Comparison between Heinrich's Law and the Number of Events in Domestic Nuclear Power Plants

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1. Introduction

Heinrich's law has been well known as the probabilistic law in which one accident with serious injury from a work place hazard can be statistically led from a certain number of disasters without injury.

In nuclear power plants, a plant trip and component failure including incipient failure, degradation failure and critical failure has occurred. A plant trip can be costly and bring casualties and heavy losses.

The purpose of this paper is to compare Heinrich's law and the number of events in domestic nuclear power plants in order to understand the number of events that conform to Heinrich's law by using TR (Trouble Report) data.

2. Methods and Results

2.1 Heinrich's Law

Developed in 1931, Heinrich's accident pyramid applies the law of averages to safety. Generally accepted for approximately 70 years, the pyramid illustrates Heinrich's theory of accident cause: unsafe acts lead to minor injuries and, over time, to major injury. The accident pyramid proposes that for every 300 unsafe acts (no‐injury events) there are 29 minor injuries and 1 major injury. That is 90.9% of all accidents produce no injuries, 8.8% produce minor injuries, and 0.3% produce no injuries [1].

Fig. 1 Heinrich's Law

2.2 The Number of Events in Domestic Nuclear Power Plants

We utilized TR data of PSA (Probabilistic Safety Assessment) scope components for UCN (Ulchin) Units 3/4, YGN (Yonggwang) Units 3/4, and Kori 3/4 to compare the number of events in domestic nuclear power plants and Heinrich's law. For the TR data of the UCN and YGN plants during the first commercial operation date to 2002, we used the TR data in the KIND (Korean Information System for Nuclear Reliability Data) and we also used data in the PRinS (Plant Reliability Data Information System) for the TR data of the Kori plant during July of 2002 to June of 2007, including plant trip history. It is required to define terms since Heinrich's law is based on the loss of lives. Events in nuclear power plants, however, are based on plant trips or component failures. Therefore we considered a plant trip, a critical component failure, and a component degradation failure, including an incipient failure as a major injury, a minor injury, and a no-injury accident in Heinrich's law in terms of plant operation and cost.

- Result of the UCN 3/4 and YGN 3/4

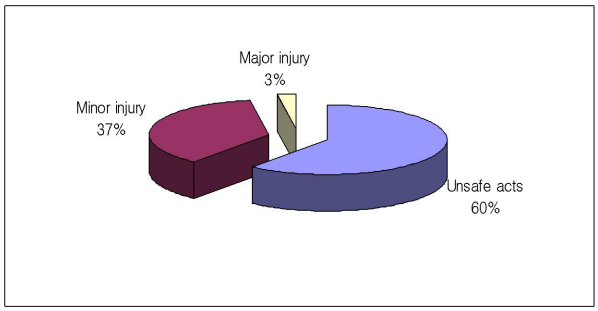

Fig. 2 Result of the UCN 3/4 and YGN 3/4

Figure 2 shows 60% produce unsafe acts (incipient and degradation failures), 37% produce minor injuries (critical component failures), and 3% produce major failures (plant trips). Compared to Heinrich's law, the proportions of major and minor injury of all accidents are greater than those of Heinrich's law as a whole. The number of plant trips during the first year related to the first commercial operation date was pretty higher than others. Even if the number of plant trips during the year is eliminated, the portion for major injury becomes 2%. Therefore there is a big gap between Heinrich's law and the number of events data in the UCN 3/4 and the YGN 3/4.

- Results of the Kori 3/4

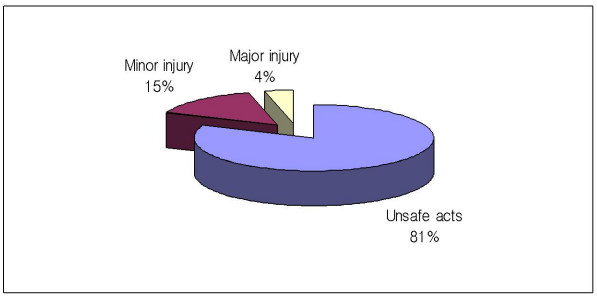

Fig. 3 Result of the Kori 3/4

Figure 3 shows 81% produce unsafe acts (incipient and degradation failures), 15% produce minor injuries (critical component failures), and 4% produce major failures (plant trips). Compared to the Figure 2, the proportion of minor injury occurred in the Kori 3/4 is reduced, but the ratio of unsafe acts to minor injury is still greater than that of Heinrich's law. And, the proportion of major injury in the Kori 3/4 is greater than that of the UCN 3/4 and the YGN 3/4. The result of the Kori 3/4 also shows there is a big gap between Heinrich's law and the number of events data.

3. Conclusions

The purpose of this paper is to compare Heinrich's law with the number of events in domestic nuclear power plants in order to understand if the number of events conforms to Heinrich's law by using the TR data. We considered a plant trip, a critical component failure, and a component degradation failure including an incipient failure as a major injury, a minor injury, and a no-injury accident in Heinrich's law in terms of plant operation and cost. We utilized the TR data of PSA scope components for the UCN 3/4, YGN 3/4, and Kori 3/4. The result shows that there are big differences between Heinrich's law and the number of events data in the UCN 3/4, YGN 3/4, and Kori 3/4. The difference may come from the different situation that Heinrich's law is based on the loss of lives. The number of events in nuclear power plants, however, is based on plant trip or component failure. Since a plant trip is comparable to the major injury considering the plant operation and cost aspect, it is required to reduce the number of plant trips in nuclear power plants.

ACKNOWLEGEMENT

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REFERENCES

[1] Heinrich H.W., "Industrial accident prevention: a scientific approach (4th ed.)," McGraw-Hill, 1973.