

# Case Study on Influence Factor Trend Analysis of the Accidents & Events of Nuclear Power Plants by applying Nuclear Safety Culture Framework

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## 1. Introduction

In nuclear industry, research on safety culture has been reviewed in a variety of ways, including human factors perspective approach, regulatory and supervisory sides. However safety culture elements focused that are taken into account are all different because of the different cultures work environment according to characteristics of specialized area of each organization on domestic nuclear industry. In order to develop a system for promoting sustainable safety culture, derivation of fundamental and field-oriented realistic safety culture influence multifarious factors from individuals, organizations, and leaders that are inherent in the domestic nuclear power plants were essentially considered.

This study 1) established the standard based on frameworks of safety culture principles that show safety culture promotion goals, 2) analyzed the linkages with the frameworks that were established by analyzing each incident cause and weak point from selected 268 cases (rating over INES grade 1) among 4,088 cases (as of April 1, 2015). The 4,088 cases were selected as a result of database analysis from 702 accidents recorded in accident and rating evaluation reports that were published in the National Nuclear Safety Commission and overseas IRS (International Reporting System for operating Experience), and 3) finally conducted a trend analysis studies with these comprehensive results.

## 2. Analysis Method

702 domestic and 268 overseas incidents among a variety of day-to-day safety culture process input data were selected for analyzing the trend factors affecting nuclear plants safety culture events according to the analysis method process shown in Fig.1.

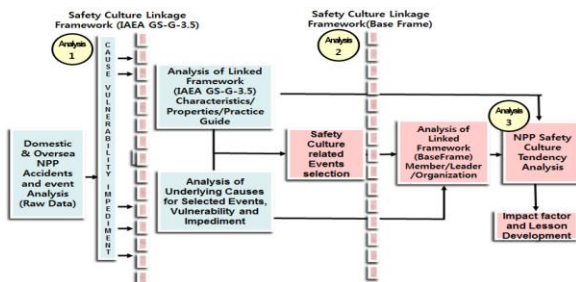


Fig. 1. Analysis Method Process Using Framework

## 2.1 Safety Culture Screening Process

The screen filter established to classify the safety culture related events for total domestic and overseas 970 incidents is the framework consisted of the principles, elements and practice guidelines that were presented in IAEA S-G-3.5, Appendix I.

Safety culture related accidents are classified as 1) the cases of the linkages found in direct or root causes of each incident which were analyzed by utilizing a consultants with over 30 years of experience in the nuclear industry and established framework according to the IAEA S-G-3.5, Appendix I, or 2) the accidents that were rated upward due to a lack of safety culture.

Table 1 shows the results classified as safety culture related accidents among analyzed target events.

Table 1 : Safety culture related accidents in nuclear plant events

Total (Events)	Safety Culture related
Domestic nuclear plants (since 1978)	19 Safety Culture upgraded Higher (?) because of safety culture issue
	319 Safety Culture Deficiency
702 total domestic accidents	338 total safety related accidents (48.1%)
Overseas (since 1987)	268 (rating over INES grade 1)
4088 IRS	164 Safety Culture related events (61.1%)

Safety culture related domestic and overseas events were 338 and 164, respectively. Among 24 events upgraded by the grade classification system, the upgraded accidents due to a lack of safety culture were 19, which were accounted for a high proportion (79.1%), compared to other additional upward factors.

Fig.2 shows the results of yearly safety culture event classification over the entire 702 incidents occurred in the domestic nuclear power plant accidents.

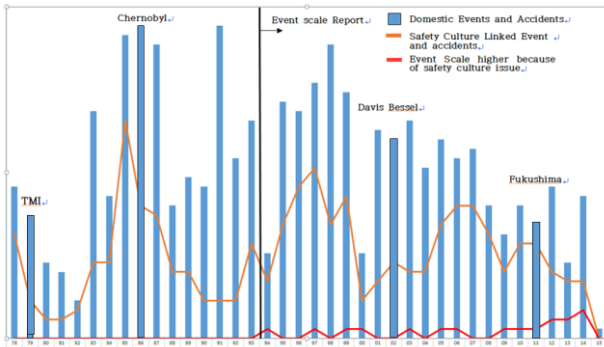


Fig. 2. Safety culture events over yearly entire incidents

The rating evaluation on the accidents prior to the April 1993 has not been made, and the event summary and incident investigation report showed the same information. Thus realistic trend of safety culture lacked incidents over entire events were able to be analyzed through the graph referencing in the event scale report. Accordingly, looking at trends since 1993, total number of events per year were decreased according to the technology development on the safety of electric, instruments and mechanics from the past to the present. However, the proportion of safety culture related incidents over events occurring each year has remained almost the same. The reason could be inferred that the influence of safety culture on the incidents is relatively important because of the further increasing effect of safety culture and the tendency of the noticeably increasing events of rating upgrade due to a lack of safety culture in nuclear plant accidents.

### 2.2 Safety Culture Analysis based on BF elements

The definition of safety culture elements was the Traits of a Healthy Nuclear Safety Culture in a view point of member/leader/organizational perspective developed by INPO in April 2013. Based on this, domestic framework (Nuclear Safety Culture Base Frame) was developed by reflecting the unique characteristics of the domestic nuclear industry in order to establish the basis for deriving the safety culture influence factors in domestic and overseas safety culture related 502 accidents. And trend analysis has been proceeded to derive linkage elements between accident generation reasons and Framework (Nuclear Safety Culture Base Frame) consisted of 3 principles, 12 traits and 39 attributes.

Hanul-6, 2012, Inadequate safety injection during overhaul outage					
Initiating Event / post-accident			Initiating Event		
Safety Culture Deficiencies			A technician participated the operation, however he did one part not the whole. Also he was not educated about recently operation.		
Base Frame connectivity			Weighting factor		follow-up action Check
Principle	Traits	Attributes	Rate	percent	
Member	1 Nuclear safety responsibility	1-2 Assured sense of job ownership	1	12.5 %	Educating for professional development
Leader	4 Leadership focused on safety values	4-1 Adequate allocation of resources	3	37.5 %	
Organization	7 Management on continuous education	7-4 Systematic training and education assuring knowledge transfer	4	50.0 %	

Fig. 3. Base Frame analysis using weighting factors

Prior to the linkage analysis of the cause of the incident and the developed Base Frame, each one of the safety culture related factors was derived and read-out from the accident analysis and measures after accidents by referencing accident reports and rate classification reports with a help of consultation from experienced experts of nuclear power plants. This work was done by applying weighting factors per frame attributes shown in Fig.3.

This detailed analysis method can 1) interpret the things that are hidden or shown in the event log, 2) derive the complex safety culture influence factors for one cause, and 3) determine follow-up measures for each derived influencing elements. Out of these, unique safety cultural weak points of the domestic nuclear industry can be inferred.

### 3. Analysis of Tend Case Study

Case study was conducted through a comparative analysis of trends of the accidents for domestic and overseas nuclear plant incidents which were derived from a variety of ways of trend analysis, analysis of the safety culture influence factors, and linkages between frame work(Base Frame) and safety culture related causes of accidents.

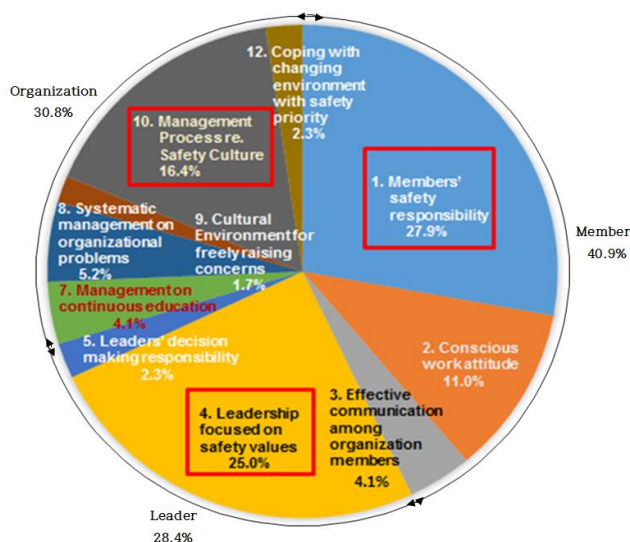


Fig.4 Domestic NPP Accidents and 12 Events Safety Culture Impact Traits Analysis Results

As shown in Fig.4, the results of domestic safety culture related 338 event analysis have appeared in a similar importance between "member safety responsibility" and "leadership focused on safety values" for elements of the personal, manager or leader. And factors related to the organization "organizational work process management with safety as the overriding priority" have ranked the third with a high specific gravity. In addition, "coping with changing environment with safety as overriding priority" of a unique cultural influence factor of the domestic nuclear industry was derived, which was not derived from the Screen Filter of IAEA GS-G-3.5 Appendix I.

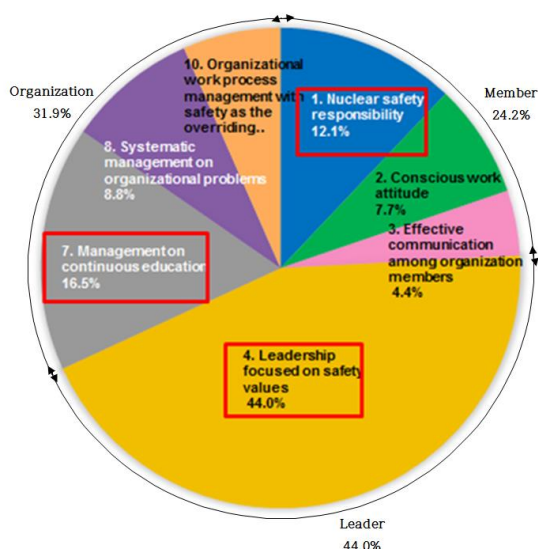


Fig. 5. Overseas NPP Accidents and Events Safety Culture Impact 12 Traits Analysis Results

In case of overseas 164 safety culture related

accidents, the overall trend showed similar to the domestic safety culture related accidents. However, "management on continuous education" including "systematic training and education assuring knowledge transfer" and "Regularly scheduled self-assessment" occupied a lot of shares. And when compared the safety culture influence factors for domestic and overseas accidents with base frame Principle (Member, Leader & Organization), domestic member and overseas leader showed distinctive differences trend of 40.9% and 44.0% respectively.

#### 4. Conclusions

From the investigations, followings were concluded.

- 1) In order to analyze the safety culture, analysis methodology is required.
- 2) Analytical methodology for building sustainable safety culture promoting a virtuous cycle system was developed
- 3) Among variety of process input data, 970 domestic and overseas incidents were selected as targets and 502 accidents were classified as safety culture related events by utilizing screen filter of IAEA GS-G-3.5 Appendix I and Framework (Nuclear Safety Culture Base Frame) developed by BEES, Inc. for safety culture analysis method.
- 4) As a result, complex safety culture influence factors for the one reason which was difficult to separate by conventional methods was able to be analyzed.
- 5) The cumulative data through the system was results of virtuous trend analysis rather than temporary results. Thus, it could be unique cultural factors of the domestic industry and could derive trend differences for domestic safety culture factors accordingly.
- 6) Case study with a tool utilized in this study can help promote sustainable development of safety culture systems, because field applicable realistic safety culture influence factors can be derived by considering versatile factors, if the results are accumulated through a variety of trend analysis on each plant, individual and organization, etc.

#### References

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- [6] International Reporting System for Operating Experience Database