A Generation Risk Assessment for CCWS at UCN 3

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1. Introduction

Generation Risk Assessment (GRA) is defined as[1], "… the process of predicting the risk of a generation loss during a future operation by estimating the probability and duration of a plant trip or derate due to equipment degradation or failure." GRA is to a lost generation (MWh/yr) as Probabilistic Safety Assessment (PSA) is to a core damage frequency.

"Generation Risk" is used as a means of determining where capital improvements or decreased (increased) maintenance is appropriate. Also, GRA will help spare parts inventory control, trip monitor development, etc., and eventually become a basis for Nuclear Asset Management [2].

There are two methods to build a GRA model: 1) To build a GRA model from scratch by considering a plant trip, 2) To convert an existing PSA model to a GRA one. A GRA model for a Component Cooling Water System (CCWS) of UCN 3 was developed by converting the existing PSA results. It is not necessary to model an entire plant before applying a GRA. The GRA for the CCWS of UCN 3 is described in this paper.

2. Methods and Results

2.1 Development of a GRA Model for a CCWS

CCWS fault tree (FT) model for UCN 3 PSA is used for the CCWS GRA model development. First of all, the CCWS PSA FT is quantified, and the generated PSA cutsets are converted by using some rules. Some example rules are shown as follows;

- Delete the cutsets containing initiating events
- Delete the cutsets which do not have mission time events
- Change the mission time from 24 hrs to 1 year for one mission time event
- Change the mission time from 24 hrs to MTTR for another mission time event
- ….

The converted cutsets for the CCWS GRA of UCN 3 are shown in Figure 1.

2.2 Interpretation of the Results

If the GRA cutsets as shown in Figure 1 are quantified, the possible generation loss of the CCWS during a power operation is 0.366 EFPH/yr (where, EFPH= Effective Full Power Hours). Thus,

Generation Loss of the CCWS = 0.366 EFPH/yr
= 0.366 EFPH/yr x 950Mwh÷12x 20$/Mwh
= $580/month

That is, if the current failure rate of the CCWS equipment is maintained, then the expected generation loss is $580/month.

In order to evaluate the importance of the CCWS equipment, the Risk Achievement Worth (RAW) and the Risk Reduction worth (RRW) are calculated. The results are displayed in the four quadrant plot as shown in Figure 2. In Figure 2, the X-axis is for the RRW, and the Y-axis is for the RAW.

In Figure 2, there is no basic event which belongs to the upper right-hand quadrant (high RAW, high RRW). There are two basic events (No. 1 and No. 10) which belong to the upper left-hand quadrant (high RAW, low RRW). Two basic events are all the CCF events whose occurring probability is very low, but if they occur, the generation losses are above 30 million dollars per month. For example, since the RAW of the No. 1 basic event (Running CCF of All pumps) is 5.37×10^4, if the No. 1 basic event occurs, the expected generation loss can be estimated as follows:

Generation Loss > $\$3 \times 10^7$/month
= $580/month x 5.37×10^4 (= RAW)

3. Conclusions

GRA for the CCWS of UCN 3 was performed. Since the generation loss of the CCWS is small (0.366 EFPH/yr), it is not necessary to take an action to prevent a CCWS from an unexpected trip. However, maintenance engineer should be careful of the CCF events since the RAWs of the CCF events are high.

Acknowledgement

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REFERENCES

[1] EPRI, Generation Risk Assessment (GRA) Plant Implementation Guide, 1008121, Report Summary, 2004

[2] Dave Blanchard, Training of GRA and its Applications held at KAERI, Nov. 2007

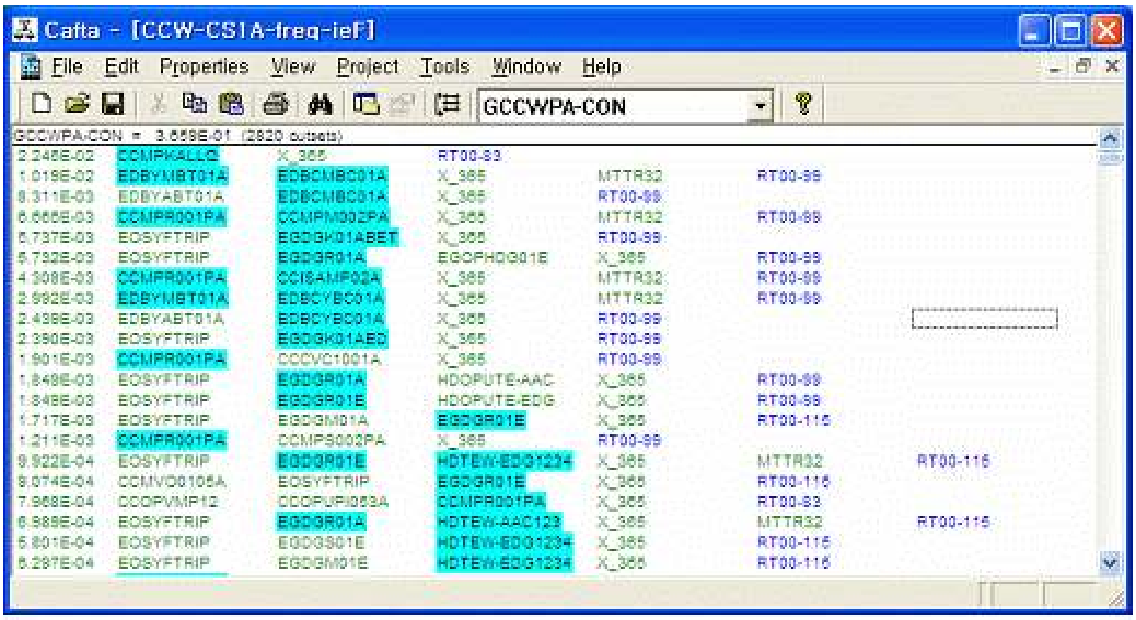

Figure 1. The Cutsets for CCWS GRA Converted from PSA Results

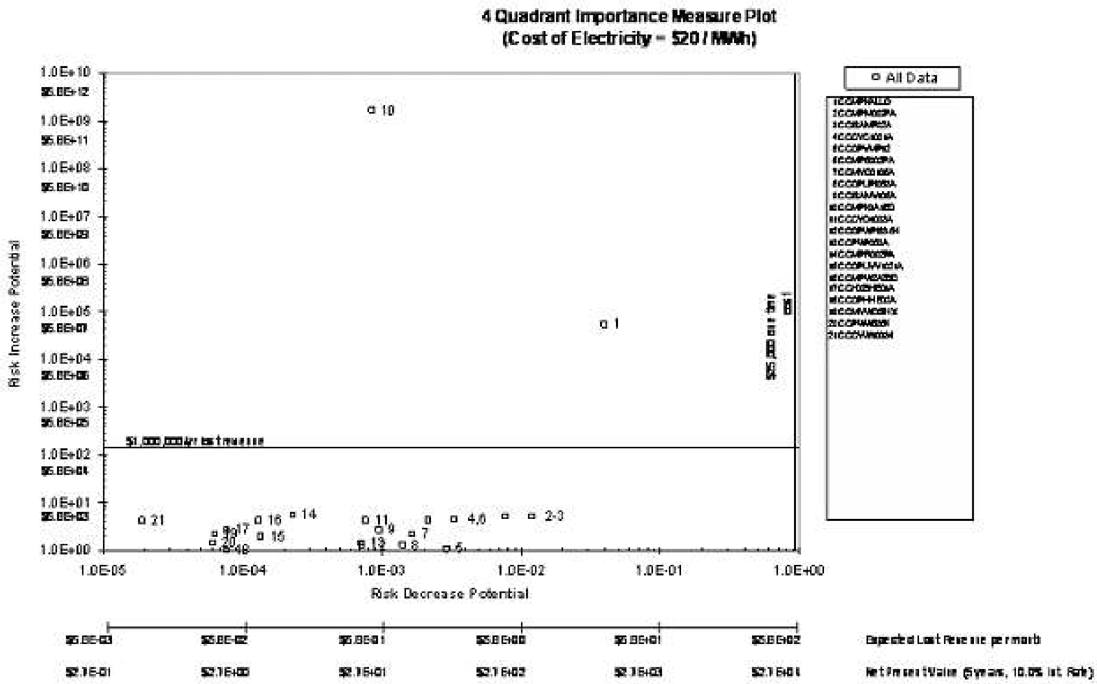

Figure 2. Four Quadrant Importance Measure Plot for CCWS