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APPLICATION OF THE INTERNATIONAL GUIDELINES

FOR

MACHINERY BREAKDOWN PREVENTION AT NUCLEAR POWER PLANTS

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This paper provides a chronology of the development of the **"International Guidelines for Machinery Breakdown Prevention at Nuclear Power Plants [1]"** and describes the results of nuclear insurance inspections conducted using these guidelines at nuclear power plants worldwide. Included is a summary of Guideline content and of insurance loss experience between 1966 and 2000.

Introduction

For more than forty years as a specialized branch of the worldwide insurance industry, nuclear insurance pools have underwritten property damage protection for nuclear facilities throughout the world. More than 85% of the world's commercial nuclear reactors as well as other nuclear operations are insured by the nuclear insurance pools. The nuclear insurance pools are comprised of members from all western and most east Asian countries and in recent years has expanded to include newly formed nuclear insurance pools in central and eastern Europe.

At nuclear power plants worldwide, an enviable record of operational safety has been attained. Nevertheless, electrical and mechanical equipment does break down occasionally. Although these failures do not necessarily compromise nuclear safety, they can cause significant damage to equipment, leading to a considerable loss of generating revenue and causing sizeable insurance losses.

Since insurers have a large financial stake in nuclear power plants, their goal is to minimize insurance losses, including the failure of systems and equipment and ensuing consequential damages. To ensure that the insurance risk is properly underwritten, insurance companies analyze loss information, develop loss prevention guidelines and focus loss control activities on those areas where insurance risk is most significant.

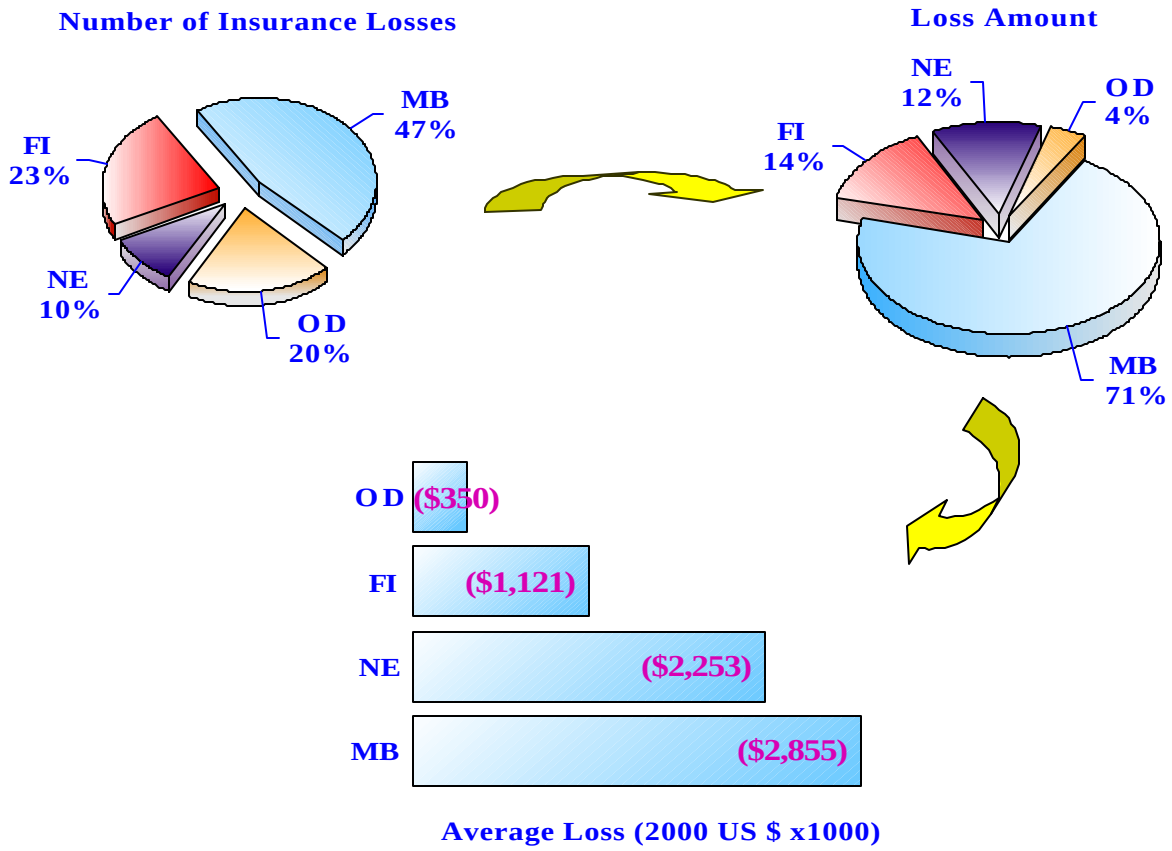
Several different kinds of nuclear insurance coverage are offered by nuclear insurers. This paper addresses Machinery Breakdown insurance, which normally covers mechanical and electrical failures. Machinery breakdown events include: turbine and electrical generator

failures; catastrophic failures of steam, condensate and feedwater piping; foreign material damage in primary and secondary systems affecting both electrical and mechanical systems; and catastrophic failures of transformers, load distribution centers and switchyard equipment. Additionally, machinery failures at power plants can cause major fire events.

A review of more than 600 property insurance losses covering the period between 1966 and 2000 [2] reveals that the majority of the insurance risk (loss frequency x monetary damages) is caused by machinery breakdown events. Figure 1 below provides a statistical compilation of those insurance losses, segregated into four peril types. The four peril types, commonly referred to as "causes of loss," are: Fire (FI), Machinery Breakdown (MB), Nuclear (NE) and Other (OD).

These loss statistics reflect the gross reported losses without consideration of policy deductibles and range from approximately US $41,000 to more than US $100 million. The losses have been inflation-adjusted to 2000 US dollars. Excluded are business interruption losses which are insurance losses resulting from the loss of revenue due to the inability of the damaged facility to generate electricity. Excluded also is the 1979 Three Mile Island Unit 2 loss as it is treated as an outlier.

Figure 1 - Cause of Insurance Loss (1966 - 2000)



Development of the International Guidelines for Machinery Breakdown Prevention

In May 2000, the International Guidelines for Machinery Breakdown Prevention at Nuclear Power Plants was published. The Guidelines are reflective of experience developed by international nuclear insurance engineers, international insurance loss experience and insights provided by nuclear plant operators.

The Guidelines are not intended to be prescriptive, but to be used as guidelines by international insurance pool engineers to conduct insurance loss control inspections at nuclear facilities worldwide. The results of such inspections are also used by nuclear underwriters to evaluate the insurability of a nuclear facility.

The Guidelines are provided to nuclear plant operators to provide a common foundation from which an insurance risk assessment may be conducted.

The Guidelines are divided into twelve chapters, starting with chapters addressing administration, operating and maintenance programs, followed by area specific chapters. Each chapter is reflective of contemporary systematic insurance risk management principles addressing potential insurance risk in that area. Table I provides a master listing of each area. Although all areas within a nuclear facility are vulnerable to machinery breakdown losses, it is important to note that the Guidelines do not necessarily address areas that are governed by nuclear regulatory authorities, whose primary emphasis is nuclear safety.

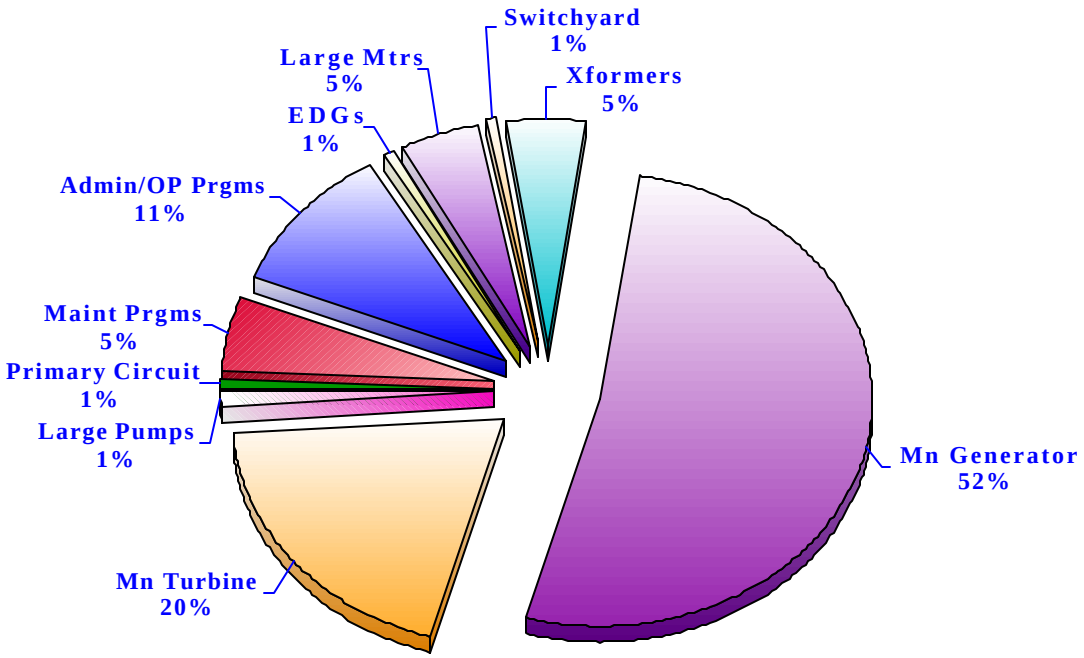
Table I - Chapter Overview
International Guidelines for Machinery Breakdown

1	Administration / Operating Programs
2	Maintenance Programs
3	Primary Circuit
4	Main Turbine and Support Systems
5	Secondary Circuit
6	Large Pumps
7	Safety Devices for Overpressure Protection
8	Main Electrical Generator and Support Systems
9	Electrical Transformers (oil filled)
10	Switchyard and Electrical Equipment
11	Large Motors and Emergency Generators (> 1 Mwe)
12	Emergency Prime Movers

Engineer Inspection Results

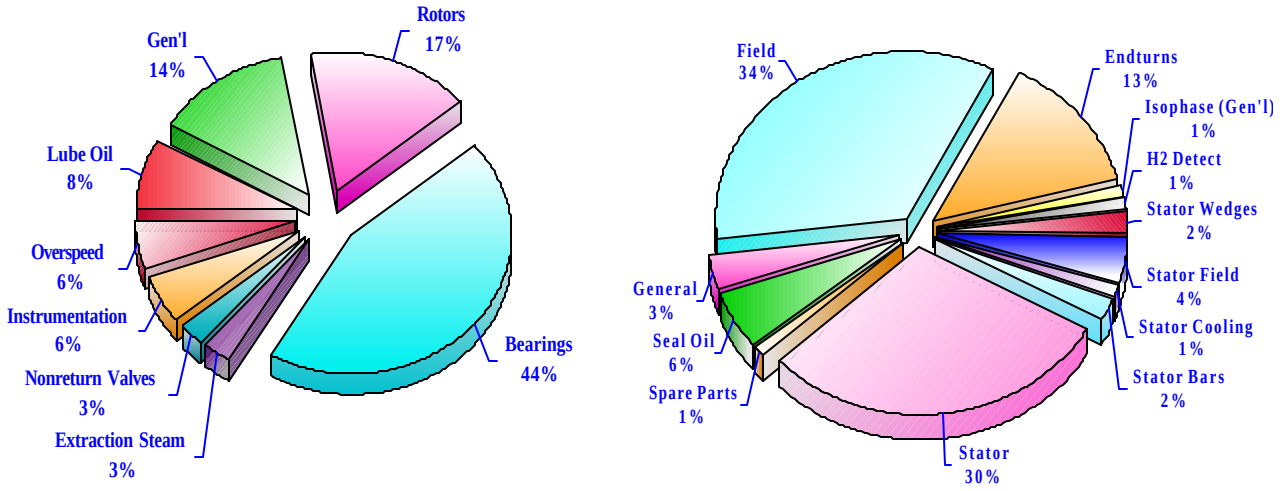
To date, 15 plants in nine countries have been inspected using the International Guidelines. The nine countries are located in North America, Eastern and Western Europe and the Pacific Rim. The 15 engineering loss control inspections resulted in 170 recommendations to address moderate to significant insurance risk issues. Figure 2 provides a distribution of the recommendations relative to specific guideline chapters.

Figure 2 - Number of Recommendations per Chapter



From the figure, it can be seen that the largest number of insurance loss control recommendations were offered relative to the Main Electrical Generator (and Support Systems) and the Main Turbine. Additional insight can be gained by reviewing the recommendations at the subcomponent level for the Main Turbine and Main Electrical Generator areas. The results are shown in Figure 3.

Figure 3 - Main Turbine & Electrical Generator Recommendations



Main Turbine

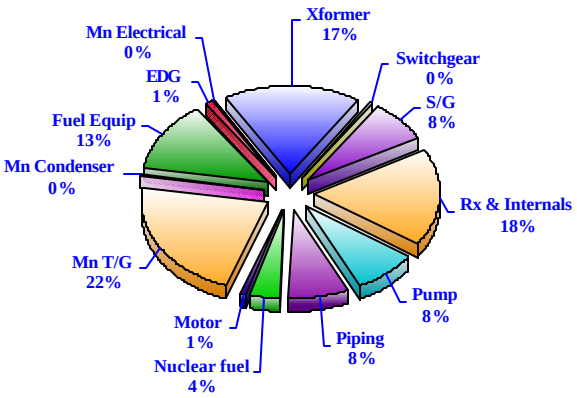
Main Generator

Insurance Loss Experience

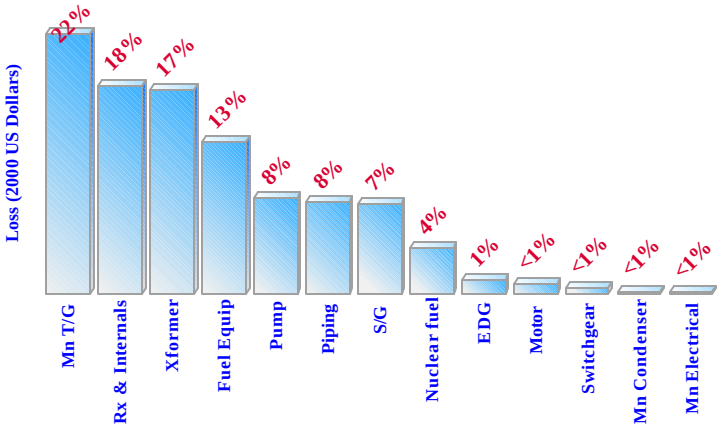
As discussed previously and illustrated in Figure 1, MB (Machinery Breakdown) insurance losses constitute the vast majority of insurance losses. Figure 4 provides the results of a more detailed analysis of the machinery breakdown loss history. As can be seen, the analysis reveals that the largest nuclear insurance risk (loss frequency x monetary damages) involves Main Turbines, Main Generators, Reactor and Internals, Transformers and Pumps.

Figure 4 - Machinery Breakdown Losses by Component (1966-2000)

Number of MB Losses



MB Loss Amount



Conclusion

As illustrated the Guidelines contain loss control guidance that is reflective of both loss experience and areas of prospective insurance risk based on inspection and plant operation experience. To date, application of the International Machinery Breakdown Guidelines indicates that there are many strengths and some weaknesses in select areas at the nuclear facilities inspected by insurance engineers. Plant operators' response to inspection recommendations is quite positive and reflective of the insureds' commitment to accommodate insurance risk perspective.

References

[1] International Guidelines for Machinery Breakdown Prevention at Nuclear Power Plants, May 2000.

[2] "Nuclear Property Insurance Experience of an Aging Global Nuclear Industry," W. Wendland, P.E., 8th International Conference on Nuclear Engineering, Baltimore, Maryland, USA, April 2000.