1. **Background and Goal of the present work**

A threat and security analysis concerning the Physical Protection System (PPS) of Nuclear material (NM) and Radioactive material (RM) is a complex sector because of their widely used. But their probable factors may be misrepresented by the incorrect performer to achieve particular anti-state goal in the form of deterrence and violence. Besides, threats in the forms of terrorism are nowadays seen from terrorists obtaining NM and RM in order to expand and fabricate radiological weapons specially capitalizing by the spirit of the fundamentalism and extremism. Therefore, a threat and security analysis and evaluation relating to the PPS of NM and RM dependent on the number of disparate and non-quantifiable features. These features involve technical, organizational, political, ethical and national security issues, and must be approached on the basis of expert judgments and evaluations. Hence, this study presents a comparative evaluation and assessment of threat and security interfacing. This paper gives an overview on the evaluation of safety and security. Relevant national and international community should treat equally the legitimate possession of the RM and NM from the viewpoint of terrorism impact. The latest developments and weaknesses on threat and security interfacing concerning the PPS of NM and RM are highlighted.

1. **Nuclear threat and security interfacing**

***2.1. Relation between Physical Protection System, Nuclear Threat and Security***

A Physical Protection System (PPS) consists of the physical protection personnel, organizational and technical measures and actions carried out by it. Hence, the overall objective of the PPS is usually to minimize the vulnerability to and opportunity for unauthorized removal of NM or RM in use of storage. Therefore, nuclear threat, security and safety should be viewed as complementary, and many of the measures designed to address one can also address the other. Synergies that exist between the processes applied to meet both physical protection and safety requirements should be fully exploited. However, Nuclear Security is the State’s responsibility. State should establish, implement, maintain and sustain an effective and appropriate Nuclear Security Regime to overcome nuclear threat by protecting persons, property, society, and the environment. In this analysis, a typical studies on facilities / capabilities in position, under-development and absence were considered as present strength, transitional maturity and national weakness respectively. The PPS demand vs. strength gap and preparedness on effective PPS development is shown in Fig-1 graphically.

**Fig 1** Typical strength-weakness-gap for PPS development

* 1. ***Facility Characterization: Physical Condition and Safety Considerations***

In continually changing threat environment, the security of nuclear reactor has become increasingly important, not only for operating reactors, but also for future commercial nuclear power reactors. So any new nuclear reactors must be adequately protected from nuclear threats, even as they continue to evolve. Approaching on security challenges for new reactor, state must have a "Security Policy" and must have a "Facility Security Plan". A threadbare analysis was carried out based on the national, regional and international malicious events on each threat. Genrally, nuclear safety and nuclear security have a common purpose - the threat overcome by protecting of people, society and the environment. Many of the principles to ensure protection are common, although their implementation may differ. Moreover, many elements or actions serve to enhance both safety and security simultaneously. In any nuclear power plant (NPP) perspective, opertor and owner are responsible for ensuring nuclear safety whereas the state is responsible for ensuring nuclear security.

* 1. ***Threat Identification and* *Possible Action Plans***

Probable threat and security status along with possible action plans analyzed are shown in Table 1. Threat parmaters are categorized as CT-I, CT-II and CT-III respectively, whereas security level (SL) is denoted as level 1, 2 and 3, respectively. Subsequently, emegerncy level (EL) is expressed as alert, site and monitoring which is dependent on the severity of impact and risk and hence, general, respectively. As for example, vehicle ramming is categorized as CT-I and the security status is the first level (SL: 1) indicating Alert Emergency enhanced possible action plans to be activation of specific supporting plan. Similarly, other parameters are categorized and their security status is shown in Table 1.

**Table 1** Probable threat and security status

|  |  |  |  |
| --- | --- | --- | --- |
| **Category (TC)** | **Probable Threat** | **Security Status** | **Possible Action Plans** |
| I | Vehicle Ramming  | SL: 1EL: Alert | Activation of specific supporting plan |
| II | Insider Threat | SL: 2EL: Site | Activation of specific supporting plan |
| Disruption of Building & Security Systems | SL: 2EL: Site | Activation of specific supporting plan |
| Workplace Violence  | SL: 2EL: Site | Activation of specific supporting plan |
| Explosive Device  | SL: 2EL: Site | Activation of specific supporting plan |
| III | Aircraft as a Weapon | SL: 3EL: General | Activation of Nuclear Emergency Response Plan |
| Natural disaster hampering nuclear security  | SL: 3EL: General | Activation of Nuclear Emergency Response Plan |
| CBR Release | SL: 3EL: General | Activation of Nuclear Emergency Response Plan |

1. **Evaluation of nuclear threat and security**

***3.1. Threat Assessment Model***

The system is designed using fuzzy inference system (FIS) in a form of “IF and THEN” rules which relate input and output variables. The multi fuzzy inference system for threat modelling consists of three fuzzy inference systems (FIS) is shown in Fig 2. The first fuzzy inference system (FIS 1) determines the overall capabilities. The second fuzzy inference system (FIS 2) determines the overall likelihood.



**Fig 2** Fuzzy threat assessment model

* 1. ***Evaluation of Threat Matrix***

Using MATLAB the fuzzy control surface was developed as shown in Fig 3. These can serve as a visual depiction of how the FES operates dynamically over time. The plot shows that when TC-I and TC-II increase, the SL will be higher.

|  |
| --- |
|  |
| **Fig 3** Graphically surface viewer for threat matrix |

1. **Conclusions and Acknowledgements**
	* The evaluation of the proposed model shows a system that can be effectively used for threat and security assessment on nuclear and radioactive materials.
	* This model will assist nuclear security persons or policy makers to categorize the threat levels comfortably and possible action plans accordingly.
	* The authors gratefully acknowledge MIST to provide necessary support the project and the work of experts who contributed to the presented results.