An Application of a Logic Alarm Cause Tracking System(LogACTs) to Wolsong 3&4

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1. Introduction

After the TMI accident, many alarm reduction systems and diagnostic systems have been studied to reduce nuisance alarms and to detect the causes of an abnormal state. In this paper, an operator-aid system is proposed for 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. The system can be used by an operator to identify the detailed causes of an alarm without checking all the causes of the candidates by alarms. The proposed system will be applied to a nuclear power plant of a CANDU type, Wolsong 3&4 Nuclear Power Plant.

2. Alarm Processing Methodology (DAS)

This section describes the alarm processing functions to filter and suppress the temporary and nuisance alarms as a submodule of LogACTs(Logic Alarm root Cause Tracking system). The function of an alarm processing system should be limited to integrating plant information to the system, prioritizing alarm signals based on some methods as discussed below, and providing limited aids to a fault diagnosis[1,2,3,4,5].

2.1. Plant Mode Dependency Processing

Prioritizing alarm messages depending on the operating mode of the plant is another popular method that has been applied in many other annunciator 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. In the mode dependency processing, alarms are processed depending on the "global" state of the plant, during a state dependency processing, they are handled depending on the "local" state of equipment.

2.2. 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.

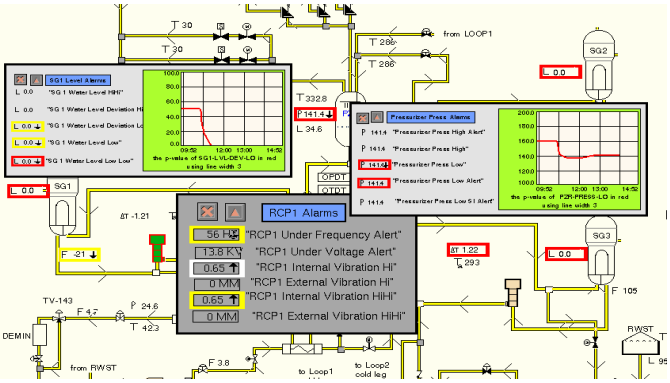

Fig 1 Alarm suppressed by Multi-setpoint Relationships Processing.

2.3. Cause-Consequence Relationships Processing

Another method that has been applied is a cause-consequence relationship, sometimes called a direct precursor. This term has been used in the early disturbance analysis systems; e.g., the basic model was called cause-consequence trees. 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 Relationships 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.

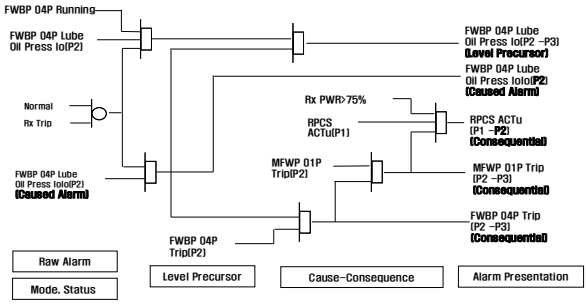

Fig 2 Sequential alarms by the Cause-Consequence Relationships

3. Logic Alarm Root Cause Tracking Methodology(LogACTs)

This section describes an alarm cause tracking function to detect and track a root cause of alarms and abnormal states as a submodule of LogACTs(Logic Alarm root Cause Tracking system). LogACTs tracks the causes of the alarms when generated by a process disturbance as a result of sensor failures or hardware failures. LogACTs uses the logical information acquired from the LDs(Logic Diagrams) and ARPs(Alarm Response Procedures) which include a logical relationship between the alarms and the system states. It uses the logical relationships between the object oriented and visualized logics which are constructed from the logic diagrams and alarm response procedures. Figure 3 shows the tracking of an alarm cause when linking the operating state of the related component to the presented alarms or alarm response procedures. LogACTs provides an operator with the causes of an alarm, the tracking path from the alarm to its causes on logic diagrams, the precedent alarms and the alarm response procedure with the detected causes, related directions and so on.

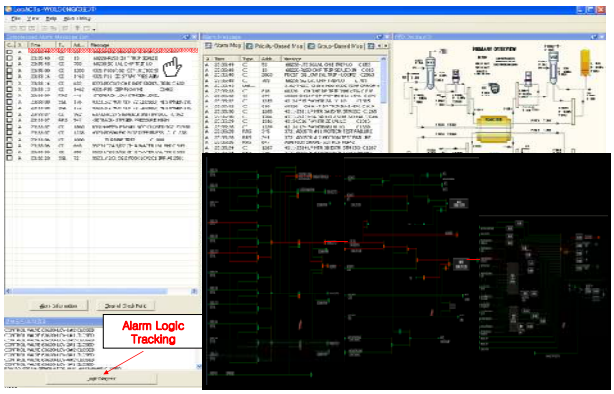

Fig 3 Tracking of alarm cause by tracking logic of the operating state of the related components

4. Configuration of LogACTs

LogACTs has separately been configured from the existing control computer, DCC and Annunciator Winows. Signals for processing and tracking an alarm enter the LogACTs from the DCC(Digital Control Computer) through the TCP/IP Protocol. LogACTs will be designed by the Web-based System to be configured as one processing server and several clients.

Software of the LogACTs will be modulated to the software modules. There are three major modules which are LogACTs Server Module for a data collecting from the DCC, alarm processing to suppress and filter the temporary and nuisance alarms, and tracking of an alarm cause, LogACTs Web Client Module for accessing from the Web-environment, and LogACTs Client Module for a display of the compressed alarm message list, alarm message list, alarm cause, alarm information, and so on. Figure 4 shows the software configuration of the LogACTs.

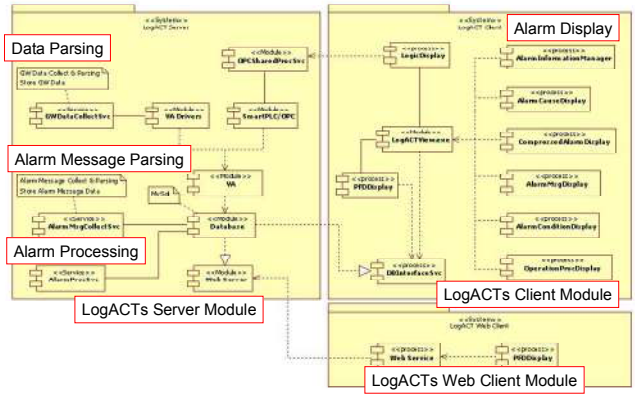

Fig 4 Software Configuration of the LogACTs

5. Conclusions

In light of the need to enhance the plant information to operators, and of the technological advances, an advanced alarm processing and alarm cause tracking system has been developed. It tracks the logics of an alarm, finds the causes of an alarm, displays the highlighted alarm procedure related to the causes, and suppresses and filters 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. The proposed system has been developed for the Wolsong 3&4 Nuclear Power Plants.

Acknowledgement

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