ESTABLISHMENT OF INTEGRATED RISK MANAGEMENT SYSTEM (IRMS)

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Abstract

In Korea, the Process Safety Management (PSM) by the Law of Industry, Safety and Health has been performed for preventing major accidents of chemical plants since 1996. In terms of preventing chemical accidents more precisely, it is essential to develop a tool for quantitative risk assessment. For this, KOSHA (Korea Occupational Safety and Health Agency) developed an "Integrated Risk Management System (IRMS)". The system is designed to assimilate data on chemical plant hazards from external database, to integrate these data with location information (topographic and demographic), and to make them user-friendly accessible. The system consists of several main functions: display of five major Korean petrochemical complex layout, display of equipment layout with its information utilizing the external database, zonation of the hazard effected area with consequence analyses, the most probable accident scenario generation, accident/incident database and calculation of frequency of accident using equipment reliability database, etc. The highlight of IRMS is to provide the risk contours using GIS(Geographical Information System) technology. IRMS is intended to manage hazardous installation more systematically and effectively, to reduce the number of accident remarkably, further minimizing production loss in the plant.
The system is now under test by 20 users in Korean companies and emergency authorities in advance of applying to whole Korean PSM(Process Safety Management) sites.

Keywords
IRMS, GIS(Geographical Information System), Risk contour

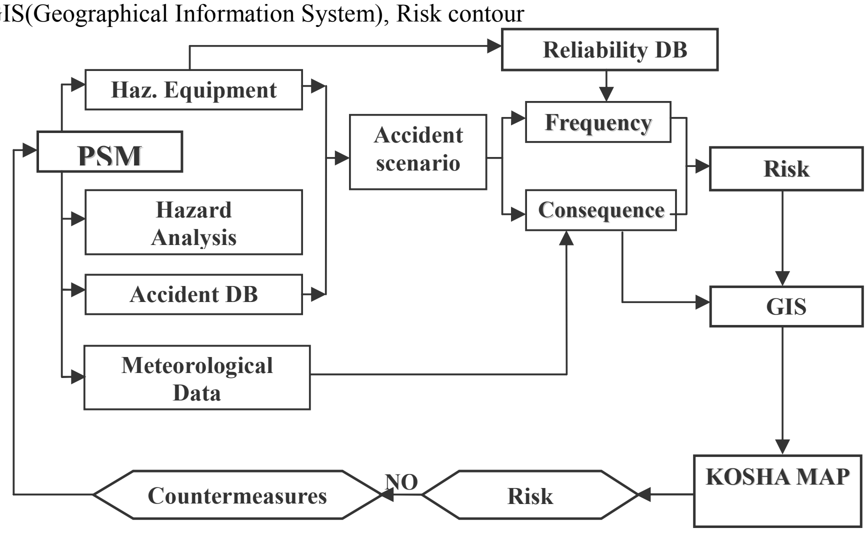

Figure 1. The Integrated Risk Management System (IRMS)

Introduction

Chemical incidents occur hundreds of thousands of times every year in the world, often resulted in devastating and exorbitantly expensive consequences. For the prevention of such chemical accidents, there have been lots of studies on hazard finding, risk assessment, consequence analysis, mitigation measures and emergency response. We believe that integration of such element, which has been developed individually, is able to develop the safety, health and environment control technique to higher level and let the safety engineers use risk management program more easily and friendly

Most of chemical plants in Korea have performed the PSM by the Law of Industry, Safety and Health for preventing severe accidents of chemical plants since 1996.

KOSHA developed a GIS-based Integrated Risk Management System for the quantitative risk assessment and PSM of chemical plants.

The IRMS system (Fig.1) includes the development of methodology, software tools and database necessary for quantitative risk assessment, which are consequence analysis software, graphical display of results on a geometric map, reliability analysis software, component reliability database, and equipment and hazardous material information databases.

The quantification of risk consists of two major parts: one is a deterministic analysis, such as the consequence analysis of an explosion of flammable material, and the other is a probabilistic part such as the frequency analysis of an explosion or reliability analysis of the protection system.

The highlight of IRMS is to provide the risk contours using GIS technology. Data of hazardous installations and the result of consequence and emergency exit route, etc are also provided to the users through computer screen.

New challenges of IRMS is that KOSHA tried to apply IT into safety management field in Korea, and to integrate various programs of risk assessment into one package for safety engineers to use IRMS friendly by sharing the data stored and easy operation of each programme. This IRMS was proposed as one useful model for risk management in the conclusion of OECD workshop in 2001

Use of GIS for Risk Management

- Map and Layout Marking Capacity

This is the very basic function of GIS that allows illustration on the computer screen of digital map, plant layout, as well as location and image of an equipment in the area in question. This function will show all kinds of the consequence results in the map as well.

- Obtaining Information Facilities Using Database

Information on name, location, capacity, size, composed material, and processed material of an equipment as well as operation temperature and pressure, designed temperature and pressure, and others are displayed using table forms.

- Polygon Search Function

An inspection of various information within a specified polygon is possible. Using this, quick search of the following are possible: population within an administrative area or other specified areas, population within area in question due to spreading or installation damage estimate, fire stations divided according to the administrative area, and others. To effect this, data on emergency response authority, administrative area data, location of and data on installations in populated areas, population data, and other city related installation data have been collected.

- Damage Forecast

Extent of damage due to PLUME, over pressure, and heat leak are displayed on the digital map that is connected to consequence programs. The number of victims in an accident and other information can be estimated using this. Environmental consequence can be also forecasted if we apply environmental parameters into the program.

- Escape Route and Approach Route Proposal

In case of a safety and environmental emergency situation, escape routes for local residents and approach routes for fire engines needed for accident control are indicated. GIS map is used as backdrop for this function.

Programs and Data for IRMS

- Establishment of Dangerous installation Database

Establishment of the database for dangerous installations and materials in PSM sites has been completed. This can be used as common source for risk assessment for SHE area. All data relating to the hazardous equipment such as capacity operating/design condition, fluid contained and MSDS, etc are stored in said database.

PSM sites who handle chlorine are searched from the database as shown in Fig. 2

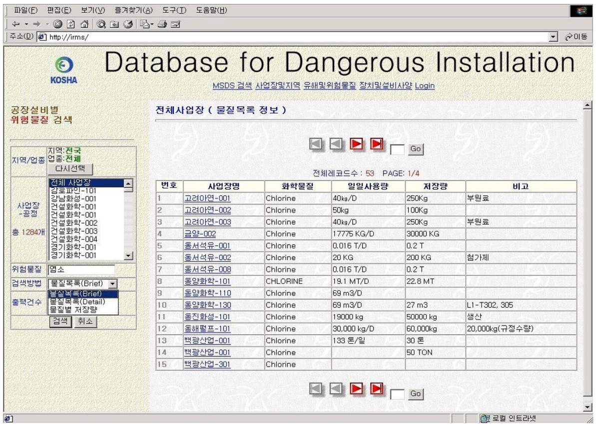

Figure 2. A list of chorine handling sites

- Establishment of Installation Reliability Database

KOSHA developed the reliability analysis program to input and analyze the reliability data, which is to be used for the calculation of frequency of incident occurrence. Fig 3. is the procedure of data analysis.

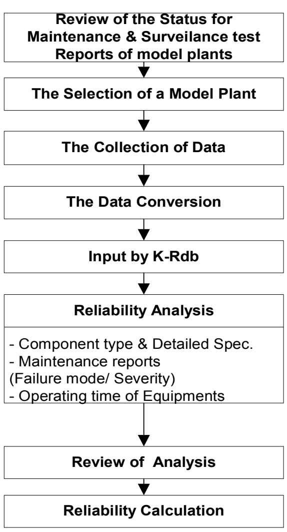

Figure 3. The procedure of reliability data analysis

For constructing the component reliability database of Korean chemical plants, we collected and analyzed about 11,500 maintenance reports. Using database, we calculated reliability data such as failure rate for 60 types of components.

- Establishment of major past industrial accident Database

KOSHA collected 1,800 cases of major industrial accidents around the world and developed a program which can build, sort and analyze the carious accident data systematically.

The program was developed for not only stand-alone environment but also server/client environment that using the Internet as shown in Fig 4. In the part of statistical process, it provides quick system response and variable reports while statistical process with OLAP(On Line Analytic Processing) server for using data warehousing.

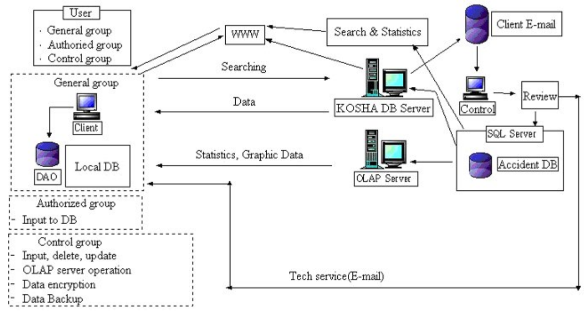

Figure 4. The structure of accident database system

- Establishment of accident Scenario Simulation

KOSHA developed a systematic method of generating accident scenarios and implemented software. This system is composed of a scenario generation model and a scenario verification model. In the scenario generation model, many accident scenarios are generated by accident scenario factors including process information and accident progress factors. The scenario verification model verifies the generated accident scenarios based on an expert knowledgebase and an accident history database.

Accident scenarios are combinations of hazard locations and accident sequences. Hazard locations are determined by process risk. In this system process risk (Ranking Values) is defined by the likelihood (UFL : Unit Factor for Likelihood) and consequence (UFC : Unit Factor for Consequence) for each accident scenario factors as shown in Fig 5.

Once an accident scenario has been developed, for each step of the accident sequence, the factors affecting the sequence and the variable conditions could be verified by related actual accident data. The system analyzed the causes of accidents, represented the effect of failure combinations, and found the most probable dangerous scenarios in complex processes.

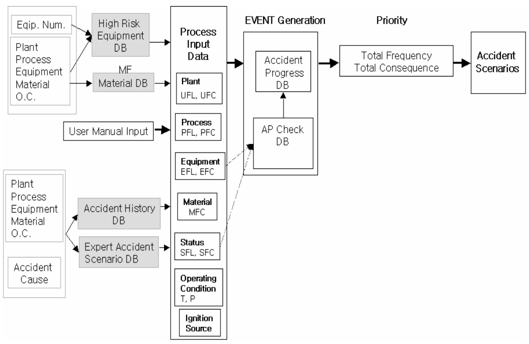

Figure 5. Flowchart of accident scenario generation

- Establishment of Dangerous Installation Location Information System

Initially, plants in one petrochemical complex area were used as trial cases in the successful development of the location information system. Since then, it has been expanded to cover five complex areas.

- Development of Damage Forecast Program

Prototypes of KOSHA Consequence program have been developed and it is under test at sites within this year.

The program is composed of material database, discharge calculation, dispersion calculation, heat effect calculation, over pressure effect calculation and wind field calculation modules as shown in Fig 6.

Material database modules has properties database of over 1,000 materials. If user wants properties of mixture, it estimates them using general mixing rule such as Margules equation, van Laar equation, Wilson equation and etc.

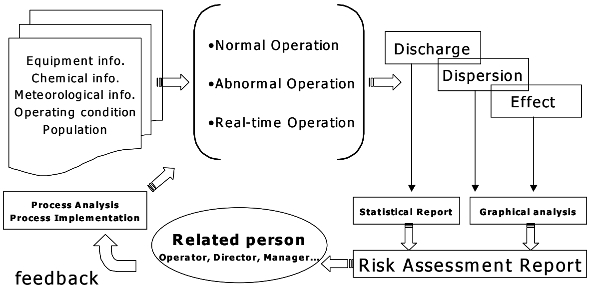

Figure 6. The flow-chart of consequence analysis model.

- Development of Risk contouring program

Risk contouring program, which is the final goal of IRMS, was developed and it is under test within this year. This program provides us with various types of risk including risk indices, individual risks and societal risk.

Sample of individual risk contour using GIS is shown in Fig 7.

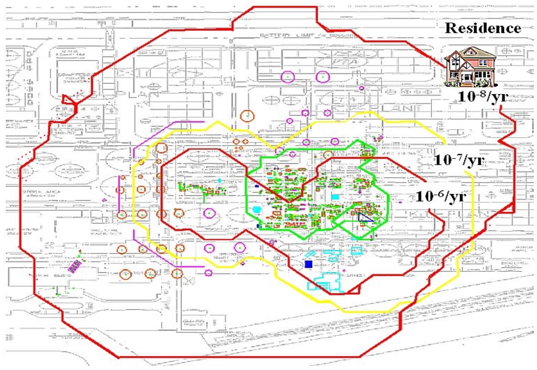

Figure 7. Individual risk contour

Conclusion

If the IRMS is used as the risk management for chemical industries, a substantial amount of benefits can be expected in many areas. In technological area, the degree of safety can be raised by employing a fast and effective analysis and systematic risk management which are made possible by the combination of separate safety management and technological factors. And the result of quantified risk assessment allows plant managers to make rational decisions on the point of investment. In economical area, the IRMS can help preventing the loss of lives and properties by enormously decreasing the occurrences of accidents. In addition, an effective operation of installations is possible using the established database and system, thus decreasing the production loss at plants. Moreover, if we use this system to the risk management for health and environment aspect, the stored data and methodology in IRMS can be utilized commonly. In this regards, efforts for integration of SHE in the risk management field is also recommended to be extended as much as possible in the future.

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