A Study on the System Importance Analysis in SMART

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1. Introduction

Importance analysis using RAW(Risk Achievement Worth) and RRW(Risk Reduction Worth) for the systems of SMART(**S**ystem integrated **M**odular **A**dvanced **R**eac**T**or) was performed. Usually PSA quantification softwares provide importance measures for basic events(BEs), and for components with receiving some users' input. However, generally, importance measures for systems are not automatically supplied by the softwares, but require the users' manual work.

In this paper, the method how to get system importance measures is described using AIMS[1], and the characteristics of system importance measures in SMART are described.

2. System Importance Analysis

2.1 Methods to Get System Importance Measures

The method to get a system importance measures is described using AIMS as the followings;

1) At OneTop model, use 'True/False list' of analysis menu.

2) To get RAW, make 'True' for some BEs. For example, to get Safety Injection System(SIS) RAW, it is enough to make only 4 SI pumps fail to run as shown in Fig. 1. Since if we make unnecessarily many components 'True', which causes underestimated RAW due to unnecessary Boolean reduction.

3) To get RRW, make 'False' for all BEs of the corresponding system listed in the MCS. For example, to get SIS RRW, all SI BEs are set 'False' as shown in Fig. 2.

4) At OneTop model, use 'Generate Cutsets' of analysis menu.

5) After checking cutoff value and selecting the recovery file for post process in the pop-up, then generate cutsets.

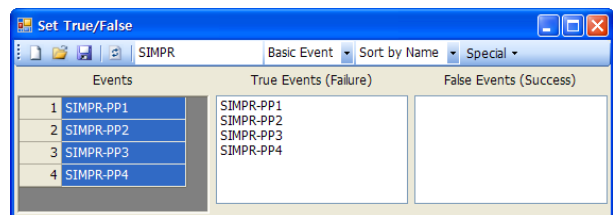6) Using the increased CDF and decreased CDF through step 2) and step 3), RAW and RRW are derived, respectively.

Fig. 1. An example screen to set 4 SI pumps 'True'

2.2 Common components issue

Many components are used in common between two systems. For example, valve SICVO-540 is used in SIS and Shutdown Cooling System(SCS). Thus, if we make the common components 'True', i.e. 'Unavailable' to get SIS RAW, since SCS is also unavailable, the SIS RAW is overestimated. The other way around, to get

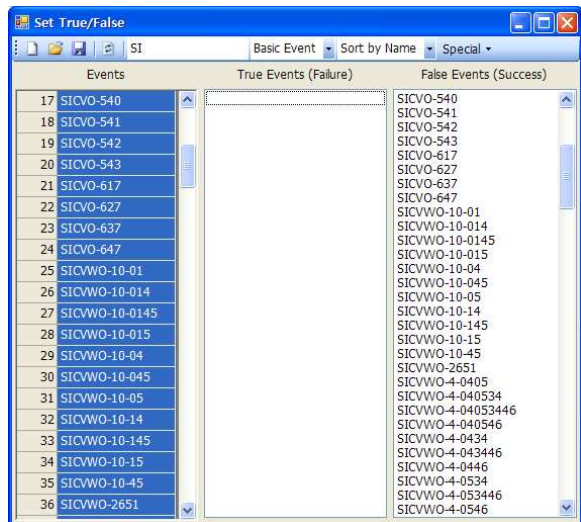SCS RRW, all SCS BEs are made 'False' and the SI BEs used commonly with SCS should be also set 'False'.

Fig. 2. An example screen to set all SI BEs 'False'

2.3 System Importance Measures in SMART

In Table 1, the RAW of PRHRS is very high because the transient accident cannot be easily overcome if PRHRS is not available. The RAW of ESFAS is the most dominant because the PRHRS, which is working as like the AFWS in conventional NPPs, is also governed by the signals to close main steam isolation valves and main feedwater isolation valves. In Table 1, we can see that the RAWs of supporting systems such as electric power, component cooling water system, etc., are also very high. The reason is that the transient accidents whose contribution to the CDF is 40%, while that of the LOCA accident is 60%.

In Table 2, RRWs of all systems are very similar, which means the reliabilities of systems are allocated in a balanced manner.

3. Conclusions

The method to get system importance measures is described, and the common components should be carefully handled. The characteristics of system importance measures in SMART are described. The high RAW of PRHRS and ESFAS are analyzed.

REFERENCES

[1] S.H. Han, et. al. Improved Features in a PSA Software AIMS-PSA, Trans. of the Korean Nuclear Society Spring Meeting Pyeongchang, Korea, May 27-28, 2010

Table 1. System RAW of SMART

System	RAW	%
SIS	176.5	0.03
SDS	23.7	0.00
SCS	1.9	0.00
RPS	79.0	0.01
PRHRS	6049.3	1.08
MFWS/MSS	9.9	0.00
HVAC	7738.3	1.39
ESWS	7738.3	1.39
ESFAS	521063.9	93.31
EPS	7775.2	1.39
CVCS	3.4	0.00
CSS	28.4	0.01
CCWS	7738.3	1.39
Total		100.00

Table 2. System RAW of SMART

System	RRW	%
SIS	1.15	8.05
SDS	1.21	8.45
SCS	1.02	7.13
RPS	1.03	7.22
PRHRS	1.12	7.84
MFWS/MSS	1.05	7.36
HVAC	1.11	7.76
ESWS	1.01	7.07
ESFAS	1.44	10.09
EPS	1.01	7.09
CVCS	1.08	7.57
CSS	1.02	7.16
CCWS	1.03	7.22
Total		100.00