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# Aging Trend about Piping from OPDE database

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## 1. Introduction

As the interests on the aging of passive components and its application to a PSA (Probabilistic Safety Assessment) are increasing, researches about a passive component aging research are being promoted actively. On September 2004, JRC (Joint Research Center) Network on “Incorporating Ageing Effects into PSA” was launched to start discussions of the aging issues in relation to incorporating the aging effects into the PSA tools and to come to some consensus on the objectives and work packages of the Network [1].

The purpose of this paper is to figure out the aging trend of piping based on the OPDE (OECD Piping Failure Data Exchange) database. A few reports have made mistakes in evaluating the aging trends from several databases. They arranged the data in a calendar order even though the first operation days of each NPP (Nuclear Power Plant) are different. To overcome the misunderstanding, we describe how to understand the data structure and how to select the data scope for an aging trend analysis with the OPDE database [2].

In this paper, we summarize the understanding of the data structure and the aging trend analysis method first, and then we investigate an aging trend from the point of view of the piping diameter and the piping material.

## 2. Data Scope for Aging Trend Analysis from OPDE Database

The objective of OPDE is to develop a well structured, comprehensive database on pipe failure events and to enable project member organizations to utilize the collected data for an application field. The OPDE database is based on the SKI-PIPE database (1998), the result of the 1994-1998 R&D projects by SKI. Therefore the OPDE database consists of selected records with a validation from the SKI-PIPE and new records added by a respective national coordinator [3].

To obtain an aging factor from a database, an understanding of the characteristics of each database is required with respect to the data structure. Because the SKI-PIPE database collected piping failures which occurred up to 1998 and the OPDE project mainly focused on piping failures which occurred after 1995, the number of countries of which pipe failure data is stored on the OPDE database is quite different from that of the SKI-PIPE database.

Figure 1 shows the data status of the OPDE database. In the case of (1) and (2) in Figure 1, piping failure records have been stored successively during both periods of the SKI-PIPE database and the OPDE database, even though the respective commercial operation date is different. Cases (3) and (4) show the ceasing of the data collection at the end date of the SKI-PIPE. The collection of the pipe failure from sixteen countries stopped after 1998. Case (5) shows that there is no pipe failure record which occurred during the period of the SKI PIPE project for some plants.

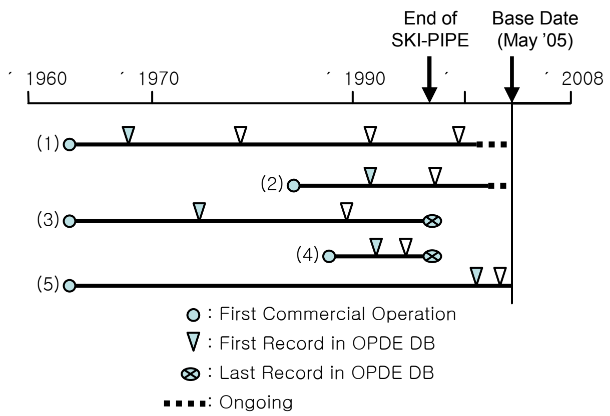

Fig.1. Data Status of OPDE DB

We select 1,424 records from 212 PWRs (Pressurized Water Reactor) by considering the above data structure. They have clear failure descriptions and their plants started their first operation after 1970.

## 3. Aging Trend of Piping

In this paper, we consider two kinds of methods to establish the aging trend with the selected data.

### *3.1 Aging Trend Analysis I*

Plant operation starting dates of all the plants are moved to an identical time point, Jan. 1, 1970. And then, each plant is divided into six groups by every five years of each plant’s operation years. With this method, we draw the aging trend of a leak frequency by the piping diameter first.

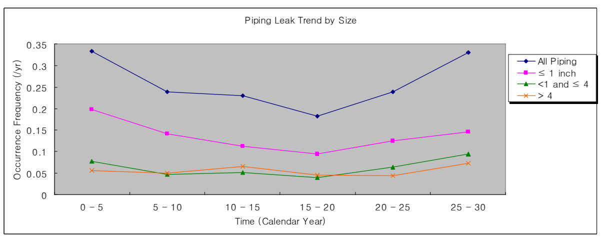

Fig.2, Trend of Piping Leak Frequency by Size

The aging trend of a leak for piping less than 1 inch shows a typical bath-tub shape. That is to say, the leak frequency is relatively high in the early operation period and it decreases by a 20-year operation and then the leak frequency increases after that. While, in the case of piping of more than 1 inch, the two frequencies show a little bit different shapes and lower values.

Next, we consider the piping leak trend by the material as well as the nominal diameter. In the case of the SS (Stainless Steel) piping, Figure 3 shows an apparent difference between piping of less than 1 inch and the others. However, in the case of CS (Carbon Steel), there is little difference among the three kinds of piping except for the large bore piping which requires some caution.

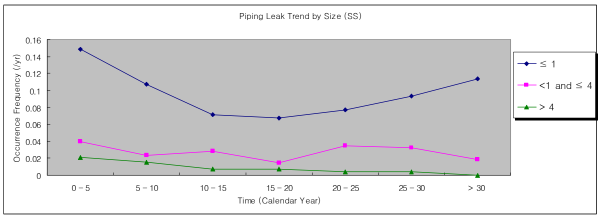


Fig.3. Trend of Piping Leak Frequency by Size (SS)

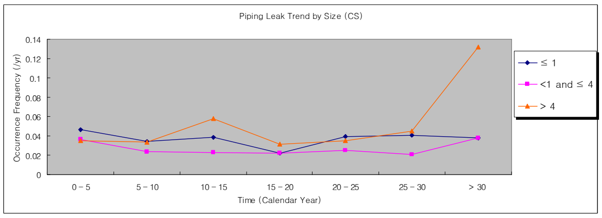


Fig.4. Trend of Piping Leak Frequency by Size (CS)

*3.2 Aging Trend Analysis II*

We categorize the 212 plants into the three groups based on the total plant operation year, 0-15, 16-25, and 26-35. And then for each group, we perform the same analysis mentioned in the previous section. Figure 5 shows the piping leak frequency for each group.

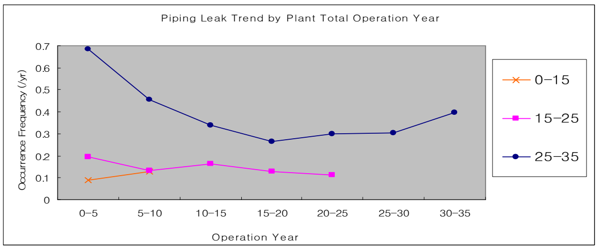


Fig.5. Trend of Piping Leak Frequency by Total Plant Operation Year

From Figure 4, we can see that the piping leak frequency of the oldest group shows a bath tub curve and an aging trend. Therefore we perform a detailed aging trend analysis with the oldest plant group.

We investigate the difference of the piping material in the case of the oldest plants. For the case of the SS piping (Figure 6), we should consider an aging trend in the case of a small bore piping of less than 1 inch. Figure 7, however, shows different shapes from the Figure 6. In the case of the CS piping, the larger the nominal diameter of piping is, the higher the leak frequency is, as plants age, especially beyond 25.

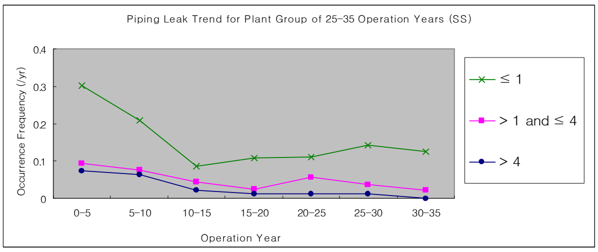


Fig.6. Trend of Piping Leak Frequency of the Oldest Plants (SS)

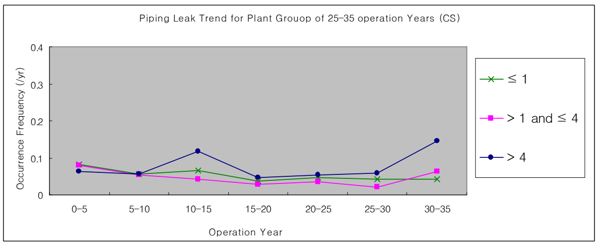


Fig.7. Trend of Piping Leak Frequency of the Oldest Plants (CS)

## 4. Conclusion

We performed an aging trend analysis with the OPDE database in this paper. First, we established the data structure of the OPDE database and selected data records for the aging trend analysis. We investigated the piping aging trend with the piping leak frequency by the piping size, and the piping material based on three groups of the total plant operation years.

From the aging trend analysis, some results can be summarized. 1) There is a difference in the aging trends between the SS ping and the CS one as well as among the pipe size. 2) With the three groups of plants based on the total plant operation years, the trend of the piping operation for the group of 25-35 years is considerably different from the others. Therefore caution is required when reflecting the aging trend by using the data in the aging PSA.

## REFERENCES

[1] JRC, Proceedings of the kick off meeting JRC Network Incorporating Ageing Effects into PSA Applications, Oct. 2004

[2] Sun Yeong Choi et al., Piping Service Experience Related to Aging in OPDE Database, International Workshop on Practical Application of Age-dependent Reliability Models and Analysis of Operational Data, Oct, 2005

[3] Sun Yeong Choi et al., Development of OPDE Piping Failure Database, Proceeding of KNS Conference, Apr, 2000