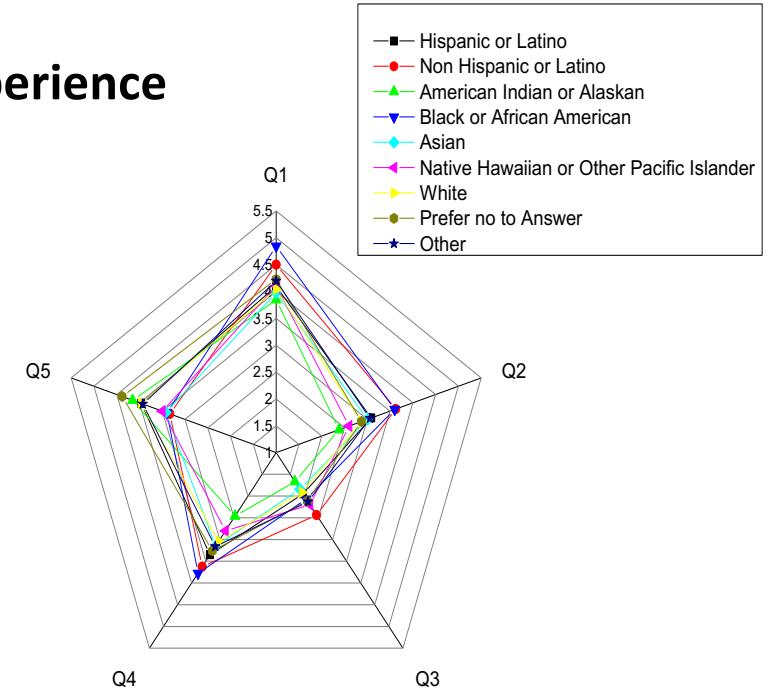
- Focus on understanding general awareness of radioactive and nuclear material safety and security by non-radiation users.
- Determine predictors of response (awareness) of general campus population
- Demographics: age, gender, education level, nationality, ethnicity, university classification (student, staff, faculty, etc.)
  - **Overall trend: awareness increased with increasing age, education, experience**



Nuclear Security General Awareness by Age.



Nuclear Security General Awareness by Degree



Nuclear Security General Awareness by Ethnicity

Results - Campus

- Chi-square test
  - P-value less than or equal to 0.05, then variables can be regarded as dependent and/or related
  - Strong evidence that demographics values are dependent or related. This is a important step to complete the Multivariable Regression

Chi-Square test: Demographics Variables			
Categorial Variables	Value	df	P-value
Age vs. Degree	4501.618	30	**≤0.001**
Age vs. Gender	2237.575	24	**≤0.001**
Age vs. Ethinicity	2232.01	240	**≤0.001**
Age vs. Nationality	2164.053	504	**≤0.001**
Age vs.Work status	4577.85	36	**≤0.001**
Degree vs. Gender	2227.448	20	**≤0.001**
Degree vs. Ethnicity	2200.247	200	**≤0.001**
Degree vs. Nationality	2164.92	420	**≤0.001**
Degree vs. Work Status	4277.279	30	**≤0.001**
Gender vs. Ethnicity	2180.026	160	**≤0.001**
Gender vs. Nationality	1937.707	336	**≤0.001**
Gender vs Work Status	2229.105	24	**≤0.001**
Ethnicity vs Nationality	3605.082	3360	**0.002**
Ethnicity vs Work Status	2161.018	240	**≤0.001**
Nationality vs. Work Status	2085.94	504	**≤0.001**

Results - Campus

- ANOVA Regression
  - Indicates the overall effect between the demographic variables in the mean scores.
  - If P-value is less than or equal to 0.05, then variables have statistical significance - there are demographic variables that are dependent or related.
  - Age, Gender, Ethnicity, and Nationality were significant. These demographics had an effect in the survey responses.
  - Post hoc analysis performed to predict responses.
    - Age: Only the groups 18-21; 31-40 and 50+ presented significance
    - Gender: Only Female and Male gender differences were significant
    - Ethnicity: Asian ethnicity scored significantly different than White.
    - Nationality: North America only presented significance difference from Central and Southern Asia with Central and Southern Asia reporting more General Awareness than North America

ANOVA Regression for General Awareness				
Source	Type III Sum Of Squares Value	df	Mean Square	P-value
Corrected Model	66.479[a]	31	2.144	**<0.001**
Age	10.782	5	2.156	**0.001**
Degree	3.180	4	.795	0.175
Gender	21.041	3	7.014	**<0.001**
Work Status	2.890	5	.578	0.329
Ethnicity	13.510	7	1.930	**<0.001**
Nationality/Continent	9.070	7	1.296	**0.012**

R Squared =0.050 (Adjusted R Square =0.038)

Conclusions

- In this assessment, integrated inferences from completed surveys and interviews implied the necessity to foster training in nuclear security across all groups and likewise encourage the leaders to cultivate a security conscious environment.
- Results also reveals the weakness in effective communication of the importance of nuclear security across the institutions.
- Results are being compared with those performed at a large hospital (and one other university and hospital in progress), to develop a risk factor that will be integrated into the overall risk index being developed.

Acknowledgements

- Research Group:
  - Marcia Robinson (MS graduate student)
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Thank You!

Questions?