Nuclear Reactors Event Reporting: The Egyptian Approach, and Challenges

Badawy M. El-sheikh

Egyptian Nuclear and Radiological Regulatory Authority, Cairo, Egypt
badawymel@yahoo.com

Abstract: Every engineering activity carries some potential of deviation from normal operation, resulting in events, which could be unexpected and may result in undesirable risk or consequences. To avoid such risks, study and evaluation of abnormal events is considered essential and the depth of evaluation depends on the severity of consequences attached to the activity. Among the various efforts to improve operational safety of nuclear installations, systematic collection, evaluation and feedback of operational experience are considered valuable and effective. Such a system enables all safety related events to be analyzed for determination of the root causes and necessary corrective and preventive action to be taken to avoid their recurrence and to enhance operational safety at Nuclear Power Plants. programs to collect and analyse operating experience are established, results obtained and conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies. This paper provides a general overview and analysis of events reported by Egyptian research reactors and the Licensee approach for future nuclear program with its challenges.

[Badawy M. El-sheikh. **Nuclear Reactors Event Reporting: The Egyptian Approach, and Challenges.** *N Y Sci J* 2013;6(3):21-26]. (ISSN: 1554-0200). http://www.sciencepub.net/newyork. 4

Key words: operational experience feedback**,** accident precursor analysis, licensee report

1. Introduction

Operating experience is a valuable source of information for learning about and improving the safety and reliability of nuclear installations. It is essential to collect such information in a systematic way that conforms with agreed reporting thresholds for events occurring at nuclear installations during commissioning, operation, surveillance and maintenance activities and decommissioning, and on deviations from normal performance by systems and by personnel, which could be precursors of events[1]

The efficient feedback of operating experience (OE) is a valuable source of information for improving the safety and reliability of nuclear power plants (NPPs). It is therefore essential to collect information on abnormal events from both internal and external sources. Internal operating experience is analysed to obtain a complete understanding of an event and of its safety implications. Corrective or improvement measures may then be developed, prioritized and implemented in the plant if considered appropriate. Information from external events may also be analysed in order to learn lessons from others' experience and prevent similar occurrences at our own plant.[2]

The primary objectives of a system for the feedback of operational experience are that no safety related event remains undetected and that corrections are made to prevent the recurrence of safety related events by improving the design and/or the operation of the installation. This criterion reflects the notion that an accident of any severity would most probably have been marked by precursor events, and to this extent would have been predictable and, therefore, avoidable**.** Feedback of experience also increases knowledge of the operating characteristics of equipment and performance trends, and provides data for quantitative and qualitative safety analysis

An accident precursor as defined by The National Academy of Engineering workshop is any event or group of events that must occur for an accident to occur in a given scenario. One dictionary definition (among many) is "one that precedes and indicates the approach of another." [3]. And a comprehensive accident precursor program should accomplish a number of goals [4]:

1. Identify the nature of accident precursors for the industry. This requires that precursor categories be defined based on accident sequences determined from full-scope risk assessments for the entire range of facilities and systems. This is important because accident precursors are typically small segments of one or more accident sequences, and assessing accident precursors includes mapping these events onto the risk models. If noteworthy events are observed that cannot be mapped, the risk models may not be adequate.
2. Prioritize or rank precursor categories based on both frequency of occurrence and risk significance. Ranking by frequency of occurrence for each category of precursor indicates the weaknesses in facilities at risk for accidents. Ranking by risk significance focuses attention on the precursor categories for which there is less protection. Because

the analyses of these two ranking methods are quite different, the program should establish procedures and criteria for each.

3. Provide a means of feedback to the industry. Analysis is useless unless it is reflected in the design, operation, and maintenance of facilities and systems. Vulnerabilities must be addressed either to reduce the frequency of occurrence or to increase resistance to the consequences.

This paper provides a general overview and analysis of nuclear reactor events reports concentrated on research reactors and Egyptian Regulatory Authority (ENRRA) Licensee approach for future nuclear program with its challenges.

2- Operational Eexperience Feedback Related Statement Eeferences.

According to IAEA Safety Requirements publication No. GS-R-1 [5], it states the regulatory body's responsibility to establish national regulations in the field of operating experience feedback and to ensure that operating experience is appropriately analysed, that lessons to be learned are disseminated, and that appropriate records relating to the safety of facilities and activities are retained and are retrievable. And Article 19 of the Convention, concerning Operation, requires that "…each Contracting Party shall take the appropriate steps to ensure that (vi) incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body; (vii) programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies"[6]

Status and Challenges:

According to law No. 7 for 2010 [7], the main function of the Egyptian Nuclear and Radiological Regulatory Authority (ENRRA) becomes the regulatory control of all the nuclear and radiation facilities and activities in Egypt not the research in the nuclear and radiation science. This change in the function facing some challenges mainly preparation of the regulations, guides and standards required to regulate the facilities and activities. Establishment national regulations in the field of operating experience feedback is one of this important regulations. Also, the establishment of a system to collect and analyse operating experience should be taken into consideration[8] .

3- Basic Elements of a National System of Operational Experience (OE) And Regulatory Responsibity.

3-1 Reporting of Abnormal Events.

Information on events, anomalies, situations and conditions starts at the plant level and should be communicated within the operating organization and then, in accordance with the relevant requirements, to the regulatory body, to other operating organizations and to research organizations, designers, contractors and other relevant parties. A detailed procedure should be developed by the operating organization on the basis of the requirements for a national system established by the regulatory body. This procedure should define the process for dealing with all internal and external information on events at nuclear installations. The procedure should precisely define the structure of the system for the feedback of operational experience, the types of information, the channels of communication, the responsibilities of the groups and organizations involved, and the purpose of the documentation produced.

The following reporting categories (1-7) are recommended by the IAEA Safety Guide No. 93 on Systems for Reporting Unusual Events in Nuclear Power Plants [9], to identify events having an actual or potential safety significance.

1) Release of radioactive material or exposure to radiation

(a) Release of radioactive material that exceeds prescribed limits whether it is

Confined into the site or extends beyond it, or

(b) Exposure to radiation that exceeds prescribed dose limits for site personnel or

members of the public.

2) Degradation of items important to safety

(a) Fuel cladding failure, or

(b) Degradation of the primary coolant pressure boundary, main steam or

Feedwater line, or

(c) Degradation of containment function or integrity, or

(d) Degradation of systems required to control reactivity, or

(e) Degradation of systems required to control the system pressure temperature, or

(f) Degradation of essential support systems.

3) Deficiencies in design, construction, operation (including maintenance and surveillance), quality assurance or safety evaluation.

4) Events indicating generic problems of design, construction, operation, quality assurance or safety evaluation

5) Events leading to important modifications of design, construction, operation (including maintenance and surveillance) and quality assurance

as a consequence of events that have occurred in other plants.
6) Events of potential safety significance.
7) Unusual events of either man-made or natural origin that directly or indirectly affect the safe operation of the plant. Events that do not reach the threshold of reporting criteria, but still are safety significant, such as safety systems unavailabilities, or the finding of a defective component of safety systems upon performing preventive maintenance, etc., are also recorded and analysed at the plant level. These records are loaded into appropriate databases for statistical analysis and consulting.

3-1-1 Research reactors event reported

According to guide on incident reporting system for research reactors , January 2000, IAEA [10], Unusual events that meet one or more of the following criteria could be considered as appropriate for reporting to the IRSRR:.
(a) The unusual event identifies important lessons learned that allow the international
research reactor community to prevent a recurrence of a similar event or to avoid the
occurrence of a more serious unusual event in terms of safety; or
(b) The unusual event is itself (potentially) important or serious in terms of its safety
implications or whether it (potentially) reduces the defense in depth significantly; or
(c) The unusual event is a repercussion of similar events previously reported to IRSRR, but which identifies new lessons learned.

3-1-2 Contents of detailed event report :

Detailed requirements concerning the content and format of an unusual event report are given in the IAEA Safety Guide No. 93 [9]. In accordance with this document the report on an unusual event should include the following:
1) Narrative description
Operational state prior to the event including status of relevant systems, event description in chronological order, component or system faults, findings during maintenance and surveillance, operator actions/procedural controls, short term actions, previous occurrences and consequences.
2) Safety assessment
This should contain an assessment of the safety consequences and implications of the event. The primary aim of the safety assessment is to ascertain why the event occurred and whether the event would have been more severe under reasonable and credible alternative conditions, such as different power levels or operating modes; in addition, the safety significance should be pointed out.
3) Root causes and corrective actions
This should analyze the root cause of the event down to human factors (including procedures), man-machine interfaces or design and manufacturing; actions taken or planned, including those to reduce the probability of similar future events.
4) Lessons learned
The importance of the event with respect to the lessons learned and their classification identified with each lesson learned.

3-1-3 Event classification

Figure 1 shows a typical classification and number of events at a plant during a year where :
1 Refer to Event affecting nuclear safety
10 Refer to Events affecting plant performance (Reactor trips, safety system actuations, unavailability of safety systems) – Potential effect on nuclear safety.
100 Refer to Events affecting plant reliability (Plant transients, equipment failures/unavailability)- Potential effect on nuclear safety
1000 Refer to Events with no immediate significant impact on nuclear safety, although they still may imply a potential effect on nuclear safety (underlaying factors, causes, additional factors and conditions which may be assumed).

1

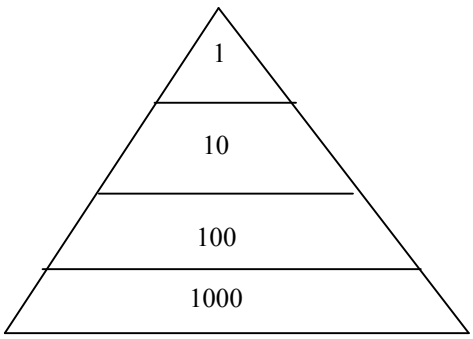

FIG. 1. Typical distribution of event types [2].

Status and Challenges

According to law No. 7 for 2010, Section III, chapter 2, article 40 [7]:

"The licensee has to submit a report on any incident occurring at the facility, whether during operation or during a maintenance and decommissioning, particularly with regard to safety and security established or those that are likely to result in the effects of radiation to humans or property or the environment in accordance with rules and procedures, which are issued from Authority". The challenge, these rules and detailed procedures should be Prepared. And till this time the NRRA regulatory authority should follow the IAEA , or vendor's country regulations and format.

3-2 Screening And In-depth Analysis And Regulatory Responsibility

According to IAEA Safety Standard Series No. NS-G-2.11 [1], All organizations involved in the process of operational experience feedback should screen information on events, taking into account their own needs (Operating organizations, Regulatory bodies, Vendors companies and etc).. Regulatory bodies should review the screening of events to gain insights that can be used to inform their inspection programmes, licensing activities, and the elaboration of regulations and requirements for safety backfits. Regulators should screen national reports for their international use.

The screening process consists of [11]:

1) Review of the event reports for immediate implications on the safe operation of NPPs.

2) Determination of significance of events for impact on plant safety and availability .

3) Review against established thresholds, consistent with the significance of the event, which determine the depth of analysis .

Paragraph 5.16 of Safety Standards Series No. GS-R-1 [5] establishes a requirement that "the regulatory body shall carry out inspections at short notice if an abnormal occurrence warrants immediate investigation"

Event analysis is prioritized depending on the event significance. The main phases of event analysis are summarized as follows:

Establishment of the complete event sequence (what happened);

Determination of the deviations (how it happened);

Direct cause (why it happened);

Root cause (why wasn't it prevented);

Assessment of safety significance (what actions are required) and;

Identification of corrective actions (how its recurrence can be prevented).

And according to IAEA No. NS-G-2.11[1], At the plant level, as well as at the level of the regulatory body, several follow-up activities should be undertaken after the analysis of an event. These activities comprise documentation of the analysis of the event and storage of the documentation, dissemination of significant results, and monitoring of the implementation of corrective actions and assessment of their effectiveness.

Also, It should be noted that the designation of the safety significance may be changed in the analysis of the event. The regulatory body should be kept informed of any such changes so that it can perform its duties and discharge its responsibilities.

There are four accepted main methodologies for nuclear event investigation, establishing the strategy of an inquiry and describing an integrated system of event investigation activities [12]:

• Root Cause Analyses;
• Probabilistic Safety analysis based methodology (Precursor Analyses);
• Deterministic Transient Analyses;
• Safety Culture Impact Assessment.

Table 1. shows the comparison between features of the deterministic safety assessment and the probabilistic safety assessment

Status and Challenges

Egypt nuclear power plants program suffers stopping from time to time and this affects on all safety and operational experience requirements and procedures. So, our experience depending only on personal research and operating research reactors. Regulatory authority immediate review every event reports and follow-up any activities are carried out after an event investigation and sending inspection groups. But because the events occurred did not have a significant radiological release or personnel exposure, the magnitude of investigation was low effectiveness. Also regulatory authority does not follow or recommend any specific technique for evaluation. So, we have also challenges for later beginning in using event analysis methods and tools. Table 2: shows that examples of events reported from operating organization of Egypt second research reactor ETRR-2 during last ten years.

3 -3 Implementation of Actions.

After arrived to the outputs from qualitative deterministic analysis (the event investigation) and the quantitative PSA analysis, Consideration of both types of information provides a more objective basis for decision-making when it comes to select which of

the recommendations to implement and to specify the timescale. To monitor the timeliness of implementing corrective actions, and to adjust the priority of corrective/preventive actions if this becomes necessary in the light of recent operating experience; and to ensure that the completed actions have been successful in preventing recurrence of the event. In any case the corrective actions may have implications for other operating organizations and regulatory body.

Table 1. Comparison between features of the deterministic safety assessment and the probabilistic safety assessment [13,14]

	Deterministic safety assessment	Probabilistic safety assessment
Events to be covered	Small number of representative events considered to be severest among conceivable events	All accidents considered to be significant
Frequency	Simply assumed to occur (no discussion of its frequency)	Since the frequency has a probability distribution, it is assessed with a median value, or a mean value and uncertainty width
Method of an accident analysis	In accordance with the scenario defined by the Regulatory Guide it is analysed based on conservative assumptions (for example, a single failure is assumed for the most effective accident mitigation system)	Taking into account progresses of variousconceivable accidents, all significant accidents (accident sequences) are analyzed under the realistic assumptions (multiple failures of mitigation systems are to be assumed)
Risk assessment	NA or qualitative analysis	Quantitative analysis
Treatment of uncertainties	Discussion on uncertainties is avoided by following 'the conservative methods for accident analysis'	Quantitative analysis including the propagation of uncertainties (in order to make a realistic assessment, the uncertainty will become large in addressing the areas with poor knowledge)
Interpretation of assessment results	Individual interpretation for each accident	Comprehensive interpretation based on all accident sequences
Examples of application	Documents of the Application for Reactor Establishment Licence	US NRC: An Assessment of Accident Risks in

Table 2. Description of examples of events reported from ETRR-2 during last ten years (2003-30012)

Event NO.	Event Short Description
NO. 1	Spurious of Second Shutdown System due to malfunction of the LCs of one of RPS cards.
NO. 2	Triggering of all safety systems due to UPS NO.1 was instantaneously failed due to short circuit in on/off indication lamp. Because of the fail safe criteria of the RPS, all safety system
NO. 3	Common failure of secondary cooling instruments resulting from water leakage in surveillance room due to drain valve not totally closed. This lead to the water level covers the instrument and causing failure in temperature and flow

4- Conclusions

Regulatory body should be aware with importance of the effective of operating experience feedback system (OEF) and by goals of accident precursor analysis as a valuable sources of information for improving the safety and reliability of nuclear power plants (NPPs) and in reducing the frequency of occurrence of accidents. National system and programs to collect and analyse international operating experience data should be established and the reported incidents significant to safety should be investigated and evaluated according to the international systems and procedures. National regulations and detailed procedures in event reporting, screening, investigating, evaluating and etc. should be detailed and completed.

References:

1. INTERNATIONAL ATOMIC ENERGY AGENCY, "A System For The Feedback of Experience From Events In Nuclear Installations, IAEA- Safety Standard Series No. NS-G-2.11, IAEA, VIENNA, (2006).
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Precursor Analyses — The Use of Deterministic and PSA Based Methods in the Event Investigation Process at Nuclear Power

Plants, IAEA-TECDOC-1417, IAEA, Vienna (2004).
3. WILLIAM R. CORCORAN, "Defining and Analyzing Precursors': ACCIDENT PRECURSOR ANALYSIS AND MANAGEMENT, Nuclear Safety Review Concepts Corporation, National Academy of Engineering, Washington, USA, 2004
4. MARTIN B. SATTISON, "Nuclear Accident Precursor Assessment: The Accident Sequence Precursor Program" ACCIDENT PRECURSOR ANALYSIS AND MANAGEMENT, National Academy of Engineering, Washington, USA, 2004.
5. INTERNATIONAL ATOMIC ENERGY AGENCY, Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, IAEA Safety Standards Series No. GS-R-1, IAEA, Vienna (2000).
6. INTERNATIONAL ATOMIC ENERGY AGENCY, Convention on Nuclear Safety, I AEA- Legal Series No.16, IAEA, Vienna, (1994).
7. Law of Egyptian Nuclear and Radiation Activities Regulating, law No. 7, 2010
8. BADAWY M. Elsheikh, "NUCLEAR REACTORS EVENT REPORTING EXPERIENCE: THE EGYPTIAN LICENSEE APPROACH, AND CHALLENGES" IAEA**,** Technical Meeting on Lessons learned from Precursor Analysis, Brussels Belguim, 7-9, 11/2012**.**
9. INTERNATIONAL ATOMIC ENERGY AGENCY, "Systems for Reporting Unusual Events in Nuclear Power Plants", IAEA- Safety Series No.93, IAEA, Vienna, 1989.
10. INTERNATIONAL ATOMIC ENERGY AGENCY, "Guide on incident reporting system for research reactors, IAEA**,** January (2000).
11. HABIB M.A., M.RAHMAN, M.SALEEM ZAFAR, N.MAQBUL, "Deterministic Analysis of Events For Evaluating Safety Margins At NPPS- A Regulatory Perspective".
12. DUSIC M, "Analysis of Operational Events in NPPs. Presentation at Joint IAEA/EC Regional Workshop on Operational Events, Transients and Precursor Analyses. EC - JRC IE, Petten, Netherlands, 24 – 28 August 2009.
13. "Probabilistic Safety Assessment (PSA). Japan Nuclear Energy Safety Organisation (JNES), 2007.
14. STANISLOVAS ZIEDELIS, MARC NOEL, "Comparative Analysis of Nuclear Event Investigation Methods, Tool And Techniques" European Commission, Joint Research Centre, Institute for Energy, EUR 24757 EN – 2011.

1/22/2013