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Environmental risk assessment (ERA) and its management by QRA method and safety checklist

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Abstract
Before 1984 the Bhopal Gas Disaster in India there were two sets of Assessment Work namely Aspects Impact Assessment/Environmental Impact Assessment (EIA) and Risk Assessment (RA). These two frameworks provided scientific assessment procedures in the field of environment and safety separately. Thereafter in India, a new approach emerged toward the Assessment which is the combination of EIA and RA as ERA (Environmental Risk Assessment). An ERA is also termed Ecological Risk Assessment. This is a scientific framework for the environmental Risks Assessment to take care of the Environment and Safety Aspects of the Industry, People, and surrounding. This paper introduces the concepts, development history, recent research methods, recent standards and results as well as their applications There are two methods to carry out HRA. Quantitative and Qualitative methods. In the qualitative method, there are various sub-methods. This paper in on one of the sub-method of the qualitative risk assessment, the Safety Checklist method. (Figure I)

Keywords: ERA, Environmental Risk Assessment, Ecological Risk Assessment, ERA Research, Environmental Risk Assessment Research, India, Kumar Navin, PhD, Safety Checklist, Safety with Navin, India)

Introduction

The environmental Risk Assessment is the factors of all the input and output of a plant, process, storage, or combination, environment and ecology which can result in undesired, uncontrolled incidents which can penetrate its limit or exceed its limit and cause harm to people, plant, processes, community, working environment and environment at a large. Ecology and the Environment can also impact the Plant and processes.

ERA is the new trend in the field of Environment, Safety, Health, and Community Safety. There is a wider scope and coverage of ERA than EIA or RA. There are various methods to carry out ERA like the Qualitative Risk Assessment method and Quantitative Risk Assessment method.

There are 7 stages of any plant. Industry Stage I is the Pre-design stage, Industry Stage II Design /Modification Stage, Industry Stage III is Construction Stage, Industry Stage IV is Commissioning Stage, Industry Stage V Operations and Maintenance, Industry Stage VI De commissioning /Shutdown Stage, and Industry Stage VII is the post Incident/Accident Stage.

There are various methods of qualitative Hazard Identification /Hazard Analysis Techniques like Hazard Indices, Primary Hazard Analysis, What-if analysis, Checklist, Process design checks, and use of checklists, HAZOP study, Failure Mode and Effect Analysis, Fault Tree Analysis, Event Tree Analysis, Plant Safety Audit. The checklist method is the only method that can be used at all 7 stages. For all 7 stages, there are different types of the checklist, and even for one stage, there will be various types of the checklist. The checklist method is easy to use, easy to understand, easy to communicate, and easy to track progress. Some of the Hazard identification checklists also cover the next higher level of the Risk Assessment Processes.

The type of Hazard Identification /Risk Assessment Process is Quantitative Risk Assessment which is also known as Consequence Analysis Methodology. In this methodology, various types of studies and models are available like 1) Discharge Rate Models 2) Flash and Evaporation Models,3) Dispersion Models. The Dispersion models mainly of two types Dense gas Dispersion Model and another type is Natural /positively Buoyant Plum and Puff Models 4) Fire and Explosion Models. This is of four types a) Pool Fire and Jet Fire b) Vapour Cloud Explosion (UVCE) and Flash Fire c) Physical Explosion and d) BLEVE and Fire Ball

Once the Hazard is identified from the Quantitative Risk Assessment protocol it is necessary to use effect models to understand the level of consequence out of that release. This process is commonly called “Methods of determining consequence effects”. The released material can cause consequences for 4 nature.

a) Effect due to projects b) Explosion Pressure c) thermal intensity and gas toxicity dose. Probit equations are used for, the time of toxic exposure calculation, thermal intensity calculation, and explosion pressure can be calculated

In this paper, the checklist method is covered which is being used at Stage V Maintenance Stage which is a non-routine work for this industry.

Historical Development of ERA

Historical Development of ERA in the United States:

United States is the first country to enact the National Environmental Protection Act (NEPA) of 1969 making Environment Impact Assessment (EIA) mandatory

In the US the ERA started much before 1984. In the 1970s one of the United State conferences named “Large Scale Nuclear Power Plant in the theoretical possibility of major

accidents and Consequence." professionals studied 1970 were presented. The conference was organized by States Atomic Energy Commission (USNRC).
USEPA (United State Environment Protection Agency) published a report Framework for Ecological Risk Assessment in 1992. Which got replaced in the year 1998 by a new guideline "Guideline for Ecological Risk Assessment'. The interaction between the following parties at the beginning (planning and problem formulation) and end (risk characterization) of the risk assessment process is a prominent focus of the recommendation. Site representatives as Risk Managers, experts as risk assessors, and interested parties.

Development of ERA in Japan
In Japan, in the year 1975, the Conference of Human Environment International Sciences was held in Tokyo. Walter proposed an environmental impact assessment should include the impact analysis in the policy, and make contingency Plans.

Development of ERA in Europe
European Economic Communities (EEC) in the year 1987 made a provision for the factory that they must carry out Environmental Risk Assessment which may be prone to chemical accidents.

Development of ERA in China
In the year 2004, China formulated a Technical Guideline for the Environmental Risk Assessment on Projects (HJ/T169-2004). As per S.Y.Liu, H/Q Wang, W.L.Li, China. Published paper. The major research methods in China "Current Progress of Environment Risk Assessment Research" The ERA methods have been divided into two parts Quantitative and qualitative methods (Figure 1)

Development of ERA in India
As per the Environmental Clearance Guideline, the provisions of EIA are there and the content of the Risk assessment is also there. That is applicable to certain Gas Industries and for isolated Gas and chemical storage above threshold quantities of gas/chemical specific. On May 23, 1986, the Indian government passed the Enviro nment (Protection) Act, Making EIA statutory was one of the decisions made to carry out. Following due process, a notification was released on January 27, 1994, and later revised on May 4, 1997, April 10, 2000, January 27, 2000 and last amended to make environmental impact assessment mandatory for certain activities.

An ERA is emerging in some of Indian Industries in the following framework.
The Environmental Risk Assessment Process involves five steps. Step I Planning Stage. problem formulation by determining the scope and boundaries of the assessment, and selecting ecological entities that will be the focus of the assessment Step II is the identification of the hazards, Step III is the Analysis of the hazards like evaluation of its failure, evaluation of its level of impact, evaluation of its duration of impact, evaluation of the impact at a distance from the source i.e Hazard Range, evaluation of its nature, evaluation of its damage potential, Evaluation of the Vulnerability Probability of the Incident, Step IV Assessment of the Risk also called risk categorization utilizes an ecological viewpoint while discussing and analyzing and reporting risks. Step V Prioritization of its action /activity including substitution Step VI Post incident plan like mitigation plan, On-Site- Emergency Planning, Off-Site Emergency Plan, Rehabilitation.

Materials & Methods (Methodology)
For this work the following methodology was adopted:
Survey Method
Compression and Analysis Method
Group Discussion
The study has been carried out in different steps at different stages:
A guideline we prepared and communicated to all concerned. The checklist needs to be made with the date, time, location and name of the person(s) who made it for the maintenance work to be done. Participants should not discuss or disclose their checklist with other members. There was a motivational award and recognition system made and declared by the organisation.

Step I: A list of all work has been made by a team of Risk Assessors, Risk Managers, and interested parties. Thereafter a separate list was made for non-routine activities. They have listed 10 High-Risk activities.

Step II: For checklist preparation: Two supervisors were advised to prepare a checklist separately for all the above-mentioned 10 maintenance jobs. A total of 40 checklists were made and dropped in the drop box by putting step number II with the date, time, location and name of the person(s) who made it for the maintenance work.
The same work was repeated to prepare on three different dates.

Step III: for checklist preparation: Two teams of two workmen were advised to make an ERA checklist for the same 10 jobs. A total of 60 checklists were made and dropped in the drop box by putting step number III with the date, time, location and name of the person(s) who made it for the maintenance work.

Step IV: For checklist preparation: Both Supervisors were advised to consult and make a combined ERA checklist of the same 10 jobs. A total of 30 checklists were made and dropped in the drop box by putting step number IV with the date, time, location and name of the person(s) who made it for the maintenance work

Step V: For checklist preparation: Both workman teams were advised to consult and make a combined ERA checklist of the same 10 jobs. A total of 20 checklists were made and dropped in the drop box by putting step number V with the date, time, location and name of the person(s) who made it for the maintenance work

Step VI: For checklist preparation: Both Supervisors and both workmen teams were advised to make a checklist jointly for the same 10 jobs. A total of 30 checklists were made and dropped in the drop box by putting step number VI with the date, time, location and name of the person(s) who made it for the maintenance work

Step VII: For checklist preparation: Both Supervisors and both workmen teams and one Electrical expert were advised to make a checklist jointly for the same 10 jobs. A total of 30 checklists were made and dropped in the drop box by putting step number VII with the date, time, location and name of the person(s) who made it for the maintenance work

Step VIII: for checklist preparation: The Risk Assessor, Risk Manager, and all interested parties were involved to make a check for the same 10 jobs. A total of 60 checklists were made and dropped in the drop box by putting step number VIII with the date, time, location and name of the person(s) who made it for the maintenance work

Step IX: The checklists were given to an external HRA expert for his study and the expert commented that not a single checklist is adequate to address all the Risk related HRA and he added some more points to the checklist. The external expert added the legal factor and points based on incident analysis points.
A footnote was added by the expert in all the 10 checklists that "this checklist needs further evaluation before the job or after every incident". The next review date was noted as 5 years.

Evaluation and Discussion on the Outcome
Evaluation Step I: All the checklists for all 10 jobs were evaluated on a xls sheet. A common language was assigned for the hazard where required totals at 16 points.
The outcome of the study:

a. Total of 27 points, the maximum points on the checklist were added during step IV when the workmen and their supervisor participated.
b. Total of 7 points checklist points got added during step VII when an electrical specialist got added to the team
c. Total of 9 specialist points got added at step VIII when there was participation from Risk Assessor, Risk managers and Interested parties.
d. Total of 18 points got added during Step IX by an external HRA expert.

The final checklist was communicated for all the 10 jobs to all and it was accepted and acknowledged by the users.

Conclusion on HRA and management
A safety Checklist is one of the easiest tools which can be used by every level of the person, at every stage of the project, Safety Checklist gets charged with the date, location and expertise of the person/team who prepares it. The safety Checklist is dynamic and gets charged with the date and location. Expert counselling can improve the checklist. Factor Analysis for example a legal analysis and points based on incident analysis points improves the checklist

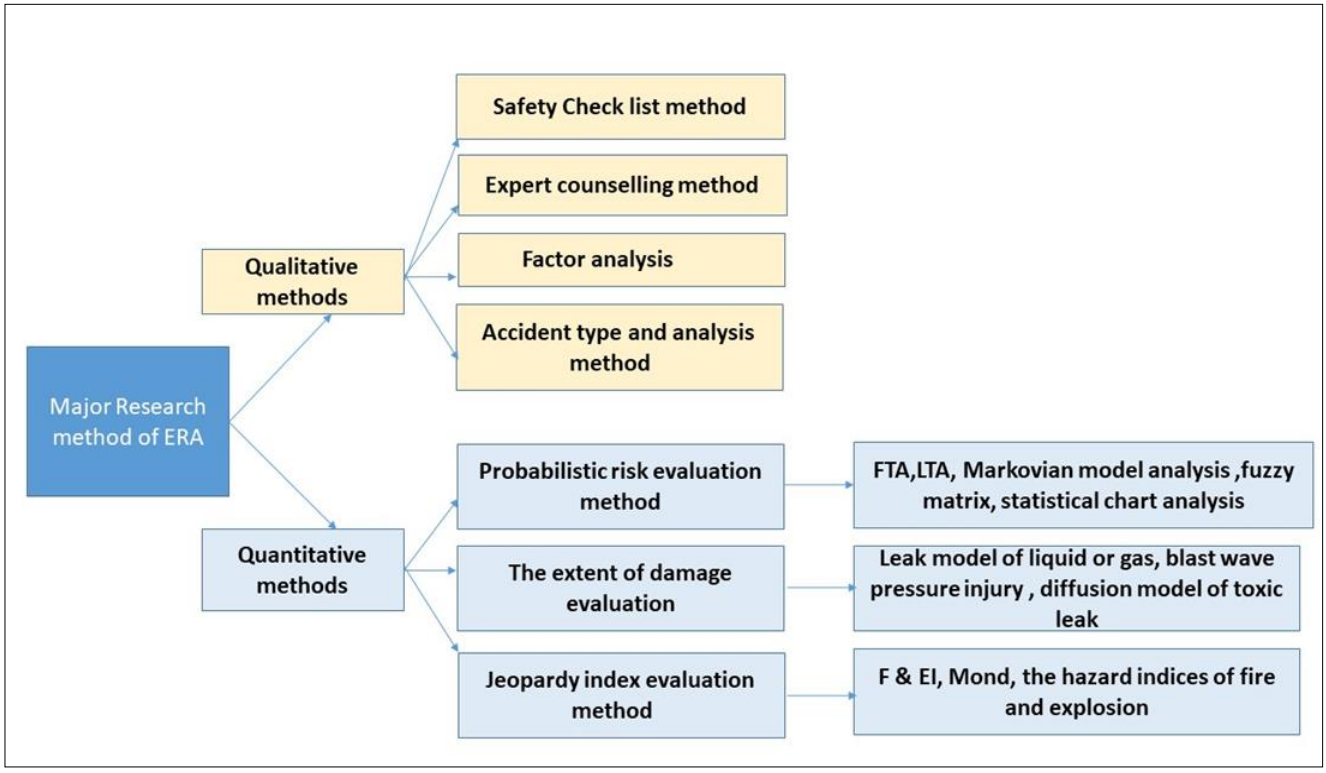

Fig 1: Major Research Methods of EPA, China (Source: Published paper of S.Y.Liu, H/Q Wang, W.L.Li, China)

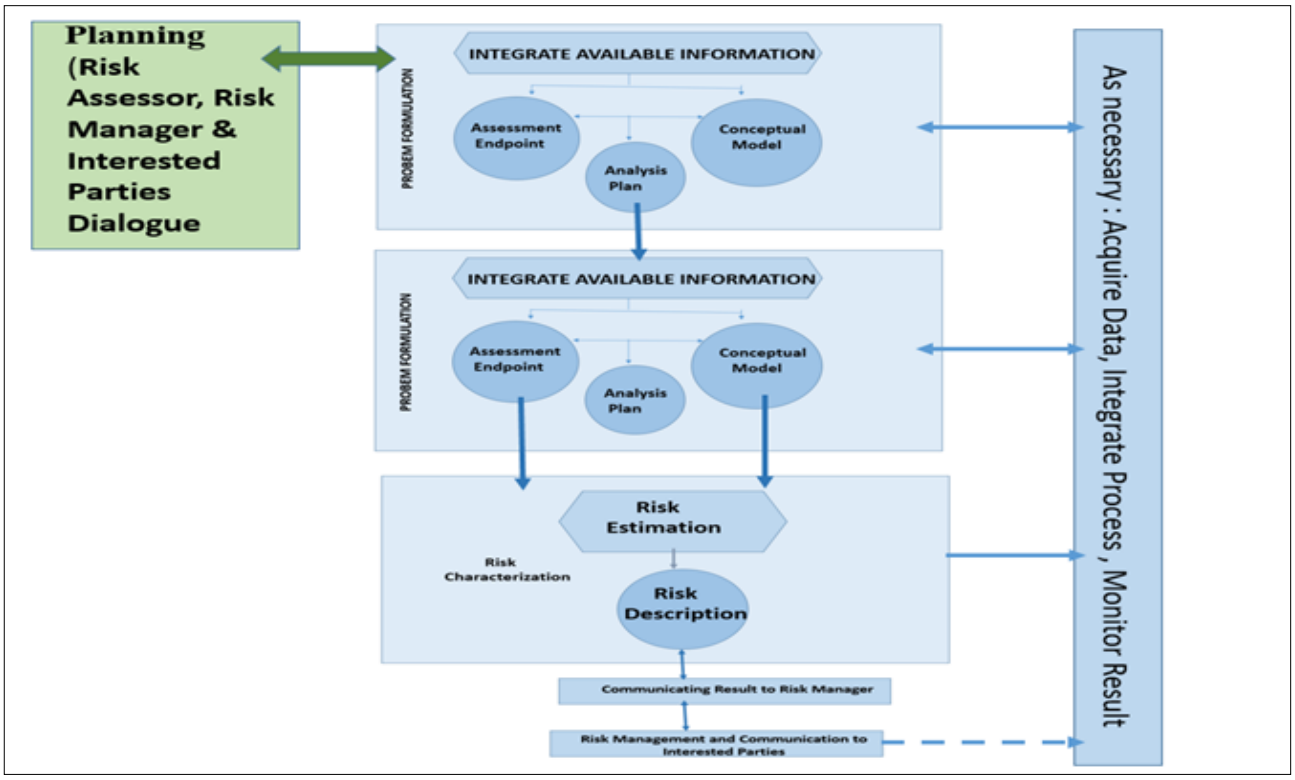

Fig 2: As per EPA 1998 The ecological risk assessment framework, with an expanded view of each phage. Within each phase, rectangular designated inputs, hexagons indicate actions, and circulars, represent outputs. (Source EPA Guideline for Ecological Risk Assessment 1998

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