Logic Alarm Cause Tracking System(LogACTs) for Wolsong 3&4

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1. Introduction

KAERI I&C.HF Research team has developed an alarm root cause tracking system (ACTs), an alarm and diagnosis-integrated operator support system (ADIOS), and a dynamic alarm system (DAS) [1, 2, 3]. An alarm processing and presentation system, LogACTs(Logic Alarm Cause Tracking system) of their researches is developed and installed into the main control room(MCR) of the Wolsong nuclear power plant(NPP) unit 3. The system is integrated with tracking the logics of an alarm, finding the causes of an alarm, displaying the highlighted alarm procedure related to the causes, and suppressing and filtering nuisance alarms due to the physical or logical connections between components or systems in an abnormal state.

2. Functions of LogACTs

In the process of the development of LogACTs, the following functions are defined and implemented;

1) Alarm compression – by applying various alarm processing techniques [4], to reduce the number of alarms during plant transients and display a list of causal and important alarms,
2) Presentation of a full list of alarm messages,
3) Presentation of the alarm messages sorted by the priorities or the system groups as used on the current alarm CRT displays of the Wolsong NPP,
4) Separation of status and program alarms from other alarm messages,
5) Presentation of alarm information for a selected alarm messages,
6) Tracking causes of the important alarms and the power reduction signals,
7) Computerization and presentation of alarm logic diagrams,
8) Checking automatically the entry conditions of the emergency operation procedures (EOPs) and the abnormal operation procedures (AOPs),
9) Presentation of trend graphs for monitoring the status of safety parameters during EOP operation
10) Retrieval of the history of alarm messages.

3. Alarm Processing Techniques

The alarm processing techniques are described to filter and suppress the temporary and nuisance alarms in LogACTs.

3.1. Plant Mode Dependency Processing

The popular alarm prioritizing technique has been applied in many annunciation systems. Many alarms are temporarily generated according to a changing operational mode or reactor shutdown. But these alarms appear and disappear in a minute. Most of these temporary alarms are nuisance alarms that an operator needs not recognize. LogACTs suppresses or filters these nuisance alarms by applying a plant mode dependency processing first whenever it is applicable.

3.2. Multi-setpoint Relationships Processing

Another method adopted in LogACTs is, so called, a multi-setpoint relationship, the implementation of which is straightforward. For instance, the priority of the alarm, "Steam Generator A Water Level Low", is lowered when the alarm, "Steam Generator A Water Level Low-Low", also is activated. Fig 1 shows displays of the "S/G 1 Level Alarms" and "PZR Press Alarms" suppressed by a Multi-setpoint Relationships Processing.

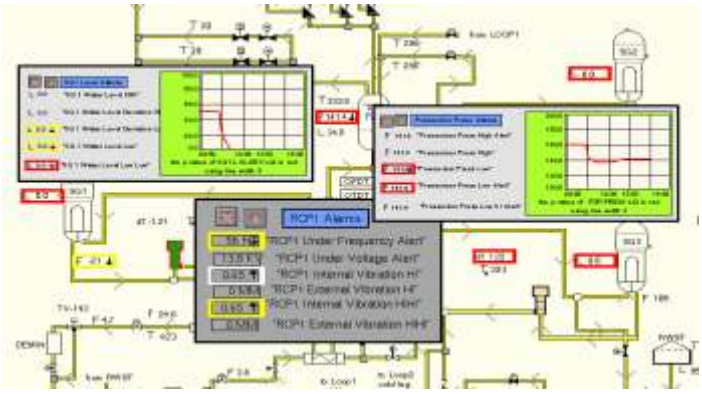

Fig 1 Alarm suppressed by Multi-setpoint Relationships Processing.

3.3. Cause-Consequence Relationships Processing

Another method that has been applied is a cause-consequence relationship, sometimes called a direct precursor. Although causality could be readily established between process variables and parameters, we could rarely find such a relationship among alarm signals. Figure 2 shows a concept of the sequential alarms by the Cause-Consequence Relation- ships when Feedwater Pump 04P trips by the alarm "Feedwater

Pump 04P Lube Oil Press LoLo". Several alarms are generated due to a trip of "Feedwater Pump 04P". Here, "Feedwater Pump 04P Lube Oil Press LoLo" becomes a causal alarm and the several sequential alarms are the consequential alarms.

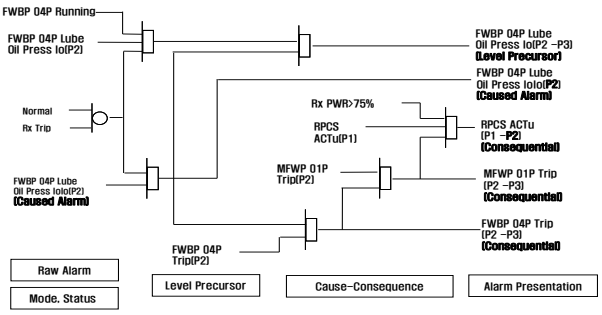

Fig 2 Sequential alarms by the Cause-Consequence Relationships

4. Logic Alarm Root Cause Tracking

Figure 3 shows the tracking result of an alarm cause when tracking the operating state of the related component to the presented alarms or alarm response procedures. There are the compressed alarm messages collecting the important and causal alarms from the generated alarms, the root cause of causal alarm and the brief alarm information in the left side of window, and all alarm messages generated and the tracking result displayed by logic diagram.

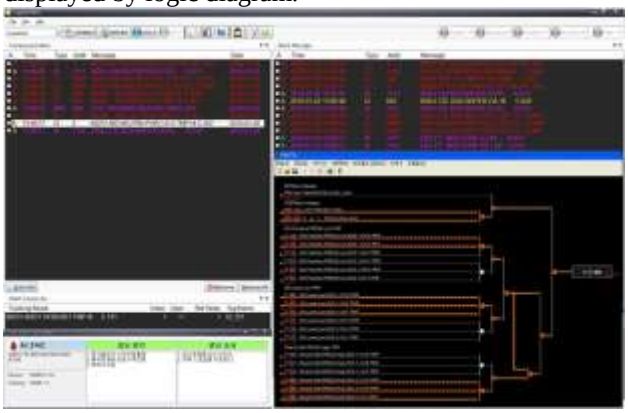

Fig 3 Tracking result of alarm cause by tracking the operating state of the related components

5. Alarm Analysis Sheet for LogACTs

In order to apply the above alarm processing methods, a careful analysis of alarms become critical in the development of computerized alarm systems. All alarms of the NPPs, to which our alarm systems may be applied, were analyzed by using the alarm signal information, the alarm procedures, the abnormal and emergency operation procedures, the control logic drawings, and the plant process drawings. A standard sheet of the alarm analysis as shown in Fig. 4 was developed and used for our alarm analysis. Information related to alarm signals, alarm processing, alarm causes, alarm classification, and so on, can be filled after the analysis. The results are stored in a database. Hence a database management program can handle them easily to perform the alarm processing.

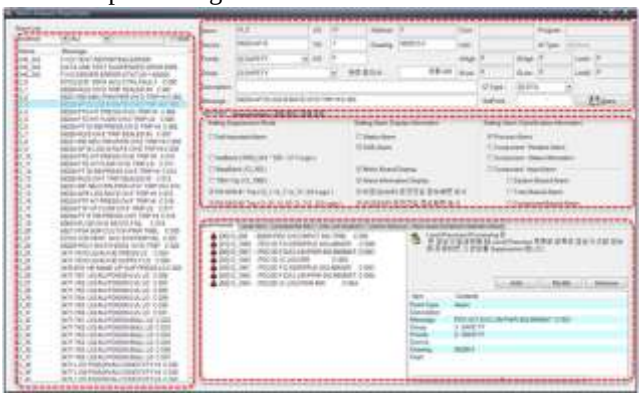

Fig 4 Alarm analysis sheet for the LogACTs

6. Conclusions

An alarm processing and presentation system, LogACTs(Logic Alarm Cause Tracking system) of their researches is developed and installed into the main control room(MCR) of the Wolsong nuclear power plant(NPP) unit 3. The system is integrated with tracking the logics of an alarm, finding the causes of an alarm, and suppressing and filtering nuisance alarms due to the physical or logical connections between components or systems in an abnormal state. The system can be used by an operator to identify the detailed causes of an alarm without checking all the causes by alarms.

Acknowledgement

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REFERENCES

[1] Jung Taek Kim, et. al, "An Evaluation Approach for Alarm Processing Improvement", IAEA Specialists Meeting (IWG-NPPCI) on Experience and Improvements in Advanced Alarm Annunciation Systems in Nuclear Power Plants, Chalk River, Ontario, Canada, 1996.

[2] Jung-Taek Kim, Kee-Choon Kwon, In-Koo Hwang, Dong-Young Lee, Won-Man Park, Jung-Soo Kim, and Sang-Jeong Lee, "Development of advanced I&C in nuclear power plants: ADIOS and ASICS", *Nuclear Engineering and Design*, **207**, pp.105–119, 2001.

[3] Jung-Taek Kim et al., "An Application on Alarm Root Cause Tracking System (ACTs)," Joint 8th Annual IEEE Conference on Human Factors and Power Plants (HFPP) and 13th Annual Workshop on Human Performance / Root Cause / Trending / Operating Experience / Self Assessment (HPRCT), Monterey, CA, 2007.

[4] Jung-Woon Lee et al. "LOGACTS (Logic Alarm Cause Tracking System) for a Nuclear Power Plant Operation," Sixth American Nuclear Society International Topical Meeting on Nuclear Plant Instrumentation, Control, and Human-Machine Interface Technologies, NPIC&HMIT 2009, Knoxville, Tennessee, April 5-9, 2009.