Importance of Psychometric Test of Anxiety to Curb Insider Threat in Nuclear Facilities

Sandeep Bhamidipati*, Arpita Datta and Alpana Goel

Amity Institute of Nuclear Science and Technology, Amity University Uttar Pradesh, Noida-201303, India

*Email: sandeepgringo@gmail.com

Abstract:

Insider threat in nuclear facilities is a serious concern and needs to be exterminated at the grass root level for the achievement of robust nuclear safety, security and safeguards. Human factor plays a vital role in this process and development of human reliability programmes (HRP) is very important to achieve safe and secure uses of nuclear materials and facilities for various applications. The human mind is enigmatic and thought process is dynamic in nature. In this context, various psychometric tests can be conducted to assess the personality, ability and integrity of the nuclear personnel. Rigorous psychological testing of nuclear personnel in various level is needed in monthly or weekly basis to counteract the insider threat. But most of the personality tests and there after interpretations of results are time consuming. In this regard, state – trait anxiety inventory (STAI) questionnaire or Beck anxiety inventory (BAI) may be preferable to conduct. Humans tend to exhibit anxiety whenever doing something malevolent and therefore physiological arousal like sweating, panicking etc, takes place. This serves as a background for STAI/ BAI psychometric test and by conducting this test on a monthly or weekly basis, one can pinpoint the anxiety levels in an individual. The STAI and BAI consists of 20 and 21 questions respectively, relating to the feelings/mood of individuals at that instant and the test taker have to mark the response on a Likert scale from 1 to 4. Greater scores represent the presence of high anxiety levels and vice versa. Particularly, in STAI, out of 20 questions, half of the questions are reverse scored and questions are jumbled every time to prevent the test taker from pretending the low anxiety levels by marking the responses in a particular accustomed way. As very minimum time is required to conduct STAI test, this test even can be conducted on daily or even hourly basis, whenever and wherever necessary.

Keywords: Nuclear security, insider threats, psychology, psychometric tests.

1. Introduction:

The achievement of robust nuclear security in nuclear facilities is an ongoing process and continuous reforms are needed to achieve immaculate nuclear security culture. There are many factors contributing to it for instance, physical protection systems (PPS), nuclear personnel, NMAC systems, cyber security etc,. Of all these factors, human factor plays a crucial role in implementing the perfect nuclear security plan that is designed according to the specific nuclear facility. The recruitment of skilled and trained nuclear professionals is very important and it's the responsibility of employees to serve the facility with proper expertise and to maintain their sincerity throughout their job tenure. According to IAEA guidelines, assessments and trustworthiness checks have to be performed continuously throughout the life-cycle of the personnel to assure their loyalty, performance management and commitment to the organisation, and this in turn aids to achieve strong nuclear security culture. [1,9]

In this context, insider threat in nuclear facilities is an alarming situation and an immense menace to the nuclear industry. According to IAEA, the term 'insider' is defined as an individual with authorised access to [nuclear material,] associated facilities or associated activities or to sensitive information or sensitive information assets, who could commit, or facilitate the commission of criminal or intentional unauthorised acts involving or directed at nuclear material, other radioactive material, associated facilities or associated activities or other acts determined by the State to have an adverse impact on nuclear security. [2]

Some of the instances of insider threats in nuclear facilities are, the sabotage at Belgian Doel 4 nuclear power reactor incident in 2014 and a protracted theft of 1.5 kg of HEU in Russia by an insider in 1992 and many more. [3, 4] So there is a strong need of the hour to totally exterminate the insider threats in nuclear facilities at the grass root level. There are many reasons of motivation for insiders like money, vengeful propensities in case of disgruntlement, abnormalities in mental health and any kind of coercion from external adversaries etc,.[2, 3, 4] Of all the above mentioned reasons, in a study on insider threat and computer system sabotage, SEI (software engineering institute) found that the majority of insiders who undertook malicious actions were triggered by job related dissatisfactions and key conclusions from different studies have demonstrated that the most common motive for an insider to become a threat is disgruntlement. [3, 4] The human mind is so enigmatic and behaves erratically at times and thought processes are also dynamic in nature. It's very difficult to exactly predict the mood and temperament of employees at a particular instant and therefore unforeseen incidents might happen at any moment. So it's better to be super vigilant all the time and in accordance with IAEA guidelines, behavioural observations and personnel reliability programmes (PRP's) are being conducted in nuclear facilities frequently. [1]

So, as a part of PRP's, different psychometric tests are being conducted to verify the trustworthiness, ability, personality, performance and also to monitor the well-being of nuclear personnel. Random drug and alcohol testing is also being conducted to reassure that the personnel are devoid of physical and mental impairment and very much fit to do their job roles. [1] This paper discusses some of the psychometric tests like state and trait anxiety inventory (STAI), depression – anxiety – stress scales (DASS 21) and Beck's anxiety inventory (BAI) to measure anxiety, stress and depression levels of nuclear personnel. These tests are very simple to administer and both test taking and results interpretation takes only about 15 minutes. So these tests can be conducted on nuclear personnel on a daily or weekly basis, wherever and whenever required and can monitor the anxiety and stress levels and any deviation from the normal scores indicates the presence of anxiety, stress or depression in the personnel and therefore suitable measures are to be taken to mitigate those conditions. If the anxiety and stress levels are high in nuclear personnel, being astray from normal, we cannot rule out the possibility that the particular individual might be involved in an anxiety provoking situation and there is a hunch that the individual might involved in a malice act that can threaten the nuclear security, for instance the abrupt or protracted theft of nuclear material or the sabotage of any equipment etc,. Since, we cannot compromise upon the loss and unauthorised access to radioactive material as it have adverse effects on public health and safety, even a minute detail of deviant behaviour matters the most in nuclear security aspects and therefore proper action is to be taken to mitigate the risks associated with altered behaviour of nuclear personnel. In this way psychometric tests are very much useful in nuclear facilities to detect and also to curb the insider threats.

2. Description of the psychometric tests:

Psychometric tests are an standard, scientific and authentic method of measuring the psychological aspects of an individual, namely the skills and knowledge, abilities, attitudes, personality traits, clinical constructs and mental disorders etc., and psychometric tests also helps to determine the extent to which an individual's aptitude and personality match to that specific job role and also checks the individual's trustworthiness and state of mind at any moment. Some of the psychometric tests described in this paper are as follows:

1. STAI:

STAI is an acronym for state and trait anxiety inventory. It consists of two forms, STAI form Y-1 for state anxiety and Y-2 for trait anxiety and each form contains 20 questions. The state anxiety scale (S-Anxiety) evaluates the current state of anxiety, asking how respondents feel

"right now", using items that measure subjective feelings of worry, nervousness, apprehension, tension because of the activation/arousal of the ANS (autonomic nervous system) in response to a specific threat. Whereas the trait anxiety scale (T-Anxiety) measures the feelings of stress, tension and worry of individuals on daily basis across typical situations in an individual's life. The responses of the questions are marked on a Likert scale from 1 (not at all) to 4 (very much so). The total anxiety scores ranging from 20 to 80 and high scores indicates the presence of high anxiety levels and vice versa. Some of the test questions are negatively worded and therefore reverse scoring is done, for instance if an individual marks option 1 then the score is 4 and so on. Internal consistency coefficients for the scale have ranged from .86 to .95; test-retest reliability coefficients have ranged from .65 to .75 over a 2-month interval (Spielberger et al., 1983). [6]

2. DASS-21:

DASS -21 is a quantitative measure of distress along the 3 axes of depression, anxiety and stress. It consists of 21 questions and 7 items for each sub scale. The responses are marked on a Likert scale ranging from 0 (never) to 3 (almost always). Scores are generated by adding all the responses and sometimes added scores can also be multiplied by factor 2. Higher scores means the presence of severe depression, anxiety and stress levels. The reliability of DASS-21 showed that it has excellent Cronbach's alpha values of 0.81, 0.89 and 0.78 for the sub scales of depression, anxiety and stress respectively. [8]

3. BAI:

BAI means Beck's anxiety inventory is a self report measure of anxiety and it consists of 21 items, which are generally the symptoms of anxiety like feeling nervous, scared etc., The responses should be marked on a Likert scale starting from 0 (not at all) to 3 (severely-it bothered me a lot). Internal consistency for the BAI = (Cronbach's a=0.92) and test-retest reliability (1 week) for the BAI = 0.75 (Beck, Epstein, Brown, & Steer, 1988). The validity of the BAI was moderately correlated with the revised Hamilton Anxiety Rating Scale (.51), and mildly correlated with the Hamilton Depression Rating Scale (.25) (Beck et al., 1988). [7]

3. Test setting and participants

In order to showcase how psychometric tests works and how the results and findings of the tests can prevent the insider threats in nuclear facilities, we (authors) have conducted the tests on Amity institute of nuclear science and technology (AINST) department students. The AINST department

is an institute in Amity University, Noida, India and there are 25 students studying nuclear science in bachelors and masters level. AINST consists of different laboratories with category 5 sealed radioactive sources of different radioisotopes that are being used to carry out the academic experiments using GM counters and scintillation detectors. Of course, according to IAEA guidelines, the protection of category 5 radioactive sources and the associated nuclear security programme is not as stringently implemented as category 1 and 2 sources but sufficient measures are to be taken according to threat situation. [4] And in view of COVID-19 there is a limitation to get access to nuclear facilities in India and therefore we (authors) decided to conduct psychometric tests in academic setting as a demo and if this process works then one can extend this idea, further to nuclear facilities and can test the anxiety levels of personnel in nuclear facilities instantly.

1. At first, the STAI test has been administered on all students in the first week and according to the responses given by students, the scoring is done appropriately and results are also analysed.
2. After two weeks, DASS 21 test has been conducted on all students and the scoring is done according to the responses marked by the students.

Table: 1 - Scores of state & trait anxiety (STAI) and anxiety, stress and depression (DASS21) of 25 students in AINST

Subject #	State anxiety	Trait anxiety	Anxiety	Stress	Depression
Subject-1	49	45	6	11	0
Subject-2	46	49	3	8	3
Subject-3	61	62	10	13	7
Subject-4	68	66	9	14	11
Subject-5	33	37	4	5	14
Subject-6	42	45	11	11	10
Subject-7	20	20	10	13	9
Subject-8	41	48	7	7	2
Subject-9	24	24	5	9	3
Subject-10	50	51	4	7	7
Subject-11	37	47	13	12	15
Subject-12	50	50	0	0	0
Subject-13	65	61	13	17	14
Subject-14	36	41	3	5	2

Subject-15	61	50	8	11	10
Subject-16	32	36	4	8	5
Subject-17	46	43	6	9	5
Subject-18	35	41	10	8	7
Subject-19	36	49	13	5	12
Subject-20	41	45	8	9	3
Subject-21	31	28	21	12	11
Subject-22	41	51	4	8	0
Subject-23	53	47	8	12	7
Subject-24	31	32	2	4	2
Subject-25	42	48	16	11	4

4. Results, Findings and Explanation:

1. Subjects 3, 4, 13 and 15 have high state and trait anxiety levels from the beginning and therefore they are not at all suitable for doing job roles in nuclear facilities, particularly as control room operators. The subjects showed high anxiety levels over the three weeks in both the psychometric tests and they actually need some psychological interventions to reduce their anxiety levels.
2. Subject 9 have very low/normal state and trait anxiety levels and after 2 weeks, the subject recorded low anxiety, stress and depression levels via DASS 21. Therefore, subject 9 is very much fit for the role of control room operator and is a very trustworthy person as of now.
3. Subjects 5,16, 24 also have low state and trait anxiety levels. So they are alternative option for the role of control room operators. But subject 5 got high depression scores according to DASS 21 test. So that individual has to improve the psychological well-being.
4. Interestingly, subjects 7,11,18, 19 and 21 have low state and trait anxiety levels, but after two weeks the subjects reported extremely high anxiety levels after conducting DASS 21. So the subjects might involved in situations that trigger higher anxiety. So the subjects 7,11, 18, 19 and 21 might be the potential insiders, but that is too early to say so.

   For time being, it's better to suspend 'two factor rule' and access controls to the above subjects until further verification and testing of their trustworthiness and anxiety levels.
5. The anxiety levels of subjects 20 and 23 are in moderate levels on STAI and reported high anxiety via DASS 21 after two weeks. The anxiety levels of subjects 6 and 25 are moderate levels on STAI but increased further after two weeks via DASS 21. So there is a possibility

that the subjects 6, 20, 23 and 25 are potential insiders but further investigation is required. For security reasons, it's better to suspend 'two factor rule' to the above subjects. This means these subjects are not authorised to take part in high level security operations.

6. Subject 10 has initially high anxiety levels, recorded via STAI and showed improvement over the two weeks and recorded low anxiety and normal stress levels which is a good sign.
7. The most suspicious individual is "subject 12". Because the subject has high state and trait anxiety levels but recorded zero depression, anxiety and stress levels via DASS 21. While inspecting all the scoring sheets of subject 12, it has been noticed that the subject has marked all the responses in a particular way, for instance subject 12 marked all options as '2' in STAI and marked all his responses as '0' in DASS -21 throughout the tests.

   Overall the subject 12 is behaving in a diplomatic and tactful way. By marking the responses in a specific way, subject-12 wants to mask his original mental state. This is the main characteristic of an insider. By primary inspection of his altered anxiety scores, we get to know about the individual and further by clearly inspecting his response sheets it is evident that the subject-12 shows deviant behaviour. Subject-12 might be an active and nonviolent adversary, but not impulsive and want to take calculated risks in sabotage or theft of nuclear materials. Therefore, apprehension or confrontation of subject-12 is necessary or even termination from the services is also a good option.
8. The results of the subjects 1, 2, 8, 14, 16, 17 and 22 are very much consistent over the three weeks i.e. the anxiety, stress and depression levels are almost same with a little bit of fluctuations and no major alteration is observed. Therefore, we can infer that the well-being of these individuals is good and they are reliable and trustworthy.

5. Further Measures:

1. After the results interpretation and findings, it is recommended to sort out the personnel in red, yellow and green category. [9]
2. The personnel in green zone should be given positive work appraisal and encouragement for sincerely doing his duties and this serves as a positive reinforcement to work more effectively.
3. Those personnel who are in yellow category needs to improve their trustworthiness in the upcoming tests and until then behavioural observations are to be continued with more vigilance.

4. Those personnel who are in red category should give proper reason for his deviant behaviour and background checks should be performed according to the reasons or details given by that personnel and in case there is a mismatch, between the details provided by that personnel and the background check results, the personnel should be terminated from the services because one cannot compromise on the nuclear security aspects and all these decision making rights lies with the operator and competent nuclear security management authorities. For instance, a nuclear personnel with high anxiety levels, when questioned says that the person has family problems then as an immediate measure, background checks should be conducted by contacting the personnel's family and friends etc., and if there is no actual problem reported, then the personnel is lying and he/she might be an potential insider.

6. Recommendations:

Some of the recommendations about how these tests are to be conducted and when or where to conduct etc., are discussed here :

1. In nuclear facilities, it's better to conduct these tests to nuclear personnel on a weekly basis and proper records should be maintained every week and any deviation in average anxiety levels of an individual is certainly concerning and needs to be addressed immediately.
2. These tests can even be administered on a daily basis before entering and leaving the facility, so that anxiety levels of personnel can be accurately known and just in case if a person leaving the facility experience high anxiety levels without proper reason should be taken into custody and enquired properly, about the cause of that person's anxiety. If this test is conducted to the personnel before entering the facility, the person's anxiety levels are to be known properly and just in case if that individual experience high anxiety or stress levels, then working inside the facility is risky and that individual should be handed over to the psychologist for reducing the anxiety/stress levels or day off should be given to that individual so that he/she can reduce the anxiety/stress levels.
3. This test should also be conducted to nuclear personnel before and after accessing the vital areas in the facility where nuclear materials are kept.
4. This test can also be conducted to truck drivers who can shift nuclear materials from one facility to another.
5. This test can also be administered wherever and whenever necessary, according to the will of the operator or any other higher nuclear security authorities.

6. There are a multitude of tests like STAI, DASS- 21, BAI and HADS etc., to measure anxiety levels and tests are to be conducted on a rotation basis instead of conducting same test all the time.
7. Especially in STAI, the questions in both state and trait anxiety forms should be jumbled every time and also reverse scoring helps in preventing the test taker from pretending the low anxiety levels by marking the responses in a particular accustomed way.

7. Conclusion:

The triggering of anxiety in individuals is due to various reasons such as family & financial problems & bereavement, environmental factors, COVID-19, career uncertainties, work related tensions etc., and mainly even due to fear of getting caught if the individual is an insider and (in case of students: academic stress, peer pressure or related issues, examination fear etc.,). Therefore rigorous psychological testing is to be done in nuclear facilities and whoever personnel reporting high anxiety levels without proper reason should be questioned immediately and background checks should be performed accordingly and if the details provided by the specific individual is varying and further triggers any suspicion, is to be named as an potential insider.

8. Future direction:

All these nuclear security programs and HRPs are essential in detecting the insider threats but at the same time, implementing these programs is a costly affair. It's also difficult to extend these programs in RRRFs because of funding issues. Moreover, nuclear personnel feels that all these programs are very much intrusive in their lives. Additionally, some countries have stringent laws that prohibits some of the screening programs. [10] In view of all these issues, administration of psychometric tests is a suitable option. The psychometric tests that are mentioned in this paper, such as STAI, DASS 21 etc., are easy to administer and takes less time in test taking and results interpretation. The operator or nuclear security officials or regulatory body of the nation can collaborate with psychologists to create customized psychometric tests specific to that facility or nation, according to different threat scenarios, can help in detecting the insider adversaries. This is a one time process, cost effective and also less intrusive to personnel.

Sometimes, it is also recommended to conduct projective personality tests on personnel once in a month, in the name of an activity and it can be helpful to detect insider adversaries and also promotes positivity within the organization. Projective personality tests such as Rorschach ink blot test and thematic apperception test (TAT) etc., helps to uncover the true internal attitudes, behaviors, moods, motivations and intentions of individuals and therefore these tests are also

equally effective when compared with objective personality tests like BIG 5 and 16PF.

Acknowledgement: We would like to thank the Supreme Personality of Godhead "Sri Krishna" for giving this idea and also like to express our gratitude to Dr. N. Deepa Mohan, Head of the Dept. and Dr. D. Ravi Shanker, Assistant Professor, both from Dept. of Applied Psychology, Gitam University, Visakhapatnam, India and Ms. Mohua Das, Psychological Counsellor, Brandix India Apparel City, Visakhapatnam, India for giving their incredible support in doing this paper.

References:

1. International Atomic Energy Agency, Assessing Behavioural Competencies of Employees in Nuclear Facilities, IAEA-TECDOC-1917, IAEA, Vienna (2020).
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Preventive and Protective Measures against Insider Threats, IAEA Nuclear Security Series No. 8-G (Rev. 1), IAEA, Vienna (2020).
3. World Institute for Nuclear Security (WINS) – Nuclear Security, STE 2 module.
4. Christopher Hobbs and Matthew Moran ; Insider threats – an educational handbook of nuclear and non-nuclear case studies; King's college London ; August 2015.
5. INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Material in Use and Storage and of Associated Facilities, IAEA Nuclear Security Series No. 11-G (Rev.1), IAEA, Vienna (2019).
6. Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.
7. Beck, A.T., Epstein, N., Brown, G., & Steer, R.A. (1988). An inventory for measuring clinical anxiety: Psychometric properties. Journal of Consulting and Clinical Psychology, 56, 893-897.
8. Lovibond SH, Lovibond PF: Manual for the Depression Anxiety Stress Scales. Sydney Psychology Foundation Australia 1995.
9. INTERNATIONAL ATOMIC ENERGY AGENCY, Self-assessment of Nuclear Security Culture in Facilities and Activities, IAEA Nuclear Security Series No. 28-T, IAEA, Vienna (2017).
10. Galya Balatsky and Ruth Duggan ; Nonproliferation, nuclear security and the insider threat ; 2012.