AN ABSTRACT OF THE THESIS OF

Joan Oylear Heaberlin for the degree of Doctor of Philosophy in Nuclear Engineering presented on July 21, 1994.

Title: A Knowledge-Based Approach for Monitoring and Situation Assessment at Nuclear Power Plants

Redacted for Privacy

Abstract approved: _____

Alan H. Robinson

An approach for developing a computer-based aid to assist in monitoring and assessing nuclear power plant status during situations requiring emergency response has been developed. It is based on the representation of regulatory requirements and plant-specific systems and instrumentation in the form of hierarchical rules. Making use of inferencing techniques from the field of artificial intelligence, the rules are combined with dynamic state data to determine appropriate emergency response actions.

In a joint project with Portland General Electric Company, a prototype system, called EM-CLASS, was been created to demonstrate the knowledge-based approach for use at the Trojan Nuclear Power Plant. The knowledge domain selected for implementation addresses the emergency classification process that is used to communicate the severity of the emergency and the extent of response actions

required. EM-CLASS was developed using Personal Consultant Plus (PCPlus), a knowledge-based system development shell from Texas Instruments which runs on IBM-PC compatible computers. The knowledge base in EM-CLASS contains over 200 rules.

The regulatory basis, as defined in 10 CFR 50, calls for categorization of emergencies into four emergency action level classes: (1) notification of unusual event, (2) alert, (3) site area emergency, and (4) general emergency. Each class is broadly defined by expected frequency and the potential for release of radioactive materials to the environment. In a functional sense, however, each class must be ultimately defined by a complex combination of in-plant conditions, plant instrumentation and sensors, and radiation monitoring information from stations located both on- and off-site. The complexity of this classification process and the importance of accurate and timely classification in emergency response make this particular application amenable to an automated, knowledge-based approach.

EM-CLASS has been tested with a simulation of a 1988 Trojan Nuclear Power Plant emergency exercise and was found to produce accurate classification of the emergency using manual entry of the data into the program.

A Knowledge-Based Approach for Monitoring and Situation Assessment at Nuclear Power Plants

by

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A THESIS
submitted to
Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

Completed July 21, 1994
Commencement June 1997

APPROVED:

Redacted for Privacy

Major Professor, representing Nuclear Engineering

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1.0 INTRODUCTION

1.1 MOTIVATION FOR COMPUTER-BASED AIDS

Under normal operating conditions, nuclear power plant staff are required to interpret the readings from numerous sensors, alarms, and displays, making judgments about the plant status, and reacting accordingly. Under abnormal operating conditions, the complexity of these tasks increases substantially; the envelope of information requiring interpretation and comprehension expands dramatically. The importance of making correct decisions within given time constraints also increases. The failure to cope with the increased conceptual complexity present during abnormal operating conditions can lead to increasingly serious malfunctions, including eventual damage to the plant and the potential release of radioactive materials to the environment.

Within the past 40 years of commercial nuclear power plant operations, the two most serious accidents, the TMI-2 accident in March 1979 and Chernobyl accident in April 1986, have been partially attributed to human error. While there

are numerous theories on the causes of human error, it is a common perception that the problem of information overload is a significant contributing factor. Given that the human capacity for processing independent pieces of data is limited, it is reasonable to assume humans placed in situations requiring the near-instantaneous interpretation of many data are prone to errors in judgment and cognitive interpretation.

One method of reducing the operational complexity of the decision-making environment during abnormal operating conditions is to employ computer-based aids. With sufficient validation and verification, such aids can monitor and interpret basic information concerning the status of the nuclear plant, allowing humans to assume the more sophisticated decision-making role. As a result, the potential for information overload is decreased, providing added assurance that appropriate emergency responses can be implemented when accidents or upset conditions occur.

1.2 IMPORTANCE OF EMERGENCY CLASSIFICATION

Emergency classification is one of many important functions to be performed as part of a response to abnormal operating conditions at a nuclear power plant. Emergencies are categorized into four emergency action level classes: (1) notification of unusual event, (2) alert, (3) site area

emergency, and (4) general emergency. Each class is broadly defined by expected frequency and the potential for release of radioactive materials to the environment.

The correct classification of an emergency immediately communicates to others both the severity of the emergency and the extent of response actions required. While the correct classification of an emergency can simplify communication and lead to effective initiation of emergency response activities, an incorrect classification can cause additional risk to the public and hinder activities in progress to mitigate damage. If the severity of the emergency is underestimated, the incorrect classification can cause a delay in notification and participation of off-site agencies, as well as a delay in consideration of appropriate protective measures for the general public. If the severity of the emergency is overestimated, the premature or unnecessary activation of off-site agencies or response actions involving the general public can lead to additional risk unrelated to the status of the nuclear plant. For example, an emergency classification that triggers an unneeded evacuation of an area surrounding the nuclear plant could result in serious traffic hazards and even loss of life.

The determination of the correct emergency action level class, as based on the potential for release of radioactive

materials to the environment, is not simple. In a functional sense, each class must be ultimately defined by a complex combination of in-plant conditions, plant instrumentation and sensors, and radiation monitoring information from stations located both on- and off-site. The dynamic nature of these data also contributes to the complexity of the emergency classification process and the potential for information overload. This complexity, plus the importance of accurate and timely classification in emergency response, makes the problem of emergency action level class determination appropriate for development of a computer-based aid.

1.3 REGULATORY BASIS FOR EMERGENCY CLASSIFICATION

Due to the importance of accurate and timely emergency classification, a well-defined regulatory basis has been established; these regulations apply to all nuclear power plants in the U.S. The regulatory requirements for emergency classification originate in 10 CFR 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities." This appendix states that the Final Safety Analysis Report (FSAR) for a nuclear power plant is required to include emergency plans which address, among other topics, the means for determining the magnitude of and continually assessing the impact of the release of

radioactive materials, including emergency action levels (EALs).

Generic definitions of EALs are found in NUREG-0610, "Emergency Action Level Guidelines for Nuclear Power Plants". This guide also provides the initiating conditions for each class of EALs which form the basis for the regulatory requirements to be addressed in the emergency classification scheme. The Notification of Unusual Event and Alert classes provide early notification of minor events which could lead to more serious consequences, given operator error or equipment failure, or might be indicative of more serious conditions which are not yet fully realized. The difference between the Notification of Unusual Event class and the Alert class is that the former involves no potential radioactive release to the environment; the latter, a limited release of up to 10 curies of I-131 equivalent or up to 10^4 curies of Xe-133 equivalent. The Site Emergency class reflects conditions where some significant releases are likely or are occurring but where a core melt situation is not indicated based on current information; potential releases are up to 1000 curies of I-131 equivalent or up to 10^6 curies of Xe-133 equivalent. The General Emergency class involves actual or imminent substantial core degradation or melting with the potential for loss of containment and releases greater than 1000

curies of I-131 equivalent or greater than 10^6 curies of Xe-133 equivalent.

Additional guidance on the development of plant-specific EALs and the emergency classification process is provided in NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants." Section D of this document, titled Emergency Classification System, states that an emergency classification and emergency action level scheme must be established for each licensee. This includes establishing specific instrument parameters or equipment status for each emergency class and addressing all postulated accidents in the FSAR.

It is interesting to note that the definitions of the emergency classes and the initiating conditions for each class of EALs found in NUREG-0610 are generic and applicable to all nuclear power plants. However, NUREG-0654 requires that a plant-specific emergency action level scheme must be developed based on these generic definitions. This regulatory approach suggests a natural hierarchy in the emergency classification process. At the highest functional levels, generically-derived categorization is applicable to emergency classification for many nuclear plants; at more complex functional levels, categorization is derived from plant-specific conditions that must be developed on an

individual basis. This apparent natural hierarchy in emergency classification lends itself to exploitation in simplifying the evaluation process.

1.4 RESEARCH OBJECTIVES

The objective of this research is to develop a computer-based aid to assist in monitoring and assessing nuclear power plant status during situations requiring emergency response. Due to the operational complexity associated with emergency classification, the development of a computer-based aid that focuses on methods to improve accuracy and timely determination of the emergency action level class was selected as the problem of interest.

Given the hierarchical nature of the emergency classification process as presented by the regulatory basis, the computer-based aid can be developed in two stages: (1) development of a generic framework, applicable to a class of nuclear plants, and (2) customization of the framework to a specific plant. The success of this type of approach would allow easy modification of the generic framework for additional nuclear plants, thereby decreasing the effort required to implement the system elsewhere.

1.5 ORGANIZATION OF DISSERTATION

In Section 2, the process of emergency classification is described and current approaches to the classification process are discussed; areas with potential for improvement are identified and preliminary requirements for the computer-based aid are presented. In Section 3, the regulatory basis for emergency classification is examined and the concept of taking advantage of the natural hierarchy in the classification process is expanded. Section 4 presents the knowledge-based approach developed for the emergency classification process. The application of this approach, with details of a customized system modified for the Trojan Nuclear Power Plant, called EM-CLASS, is described in Section 5. Finally, conclusions are presented and recommendations for future development are identified in Section 6. A listing of the prototype system (EM-CLASS) knowledge base, including rules and data parameters, can be found in the appendices.

2.0 REVIEW OF RELATED WORK

The development of computerized, knowledge-based aids for use in nuclear power plants is by no means a new concept. In a review conducted by Bernard and Washio [1989], no fewer than 298 systems were identified by the authors as in use or under development within the nuclear industry.

Knowledge-based systems are being used at nuclear power plants to enhance reactor operations by (a) improving plant capacity and reducing inadvertent technical specification violations under nominal operating conditions, (b) reducing downtime during outage periods, and (c) enhancing plant safety and recovery activities during abnormal operating conditions. They are also being used to develop knowledge-based systems that assist in developing logic models for Probabilistic Risk Assessments and other safety studies. In the area of reactor analysis, knowledge-based systems have been developed to assist users in the creation of input and interpretation of output for some of the more complex computer codes.

During the review of current literature, only two systems were identified that relate to the emergency classification process: REALM (Reactor Emergency Alarm Level Monitor) and RSAS (Reactor Safety Assessment System). The

following two sections provides brief descriptions of these systems. A comparison of these systems, and a discussion of the implications of their design features to the development of EM-CLASS, is included in Section 2.3.

2.1 REALM: REACTOR EMERGENCY ACTION LEVEL MONITOR

REALM is a system using knowledge-based systems techniques to determine which of four classification levels is appropriate for an emergency. The purpose of this system is to assess the emergency situation at a nuclear power plant and to provide a recommended level of response. The system was developed by Technology Applications, Inc. (TAI) under EPRI sponsorship [Touchton et al. 1987, Touchton 1988].

REALM is designed to operate in a real-time process environment. The system includes a first-level diagnostic system that identifies the cause of the emergency on the basis of a comparison of the symptoms that are observed and the events that are possible in a nuclear plant. The system is designed to interface with the plant and collect sensor data. Even with the automatic collection of data, it is estimated that approximately one-third of the information required must be manually entered by the user.

The rule-base consist of two general classes of rules: fast-tracking rules and high-level rules. Fast-tracking rules describe the logic defined by the Emergency Action Level tables and can be used to determine the emergency level for well-behaved scenarios (i.e., those scenarios having no ambiguities or missing data). High-level rules are used to resolve ambiguities and data conflicts, identify false alarms, and draw inferences when data is missing or uncertain.

After the emergency level has been determined, REALM carries out a "vulnerability analysis" that tells the user which events would lead to a higher emergency level and what is required to get to the next lowest level. The events leading to a higher classification are determined by identifying which rules are partially satisfied and listing the missing antecedents.

REALM was developed for Indian Point-2 in cooperation with Consolidated Edison of New York. It contains approximately 300 rules and 700 objects.

Technology Applications, Inc. had developed a similar system, called CEALMON (Computerized Emergency Action Level Monitor) that is an earlier prototype of REALM, used to demonstrate the feasibility of the concept. [TAI 1987] [Touchton et al. 1985].

CEALMON is written in GCLISP for the IBM-PC and used data-driven, rule-based problem-solving paradigm. It contains 54 rules which are divided into discrete contexts such that only portions of the rule base are processed at a given point in time. Frames are used as the data structure for CEALMON. To simulate the collection of sensor data, external files are read at regular intervals.

CEALMON operates in two modes. In actual use, the user is informed of changes as sensor data is collected and analyzed and is prompted to input manual data as required. In trial mode, the user has access to all current sensor and manual data and can explore the consequences of changes.

2.2 RSAS: REACTOR SAFETY ASSESSMENT SYSTEM

RSAS, a Reactor Safety Assessment Expert System is being developed by Idaho National Engineering Laboratory to assist a Nuclear Regulatory Commission (NRC) reactor safety team in evaluating and maintaining an overall picture of an accident in progress. It is intended to provide regulatory personnel with information regarding accident situation assessments, such as the likelihood of core damage [Sebo et al 1985, 1986, 1988]

RSAS is designed to monitor the condition of the core and the containment and the status of fission product barriers. It generates reactor status information and diagnoses problems, working in parallel with the reactor safety team. The results from RSAS are to be used as a check, ensuring that significant inferences from data is not overlooked.

Data used by the system is transmitted by voice and then transcribed into the Operations Center Information Management System by means of an on-screen fill-in form. Updated information on 10 to 20 plant parameters is assumed to be obtained every 15 minutes by talking to personnel at the plant. In addition to the plant parameter information, operator actions and licensee assessments of the situation are also recorded as free form text. This free-form text is not used by the expert system, but is used as a record of licensee actions, for later evaluation by the reactor safety team.

RSAS displays messages when important plant parameters exceed setpoint, data inconsistencies are identified, or when significant relationships may exist. An example of a significant relationship is the indication that natural circulation may not exist when core thermocouple readings indicate temperatures higher than the hot leg temperature.

The system also tracks time-dependent plant functions such as heat transfer and heat-up/cool-down rates.

A frame-based structure is used for the knowledge base. This structure allows data representation in a hierarchical manner, with highest level (i.e., more general concepts) located at the front of the tree. A key feature of the knowledge structure is that plant functions, not physical components, form the basis of the structure. This allows the knowledge base to be tailor-made for any nuclear plant by mapping from general functions to plant specific knowledge in accessible database files.

Knowledge about situations assessment for formulated in IF-THEN type rules. None of the rules contain any plant specific information. Instead, the rules refer to functional setpoints. Setpoint values for specific plant types are stored in separate database files which can be accessed when RSAS requires the use of the rule. An interesting feature of the knowledge base is that each parameter has a life length associated with it. That is, a parameter value is used, only if its "life" is active. Once a parameter is out of date, it is no longer used. This feature allows automatic upkeep of the knowledge base.

The current system contains approximately 800 rules and uses forward-chaining to reach conclusions. It also allows

multiple diagnosis, so that alternative explanations for current conditions can be projected.

2.3 DISCUSSION OF RELATED WORK

In evaluating the designs used to implement both RSAS and REALM, two significant features are evident that provide insight into the approach to be used for EM-CLASS: the knowledge base structure and the control paradigm used for making inferences within the knowledge base.

The use of frames for data structures in REALM, and its predecessor, CEALMON, allows a more general representation of data and provides an easier means for maintaining the system after implementation. The use of rule contexts for rule base segregation in REALM increases efficiency of memory management and system performance. Both of these aspects in knowledge base design can be implemented in EM-CLASS.

While RSAS does not directly assess the emergency classification level, it is representative of a computerized assessment tool which monitors incoming data, and therefore uses a data-driven, or forward-chaining, paradigm. This paradigm is also used in REALM, which, with direct access to sensor data, uses a forward-chaining problem-solving with an embedded backward-chaining system for diagnostic tasks.

3.0 KNOWLEDGE DOMAIN FOR EMERGENCY CLASSIFICATION

The following two section describe the emergency classification process developed for the Trojan Nuclear Power Plant. Section 3.1 describes the regulatory requirements that broadly categorize emergencies into four emergency action level classes. Section 3.2 describes the plant-specific information developed to define the emergency classes in terms of complex combinations of in-plant conditions, plant instrumentation and sensors, and radiation monitoring information from stations located both on- and off-site. The combined knowledge inherent in the regulatory requirements and the plant-specific systems and instrumentation represent the knowledge required to classify emergencies.

3.1 REGULATORY REQUIREMENTS

As previously summarized in Section 1.3, the regulatory requirements for emergency classification originate in three documents:

(1) 10 CFR 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities,"

(2) NUREG-0610, "Emergency Action Level Guidelines for Nuclear Power Plants," and

(3) NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants."

The definitions of the emergency classes and the initiating conditions for each class of EALs found in NUREG-0610 are generic and applicable to all nuclear power plants. However, NUREG-0654 requires that a plant-specific emergency action level scheme must be developed based on these generic definitions. Hence, there is an inherent, natural hierarchy in the emergency classification process which reflects the hierarchy of the regulatory basis. At the highest functional levels, generically-derived categorization in NUREG-0610 is applicable to emergency classification for many nuclear plants; at more complex functional levels, categorization as required by NUREG-0654 is derived from plant-specific conditions that must be developed on an individual nuclear power plant basis.

Given the hierarchical nature of the emergency classification process as presented by the regulatory basis, development of a computer-based aid developed with a generic framework, applicable to a class of nuclear plants, which can then be customized to a specific plant allows easy

modification of the generic framework for additional nuclear plants, thereby decreasing the effort required to implement the system at additional nuclear power plants.

3.2 PLANT-SPECIFIC KNOWLEDGE

For the Trojan plant, plant-specific knowledge for emergency classification is defined in "Trojan Nuclear Plant Radiological Emergency Response Plan Implementing Procedure, Emergency Procedure (EP-001), Emergency Classification."

The emergency procedures state that an emergency should be classified as soon as practical after the recognition of abnormal conditions. Once classified, the emergency should be re-evaluated and, if appropriate, reclassified at approximately 30-minute intervals. It should also be reclassified after any significant change in existing conditions or when transfer of responsibility for the emergency occurs. The accurate classification of an emergency is a critical factor in determining the appropriate emergency response actions.

The development of EP-001 uses an event-based emergency classification procedure in which in-plant conditions, plant instrumentation and sensors, and radiation monitoring information from stations are segregated into fifteen different problem areas. These problem areas are defined in

Table 1. The determination of the emergency class involves the comparison of existing conditions to a set of limits and conditions defined for each of the four emergency classes. These limits and conditions can involve one or more separate problem areas.

If emergency classes apply to more than one problem area, the response is based on the most severe classification indicated. In some cases, the combined effect of multiple emergency conditions may warrant a higher classification.

TABLE 1

Problem Areas for Emergency Classification

1. Radiological effluent release exceeding Technical Specification limits
2. Potential loss of a fission product barrier
3. Steam line break or main steam safety or relief valve failure
4. Primary leak, primary-to-secondary leakage, or pressurizer safety or relief valve failure
5. Loss of power or alarms
6. Loss of feedwater
7. Other limiting conditions for operations
8. Reactor protection system failure
9. Fuel handling accident
10. Control room evacuation
11. Fire
12. Security threat
13. Natural phenomenal
14. External hazards
15. Internal hazards

The information provided by regulatory requirements found in 10 CFR 50, Appendix E, NUREG-0654, and NUREG-0610 and the plant-specific emergency procedures in EP-001 forms a hierarchy of knowledge. The regulatory requirements provide more basic guidelines which can be applied to any nuclear power plant. The plant-specific classification scheme provides detailed interpretation.

For example, one generic initiating condition identified for the Notification of Unusual Event class is defined as the indication of fuel damage. This initiating condition is reflected in EP-001 within the second problem area: Potential Loss of a Fission Barrier. Associated with that problem area topic are plant-specific diagnostic indicators. These indicators involve the I-131 concentration in the primary coolant as a function of thermal power, or the reading from a primary radiation monitor and a lab analysis of primary coolant. Hence, the generic framework which can be applied to all plants is the determination of whether or not there is an indication of fuel damage, while the plant-specific or customized version would include an additional level of information, e.g., the threshold I-131 concentration in the primary coolant determined to be present when fuel damage is indicated. Representation of this information hierarchy influences the design of the prototype EM-CLASS, a concept that is developed in Section 5.

4.0 KNOWLEDGE-BASED SYSTEM APPROACH

4.1 OVERVIEW

An artificial intelligence technique called knowledge-based systems can be used to develop the emergency classification system. This approach allows the knowledge used to solve a given problem to be encoded and stored separate from the solution method. The major components of a general knowledge-based system are shown in Figure 1.

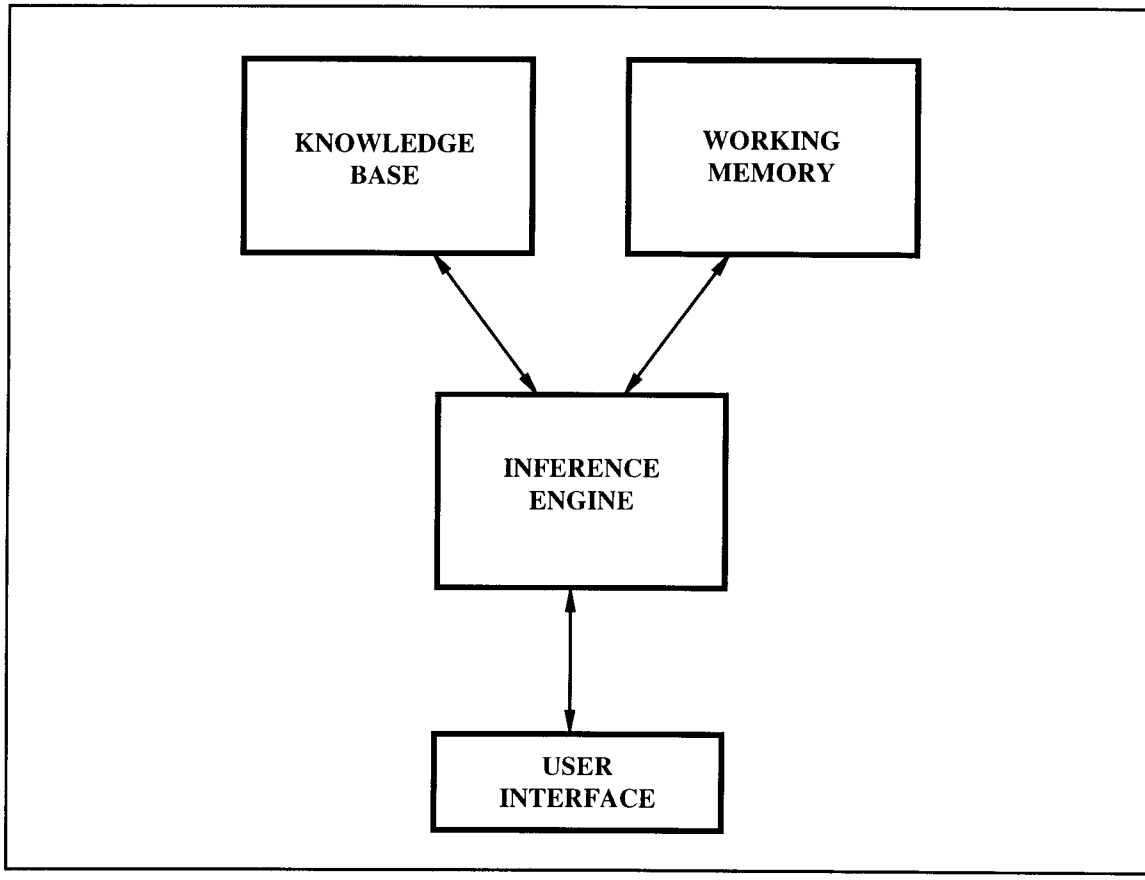

FIGURE 1
Knowledge-Based System Components

The segregation of knowledge and control functions offers a number of advantages. First, because the knowledge is stored explicitly, it is easier to modify and maintain. In addition, because the inference engine is not application specific, it can be used without modification for any number of knowledge-based systems.

The knowledge base can store several types of information. It can contain both declarative knowledge, such as facts about objects or events, and procedural knowledge, such as situation-specific information about courses of action When expert knowledge is stored in the knowledge base, the system is sometimes referred to as an expert system. When expert knowledge is encoded in the form of production rules, the system is referred to as a rule-based expert system.

Rule-based expert systems such as DENDRAL and MYCIN, developed in the 1970's, established a straight-forward representation in the form of production rules [Davis and King 1984]. In rule-based system, this knowledge is stored in the form of "if-then" rules. An example of an "if-then" rule that refers to the status of an Engineered Safety Feature (ESF) is shown below:

IF there is a loss of ESF function

THEN a minimum value of the emergency class is Unusual Event.

This rule relates two facts: (1) there is a loss of ESF function and (2) the value of the emergency class is Unusual Event.

The working memory stores knowledge pertaining to the current problem being analyzed. It contains information either provided by the user or inferred by the rules in the knowledge base by means of the inference engine.

The inference engine provides the control structure that interprets the rules and infers additional information from information provided by the user and the knowledge stored in the knowledge base. The interaction between situation-specific data and the rules are determined by the type of control structure used by the inference engine. Two of the more commonly available control methods are called backward chaining and forward chaining.

In forward chaining, known facts are compared with the premise (IF clause) of the rule. If the fact(s) match the premise clause, then the conclusion clause (THEN) is also true, thus adding a new fact to the knowledge base. For example, using the rule stated above, if it is known that the fact "there is a loss of ESF function" is true, then the conclusion, "a minimum value of the emergency class is Unusual Event" is also true. Forward chaining systems are

sometimes called data-driven systems because all knowledge gained by the system is directly related to the data initially entered into the system.

In backward chaining, the objective is to determine if a fact is true (or false) or if a value can be found for a given object. Only rules with THEN clauses containing information about the goal fact or object value are examined by the inference engine. The inference engine examines the THEN clause as a hypothesis and seeks to prove its existence by comparing the IF clause to known facts. For example, if a value for the object emergency class was required, the rule stated above would be examined. The inference engine would seek to determine if the premise clause, "there is a loss of ESF function", is true or false. It may do this by examining already known facts, asking the user, or trying to infer the information by backward chaining using other rules with have a THEN clause that assign a true or false value to the clause "there is a loss of ESF function."

4.2 KNOWLEDGE-BASED APPROACH FOR EMERGENCY CLASSIFICATION

The characteristics of the knowledge used to perform emergency classification provide a general insight into an approach to be used for developing a knowledge-based systems. The implications of these characteristic on the

design of the knowledge-based approach is described in the following sections.

4.2.1 Control Strategy

Relatively speaking, the search space, as represented by the knowledge used in emergency classification, is well-defined, with a small number of conclusions being reached by evaluating more numerous data. Given all of the different initiating conditions and postulated accidents defining emergency classification, only five conclusions can be reached: one of the four emergency classes applies to the given situation or no emergency exists. This, in itself, indicates that a backward-chaining control strategy is more efficient.

Another important characteristic to consider is that the primary goal is to identify the most severe classification; if emergency classes apply to more than one problem area, the response is based on the most severe classification indicated. For example, if the emergency class is determined to be "General Emergency", no additional classification activities are required unless the accident state changes in a manner to decrease the emergency classes to one of lesser severity. By using a goal-driven strategy, events leading to the limiting classification can be reached without evaluating the impact of all data available that

would indicate an emergency classification of lesser severity.

The selection of this control strategy is in contrast to both REALM and RSAS, which use forward-chaining. The difference in the selection of a control strategy for these two systems can be attributed to additional functions performed by REALM and RSAS, such as the identification of false alarms and development of alternate explanations for current conditions. These functions are typically symptom-based and therefore benefit from a data-driven approach.

4.2.2 Knowledge Base Structure

The characteristics of the knowledge used to perform emergency classification also provide a general insight into an approach to be used for the knowledge base structure. First, due to the general nature of the regulatory requirements and the specific nature of the classification scheme for a given nuclear plant, the knowledge can be described as being hierarchical in nature. In addition, the knowledge required to perform emergency classification covers a broad range of subject areas and generally non-overlapping. Therefore, separate knowledge components can be developed for each problem area.

These characteristics lead to a system design in which the rule base can be segregated. This allows the control of the entry of knowledge into working memory and, in turn, provides a more effective control of data gathering and inference. The segregation of the knowledge between generic data based on regulatory requirements and plant-specific interpretation of the requirements also allow the system to be implemented for another nuclear plant with minimal changes to the knowledge base. A diagram of the resulting knowledge base structure for emergency classification in shown in Figure 2. In this diagram, the root frame represents the basic storage area (working memory) where information pertinent to the current situation is stored.

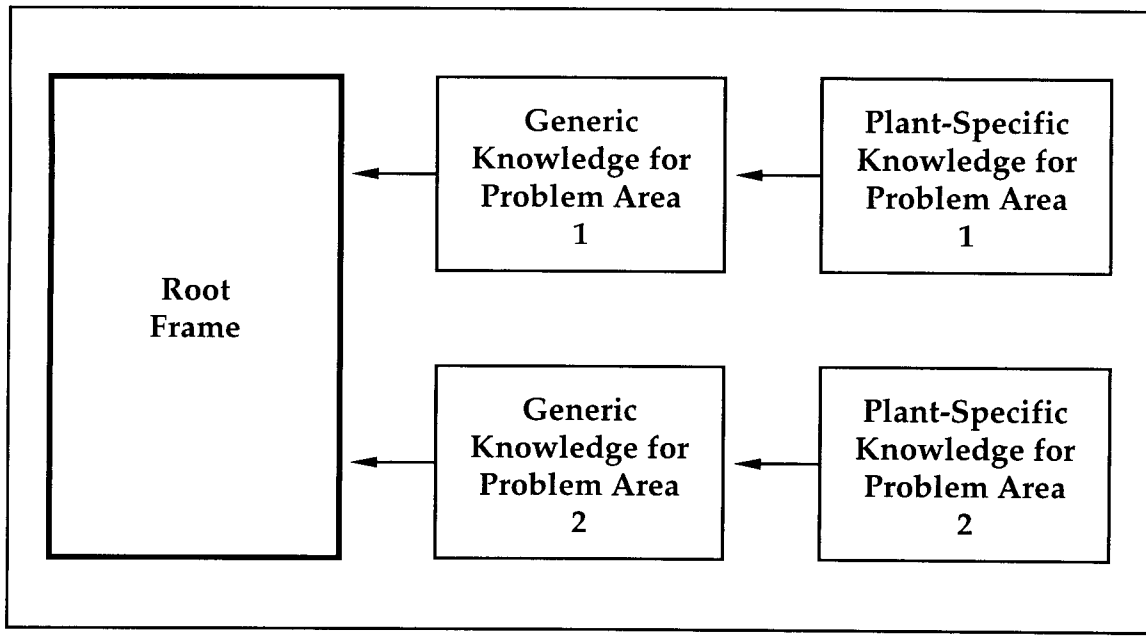

FIGURE 2
Knowledge Base Structure for Emergency Classification

5.0 PROTOTYPE SYSTEM

Using the knowledge-based approach for emergency classification described in Section 4, a prototype system called EM-CLASS (Emergency Classification) has been developed. It is based on the representation of regulatory requirements and plant-specific systems and instrumentation in the form of hierarchical rules.

EM-CLASS was developed using Personal Consultant Plus (PCPlus), a knowledge-based system development shell from Texas Instruments. PCPlus runs on IBM-PC compatible computers. This development tool features a backward-chaining inference engine with knowledge-base editing and cross-referencing capabilities. Knowledge in PCPlus is represented by IF-THEN rules, with facts presented as parameter-value pairs.

Knowledge-based systems developed with PCPlus can be delivered in LISP or in C languages. The current system is developed for LISP delivery and requires a runtime diskette for PCPlus to function.

The EM-CLASS knowledge base rules and parameters are listed in Appendices A and B. Operating instructions for the runtime version of the prototype have been developed and are listed in Appendix C.

A diagnostic or predominantly backward chaining control structure is used to model the emergency classification problem using PCPlus. The primary goal or objective of the consultation is to determine the most severe value for the emergency classification, based on information provided by the user and the knowledge base which represents the regulatory and plant-specific information for the Trojan Nuclear Power Plant. The implementation of this approach is described in the following sections.

5.1 KNOWLEDGE BASE STRUCTURE

Development shells or tools, such as PCPlus, represent an empty knowledge-based system. That is, they contain a user interface and an inference engine but have no knowledge base. However, the knowledge representation framework for the knowledge base is already predefined.

In PCPlus, rules are represented in the "if-then" format with facts included as object-value pairs. The previously stated rule taken from EP-001,

> IF there is a loss of ESF function
> THEN a minimum value of the emergency class is Unusual Event.

can be represented by the following:

```
IF        (ESF)
THEN (CLASS = "Unusual Event")
```

In this rule, ESF is a symbol representing the binary (true or false) object "there is a loss of ESF function". CLASS is a symbol representing a single-valued object "emergency classification" which can have as a value "Unusual Event".

Rules within EM-CLASS are segregated into frames which represent knowledge about emergency classification in each of the fifteen problem areas defined in Table 1. Within each frame exists a object-value pair representing the conclusion reached by the problem area knowledge, as well as a subgoal for the consultation. For example, the parameter, 02-FPBARRIER, has expected values of "No Emergency Declared", "Unusual Event", "Alert", "Site Area Emergency", or "General Emergency". A value is assigned to 02-FPBARRIER by rules contained in the FPBARRIER Frame. A listing of other parameters are listed below in Table 2.

TABLE 2

Subgoal Parameters for Emergency Classification Frames

Module	Parameter	Problem Area
1	01-RELEASE	Radiological effluent release exceeding Technical Specification limits
2	02-FPBARRIER	Potential loss of a fission product barrier
3	03-STEAM	Steam line break or main steam safety or relief valve failure
4	04-PRIMARY	Primary leak, primary-to-secondary leakage, or pressurizer safety or relief valve failure
5	05-POWER	Loss of power or alarms
6	06-FEEDWATER	Loss of feedwater
7	07-OTHER	Other limiting conditions for operations
8	08-RPS-FAIL	Reactor protection system failure
9	09-FUEL	Fuel handling accident
10	10-CR-EVAC	Control room evacuation
11	11-FIRE	Fire
12	12-SECURITY	Security threat
13	13-NATURAL	Natural phenomenal
14	14-EXTERNAL	External hazards
15	15-INTERNAL	Internal hazards

5.2 FUNCTIONAL REQUIREMENTS

Functional requirements for implementation of the emergency classification system are described in Table 3; many are already built into PCPlus. One requirement, however, is not and that relates to the type of goal

"expected" by PCPlus to activate the backward-chaining reasoning.

TABLE 3

Functional Requirements for Emergency Classification

Requirement	Description
Update	Ability to update situation assessment as new or updated data becomes available. Must function by adding only changed data, i.e., without re-entering entire data set. (Capability exists in PCPlus as a "REVIEW" function.)
Record	Provide a written record of data input and the emergency classification selected. (Capability exists in PCPlus as a "PLAYBACK" function that can be stored as a text file or printed as hardcopy.)
Explain	Provide explanations to users regarding the reasons for interim conclusions and final emergency classification selected. (Capability exists in PCPlus via built-in explanation facilities in conjunction with user-defined text phrases.)
Help	Ability to provide additional information to the assist the user in determining the correct responses to system queries; help function must be context-sensitive. (Capability exists in PCPlus via object-related help function.)

As written, the inference engine in PCPlus works to satisfy a goal by finding a single value. This would be fine if emergencies would limit themselves to a single module or problem area. However, as stated in EP-001, more than one emergency module may apply. If this is the case, all applicable emergency modules must be evaluated or eliminated. Upon completing the evaluations, the emergency classification must be set to the most severe of all assigned values.

The changes required for PCPlus are achieved by using metarules (rules about rules) and an external function written in PC SCHEME. These are described in more detail in the following section.

5.3 STRATEGY

A goal, a rule, and a function were developed to enable PCPlus to evaluate all applicable modules and report, as a conclusion, the most severe classification level. The major goal of the consultation, a parameter called STATUS, is defined as the most severe emergency classification level of a given situation, having considered all 15 logic modules. Its expected values include "No Emergency Declared", "Unusual Event", "Alert", "Site Area Emergency", or "General Emergency".

The value of STATUS is assigned by using one rule and one function. The form of the goal rule, the goal value assignment function, and how they interact to identify the most severe emergency class is described in the following sections.

5.3.1 Goal Rule

The value of STATUS is assigned by RULE001:

```
RULE001:   IF    FINDOUT 01-RELEASE AND
                 FINDOUT 02-FPBARRIER AND
                 FINDOUT 03-STEAM AND
                 FINDOUT 04-PRIMARY AND
                 FINDOUT 05-POWER AND
                 FINDOUT 06-FEEDWATER AND
                 FINDOUT 07-OTHER AND
                 FINDOUT 08-RPS-FAIL AND
                 FINDOUT 09-FUEL AND
                 FINDOUT 10-CR-EVAC AND
                 FINDOUT 11-FIRE AND
                 FINDOUT 12-SECURITY AND
                 FINDOUT 13-NATURAL AND
                 FINDOUT 14-EXTERNAL AND
                 FINDOUT 15-INTERNAL
           THEN
                 STATUS = (E (SEVERE-CLASS (LIST
                                  (VAL1 FRAME 01-RELEASE)
                                  (VAL1 FRAME 02-FPBARRIER)
                                  (VAL1 FRAME 03-STEAM)
                                  (VAL1 FRAME 04-PRIMARY)
                                  (VAL1 FRAME 05-POWER)
                                  (VAL1 FRAME 06-FEEDWATER
                                  (VAL1 FRAME 07-OTHER)
                                  (VAL1 FRAME 08-RPS-FAIL)
                                  (VAL1 FRAME 09-FUEL)
                                  (VAL1 FRAME 10-CR-EVAC)
                                  (VAL1 FRAME 11-FIRE)
                                  (VAL1 FRAME 12-SECURITY)
                                  (VAL1 FRAME 13-NATURAL)
                                  (VAL1 FRAME 14-EXTERNAL)
                                  (VAL1 FRAME 15-INTERNAL)  )))
```

FINDOUT is a function in PCPlus that forces tracing of a value for the argument following. For example, FINDOUT 01-RELEASE causes PCPlus to evaluate rules that can set a value for the parameter 01-RELEASE which is defined as the emergency classification level for logic module 1.

VAL1 is a function in PCPlus that returns the value of the parameter named by the third argument in the frame named by the second argument. For example, (VAL1 FRAME 01-RELEASE) returns the value of the parameter 01-RELEASE.

The function E in RULE001 returns the value of the user-defined function call SEVERE-CLASS and assigns it to the goal STATUS.

```
(DEFINE SEVERE-CLASS
     (LAMBDA (L)
          (COND ((MEMBER "General Emergency" L)
                      "General Emergency")
                ((MEMBER "Site Area Emergency" L)
                      "Site Area Emergency")
                ((MEMBER "Alert" L) "Alert")
                ((MEMBER "Unusual Event" L) "Unusual Event")
                (ELSE "No Emergency Declared") )))
```

SEVERE-CLASS is a Scheme function that accepts a list including the following elements "No Emergency Declared", "Unusual Event", "Alert", "Site Area Emergency", and "General Emergency". SEVERE-CLASS returns the most severe emergency classification

5.3.2 Prototype Operation

RULE001 is triggered by goal satisfaction constraint in the backward chaining inference engine in PCPlus (i.e. the goal of the consultation is to obtain a value for STATUS). PREMISE of RULE001 can be satisfied only if values are known for all 15 module parameters. Thus, the parameters representing the emergency classification levels of each module (e.g., 01-RELEASE, 02-FPBARRIER, ...) are established as subgoals. These subgoals trigger rules that conclude values for the subgoals.

When values are found for all 15 modules, RULE001 proceeds and the function SEVERE-CLASS sets the value of STATUS, the Goal Parameter, as the most severe classification in the list of values assigned to the 15 module parameters.

5.4 RULE DEVELOPMENT

5.4.1 Path Structures

There are three types of path structures within the 15 logic modules: straight-single, straight-multiple, and branching-multiple. Examples of straight and branching path structures are shown in the Figure 3. Boxes in the figures represent generic prompts to obtain a value for a parameter.

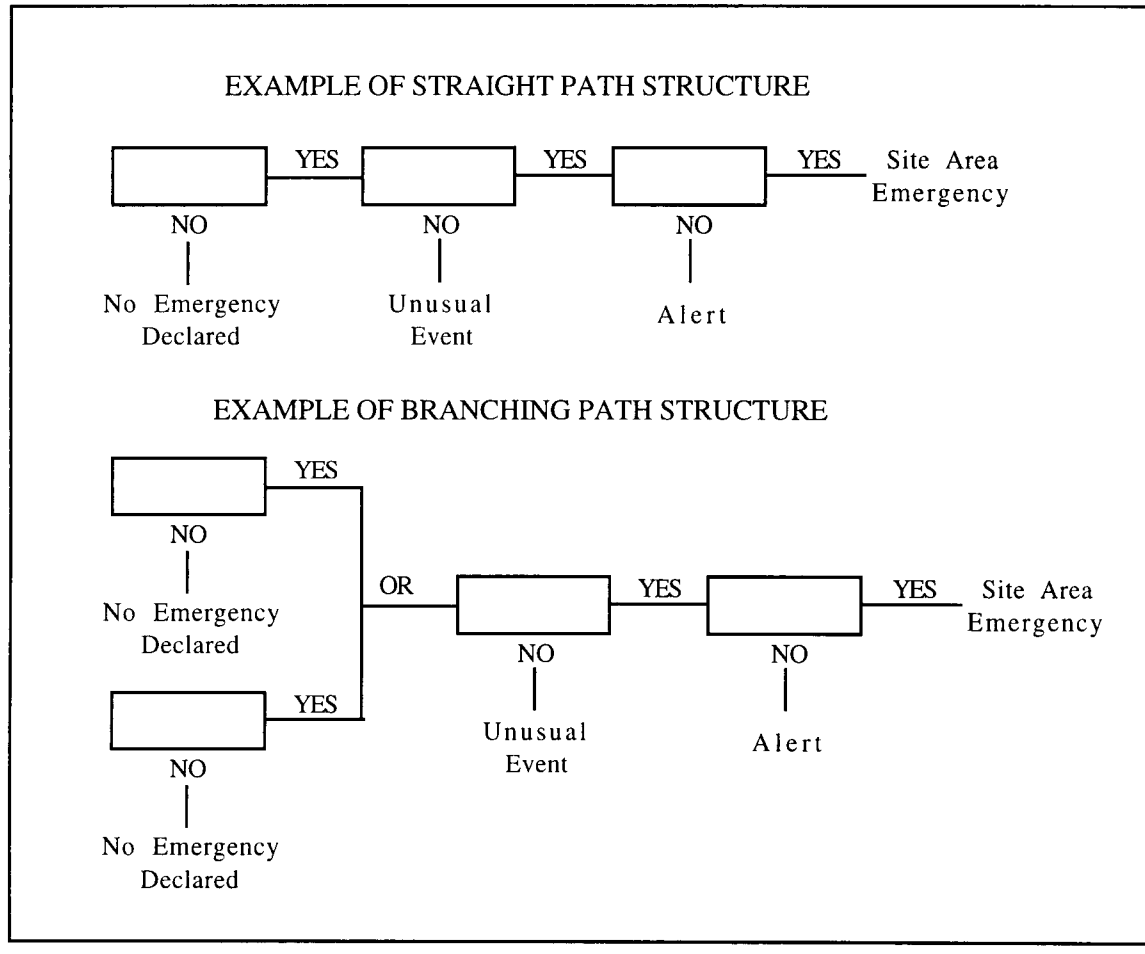

FIGURE 3
Generic Path Structures

A single path structure indicates there is only one independent path for identifying the emergency classification level within the module. A multiple path structure indicates there is more than one independent path. For example, a straight-multiple path structure would consist of multiple independent straight paths within a logic module. The logic modules can contain a single type of path structure or a combination of several, as shown in the Table 3.

TABLE 4

Path Structures for Logic Modules

	Straight	Branching	Single	Multiple
Module 1		x		x
Module 2		x		x
Module 3		x		x
Module 4	x	x		x
Module 5	x			x
Module 6	x		x	
Module 7	x			x
Module 8	x		x	
Module 9	x			x
Module 10	x		x	
Module 11	x		x	
Module 12	x		x	
Module 13	x		x	
Module 14	x			x
Module 15	x			x

To determine how these path structures would best be represented by rules, a representative module from each of types was selected for rule development analysis. It was found that the rules representing the straight or branching paths were easily developed using combinations of logical AND and OR connectors. Multiple paths within the logic module represented the only type of path structure that required the creation of additional parameters and rules.

In multiple path modules, it is necessary to ensure that all paths are evaluated. In addition, only the most severe emergency classification level must be assigned to the module. This requirement is similar to the requirement of the entire system, i.e., to ensure that all modules are evaluated and assign the most severe emergency classification level to the goal. Thus, a similar approach is used to develop rules in multiple path modules:

(1) Internal parameters, representing the emergency classification level for the path, are defined for each independent path within the module.

(2) A rule is added that forces tracing of the values for the internal parameters and assigns the most severe emergency classification to the module parameters.

For example, seven internal parameters have been created to represent the results from the seven independent paths in Module 7: MOD7-STEP1, MOD7-STEP2, MOD7-STEP3, MOD7-STEP4, MOD7-STEP5, MOD7-STEP6, and MOD7-STEP7. The rule forcing the tracing of values for these parameters and the assignment of the most severe emergency classification level is of the same form as RULE001.

```
IF
     FINDOUT MOD7-STEP1 AND
     FINDOUT MOD7-STEP2 AND
     FINDOUT MOD7-STEP3 AND
     FINDOUT MOD7-STEP4 AND
     FINDOUT MOD7-STEP5 AND
     FINDOUT MOD7-STEP6 AND
     FINDOUT MOD7-STEP7
THEN
     07-OTHER = (E (SEVERE-CLASS (LIST
                          (VAL1 FRAME MOD7-STEP1)
                          (VAL1 FRAME MOD7-STEP2)
                          (VAL1 FRAME MOD7-STEP3)
                          (VAL1 FRAME MOD7-STEP4)
                          (VAL1 FRAME MOD7-STEP5)
                          (VAL1 FRAME MOD7-STEP6)
                          (VAL1 FRAME MOD7-STEP7) )))
```

5.4.2 Rule Hierarchy

Within each problem area, rules can be used to perform three functions. They can be used to (1) determine if a specific problem area is applicable to the current emergency, (2) identify the classification level of the emergency, and (3) infer values required for emergency classification.

The rules required to determine if a problem area is applicable are referred to as Entry Rules. The rules used to determine the emergency classification with a minimal amount of information are referred to as Major Rules. Entry Rules and Major Rules are derived from EP-001.

The rules that can be used to infer values for parameters found in Entry or Major Rules are referred to as

Detailed Rules. The Detailed Rules are derived from information on the individual logic diagrams for Modules 1 through 15.

The hierarchical nature of the rules used for emergency classification arise from the fact that the problem solution can proceed at three different levels:

- Level 1, using Entry Rules, can represent the classification method used by an individual that is very familiar with the classification procedure and the plant status. Such an individual would determine immediately if a problem area applied to a current situation.

- Level 2, using Entry and Major Rules, can represent individuals with sufficient information about the plant status to respond to general questions used to determine the emergency class.

- Level 3, using Entry, Major and Detailed Rules, can represent individuals who do not have sufficient information about the plant status to determine the emergency class, but who can enter information relating to observations and instrumentation readings.

Users, depending on their expertise within a given problem area, will generally overlap these three levels. Users knowledgeable in the problem area will probably function on Levels 1 and 2, whereas less familiar users would be expected to operate at Levels 2 and 3. An individual user may also be knowledgeable in several problem areas but a novice in others.

EMCLASS was developed to accommodate all levels of users. This multi-level functionality has been designed into the system by establishing a hierarchical organization to the rules. For example, the system will start with Entry Rules (Level 1) so that the user will first be given the opportunity to eliminate a problem area. If the problem area is not eliminated, Level 2 rules will proceed and the user is asked a question such as

> "Are there any major steam line breaks with significant primary-to-secondary leakage?"

Options for answering the questions are "YES", "NO", or "UNKNOWN".

If "UNKNOWN" is chosen, Level 3 rules will proceed to determine if information is available to infer an answer to the Level 2 question. For example, the user may be asked,

in this case, if a "Steam line differential pressure safety injection signal" has occurred.

Detailed questioning will continue until a response to the Level 2 question can be inferred. If no additional information, obtained through detailed questioning, concludes a positive or "YES" value for the above question, a default value of "NO" is assigned.

5.4.3 Level 3 Rule Implementation

To understand how Level 3 is implemented within the knowledge base, it is necessary to understand what search method is used by the system to obtain information. System control of the search strategy is governed by the following properties, listed in order of system use:

- Method 1: Rules with an ASKFIRST property
- Method 2: Other Rules
- Method 3: Ask User, if Prompt for parameter exists.
- Method 4: DEFAULT value for parameter

Level 1 and 2 operation is implemented by assigning the ASKFIRST property to the Major parameters, so the user is first given the opportunity to respond. If the answer is UNKNOWN, then values for detailed parameters (Level 3 operation) will be determined by inference (Method 2) or

asking the user (Method 3). The UNKNOWN option is implemented by creating a CERTAINTY-FACTOR-RANGE property equal to UNKNOWN.

If no value is determined by the available rules, a default value of "NO" (False) is assigned by the DEFAULT property In this way, rules need only to be written assigning "YES" (True) to the major parameters.

5.5 OTHER SYSTEM FEATURES

Within the system, the user is provided with two features that provide options for guiding system interaction: (1) the user has the choice of exploring all 15 problem areas or only selected problem areas and (2) the user can also choose to have a system generated message appear during the consultation when the emergency class level increases. These features, and their means of implementation in the knowledge base, are described in more detail in the next two sections.

5.5.1 Limiting the Number of Problem Areas to Explore

This feature is implemented by obtaining the user preference, then assigning the value "NOT CONSIDERED" to problem area goals not selected.

At the beginning of the consultation, the user is requested to respond to a query with values for an INITIALDATA parameter called TOPICS:

> "Select the problem areas to be considered in determining the most severe emergency class."

The response allows the user to select one or more items from the following:

- All
- Radiological Effluent Release
- Loss of Fission Product Barrier
- Steam Line Break
- Main Steam Safety or Relief Valve Failure
- Primary or Primary-to-Secondary Leakage
- Pressurizer Safety or Relief Valve Failure
- Loss of Power or Alarms
- Loss of Feedwater
- Other Limiting Conditions
- Reactor Protection System Failure
- Fuel Handling Accident
- Control Room Evacuation
- Fire
- Security Threat
- Natural Phenomena
- External Hazards
- Internal Hazards

The user has the option to select "All" which indicated that all problem areas will be explored. If only selected problem areas are chosen, all remaining unselected problem areas are not explored.

Meta rules are used to assign a value of "NOT CONSIDERED" to the emergency class for unselected problem areas. For example, the rule listed below, MRULE001, will assign a value of "NOT CONSIDERED" if neither "Radiological Effluent Release" nor "All" are selected as a response to this INITIALDATA prompt.

```
MRULE001:  IF    ! (TOPICS = "All") AND
                 ! (TOPICS = "Radiological Effluent Release")
           THEN
                 01-RELEASE = "NOT CONSIDERED"
```

Meta-Rules are triggered before frame goals are traced. They function as Antecedent rules and are triggered only once during a frame instantiation.

In the future, heuristics can be included if judgment indicates that certain combinations of problem areas should be explored if any one area is selected (i.e., even if the user does not select the additional problem areas. The ordering of the remaining (selected) goals can also be altered by using additional meta-rules if there is a need.

5.5.2 Notification of Emergency Class Change

Two additional parameters are required to implement a notification of emergency class change: NOTIFY and LEVEL.

NOTIFY is an INITIALDATA parameter. This means that a value is requested from the user before the consultation begins. Therefore, the first question the users sees is the prompt, "Do you want to be notified if an increase in the emergency classification level is confirmed during the consultation?" The user can respond either YES or NO.

LEVEL is an internal parameter used only at the system level. Its value is set by the current, most severe emergency classification and can be 0, for "No Emergency Declared"; 1, for "Unusual Event"; 2, for "Alert"; 3, for "Site Area Emergency"; and 4, for "General Emergency". LEVEL is used to assure that notification messages appear only if the classification level has increased in severity.

At the beginning of the consultation, LEVEL is set to 0, for "No Emergency Declared". An increase in the value of LEVEL and a screen message is presented only if an emergency class higher than "No Emergency Declared" is found. For example, if it was determined that the emergency class for Problem Area 5 (05-POWER) was "Unusual Event", RULE110, listed below, would be triggered.

```
RULE110:   IF
                NOTIFY AND
                LEVEL < 1 AND
                (01-RELEASE = "Unusual Event" OR
                02-FPBARRIER = "Unusual Event" OR
                03-STEAM = "Unusual Event" OR
                04-PRIMARY = "Unusual Event" OR
                05-POWER = "Unusual Event" OR
                06-FEEDWATER = "Unusual Event" OR
                07-OTHER = "Unusual Event" OR
                08-RPS-FAIL = "Unusual Event" OR
                09-FUEL = "Unusual Event" OR
                10-CR-EVAC = "Unusual Event" OR
                11-FIRE = "Unusual Event" OR
                12-SECURITY = "Unusual Event" OR
                13-NATURAL = "Unusual Event" OR
                14-EXTERNAL = "Unusual Event" OR
                15-INTERNAL = "Unusual Event")
           THEN
                LEVEL = 1 AND
                PRINT  <screen message for UNUSUAL EVENT>
```

All rules providing a notification message to the user are ANTECEDENT (forward-chaining) rules which fire only once during a consultation in PCPlus.

5.6 PROTOTYPE EVALUATION

To evaluate the performance of EM-CLASS, use of the prototype system was compared to the non-automated emergency classification process based existing procedures in EP-001. The existing procedures required the user to manually comparing existing plant conditions to multi-page foldout logic diagrams, with one logic diagram corresponding to each of the 15 problem areas.

There are a number of problems associated with such a manual system. The use of the multi-page foldouts can be cumbersome; if all problem areas are considered in evaluating a given situation, approximately 41 pages must be reviewed. Many of the logic diagrams must be evaluated in parallel. The logic diagrams are also complex and often difficult to follow. Cross referencing between problem areas is sometimes required, making it difficult for the user to return to appropriate location in the diagrams. Also, because of the independent construction of the logic diagrams for the various problem areas, some information is requested more than once if it is used on more than one problem area.

In comparing the performance of EM-CLASS with the manual system, it was found that use of EM-CLASS did improve consistency and accuracy of the emergency classification process. It was also found that the system was useful in training an inexperienced user on how to perform the emergency classification process. However, when compared to the performance of an experienced user, it was found that the manual entry of data into EM-CLASS significantly slowed response time of the system.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The prototype EM-CLASS demonstrated that a knowledge-based approach, using a backward-chaining control structure, can effectively encode regulatory and plant-specific knowledge for emergency classification and, when combined with user-entered plant status information, can effectively assess the severity of the emergency by identifying the appropriate emergency class..

Use of the prototype system was compared to the non-automated emergency classification process based existing manual procedures in EP-001. It was found that use of EM-CLASS did improve consistency and accuracy of the emergency classification process, and that the system was useful in training an inexperienced user on how to perform the emergency classification process. However, it was found that the manual entry of data into EM-CLASS significantly slowed response time of the system when compared to the performance of an experienced user.

Before implementation of a computer-based aid, such as EM-CLASS, for emergency classification, the system response time must be improved. Since many of the instrumentation readings are available from the Plant Technical Support Center (TSC) computer, it would be possible to obtain information on-line, rather than querying the user to type

in a value. This offers a number of advantages: (1) less chance of error in data entry, (2) update information could be obtained automatically, and (3) the system could perform monitoring functions and flag any reading requiring emergency reclassification.

Continuation of this work [Greene 1991] tested the knowledge-based approach with a simulation of a 1988 Trojan Nuclear Power Plant emergency exercise. Accurate classification of the emergency was achieved and performance time was improved by mimicking automatic data entry by reading a time-dependent sensor data file. However, for development of full implementation of the knowledge-based approach in EM-CLASS for on-line monitoring, consideration should be given to the impact on the control structure and implementation software, as well as to automated data entry. For example, to make most efficient use of electronically-available data, the system strategy should be modified to just add new and/or retract old facts, and re-evaluate the emergency classification since new information may negate a previous conclusion. Strategies being developed to address non-monotonic reasoning and truth maintenance could also be evaluated in order to improve performance of the knowledge-based approach for emergency classification.

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APPENDICES

APPENDIX A

Knowledge Base Parameters

```
01-RELEASE
==========
  TRANSLATION :: (Emergency class for Module 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE011)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE001)
  CONTAINED-IN :: (RULE212)

02-FPBARRIER
============
  TRANSLATION :: (Emergency class for Module 2)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE016)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE002)
  CONTAINED-IN :: (RULE212)

03-STEAM
========
  TRANSLATION :: (Emergency class for Module 3)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE017 RULE018 RULE019 RULE020)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE003)
  CONTAINED-IN :: (RULE212)

04-PRIMARY
==========
  TRANSLATION :: (Emergency class for Module 4)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE032)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE004)
  CONTAINED-IN :: (RULE212)

05-POWER
========
  TRANSLATION :: (Emergency class for Module 5)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE044)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE005)
  CONTAINED-IN :: (RULE212)
```

```
06-FEEDWATER
============
  TRANSLATION :: (Emergency class for Module 6)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE045 RULE046 RULE047 RULE048 RULE049)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE006)
  CONTAINED-IN :: (RULE212)

07-OTHER
========
  TRANSLATION :: (Emergency class for Module 7)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE064)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE007)
  CONTAINED-IN :: (RULE212)

08-RPS-FAIL
===========
  TRANSLATION :: (Emergency class for Module 8)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE065 RULE066 RULE067 RULE068)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE008)
  CONTAINED-IN :: (RULE212)

09-FUEL
=======
  TRANSLATION :: (Emergency class for Module 9)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE074)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE009)
  CONTAINED-IN :: (RULE212)

10-CR-EVAC
==========
  TRANSLATION :: (Emergency class for Module 10)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE075 RULE076 RULE077)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE010)
  CONTAINED-IN :: (RULE212)

11-FIRE
=======
  TRANSLATION :: (Emergency class for Module 11)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE078 RULE079 RULE080 RULE081)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE011)
  CONTAINED-IN :: (RULE212)
```

```
12-SECURITY
===========
  TRANSLATION :: (Emergency class for Module 12)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE082 RULE083 RULE084 RULE085 RULE086)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE012)
  CONTAINED-IN :: (RULE212)

13-NATURAL
==========
  TRANSLATION :: (Emergency class for Module 13)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE087 RULE088 RULE089 RULE090 RULE114 RULE115
                 RULE116 RULE117 RULE118 RULE119 RULE120 RULE121
                 RULE122 RULE123 )
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE013)
  CONTAINED-IN :: (RULE212)

14-EXTERNAL
===========
  TRANSLATION :: (Emergency class for Module 14)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE099)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE014)
  CONTAINED-IN :: (RULE212)

15-INTERNAL
===========
  TRANSLATION :: (Emergency class for Module 15)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE107)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE015)
  CONTAINED-IN :: (RULE212)

5-CE-TC
=======
  TRANSLATION :: (5 core thermocouples)
  PROMPT :: (Do the highest 5 core thermocouples measure --)
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 620 degrees F" "> 620 degrees F" "> 700
             degrees F" "> 1200 degrees F" )
  USED-BY :: (RULE170 RULE171 RULE172 RULE221 RULE193 RULE229
             RULE230)

AFW
===
  TRANSLATION :: (Auxiliary feedweater flow possible)
  PROMPT :: (Is it possible to establish auxiliary feedwater
             flow?)
  TYPE :: YES/NO
  USED-BY :: (RULE210 RULE211)
```

```
AFW-NF
======
  TRANSLATION :: (No AFW flow/no pumps after 2 minutes)
  PROMPT :: (Do auxiliary feedwater [ AFW ] flow indicators
             measure zero flow 2 minutes after reactor trip or are
             AFW pumps not running 2 minutes after reactor trip? )
  TYPE :: YES/NO
  USED-BY :: (RULE198)

AFW-NO-PUMPS
============
  TRANSLATION :: (Loss of all 3 AFW pumps)
  PROMPT :: (Is there a loss of all auxiliary feedwater? :line 2
             :left 3 :attr (cyan) Answer :attr (white) YES :attr
             (cyan) if :attr (yellow ) ANY ONE :attr (cyan) of the
             following is true -- :line 2 Loss of all three AFW
             Pumps, Modes 1, 2 and 3 :line :attr (yellow) OR :line
             :attr (cyan) AFW flow indicators indicate zero flow
             within 2 minutes after reactor trip )
  TYPE :: YES/NO
  USED-BY :: (RULE045 RULE046 RULE047 RULE048 RULE049)
  COMMENT :: "Module 6, Step 1 - Entry Point"

AFW-RT1
=======
  TRANSLATION :: (Rx trip, all 3 AFW pumps fail)
  PROMPT :: (Is there a reactor trip followed by failure of all
             three auxiliary feedwater pumps? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE198)
  USED-BY :: (RULE046 RULE047 RULE048 RULE049)
  COMMENT :: "Module 6, Step 2"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

AFW-RT2
=======
  TRANSLATION :: (AFW not restored in 30 min of Rx trip)
  PROMPT :: (Is it true that auxiliary feedwater cannot be
             restored within 30 minutes? )
  TYPE :: YES/NO
  USED-BY :: (RULE047 RULE048 RULE049)
  COMMENT :: "Module 6, Step 3"

AFW-RT3
=======
  TRANSLATION :: (Loss of all charging)
  PROMPT :: (Is there a loss of all charging?)
  TYPE :: YES/NO
  USED-BY :: (RULE048 RULE049)
  COMMENT :: "Module 6, Step 4"

AIRBN-ACT
=========
  TRANSLATION :: (Iodine/Airborne part > 100 MPC)
  PROMPT :: (Is there unexpected general area iodine or particulate
             airborne concentration > 100 MPC? :line 2 :left 3 :attr (
             cyan ) MPC for iodine: :tab 8 1 E-8 microCi/cc :line MPC for
             particulate: :tab 3 3 E-7 microCi/cc )
  TYPE :: YES/NO
  USED-BY :: (RULE207)
```

```
ALARM-LOSS
==========
  TRANSLATION :: (Annunciators & comp alarms lost >5 min)
  PROMPT :: (Is there a loss of all control room annunciators and
             computer alarms for > 5 minutes? )
  TYPE :: YES/NO
  USED-BY :: (RULE041 RULE042 RULE043)
  COMMENT :: "Module 5, Step 7 - Entry Point"

ARM-15
======
  TRANSLATION :: (ARM-15A or ARM-15B dose rate)
  PROMPT :: (Enter the highest dose rate measured by :attr (yellow)
             ARM-15A :attr (white) or :attr (yellow) ARM-15B. :left 3
             :line 2 :attr (cyan) Area Radiation Monitor Locations :left
             6 :line ARM-15A Containment, Elevation 133 ft., Pressurizer
             Shed :line ARM-15B Containment, Elevation 106 ft., Laydown
             Area )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 2.0E3 mrem/hr" "> 2.0E3 mrem/hr" "> 100 R/hr, High
             alarm" )
  USED-BY :: (RULE204 RULE176 RULE193)

ARM-15-LK
=========
  TRANSLATION :: (EAB dose rate based on ARM 15A or 15B)
  PROMPT :: (Enter the calculated dose rate at the Exclusion Area
             Boundary, based on ARM-15A or ARM-15B readings, coupled with
             Containment leakage. Use adverse meteorological conditions
             [Pasquil F Stability, 1 m/sec wind velocity]. Select from --
             :left 3 :line 2 :attr (white) LIMIT A :tab 3 :attr (cyan)
             Less than 1 mR/hr :line :attr (white) LIMIT B :tab 3 :attr (
             cyan ) > 1 mR/hr :line :attr (white) LIMIT C :tab 3 :attr (
             cyan ) > 50 mrem/hr whole body for 0.5 hrs :line :tab 15 or
             5 times this level to the thyroid :line :attr (white) LIMIT
             D :tab 3 :attr (cyan) > 500 mrem/hr whole body for 2 minutes
             :line :tab 15 or 5 times this level to the thyroid )
  TYPE :: SINGLEVALUED
  EXPECT :: (LIMIT A LIMIT B LIMIT C LIMIT D)
  USED-BY :: (RULE141 RULE142)

ARM-20
======
  TRANSLATION :: (ARM-20 exposure rate)
  PROMPT :: (Enter the highest reading for ARM-20.)
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 10 R/hr" "> 10 R/hr, High alarm" "> 25 R/hr
             [Refueling]" "> 200 R/hr [Power Operation]" )
  USED-BY :: (RULE205 RULE193)

ARM-21
======
  TRANSLATION :: (ARM-21 >15R/hr [Refuel] >200 [Operation])
  PROMPT :: (Is ARM-21 measuring > 15 R/hr during refueling or > 200 R/hr
             during power operation? )
  TYPE :: YES/NO
  USED-BY :: (RULE206)
```

```
ARM12/13-HI
===========
  TRANSLATION :: (High alarm on ARM-12 or ARM-13)
  PROMPT :: (Is there a high alarm for either of the following area
             radiation monitors? :left 3 :line 2 ARM-12 :tab 5 :attr (
             cyan ) High alarm at :attr (yellow) >15 mr/hr :line 2 :attr
             (white ) ARM-13 :tab 5 :attr (cyan) High alarm at :attr (
             yellow ) >15 mr/hr )
  TYPE :: YES/NO
  USED-BY :: (RULE125 RULE126 RULE127)

ARM22/23
========
  TRANSLATION :: (Dose rate from ARM-22 or ARM-23)
  PROMPT :: (Enter the highest dose rate measured by :attr (yellow)
             ARM-22 :attr (white) or :attr (yellow) ARM-23. :left 3 :line
             2 :attr (cyan) Area Radiation Monitor Locations :left 6
             :line ARM-22 North Site Boundary :line ARM-23 South Site
             Boundary )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 1.0 mR/hr" ">1.0 mR/hr" ">50 mR/hr for 0.5 hr" "
             >500 mR/hr for 2 minutes" ">1000 mR/hr" )
  USED-BY :: (RULE159 RULE161 RULE156)

ARMS-HI1
========
  TRANSLATION :: (ARMS 1-5, 7-10, or 12-14 >2.5R/hr)
  PROMPT :: (Are any of the following ARMs measuring > 2.5 R/hr? :line 2
             :left 3 ARM 1-5 :line ARM 7-10 :line ARM 12-14 )
  TYPE :: YES/NO
  USED-BY :: (RULE200)

ARMS-HI2
========
  TRANSLATION :: (ARMS 6, 16, or 17 >100 R/hr)
  PROMPT :: (Are any of the following ARMs measuring > 100 R/hr? :line 2
             :left 3 ARM 6 :line ARM 16 :line ARM 17 )
  TYPE :: YES/NO
  USED-BY :: (RULE201)

ARMS-HI3
========
  TRANSLATION :: (ARM-11 exposure rate > 10 mR/hr)
  PROMPT :: (Is ARM-11 measuring > 10 mR/hr?)
  TYPE :: YES/NO
  USED-BY :: (RULE202)

ARMS-HI4
========
  TRANSLATION :: (ARMS 18, 19, or 25 > 15 R/hr)
  PROMPT :: (Are any of the following ARMs measuring > 15 R/hr? :line 2
             :left 3 ARM 18 :line ARM 19 :line ARM 25 )
  TYPE :: YES/NO
  USED-BY :: (RULE203)

BIV-FTC
=======
  TRANSLATION :: (Blowdown isolation valves fail to close)
  PROMPT :: (Have the blowdown isolation valves failed to close?)
  TYPE :: YES/NO
  USED-BY :: (RULE132 RULE136)
```

```
CONT-COOL
=========
  TRANSLATION :: (Loss of containment cooling)
  PROMPT :: (Is there a loss of Containment cooling?)
  TYPE :: YES/NO
  USED-BY :: (RULE192)

CONT-HIGH
=========
  TRANSLATION :: (High containment pressure)
  PROMPT :: (Does there exist High Containment Pressure, High Containment
             Sump level, High Containment Humidity, or an ARM 16A or 16B
             alarm? )
  TYPE :: YES/NO
  USED-BY :: (RULE228)

CONT-P
======
  TRANSLATION :: (Containment pressure)
  PROMPT :: (Enter the highest Containment pressure.)
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 3.5 psig" "> 3.5 psig, High alarm" "Approaching 60
             psig" )
  USED-BY :: (RULE181 RULE175 RULE176 RULE192)

CR-EVAC
=======
  TRANSLATION :: (Control room evacuated)
  PROMPT :: (Is the control room being evacuated?)
  TYPE :: YES/NO
  USED-BY :: (RULE075 RULE076 RULE077)
  COMMENT :: "Module 10, Step 1 - Entry Point"

CR-EVAC-NO-SD
=============
  TRANSLATION :: (No shutdown sys control in 15 min)
  PROMPT :: (Is the control of shutdown systems incapable of being
             established from local stations within 15 minutes? )
  TYPE :: YES/NO
  USED-BY :: (RULE076 RULE077)
  COMMENT :: "Module 10, Step 2"

CR-LIGHTS
=========
  TRANSLATION :: (Loss of Control Room normal lighting)
  PROMPT :: (Has there been a loss of control room normal lighting?)
  TYPE :: YES/NO
  USED-BY :: (RULE189)

EAB-CALC
========
  TRANSLATION :: (EAB dose rt >1 rem/hr wb or >5 thyroid)
  PROMPT :: (Does the dose rate calculated at the Exclusion Area Boundary
             under actual meteorological conditions exceed 1 rem/hr whole
             body or 5 rem/hr thyroid? )
  TYPE :: YES/NO
  USED-BY :: (RULE144)
```

```
EAB-DOSE
========
  TRANSLATION :: (EAB dose >1 rem wb or >5 rem thyroid)
  PROMPT :: (Is the integrated dose projected to be >1 rem whole body or
             >5 rem thyroid beyond the Exclusion Area Boundary? )
  TYPE :: YES/NO
  USED-BY :: (RULE162)

EAB-I-131
=========
  TRANSLATION :: (EAB I-131 concentration)
  PROMPT :: (The highest I-131 concentration [or thyroid dose rate]
             measured at the Exclusion Area Boundary is -- )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 1.0E-10 microCi/cc" ">1.0E-10 microCi/cc" ">1.0E-7
             microCi/cc [>250 mrem/hr] for 0.5 hr" ">1.0E-6 microCi/cc
             [>2500 mrem/hr] for 2 minutes" )
  USED-BY :: (RULE157 RULE160)

EAB-LMT
=======
  TRANSLATION :: (Measured EAB dose rate)
  PROMPT :: (Enter the highest dose rate measured at the Exclusion Area
             Boundary. Select from -- :left 3 :line 2 :attr (white) LIMIT
             A :tab 3 :attr (cyan) Less than 1 mR/hr :line :attr (white)
             LIMIT B :tab 3 :attr (cyan) > 1 mR/hr :line :attr (white)
             LIMIT C :tab 3 :attr (cyan) > 50 mrem/hr whole body for 0.5
             hrs :line :tab 15 or 5 times this level to the thyroid :line
             :attr (white) LIMIT D :tab 3 :attr (cyan) > 500 mrem/hr
             whole body for 2 minutes :line :tab 15 or 5 times this level
             to the thyroid :line :attr (white) LIMIT E :tab 3 :attr (
             cyan ) > 1 rem/hr whole body :line :tab 15 or 5 times this
             level to the thyroid )
  TYPE :: SINGLEVALUED
  EXPECT :: (LIMIT A LIMIT B LIMIT C LIMIT D LIMIT E)
  USED-BY :: (RULE155 RULE158 RULE143)

ECCS
====
  TRANSLATION :: (Indications of successful ECCS)
  PROMPT :: (Are there indications of successful ECCS?)
  TYPE :: YES/NO
  USED-BY :: (RULE192)

ECCS-FAIL
=========
  TRANSLATION :: (Indications of ECCS not actuated)
  PROMPT :: (Are there control room indications of ECCS not actuated, or
             no flow indications on centrifugal charging, safety
             injection and RHR pumps, after operator action? )
  TYPE :: YES/NO
  USED-BY :: (RULE193)
```

```
EXT-EXIST
=========
  TRANSLATION :: (Crash, derailment, explosion within EAB)
  PROMPT :: (Is there a crash, derailment or explosions being experienced
             in the general area? :line 2 :left 3 :attr (cyan) Answer
             :attr (white) YES :attr (cyan) if :attr (yellow) ANY ONE
             :attr (cyan) of the following is true -- :line 2 :left 6
             Aircraft, ship, etc. crash within the EAB :line :attr (
             yellow ) OR :line :attr (cyan) Aircraft circling and
             threatening the plant :line :attr (yellow) OR :line :attr (
             cyan ) Train derailment within the EAB :line :attr (yellow)
             OR :line :attr (cyan) Explosion within the EAB or warning
             from offsite :left 3 :line 2 with potential effect on plant
             operations, as determined by the Shift Supervisor. )
  TYPE :: YES/NO
  USED-BY :: (RULE091 RULE092 RULE093 RULE094)
  COMMENT :: "Module 14, Step 1 - Entry Point"

EXT-SERIOUS-DMG
===============
  TRANSLATION :: (Damage to plant structure or equipment)
  PROMPT :: (Is there serious damage to plant structure or equipment?
             :line 2 :left 3 :attr (cyan) Answer :attr (white) YES :attr
             (cyan ) if :attr (yellow) ANY ONE :attr (cyan) of the
             following is true -- :line 2 Aircraft, ship, etc. crash into
             plant structures. :line :attr (yellow) OR :line :attr (cyan)
             Determination by Shift Supervisor of missile impacts on
             facility with resultant damage. :line :attr (yellow) OR
             :line :attr (cyan) Determination by Shift Supervisor of
             known explosion at facility resulting in damage to plant
             structures or equipment. )
  TYPE :: YES/NO
  USED-BY :: (RULE092 RULE093 RULE094)
  COMMENT :: "Module 14, Step 2"

EXT-SEVERE-DMG
==============
  TRANSLATION :: (Severe damage to plant!)
  PROMPT :: (Is there damage to vital plant structure or equipment? :line
             2 :left 3 :attr (cyan) Answer :attr (white) YES :attr (cyan)
             if :attr (yellow) ANY ONE :attr (cyan) of the following is
             true -- :line 2 Aircraft, ship or other vehicle crash
             causing damage or fire in any one of the following areas:
             Containment, Control Room, Auxiliary Building, Fuel
             Building, Turbine Building or Intake Structure. :line :attr
             (yellow ) OR :line :attr (cyan) Missile or explosion impact
             causing loss of all functions needed for hot shutdown. )
  TYPE :: YES/NO
  USED-BY :: (RULE093 RULE094)
  COMMENT :: "Module 14, Step 3"
```

```
EXT-TOXIC1
==========
  TRANSLATION :: (Toxic/flammable gases in general area)
  PROMPT :: (Is there a toxic or flammable gas release in the general
             area? :line 2 :left 3 :attr (cyan) Answer :attr (white) YES
             :attr (cyan) if :attr (yellow) ANY ONE :attr (cyan) of the
             following is true -- :line 2 Toxic or flammable gas release
             of a magnitude that threatens personnel, as determined by
             the Shift Supervisor. :line :attr (yellow) OR :line :attr (
             cyan ) Toxic or flammable gas release warning from offsite.
             )
  TYPE :: YES/NO
  USED-BY :: (RULE095 RULE096 RULE097 RULE098)
  COMMENT :: "MODULE 14, STEP 4 - ENTRY POINT"

EXT-TOXIC2
==========
  TRANSLATION :: (Toxic/flammable gases in vital area)
  PROMPT :: (Is there an entry of toxic or flammable gases into facility
             vital areas that threatens to render safety-related
             equipment inoperable? :line 2 :left 3 :attr (cyan) Answer
             :attr (white) YES :attr (cyan) if :attr (yellow) ANY ONE
             :attr (cyan) of the following is true -- :line 2 Indications
             by observations or warning from outside the plant of toxic
             or flammable gases entering a vital area. :line :attr (
             yellow ) OR :line :attr (cyan) Detection of gases in a vital
             area in concentrations which exceed either the limits of
             flammablity or toxicity. )
  TYPE :: YES/NO
  USED-BY :: (RULE096 RULE097 RULE098)
  COMMENT :: "Module 14, Step 5"

EXT-TOXIC3
==========
  TRANSLATION :: (Toxic/flammable gases degrade safety)
  PROMPT :: (Is there an uncontrolled entry of toxic or flammable gases
             approaching toxic or explosive levels into vital areas which
             involve a significant degradation of plant safety? :line 2
             :left 3 :attr (cyan) Answer :attr (white) YES :attr (cyan)
             if :attr (yellow) ALL :attr (cyan) of the following are true
             -- :line 2 Uncontrolled entry of toxic or flammable gases
             into any one of the following areas: Control Room, Cable
             Spreading Rooms, Containment, Switch Gear Room, Safe
             Shutdown Panels, Emergency Diesel Generator Rooms. :line
             :attr (yellow) AND :line :attr (cyan) Lack of access to the
             area renders a safety-related system inoperable or potential
             for fire or explosion in the area is great. :line 2 :attr (
             green ) [Press F1 for gas concentrations] )
  TYPE :: YES/NO
  USED-BY :: (RULE097 RULE098)
  HELP :: (:attr (yellow) TOXIC GASES -- :line 2 Ammonia :tab 5 100 ppm
           :line SO-2 :tab 10 5 ppm :line Chlorine :tab 5 15 ppm :line 2
           FLAMMABLE GASES -- :line 2 >50% lower flammable limits )
  COMMENT :: "Module 14, Step 6"
```

```
FIRE
====
  TRANSLATION :: (Fire lasting > 10 minutes)
  PROMPT :: (Is there a fire lasting more than 10 minutes within the
             Control, Fuel, Auxiliary, Turbine, or Containment buildings?
             :line 2 :left 3 :attr (cyan) Answer :attr (white) YES :attr
             (cyan ) if :attr (yellow) ANY ONE :attr (cyan) of the
             following is true -- :line 2 Observation of fire lasting >
             10 minutes. :line :attr (yellow) OR :line :attr (cyan) Fire
             detection device alarm with confirming observation
             indicating fire lasting > 10 minutes. )
  TYPE :: YES/NO
  USED-BY :: (RULE078 RULE079 RULE080 RULE081)
  COMMENT :: "Module 11, Step 1 - Entry Point"

FIRE-SAFETY1
============
  TRANSLATION :: (Fire affects required safety systems)
  PROMPT :: (In the judgement of the Shift Supervisor, could the fire
             affect safety systems required for the present mode of
             operation? )
  TYPE :: YES/NO
  USED-BY :: (RULE079 RULE080 RULE081)
  COMMENT :: "Module 11, Step 2"

FIRE-SAFETY2
============
  TRANSLATION :: (Fire defeats redundant sfty sys trains)
  PROMPT :: (In the judegment of the Shift Supervisor, is the fire
             defeating redundant safety system trains or functions when
             plant conditions may require their use for accident
             mitigation? )
  TYPE :: YES/NO
  USED-BY :: (RULE080 RULE081)
  COMMENT :: "Module 11, Step 3"

FPB-COOLANT
===========
  TRANSLATION :: (Subcool margin loss/overpressurized)
  PROMPT :: (Are there any reactor coolant indicators of a loss of
             subcooling margin or overpressurization? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE169 RULE170 RULE171 RULE172 RULE173 RULE174)
  USED-BY :: (RULE012 RULE013 RULE014 RULE015)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 2, Step 2 - Entry Point"

FPB-CORE
========
  TRANSLATION :: (Loss of core cooling capability)
  PROMPT :: (Is there a loss of core cooling capability?)
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE172 RULE221)
  USED-BY :: (RULE014 RULE015)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 2, Step 5"
```

```
FPB-FUEL
========
  TRANSLATION :: (Fuel damage indications exist)
  PROMPT :: (Are there any indications of fuel damage?)
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE165 RULE166 RULE167 RULE168)
  USED-BY :: (RULE012 RULE013 RULE014 RULE015)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: (MODULE 2, STEP 1 - ENTRY POINT)

FPB-FUEL-DMG
============
  TRANSLATION :: (Possibility of fuel damage exists)
  PROMPT :: (Does the possibility of fuel damage exist?)
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE165 RULE168 RULE171 RULE172)
  ANTECEDENT-IN :: (RULE223 RULE222)
  USED-BY :: (RULE013 RULE014 RULE015 RULE175 RULE177)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 2, Step 3"

FPB-LOSS-1
==========
  TRANSLATION :: (loss or imminent loss of 1 fission product barrier)
  PROMPT :: (Has there been a loss or imminent loss of one fission
             product barrier? :line 2 :left 3 :attr (cyan) Answer :attr (
             white ) YES :attr (cyan) if :attr (yellow) ANY ONE :attr (
             cyan ) of the following is true -- :left 6 :line 2 Loss or
             imminent loss of fuel cladding :line :attr (yellow) OR :line
             :attr (cyan) Loss or imminent loss of RCS pressure boundary
             resulting in leakage >50 GPM :line :attr (yellow) OR :line
             :attr (cyan) Loss or imminent loss of Containment integrity
             as defined by Standard Technical Specification Modes 1, 2,
             3, & 4 )
  TYPE :: YES/NO
  UPDATED-IN :: (RULE222)
  USED-BY :: (RULE217 RULE218 RULE219 RULE220)

FPB-LOSS-2
==========
  TRANSLATION :: (loss or imminent loss of 2 fission product barriers)
  PROMPT :: (Has there been a loss of two fission product barriers or a
             loss of one with the imminent loss of the second barrier?
             :line 2 :left 3 :attr (cyan) Answer :attr (white) YES :attr
             (cyan ) if :attr (yellow) ANY TWO :attr (cyan) of the
             following is true -- :left 6 :line 2 Loss or imminent loss
             of fuel cladding :line :attr (yellow) OR :line :attr (cyan)
             Loss or imminent loss of RCS pressure boundary resulting in
             leakage >50 GPM :line :attr (yellow) OR :line :attr (cyan)
             Loss or imminent loss of Containment integrity as defined by
             Standard Technical Specification Modes 1, 2, 3, & 4 )
  TYPE :: YES/NO
  UPDATED-IN :: (RULE223)
  USED-BY :: (RULE218 RULE219 RULE220)
```

```
FPB-LOSS-3
==========
  TRANSLATION :: (Loss of 3 fission product barriers)
  PROMPT :: (Has there been a loss of 3 fission product barriers or a
             loss of 2 fission product barriers with an imminent loss of
             the third barrier? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE172 RULE175 RULE176 RULE177)
  USED-BY :: (RULE219 RULE220)
  COMMENT :: "Module 2, Step 4"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

FUEL-DMG-LOC
============
  TRANSLATION :: (Fuel handling accident location)
  PROMPT :: (What is the location of the fuel handling accident?)
  TYPE :: SINGLEVALUED
  EXPECT :: (Containment Fuel Building)
  USED-BY :: (RULE072 RULE073 RULE124 RULE125 RULE126 RULE127)

FUEL-HANDLING
=============
  TRANSLATION :: (Spent fuel handling accident)
  PROMPT :: (Has there been a spent fuel handling accident damaging one
             or more fuel assemblies? )
  TYPE :: YES/NO
  USED-BY :: (RULE071 RULE072 RULE073 RULE124 RULE125 RULE126
             RULE127)
  COMMENT :: "Module 9, Step 2 - Entry Point"

FUEL-NUMBER
===========
  TRANSLATION :: (More than one fuel assembly damaged)
  PROMPT :: (Is there major damage to more than one spent fuel assembly?)
  TYPE :: YES/NO
  USED-BY :: (RULE072 RULE073 RULE125 RULE126)

HPI
===
  TRANSLATION :: (High pressure injection possible)
  PROMPT :: (Is it possible to establish high pressure injection?)
  TYPE :: YES/NO
  USED-BY :: (RULE209)

I-131
=====
  TRANSLATION :: (Site I-131 concentration)
  PROMPT :: (The I-131 concentration determined by analysis is -- :line 2
             :attr (green) :tab 3 [Press "F1" for Technical Specification
             Limits.] )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than Tech Spec limits" "> Tech Spec limits" "> 10 times
             Tech Spec limits" )
  USED-BY :: (RULE133 RULE137)
  HELP :: (:attr (green) Technical Specification limits for I-131
           concentrations: :line 2 :attr (yellow) CONTAINMENT :line :attr
           (white ) :tab 3 1.2 E-7 microCi/cc :line 2 :attr (yellow)
           AUXILIARY BUILDING VENTS :line :attr (white) :tab 3 5.8 E-8
           microCi/cc )
```

```
I-131-PC
========
  TRANSLATION :: (I-131 primary coolant activity)
  PROMPT :: (Enter the I-131 primary coolant specific activity
             [microcuries/gram]. :line 2 :attr (green) [Press "F1" for
             help.] )
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  USED-BY :: (RULE165 RULE166 RULE183)
  HELP :: (:attr (cyan) Enter a positive integer value. :line 2 Example:
           :tab 3 :attr (yellow) 75 )
  RANGE :: (0 1000)

I-131-RLS
=========
  TRANSLATION :: (Releasing I-131 to environment)
  PROMPT :: (Is I-131 determined to be releasing to the environment?)
  TYPE :: YES/NO
  USED-BY :: (RULE133 RULE137)

I-131-RR
========
  TRANSLATION :: (I-131 rls >2.4E-4 Ci/sec for 0.5 hr ...)
  PROMPT :: (Does a grab sample analysis show equivalent I-131 release
             rate >2.4 E-4 Ci/sec for 0.5 hr or >2.4 E-3 Ci/sec for 2
             minutes? )
  TYPE :: YES/NO
  USED-BY :: (RULE154)

I-LIMIT
=======
  TRANSLATION :: (I-131 primary coolant activity limit)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE163 RULE164)
  USED-BY :: (RULE166 RULE183)

INT-OTHER1
==========
  TRANSLATION :: (Other unusual plant conditions exist)
  PROMPT :: (Are there other plant conditions being experienced or
              projected beyond usual limits? :line 2 :left 3 :attr (cyan)
              Answer :attr (white) YES :attr (cyan) if :attr (yellow) ANY
              ONE :attr (cyan) of the following is true -- :line 2 Other
              plant conditions exist that :line 2 :left 6 Require plant
              shutdown under Technical Specification requirements :line
              :attr (yellow) OR :line :attr (cyan) Result in the plant not
              being in a controlled or expected condition while operating
              or shutdown, as stated in 10 CFR 50.72 [ 3 ] )
  TYPE :: YES/NO
  USED-BY :: (RULE103 RULE104 RULE105 RULE106)
  COMMENT :: "Module 15, Step 3 - Entry Point"
```

```
INT-OTHER2
==========
  TRANSLATION :: (Other serious plant conditions exist)
  PROMPT :: (Are there other plant conditions that can be considered
             serious? :line 2 :left 3 :attr (cyan) Answer :attr (white)
             YES :attr (cyan) if :attr (yellow) ALL :attr (cyan) of the
             following are true -- :line 2 Other plant conditions exist
             that warrant :line 2 :left 6 Precautionary activation of the
             Technical Support Center and the Emergency Operations
             Facility :line :attr (yellow) AND :line :attr (cyan) Placing
             Headquarters support personnel on standby at the descretion
             of the Plant General Manager. )
  TYPE :: YES/NO
  USED-BY :: (RULE104 RULE105 RULE106)
  COMMENT :: "Module 15, Step 4"

INT-OTHER3
==========
  TRANSLATION :: (Other severe plant conditions exist)
  PROMPT :: (Are there other plant conditions that can be considered
             severe? :line 2 :left 3 :attr (cyan) Answer :attr (white)
             YES :attr (cyan) if :attr (yellow) ALL :attr (cyan) of the
             following are true -- :line 2 Other plant conditions exist
             that warrant :line 2 :left 6 Activation of the emergency
             centers and monitoring teams :line :attr (yellow) AND :line
             :attr (cyan) Precautionary public notification at the
             descretion of the Plant General Manager. )
  TYPE :: YES/NO
  USED-BY :: (RULE105 RULE106)
  COMMENT :: "Module 15, Step 5"

INT-TURBINE-CP
==============
  TRANSLATION :: (Turbine failure --> casing penetration)
  PROMPT :: (Is there a turbine failure causing casing penetration?)
  TYPE :: YES/NO
  USED-BY :: (RULE101 RULE102)
  COMMENT :: "Module 15, Step 2"

INT-TURBINE-SD
==============
  TRANSLATION :: (Turbine rotating component --> shutdown)
  PROMPT :: (Is there a turbine rotating component causing rapid plant
             shutdown? :line 2 :left 3 :attr (cyan) Answer :attr (white)
             YES :attr (cyan) if :attr (yellow) ALL :attr (cyan) of the
             following are true -- :line 2 Turbine trip :line :attr (
             yellow ) AND :line :attr (cyan) Confirmation of rotating
             component failure )
  TYPE :: YES/NO
  USED-BY :: (RULE100 RULE101 RULE102)
  COMMENT :: "Module 15, Step 1 - Entry Point"

IV-FTC
======
  TRANSLATION :: (Isolation valves fail to close)
  PROMPT :: (Have the isolation valves failed to close?)
  TYPE :: YES/NO
  USED-BY :: (RULE135 RULE131)
```

```
LAB-FF
======
  TRANSLATION :: (Failed fuel fraction)
  PROMPT :: (Has a lab analysis been performed which indicates failed
             fuel has -- )
  TYPE :: SINGLEVALUED
  EXPECT :: ("not increased" "increased 0.1% in 30 minutes" "increased 1%
             in 30 minutes" "increased to a total fraction of 5%" )
  USED-BY :: (RULE167 RULE168 RULE184)

LEVEL
=====
  TRANSLATION :: (Level of emergency classification   )
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE108 SREFMARK RULE110 RULE111 RULE112 RULE113)
  ANTECEDENT-IN :: (SREFMARK RULE110 RULE111 RULE112 RULE113)

LKG-COOLANT
===========
  TRANSLATION :: (Reactor coolant leakage rate >50 gpm)
  PROMPT :: (Is there a significant [ >50 gpm] reactor coolant leakage
             rate? )
  TYPE :: YES/NO
  USED-BY :: (RULE027 RULE028 RULE029 RULE030 RULE031)
  COMMENT :: "Module 4, Step 7"

LKG-P-TS
========
  TRANSLATION :: (Primary Tech Spec leak rates exceeded)
  PROMPT :: (Are primary system Technical Specification leak rates
             exceeded? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE224 RULE225 RULE226)
  USED-BY :: (RULE026 RULE027 RULE028 RULE029 RULE030 RULE031)
  COMMENT :: "Module 4, Step 5 - Entry Point"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

LKG-P/S-TS
==========
  TRANSLATION :: (Pri-to-sec Tech Spec leak rate exceeded)
  PROMPT :: (Are primary-to-secondary Technical Specification leak rates
             exceeded? :line 2 :left 3 :attr (cyan) Answer :attr (white)
             YES :attr (cyan) if :attr (yellow) ANY ONE :attr (cyan) of
             the following is true -- :line 2 Verified
             primary-to-secondary leak rate > 1 gpm total for 4 hours,
             actual or anticipated :line :attr (yellow) OR :line :attr (
             cyan ) Verified primary-to-secondary leak rate > 500 gpd per
             steam generator for 4 hours, actual or anticipated, as
             identified by daily RCS leakage evaluation )
  TYPE :: YES/NO
  USED-BY :: (RULE021 RULE022 RULE023 RULE024 RULE025)
  COMMENT :: "Module 4, Step 1 - Entry Point"
```

```
LKG-SGT
=======
  TRANSLATION :: (Rapid gross failure of 1+ SG tubes)
  PROMPT :: (Is there a rapid gross failure of one or more steam
             generator tubes [several hundred gpm primary-to-secondary
             leak rate] ? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE188)
  USED-BY :: (RULE022 RULE023 RULE024 RULE025 RULE189 RULE190
             RULE191)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 4, Step 2"

LKG-SGT-LOP
===========
  TRANSLATION :: (Loss of offsite power)
  PROMPT :: (Is there loss of offsite power?)
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE189)
  USED-BY :: (RULE023 RULE024 RULE025)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 4, Step 3"

LKG-SGT-SVFR
============
  TRANSLATION :: (SG/P PORVs/safety vlvs fail to reseat)
  PROMPT :: (Have any steam generator or pressurizer PORVs or safety
             valves failed to reseat following reduction of applicable
             pressure? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE190 RULE191)
  USED-BY :: (RULE023 RULE024)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 4, Step 4"

LKG-UNID
========
  TRANSLATION :: (Unidentified primary system leak)
  PROMPT :: (Is there unidentified leakage >1 gpm for 4 hours, actual or
             anticipated? )
  TYPE :: YES/NO
  USED-BY :: (RULE225)

LKG-VER
=======
  TRANSLATION :: (Verified Primary System leakage)
  PROMPT :: (Is there a verified primary system leak rate -- :line 2
             :left 3 :attr (cyan) > 10 gpm from the Reactor Coolant
             System :line :attr (yellow) OR :line :attr (cyan) > 20 gpm
             total controlled leakage from all Reactor Coolant Pumps
             :line :attr (yellow) OR :line :attr (cyan) > 6 gpm
             controlled leakage from any one Reactor Coolant Pump at a
             Reactor Coolant System pressure of 2230 +/- 20 psig :line 2
             :attr (white) for 4 hours, actual or anticipated? )
  TYPE :: YES/NO
  USED-BY :: (RULE226)
```

```
LMT-ACTIVITY
============
  TRANSLATION :: (Hi rad levels or airborne radioactivity)
  PROMPT :: (Are there sustained high radiation levels or high airborne
             radioactivity which indicates a severe degradation in the
             control of radioactive materials in the plant? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE200 RULE201 RULE202 RULE203 RULE204 RULE205
                 RULE206 RULE207 )
  USED-BY :: (RULE058 RULE059)
  COMMENT :: "Module 7, Step 5 - Entry Point"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

LMT-COLD-SD
===========
  TRANSLATION :: (System needed for cold shutdown lost)
  PROMPT :: (Is there a complete loss of any function needed for plant
             cold shutdown? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE208)
  USED-BY :: (RULE060 RULE061)
  COMMENT :: "Module 7, Step 6 - Entry Point"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

LMT-CONT-INTEG
==============
  TRANSLATION :: (Loss of containment integrity)
  PROMPT :: (Is there a loss of Containment integrity, requiring shutdown
             by Technical Specification 3.6.1.1 ? )
  TYPE :: YES/NO
  ANTECEDENT-IN :: (RULE223 RULE222)
  USED-BY :: (RULE050 RULE051)
  COMMENT :: "Module 7, Step 1 - Entry Point"

LMT-ECCS
========
  TRANSLATION :: (ECCS initiation & discharge to Rx)
  PROMPT :: (Is there an ECCS initiation and discharge to the reactor
             vessel? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE199)
  USED-BY :: (RULE054 RULE055)
  COMMENT :: "Module 7, Step 3 - Entry Point"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

LMT-ESF/FIREP
=============
  TRANSLATION :: (Loss of ESF requiring shutdown)
  PROMPT :: (Is there a loss of ESF requiring shutdown by Technical
             Specification 3.5 [ ECCS ] while in Mode 1 or 2 ? )
  TYPE :: YES/NO
  USED-BY :: (RULE052 RULE053)
  COMMENT :: "Module 7, Step 2 - Entry Point"
```

```
LMT-HOT-SD
==========
  TRANSLATION :: (System needed for hot shutdown lost)
  PROMPT :: (Is there a complete loss of any function needed for plant
            hot shutdown? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE209 RULE210 RULE211)
  USED-BY :: (RULE062 RULE063)
  COMMENT :: "Module 7, Step 7 - Entry Point"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

LMT-INJURY
==========
  TRANSLATION :: (Injured are overexposed or contaminated)
  PROMPT :: (Is transportation required from the site to a hospital of an
            injured individual who is overexposed and/or contaminated? )
  TYPE :: YES/NO
  USED-BY :: (RULE056 RULE057)
  COMMENT :: "Module 7, Step 4 - Entry Point"

LOCA-CHG-PMP
============
  TRANSLATION :: (LOCA > charging pump capacity)
  PROMPT :: (Is there a known LOCA greater than charging pump capacity?)
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE227 RULE228)
  USED-BY :: (RULE028 RULE029 RULE030 RULE031 RULE175 RULE192
            RULE193)
  COMMENT :: "Module 4, Step 8"
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN

LOCA-CHR-FAIL
=============
  TRANSLATION :: (Containment heat removal system fails)
  PROMPT :: (Is there an initially successful emergency core cooling with
            subsequent failure of the containment heat removal system
            [containment air coolers, etc] over several hours? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE192)
  USED-BY :: (RULE029 RULE030 RULE031)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 4, Step 9"

LOCA-ECCS-FAIL
==============
  TRANSLATION :: (ECCS fails -> severe core degradation)
  PROMPT :: (Is there a failure of ECCS to perform, leading to severe
            core degradation or melt? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE193)
  USED-BY :: (RULE029 RULE031)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 4, Step 10"
```

```
MOD1-STEP1
==========
  TRANSLATION :: (Emrgncy class for Mod 1, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE002 RULE003 RULE004 RULE005 RULE006)
  USED-BY :: (RULE011)

MOD1-STEP4
==========
  TRANSLATION :: (Emrgncy class for Mod 1, entry Step 4)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE007 RULE008 RULE009 RULE010)
  USED-BY :: (RULE011)

MOD14-STEP1
===========
  TRANSLATION :: (Emrgncy class for Mod 14, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE091 RULE092 RULE093 RULE094)
  USED-BY :: (RULE099)

MOD14-STEP4
===========
  TRANSLATION :: (Emrgncy class for Mod 14, entry Step 4)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE095 RULE096 RULE097 RULE098)
  USED-BY :: (RULE099)

MOD15-STEP1
===========
  TRANSLATION :: (Emrgncy class for Mod 15, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE100 RULE101 RULE102)
  USED-BY :: (RULE107)

MOD15-STEP3
===========
  TRANSLATION :: (Emrgncy class for Mod 15, entry Step 3)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE103 RULE104 RULE105 RULE106)
  USED-BY :: (RULE107)

MOD2-STEP1/2
============
  TRANSLATION :: (Emrgncy class for Mod 2, entry Step 1&2)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE012 RULE013 RULE014 RULE015)
  USED-BY :: (RULE016)

MOD2-STEP5
==========
  TRANSLATION :: (Emrgncy class for Mod 2, entry Step 5)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE217 RULE218 RULE219 RULE220)
  USED-BY :: (RULE016)

MOD4-STEP1
==========
  TRANSLATION :: (Emrgncy class for Mod 4, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE021 RULE022 RULE023 RULE024 RULE025)
  USED-BY :: (RULE032)
```

```
MOD4-STEP5/6
============
  TRANSLATION :: (Emrgncy class for Mod 4, entry Step 5&6)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE026 RULE027 RULE028 RULE029 RULE030 RULE031)
  USED-BY :: (RULE032)

MOD5-STEP1
==========
  TRANSLATION :: (Emrgncy class for Mod 5, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE033 RULE034 RULE035 RULE036 RULE037)
  USED-BY :: (RULE044)

MOD5-STEP5
==========
  TRANSLATION :: (Emrgncy class for Mod 5, entry Step 5)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE038 RULE039 RULE040)
  USED-BY :: (RULE044)

MOD5-STEP7
==========
  TRANSLATION :: (Emrgncy class for Mod 5, entry Step 7)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE041 RULE042 RULE043)
  USED-BY :: (RULE044)

MOD7-STEP1
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE050 RULE051)
  USED-BY :: (RULE064)

MOD7-STEP2
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 2)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE052 RULE053)
  USED-BY :: (RULE064)

MOD7-STEP3
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 3)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE054 RULE055)
  USED-BY :: (RULE064)

MOD7-STEP4
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 4)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE056 RULE057)
  USED-BY :: (RULE064)

MOD7-STEP5
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 5)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE058 RULE059)
  USED-BY :: (RULE064)
```

```
MOD7-STEP6
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 6)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE060 RULE061)
  USED-BY :: (RULE064)

MOD7-STEP7
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 7)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE062 RULE063)
  USED-BY :: (RULE064)

MOD9-STEP1
==========
  TRANSLATION :: (Emrgncy class for Mod 9, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE069 RULE070)
  USED-BY :: (RULE074)

MOD9-STEP2
==========
  TRANSLATION :: (Emrgncy class for Mod 9, entry Step 2)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE071 RULE072 RULE073 RULE124 RULE125 RULE126
            RULE127)
  USED-BY :: (RULE074)

MODE-4
======
  TRANSLATION :: (Plant in hot shutdown, Mode 4)
  PROMPT :: (Is the plant in hot shutdown [Mode 4 ] ?)
  TYPE :: YES/NO
  USED-BY :: (RULE211)

MSIV-F-SG
=========
  TRANSLATION :: (MSIV from affected SG failed)
  PROMPT :: (Have the main steam isolation valves from the affected steam
            generator failed? )
  TYPE :: YES/NO
  USED-BY :: (RULE177)

MSIV-F-SL
=========
  TRANSLATION :: (MSIV in steam line fail to isolate)
  PROMPT :: (Have the main steam isolation valves in the affected steam
            line failed to isolate? )
  TYPE :: YES/NO
  USED-BY :: (RULE182)

NAT-CIRC
========
  TRANSLATION :: (Sustain natural/forced circulation)
  PROMPT :: (Is it possible to sustain natural or forced circulation?)
  TYPE :: YES/NO
  USED-BY :: (RULE208)
```

```
NAT-EQUAKE
==========
  TRANSLATION :: (Severity of earthquake)
  PROMPT :: (Enter the severity of the earthquake. Select from -- :line 2
             :attr (white) SEVERE :tab 3 :attr (cyan) Earthquake > SSE
             levels causing SSE alarms on triaxial sensors. :line 2 :attr
             (white ) SERIOUS :tab 2 :attr (cyan) Earthquake > OBE levels
             but less severe than SSE levels which cause :line :tab 9 OBE
             alarms on triaxial acceleration sensors :attr (yellow) AND
             :attr (cyan) Occurrence of :line :tab 9 earthquake confirmed
             by observation or offsite agency. :line 2 :attr (white)
             UNUSUAL :tab 2 :attr (cyan) Earthquake observed by Shift
             Supervisor or detected by plant :line :tab 9 instrumentation
             but < OBE levels. :line 2 :attr (green) :tab 9 [Press "F1"
             for definition of OBE and SSE. ] )
  TYPE :: SINGLEVALUED
  EXPECT :: (SEVERE SERIOUS UNUSUAL)
  USED-BY :: (RULE088 RULE089 RULE090)
  HELP :: (:attr (yellow) OBE :tab 3 Operating Basis Earthquake :line 2
           SSE :tab 3 Safe Shutdown Earthquake )

NAT-FLOOD
=========
  TRANSLATION :: (Severity of flood or wave surge)
  PROMPT :: (Enter the severity of the flooding or wave surge. Select
             from -- :line 2 :attr (white) SEVERE :tab 3 :attr (cyan)
             Exceeding grade level (45 feet MSL) :line 2 :attr (white)
             SERIOUS :tab 2 :attr (cyan) Within 5 feet of grade level [
             40 to 45 feet MSL ] and rising :line 2 :attr (white) UNUSUAL
             :tab 2 :attr (cyan) Greater than 27 feet MSL [ 2 feet above
             service water pump room :line :tab 9 floor] but less than 40
             feet MSL [within 5 feet of grade level] :line 2 :tab 9 MSL -
             Mean Sea Level )
  TYPE :: SINGLEVALUED
  EXPECT :: (SEVERE SERIOUS UNUSUAL)
  USED-BY :: (RULE114 RULE115 RULE116)

NAT-TORNADO
===========
  TRANSLATION :: (Tornado is striking facility)
  PROMPT :: (As determined by the Shift Supervisor, is the tornado
             striking the facility? )
  TYPE :: YES/NO
  USED-BY :: (RULE117 RULE118)
```

```
NAT-TYPE
========
  TRANSLATION :: (Type of natural phenomenon)
  PROMPT :: (What type of natural phenomenon is occurring? :attr (green)
             [Press "F1" for more information.] )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Earthquake" "Flood or Wave Surge" "Tornado" "High Winds" "
             Volcano-related Events" )
  USED-BY :: (RULE088 RULE089 RULE090 RULE114 RULE115 RULE116
              RULE117 RULE118 RULE119 RULE120 RULE121 RULE122 RULE123 )
  HELP :: (:attr (yellow) Enter -- :line :attr (white) Earthquake :attr (
           cyan ) if one observed by Shift Supervisor :line :tab 11 or
           detected on plant seismic :line :tab 11 instrumentation. :line
           :attr (white) Flood... :tab 3 :attr (cyan) if level > 27 feet
           Mean Sea Level. :line :attr (white) Tornado :tab 4 :attr (cyan
           ) if any determined to be onsite by :line :tab 11 Shift
           Supervisor. :line :attr (white) High Winds :attr (cyan) if
           sustained wind speed > 75 mph. :line :attr (white) Volcano...
           :attr (cyan) if heavy ashfall or mud flow causes :line :tab 11
           plant shutdown. )

NAT-UNUSUAL
===========
  TRANSLATION :: (Natural phenomenon being experienced)
  PROMPT :: (Is there a natural phenomenon being experienced or projected
             beyond usual limits? :attr (green) [Press "F1" for more
             information.] )
  TYPE :: YES/NO
  USED-BY :: (RULE087 RULE088 RULE089 RULE090 RULE114 RULE115
              RULE116 RULE117 RULE118 RULE119 RULE120 RULE121 RULE122
              RULE123 )
  HELP :: (:attr (cyan) Answer :attr (white) YES :attr (cyan) if an :attr
           (white ) Earthquake :attr (cyan) is observed by Shift
           Supervisor or detected on plant seismic instrumentation, or a
           :attr (white) Flood or Wave Surge :attr (cyan) level is > 27
           feet Mean Sea Level, or a :attr (white) Tornado :attr (cyan)
           is determined to be onsite by Shift Supervisor, or :attr (
           white ) High Winds :attr (cyan) occur with sustained wind
           speed > 75 mph, or :attr (white) Volcano-related events :attr
           (cyan ) such as heavy ashfall or mud flow cause plant
           shutdown. )
  COMMENT :: "Module 13, Step 1 - Entry Point"

NAT-VOLCANO
===========
  TRANSLATION :: (Severity of volcano-related events)
  PROMPT :: (Enter the severity of the volcano-related events, such as
             heavy ashfall or mud flow. Select from -- :line 2 :attr (
             white ) SERIOUS :tab 2 :attr (cyan) Sufficiently severe to
             adversely affect a safety system, :line :tab 9 as determined
             by the Shift Supervisor :line 2 :attr (white) UNUSUAL :tab 2
             :attr (cyan) Sufficiently severe to cause the plant to
             shutdown. )
  TYPE :: SINGLEVALUED
  EXPECT :: (SERIOUS UNUSUAL)
  USED-BY :: (RULE122 RULE123)
```

```
NAT-WINDS
=========
  TRANSLATION :: (Severity of winds)
  PROMPT :: (Enter the severity of the wind, as indicated by
             meteorological instrumention readout of wind speed in the
             control room. Select from -- :line 2 :attr (white) SEVERE
             :tab 3 :attr (cyan) Exceeding design level of 100 mph :line
             2 :attr (white) SERIOUS :tab 2 :attr (cyan) Extreme winds
             near design basis level with sustained wind :line :tab 9
             speed > 90 mph but < 100 mph :line 2 :attr (white) UNUSUAL
             :tab 2 :attr (cyan) Sustained wind speed > 75 mph but < 90
             mph :line 2 :tab 9 [mph - Miles Per Hour] )
  TYPE :: SINGLEVALUED
  EXPECT :: (SEVERE SERIOUS UNUSUAL)
  USED-BY :: (RULE119 RULE120 RULE121)

NOTIFY
======
  TRANSLATION :: (Provide notification of class increase)
  PROMPT :: (Do you want the system to notify you as soon as the
             emergency classification level increases? )
  TYPE :: YES/NO
  ANTECEDENT-IN :: (RULE108 SREFMARK RULE110 RULE111 RULE112
              RULE113)

OUTSIDE-BK
==========
  TRANSLATION :: (Break outside containment, or...)
  PROMPT :: (Has there been a break outside Containment, or steam dump,
             or are steam relief or safety valves open? )
  TYPE :: YES/NO
  USED-BY :: (RULE178)

PB-LEAK
=======
  TRANSLATION :: (Detectable pressure boundary leakage)
  PROMPT :: (Is there detectable pressure boundary leakage?)
  TYPE :: YES/NO
  USED-BY :: (RULE224)

PCT-TP
======
  TRANSLATION :: (Percent rated thermal power)
  PROMPT :: (Enter the current percent of rated thermal power. :line 2
             :attr (green) [Press "F1" for help.] )
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  USED-BY :: (RULE163 RULE164)
  HELP :: (:attr (cyan) Enter a positive integer value. :line 2 Example:
           :tab 3 :attr (yellow) 75 )
  CONTAINED-IN :: (RULE164)
  RANGE :: (0 120)

PRM-10
======
  TRANSLATION :: (PRM-10 count rate)
  PROMPT :: (The highest count rate reading for PRM-10 is --)
  TYPE :: SINGLEVALUED
  EXPECT :: (Less than 3.7E3 cpm >3.7E3 cpm, High alarm >3.7E4 cpm)
  USED-BY :: (RULE132 RULE136 RULE181 RULE182 RULE188)
```

```
PRM-13
======
  TRANSLATION :: (PRM-13 > 3.6 E5 cpm)
  PROMPT :: (Is the reading for PRM-13 > 3.6 E5 cpm?)
  TYPE :: YES/NO
  USED-BY :: (RULE167 RULE184)

PRM-16
======
  TRANSLATION :: (PRM-16 > 100 mrem/hr)
  PROMPT :: (Is the reading for PRM-16 > 100 mrem/hr [High alarm]?)
  TYPE :: YES/NO
  USED-BY :: (RULE181 RULE182 RULE188)

PRM-1A
======
  TRANSLATION :: (PRM-1A count rate)
  PROMPT :: (What is the reading for PRM-1A?)
  TYPE :: SINGLEVALUED
  EXPECT :: (>3.9E7 cpm, High alarm Other values to be added)

PRM-1C
======
  TRANSLATION :: (PRM-1C count rate)
  PROMPT :: (Enter the highest count rate reading for :attr (yellow)
             PRM-1C :attr (white) in :attr (yellow) PURGE MODE. :left 3
             :line 2 :attr (cyan) PRM-1C monitors Containment Effluent
             low level noble gas. )
  TYPE :: SINGLEVALUED
  EXPECT :: (Less than 9.9E3 cpm >9.9E3 cpm >9.9E4 cpm Off-scale)
  USED-BY :: (RULE130 RULE134 RULE138)

PRM-1D
======
  TRANSLATION :: (PRM-1D count rate)
  PROMPT :: (Enter the highest count rate reading for :attr (yellow)
             PRM-1D. :left 3 :line 2 :attr (cyan) PRM-1D monitors
             Containment Effluent mid level noble gas. )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 8.0E1 cpm" ">8.0E1 cpm, High alarm (PRESSURE
             RELIEF MODE)" ">2.0E2 cpm for 0.5 hr (PURGE MODE)" ">8.0E2
             cpm (PRESSURE RELIEF MODE)" ">2.0E3 cpm for 2 minutes (PURGE
             MODE)" ">7.0E4 cpm for 0.5 hr (PRESSURE RELIEF MODE)" ">7.0E5
             cpm for 2 minutes (PRESSURE RELIEF MODE)" )
  ANTECEDENT-IN :: (RULE128)
  USED-BY :: (RULE145 RULE148 RULE139 RULE138)

PRM-1E
======
  TRANSLATION :: (PRM-1E >4.0 mR/hr for 0.5 hr or ...)
  PROMPT :: (Is :attr (yellow) PRM-1E :attr (white) reading :attr (yellow
             ) >4.0 mR/hr for 0.5 hr :attr (white) or :attr (yellow) >40
             mR/hr for 2 minutes? :left 3 :line 2 :attr (cyan) PRM-1E
             monitors Containment Effluent high level noble gas. )
  TYPE :: YES/NO
  USED-BY :: (RULE151)
```

```
PRM-2C
======
  TRANSLATION :: (PRM-2C count rate)
  PROMPT :: (Enter the highest count rate reading for :attr (yellow)
             PRM-2C. :left 3 :line 2 :attr (cyan) PRM-2C monitors
             Auxiliary Building low level noble gas. )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 4.7E3 cpm" ">4.7E3 cpm, High alarm" ">4.7E4 cpm" "
             Off-scale" )
  ANTECEDENT-IN :: (RULE129)
  USED-BY :: (RULE140 RULE146 RULE149)

PRM-2D
======
  TRANSLATION :: (PRM-2D >8.3E1 cpm for 0.5 hr or ...)
  PROMPT :: (Is :attr (yellow) PRM-2D :attr (white) reading :attr (yellow
             ) >8.3E1 cpm for 0.5 hr :attr (white) or :attr (yellow)
             >8.3E2 [High alarm] for 2 minutes? :left 3 :line 2 :attr (
             cyan ) PRM-2D monitors Auxiliary Building high level noble
             gas. )
  TYPE :: YES/NO
  USED-BY :: (RULE140)

PRM-6B
======
  TRANSLATION :: (PRM-6B count rate)
  PROMPT :: (Enter the highest count rate reading for :attr (yellow)
             PRM-6B. :left 3 :line 2 :attr (cyan) PRM-6B monitors
             Condenser Air Ejector mid level noble gas. )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 1.8E2 cpm" ">1.8E2 cpm, High alarm" ">1.8E3 cpm" "
             >1.8E5 cpm for 0.5 hr" "Off-scale for 2 minutes" )
  USED-BY :: (RULE147 RULE150 RULE152 RULE181 RULE182 RULE188)

PRM-6C
======
  TRANSLATION :: (PRM-6C >9.3 mR/hr for 0.5 hr or ...)
  PROMPT :: (Is :attr (yellow) PRM-6C :attr (white) reading :attr (yellow
             ) >9.3 mR/hr for 0.5 hr :attr (white) or :attr (yellow)
             >9.3E1 for 2 minutes? :left 3 :line 2 :attr (cyan) PRM-6C
             monitors Condenser Air Ejector high level noble gas. )
  TYPE :: YES/NO
  USED-BY :: (RULE153)

PRM-9
=====
  TRANSLATION :: (PRM-9 reading)
  PROMPT :: (The highest reading for PRM-9 is --)
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than the High alarm setpoint" "> High alarm setpoint" "
             > 10 times High alarm setpoint" )
  USED-BY :: (RULE135 RULE131)
```

```
PRM1-HI
=======
  TRANSLATION :: (High alarm on PRM 1A, 1B, or 1D)
  PROMPT :: (Is there a high alarm for any of the following process
             radiation monitors? :left 3 :line 2 PRM-1A :tab 5 :attr (
             cyan ) High alarm at :attr (yellow) >3.9E7 cpm :line 2 :attr
             (white ) PRM-1B :tab 5 :attr (cyan) High alarm at :attr (
             yellow ) >3.5E6 cpm :line 2 :attr (white) PRM-1D :tab 5
             :attr (cyan) High alarm at :attr (yellow) >8.0E1 cpm )
  TYPE :: YES/NO
  UPDATED-IN :: (RULE128)
  USED-BY :: (RULE072 RULE073 RULE124 RULE181)

PRM2-HI
=======
  TRANSLATION :: (High alarm on PRM 2A, 2B, 2C or 2D)
  PROMPT :: (Is there a high alarm for any of the following process
             radiation monitors? :left 3 :line 2 PRM-2A :tab 5 :attr (
             cyan ) High alarm at :attr (yellow) >5.2E4 cpm :line 2 :attr
             (white ) PRM-2B :tab 5 :attr (cyan) High alarm at :attr (
             yellow ) >4.7E3 cpm :line 2 :attr (white) PRM-2C :tab 5
             :attr (cyan) High alarm at :attr (yellow) >4.7E3 cpm :line 2
             :attr (white) PRM-2D :tab 5 :attr (cyan) High alarm at :attr
             (yellow ) >8.3E2 cpm )
  TYPE :: YES/NO
  UPDATED-IN :: (RULE129)
  USED-BY :: (RULE125 RULE126 RULE127)

PRM3-HI
=======
  TRANSLATION :: (High alarm on PRM 3)
  PROMPT :: (Is there a high alarm for PRM-3 :attr (yellow) [ >9.0E4 cpm]
             :attr (white) ? )
  TYPE :: YES/NO
  USED-BY :: (RULE125 RULE126 RULE127)

PRV-OPEN
========
  TRANSLATION :: (Pressurizer relief valves open)
  PROMPT :: (Are there symptoms to indicate that pressurizer relief
             valves are open? Symptoms include -- :left 3 :line 2 :attr (
             cyan ) PSZR RELIEF LINE HI TEMP alarm [ K10-C4 ] :line PSZR
             SAFETY RELIEF VALVE LEAKAGE HIGH alarm [ K10-D2 ] :line
             Safety valve high leakage indication :line PSZR RELIEF TANK
             HI/LO LEVEL alarm [ K13-D1 ] :line PSZR RELIEF TANK HI TEMP
             alarm [ K13-E1 ] :line PSZR RELIEF TANK HI PRESS alarm [
             K13-F1 ] :line PSZR PROTECTION LO PRESS alarm [ K13-D2 ]
             :line REACTOR TRIP PSZR LO PRESS alarm on the first out
             annunciator [ K14-D2 ] :line Fluctuation in pressurizer
             level :line Unaccountable increase in the frequency of
             primary make-up. )
  TYPE :: YES/NO
  USED-BY :: (RULE187 RULE190)

PWR-DG-LOSS
===========
  TRANSLATION :: (Loss of both diesel generators)
  PROMPT :: (Has there been loss of both diesel generator power sources
             as defined by standard technical specification? )
  TYPE :: YES/NO
  USED-BY :: (RULE231)
```

```
PWR-ESF
=======
  TRANSLATION :: (Can energize both ESF 4.16-kV buses)
  PROMPT :: (Is it possible to energize both ESF 4.16-kV buses from
             diesel generators? )
  TYPE :: YES/NO
  USED-BY :: (RULE196 RULE197 RULE195)

PWR-LOSS-30
===========
  TRANSLATION :: (No offsite or onsite AC power >30 min)
  PROMPT :: (Is there a loss of offsite power and loss of all onsite AC
             power >30 minutes? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE197)
  USED-BY :: (RULE035 RULE036 RULE037)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 5, Step 3"

PWR-LOSS-FW
===========
  TRANSLATION :: (No emergency feedwater makeup capability)
  PROMPT :: (Is there a loss of emergency feedwater makeup capability?
             :line 2 :attr (cyan) [Flow indicator or AFW systems shows no
             flow] )
  TYPE :: YES/NO
  USED-BY :: (RULE036 RULE037)
  COMMENT :: "Module 5, Step 4"

PWR-LOSS-TS
===========
  TRANSLATION :: (Tech Spec allowable # of power sources)
  PROMPT :: (Is there a total loss of offsite power or onsite AC
             capability below Technical Specification allowable number of
             power sources? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE194 RULE195 RULE231)
  USED-BY :: (RULE033 RULE034 RULE035 RULE036 RULE037)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 5, Step 1 - Entry Point"

PWR-OFF/AC
==========
  TRANSLATION :: (No offsite or onsite AC power)
  PROMPT :: (Is there a loss of offsite power and loss of all onsite AC
             power? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE196 RULE197)
  USED-BY :: (RULE034 RULE035 RULE036 RULE037)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 5, Step 2"
```

```
PWR-ON-DC
=========
  TRANSLATION :: (Loss of all vital onsite DC power)
  PROMPT :: (Is there a loss of all vital onsite DC power? :line 2 :left
             3 :attr (cyan) Answer :attr (white) YES :attr (cyan) if
             :attr (yellow) ALL :attr (cyan) of the following are true --
             :line 2 DC bus undervoltage alarms on all buses :line :attr
             (yellow ) AND :line :attr (cyan) Loss of 12.47-kV and
             4.16-kV position indicator lamps :line :attr (yellow) AND
             :line :attr (cyan) Failure to re-energize in 5 minutes )
  TYPE :: YES/NO
  USED-BY :: (RULE038 RULE039 RULE040)
  COMMENT :: (MODULE 5, STEP 5 - ENTRY POINT)

PWR-ON-DC-15
============
  TRANSLATION :: (Loss of all vital DC power for >15 min)
  PROMPT :: (Is there a loss of all vital DC power for > 15 minutes?
             [Failure to re-energize within 15 minutes] )
  TYPE :: YES/NO
  USED-BY :: (RULE039 RULE040)
  COMMENT :: "Module 5, Step 6"

PWR-UV
======
  TRANSLATION :: (Sustained undervoltage alarms 12.47-kV)
  PROMPT :: (How long has there been sustained undervoltage alarms on
             both 12.47-kV buses? )
  TYPE :: SINGLEVALUED
  EXPECT :: (Less than 5 minutes > 5 minutes > 30 minutes)
  USED-BY :: (RULE196 RULE197)

PWR-UV-1
========
  TRANSLATION :: (Undervoltage alrm 12.47 & 4.16 kV buses)
  PROMPT :: (Are there undervoltage alarms on the 12.47-kV and 4.16-kV
             buses? )
  TYPE :: YES/NO
  USED-BY :: (RULE189)

PWR-UV-2
========
  TRANSLATION :: (Undervoltage alrm both 12.47-kV buses)
  PROMPT :: (Are there undervoltage alarms on both 12.47-kV buses?)
  TYPE :: YES/NO
  USED-BY :: (RULE194 RULE196 RULE197)

RCP-OP
======
  TRANSLATION :: (Reactor Coolant Pumps running)
  PROMPT :: (Are there any Reactor Coolant Pumps running?)
  TYPE :: YES/NO
  USED-BY :: (RULE221 RULE193)

RCS-P
=====
  TRANSLATION :: (RCS pressure)
  PROMPT :: (The current Reactor Coolant Pressure is --)
  TYPE :: SINGLEVALUED
  EXPECT :: (Less than 1835 psig > 1835 psig > 2385 psig)
  USED-BY :: (RULE169 RULE170)
```

```
RCS-T&P
=======
  TRANSLATION :: (Reduces RCS temp and pressure)
  PROMPT :: (Is reactor coolant system temperature and pressure
             significantly reduced? )
  TYPE :: YES/NO
  USED-BY :: (RULE178)

RCS-T-HI
========
  TRANSLATION :: (RCS average temperature >590 F)
  PROMPT :: (Has it been verified that the Reactor Coolant System average
             temperature is > 590 degrees F? )
  TYPE :: YES/NO
  USED-BY :: (RULE173)

RCS-T-HI2
=========
  TRANSLATION :: (RCS temp >200 F core outlet temp)
  PROMPT :: (Has the RCS temperature increased to >200 degrees F above
             core outlet temperature? )
  TYPE :: YES/NO
  USED-BY :: (RULE208)

RHR
===
  TRANSLATION :: (RHR system operational)
  PROMPT :: (Is the Residual Heat Removal system functional or
             operational? )
  TYPE :: YES/NO
  USED-BY :: (RULE208 RULE211)

RLS-EAB
=======
  TRANSLATION :: (Dose rate >=1.0 mR/hr at the EAB)
  PROMPT :: (Do the ARMs, calculated dose, or actual measurements detect
             levels corresponding to >1 mR/hr at the EAB? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE159 RULE161 RULE157 RULE160 RULE162 RULE141
                 RULE142 RULE155 RULE158 RULE143 RULE156 )
  USED-BY :: (RULE007 RULE008 RULE009 RULE010)
  COMMENT :: "Module 1, Step 4 - Entry Point"
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN

RLS-EXC-1HR
===========
  TRANSLATION :: (Effluent rls rt >Tech Spec for 1 hr)
  PROMPT :: (Have any gaseous or liquid effluent release rates exceeded
             Technical Specification limits for 1 hour? :line 2 :attr (
             cyan ) [Note: It is not necessary to wait one hour before
             proceeding with the evaluation if any limits are exceeded.]
             )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE135 RULE132 RULE136 RULE133 RULE137 RULE154
                 RULE140 RULE147 RULE150 RULE152 RULE153 RULE131 RULE145
                 RULE148 RULE139 RULE151 RULE146 RULE149 RULE130 RULE134
                 RULE138 )
  USED-BY :: (RULE002 RULE003 RULE004 RULE005 RULE006)
  COMMENT :: "Module 1, Step 1 - Entry Point"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)
```

```
RLS-LIMIT1-1
============
  TRANSLATION :: (>50 mrem/hr wb for 0.5 hr at EAB,...)
  PROMPT :: (Do the PRMs and ARMs detect levels corresponding to >50
             mrem/hr whole body for 0.5 hour, or >500 mrem/hr whole body
             for 2 minutes [or 5 times these levels to the thyroid] at
             the EAB for adverse meteorology [Pasquill F Stability, 1
             m/sec wind velocity]? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE154 RULE140 RULE152 RULE153 RULE139 RULE151
             RULE138)
  USED-BY :: (RULE004 RULE005 RULE006)
  COMMENT :: "Module 1, Step 3"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

RLS-LIMIT1-2
============
  TRANSLATION :: (Calc >50 mrem/hr wb f/.5 hrs at EAB,...)
  PROMPT :: (Do ARMs, calculated dose or actual measurements detect
             levels corresponding to >50 mrem/hr whole body for 0.5 hour,
             or >500 mrem/hr whole body for 2 minutes [or 5 times these
             levels to the thyroid] at the EAB for adverse meteorology
             [Pasquill F Stability, 1 m/sec wind velocity]? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE159 RULE161 RULE160 RULE162 RULE142 RULE158
              RULE143)
  USED-BY :: (RULE008 RULE009 RULE010)
  COMMENT :: "Module 1, Step 5"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

RLS-LIMIT2
==========
  TRANSLATION :: (1 rem/hr wb or 5 rem/hr thyroid at EAB)
  PROMPT :: (Do the PRMs or ARMs detect levels corresponding to 1 rem/hr
             whole body or 5 rem/hr thyroid at the EAB under actual
             meteorological conditions? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE161 RULE162 RULE143 RULE144)
  USED-BY :: (RULE005 RULE006 RULE009 RULE010)
  COMMENT :: "Module 1, Step 6"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

RLS-NOT-CNTRL
=============
  TRANSLATION :: (Rls >10 Tech Spec & not controllable)
  PROMPT :: (Is the release > 10 times the Technical Specification limit
             and not immediately controllable? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE135 RULE136 RULE137 RULE154 RULE140 RULE150
                 RULE152 RULE153 RULE148 RULE139 RULE151 RULE149 RULE134
                 RULE138 )
  USED-BY :: (RULE003 RULE004 RULE005 RULE006)
  COMMENT :: "Module1, Step 2"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)
```

```
RPS-CORE-DMG
============
  TRANSLATION :: (Core cooling & makeup systems fail)
  PROMPT :: (Has a transient occurred that resulted in core damage or
             additional failure of core cooling and makeup systems? :line
             2 :left 3 :attr (cyan) Answer :attr (white) YES :attr (cyan)
             if :attr (yellow) ANY ONE :attr (cyan) of the following is
             true -- :line 2 Reactor pressure is greater than safety
             valve setpoint :line :attr (yellow) OR :line :attr (cyan)
             Containment pressure is rapidly increasing :line :attr (
             yellow ) OR :line :attr (cyan) Containment temperature is
             rapidly increasing )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE229 RULE230)
  USED-BY :: (RULE067 RULE068)
  COMMENT :: "Module 8, Step 3"

RPS-RX-CRITICAL
===============
  TRANSLATION :: (RPS fails; reactor still critical)
  PROMPT :: (Is there a failure of the Reactor Protection System to
             initiate and complete a trip which brings the reactor
             subcritical by rod drop? :line 2 :left 3 :attr (cyan) Answer
             :attr (white) YES :attr (cyan) if :attr (yellow) BOTH :attr
             (cyan ) of the following are true -- :line 2 :left 6 Plant
             conditions indicate required conditions for reactor trip
             :line :attr (white) OR :line :attr (cyan) Required
             coincidence of bistables have tripped :line :attr (white) OR
             :line :attr (cyan) Trip is manually actuated :left 3 :line
             :attr (yellow) AND :left 6 :line :attr (cyan) Control rods
             do not drop into core :line :attr (white) OR :line :attr (
             cyan ) Reactor returns to criticality after trip )
  TYPE :: YES/NO
  USED-BY :: (RULE065 RULE066 RULE067 RULE068)
  COMMENT :: "Module 8, Step 1 - Entry Point"

RT
==
  TRANSLATION :: (Reactor trip)
  PROMPT :: (Has a reactor trip occurred or is one anticipated?)
  TYPE :: YES/NO
  USED-BY :: (RULE209 RULE210)

RT-LOW-P
========
  TRANSLATION :: (Reactor trip on low pressure or ...)
  PROMPT :: (Has there been a reactor trip on low pressure [ 1865 psig],
             or is reactor pressure decreasing uncontrollably? )
  TYPE :: YES/NO
  USED-BY :: (RULE188 RULE227 RULE228)

RT-M/A
======
  TRANSLATION :: (Manual or automatic reactor trip)
  PROMPT :: (Is there a manual or automatic reactor trip?)
  TYPE :: YES/NO
  USED-BY :: (RULE198)
```

```
RVLIS
=====
  TRANSLATION :: (RLVIS full range < 39%)
  PROMPT :: (Is the Reactor Vessel Level Indicating System, RVLIS, full
             range < 39%? )
  TYPE :: YES/NO
  USED-BY :: (RULE221 RULE193 RULE230)

SEC-ADV-ATTACK
==============
  TRANSLATION :: (Adversary/bomb in protected area)
  PROMPT :: (Is there a physical attack on the protected area? :line 2
             :left 3 :attr (cyan) Answer :attr (white) YES :attr (cyan)
             if :attr (yellow) ANY ONE :attr (cyan) of the following is
             true -- :line 2 Adversary is attacking the protected area
             barrier. :line :attr (yellow) OR :line :attr (cyan)
             Adversary is within the protected area, as determined by the
             Shift Supervisor or Security Watch Supervisor. :line :attr (
             yellow ) OR :line :attr (cyan) Bomb is found within the
             protected area. )
  TYPE :: YES/NO
  USED-BY :: (RULE083 RULE084 RULE085 RULE086)
  COMMENT :: "Module 12, Step 2"

SEC-CONTROL1
============
  TRANSLATION :: (Adversary/bomb in vital area)
  PROMPT :: (Is the physical control of the plant being challenged? :line
             2 :left 3 :attr (cyan) Answer :attr (white) YES :attr (cyan)
             if :attr (yellow) ANY ONE :attr (cyan) of the following is
             true -- :line 2 Adversary is attacking the vital area
             barriers. :line :attr (yellow) OR :line :attr (cyan) Bomb is
             found within the vital area. )
  TYPE :: YES/NO
  USED-BY :: (RULE084 RULE085 RULE086)
  COMMENT :: "Module 12, Step 3"

SEC-CONTROL2
============
  TRANSLATION :: (Physical control of plant lost)
  PROMPT :: (Is the physical control of the plant lost? :line 2 :left 3
             :attr (cyan) Answer :attr (white) YES :attr (cyan) if :attr
             (yellow ) ANY ONE :attr (cyan) of the following is true --
             :line 2 Adversary has critically damaged vital equipment.
             :line :attr (yellow) OR :line :attr (cyan) Adversary has
             occupied control room or remote shutdown panel [ C-160 ]
             :line :attr (yellow) OR :line :attr (cyan) Bomb detonation
             has caused vital equipment failure. )
  TYPE :: YES/NO
  USED-BY :: (RULE085 RULE086)
  COMMENT :: "Module 12, Step 4"

SECURITY-ALERT
==============
  TRANSLATION :: (Security alert due to adversary action)
  PROMPT :: (Can a security alert be declared due to adversary action
             [per Trojan Nuclear Plant Security Plan] ? )
  TYPE :: YES/NO
  USED-BY :: (RULE082 RULE083 RULE084 RULE085 RULE086)
  COMMENT :: (MODULE 12, STEP 1 - ENTRY POINT)
```

```
SF-POOL-LOW
===========
  TRANSLATION :: (Spent fuel pool <10 feet above fuel)
  PROMPT :: (Is the spent fuel pool level <10 feet above the fuel?)
  TYPE :: YES/NO
  USED-BY :: (RULE069 RULE070)
  COMMENT :: "Module 9, Step 1 - Entry Point"

SG-FLOW-EXC
===========
  TRANSLATION :: (Excess flow to/from affected SG)
  PROMPT :: (Is there excess feedwater flow to and steam flow from the
             affected steam generator? )
  TYPE :: YES/NO
  USED-BY :: (RULE180)

SG-LVL-DC
=========
  TRANSLATION :: (Decreasing levels on all SGs)
  PROMPT :: (Is there decreasing wide range steam generator [ SG ] levels
             on all SGs? )
  TYPE :: YES/NO
  USED-BY :: (RULE198)

SG-P-EQ
=======
  TRANSLATION :: (All SG pressures equal)
  PROMPT :: (Are all steam generator pressures approximately equal and
             not decreasing in an uncontrolled manner? )
  TYPE :: YES/NO
  USED-BY :: (RULE227)

SG-P-W100
=========
  TRANSLATION :: (All SG pressures < 100 psig dif)
  PROMPT :: (Are steam generator pressures within 100 psig of each other?
             )
  TYPE :: YES/NO
  USED-BY :: (RULE228)

SG-TB-R
=======
  TRANSLATION :: (Symptoms of SG tube rupture)
  PROMPT :: (Do symptoms of a steam generator tube rupture exist?)
  TYPE :: YES/NO
  USED-BY :: (RULE177)

SG-VLV-O1
=========
  TRANSLATION :: (Open SG safety or relief valve)
  PROMPT :: (Is there a visual and/or audible indication of an open steam
             generator safety or relief valve? )
  TYPE :: YES/NO
  USED-BY :: (RULE179)

SG-VLV-O2
=========
  TRANSLATION :: (Open SG valve/vent stack indications)
  PROMPT :: (Is there a visual or audible indication at the vent stacks
             of an open steam generator safety or relief valve? )
  TYPE :: YES/NO
  USED-BY :: (RULE191)
```

```
SGB-RIVER
=========
  TRANSLATION :: (Steam generator blowdown to river)
  PROMPT :: (Is the steam generator blowdown directed to the river?)
  TYPE :: YES/NO
  USED-BY :: (RULE132 RULE136)

SIS
===
  TRANSLATION :: (Safety injection system operational)
  PROMPT :: (Is the Safety Injection System operational? :left 3 :line 2
             :attr (cyan) [Can SIS be verified with redundant
             instrumentation?] )
  TYPE :: YES/NO
  USED-BY :: (RULE199)

SIS-FLOW
========
  TRANSLATION :: (Charging flow or SIS flow indicated)
  PROMPT :: (Are there positive indications of charging flow [ F1-917 ]
             or SIS flow [ F1-918 or F1-922 ] ? )
  TYPE :: YES/NO
  USED-BY :: (RULE199)

SM-ALARM
========
  TRANSLATION :: (Subcooling margin alarm)
  PROMPT :: (Is there a valid subcooling margin monitor alarm [ 0 degrees
             F ] ? )
  TYPE :: YES/NO
  USED-BY :: (RULE174)

ST-FLOW-INC
===========
  TRANSLATION :: (Steam flow increase)
  PROMPT :: (Is there an increase in the steam flow?)
  TYPE :: YES/NO
  USED-BY :: (RULE178)

ST-HIGH-SIS
===========
  TRANSLATION :: (High steam flow saftey injection signal)
  PROMPT :: (Is there a High steam flow safety injection signal?)
  TYPE :: YES/NO
  USED-BY :: (RULE182)

ST-LKG
======
  TRANSLATION :: (Steam line breaks prim-to-sec leakage)
  PROMPT :: (Are there any major steam line breaks with significant
             primary-to-secondary leakage? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE181 RULE182)
  USED-BY :: (RULE018 RULE019 RULE020 RULE183 RULE184)
  COMMENT :: "Module 3, Step 3"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)
```

```
ST-LKG-FD
=========
  TRANSLATION :: (Indications of fuel damage exist)
  PROMPT :: (Are there indications of fuel damage?)
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE183 RULE184)
  USED-BY :: (RULE019 RULE020)
  COMMENT :: "Module 3, Step 4"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

ST-PD-SIS
=========
  TRANSLATION :: (Steam line differential pressure SIS)
  PROMPT :: (Is there a steam line differential pressure safety injection
             signal? )
  TYPE :: YES/NO
  USED-BY :: (RULE181)

ST-SEC-DEPRES
=============
  TRANSLATION :: (Secondary system rapid depressurization)
  PROMPT :: (Are there indications of secondary system rapid
             depressurization? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE178)
  USED-BY :: (RULE017 RULE018 RULE019 RULE020)
  COMMENT :: "Module 3, Step 1 - Entry Point"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

ST-VLV-RESEAT
=============
  TRANSLATION :: (SG safety/relief valves fail to reseat)
  PROMPT :: (Have any steam generator safety or relief valves failed to
             reseat following reduction of applicable pressure? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE179 RULE180)
  USED-BY :: (RULE017 RULE018 RULE019 RULE020)
  COMMENT :: "Module 3, Step 2 - Entry Point"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

ST/P-VLV-RESEAT
===============
  TRANSLATION :: (Pszr or SG sfty/rlf vlvs fail to reseat)
  PROMPT :: (Have any pressurizer or steam generator safety or relief
             valves failed to reseat following reduction of applicable
             pressure? )
  TYPE :: YES/NO
  ASKFIRST :: YES
  UPDATED-BY :: (RULE187)
  USED-BY :: (RULE026 RULE027 RULE028 RULE029 RULE030 RULE031)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 4 Step 6 - Entry Point"
```

```
STATUS
======
  TRANSLATION :: (Most severe emergency class)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE001)
  ANTECEDENT-IN :: (RULE212 RULE213 RULE214 RULE215 RULE216)

TOPICS
======
  TRANSLATION :: (Problem areas to consider)
  PROMPT :: (Select the problem areas to be considered in determining the
             most severe emergency class. )
  TYPE :: ASK-ALL
  EXPECT :: ("All" "Radiological Effluent Release" "Loss of Fission
             Product Barrier" "Steam Line Break" "Main Steam Safety or
             Relief Valve Failure" "Primary or Primary-to-Secondary
             Leakage" "Pressurizer Safety or Relief Valve Failure" "Loss
             of Power or Alarms" "Loss of Feedwater" "Other Limiting
             Conditions" "Reactor Protection System Failure" "Fuel
             Handling Accident" "Control Room Evacuation" "Fire" "Security
             Threat" "Natural Phenomena" "External Hazards" "Internal
             Hazards" )
  USED-BY-THE-WAY :: (MRULE004 MRULE003 MRULE002 MRULE001
                      MRULE015 MRULE014 MRULE013 MRULE012 MRULE011
                      MRULE010 MRULE009 MRULE008 MRULE007 MRULE006
                      MRULE005 )

TRANSIENT
=========
  TRANSLATION :: (Transient initiated or in progress)
  PROMPT :: (Is a transient occurring that requires operation of shutdown
             systems with failure to trip? :line 2 :left 3 :attr (cyan)
             Answer :attr (white) YES :attr (cyan) if :attr (yellow) ANY
             ONE :attr (cyan) of the following is true -- :line 2
             Immediate action steps in EI-0 and FR S.1 to verify reactor
             subcritical not completed :line :attr (yellow) OR :line
             :attr (cyan) Reactor is critical )
  TYPE :: YES/NO
  USED-BY :: (RULE042 RULE043 RULE066 RULE067 RULE068)
  COMMENT :: "Module 5, Step 8 and Module 8, Step 2"

TS-3811
=======
  TRANSLATION :: (Tech Spec 3.8.1.1 exceeded)
  PROMPT :: (Has Technical Specification 3.8.1.1 action statement
             requiring shutdown been exceeded? )
  TYPE :: YES/NO
  USED-BY :: (RULE195)
```

APPENDIX B
Knowledge Base Rules

This appendix contains a listing of rules in the EM-CLASS knowledge base. The rules are written in ARL, Abbreviated Rule Language. ARL clauses, found in both the premise and conclusion portions of the rules, use the following forms:

<parameter>

! <parameter>

<parameter> = <value>

! (<parameter> = <value>)

Parameters having values of "YES" or "NO" can be represented by the first two forms. The form "<parameter>" is true if the parameter has been assigned a "YES" value. The form "! <parameter>" indicates the parameter has been assigned a "NO" value.

Parameters having user-defined values can be represented by the last two forms. The form "<parameter> = <value>" is true if the parameter has been assigned the value <value>. The form "! (<parameter> = <value>)" is true only if the parameter has been assigned a value and the assigned value is not <value>.

The rules are listed by rule-group, as they are stored in the knowledge-base. General rules that apply to goal constraints and system operation are listed first, followed by the rules that apply to Modules 1 through 15. Within each rule group, the rules are listed in the order in which they are considered in the knowledge base.

Rules that can determine a value for the current subgoal are used in numerical order, unless a utility property, ranging from -100 to 100, is added. If a utility property exists, the rule with the highest utility value is used first. The utility property, and therefore the order in which the rules are used, can be changed during the consultation if required. However, at the present time, the prototype does not make use of this dynamic rule-ordering; utility values are assigned according to the values listed in this appendix and are not changed during the consultation.

```
=====================
GENERAL-RULES
=====================

    RULE001
    =======
      SUBJECT :: GENERAL-RULES
      IF    :: (FINDOUT 01-RELEASE AND FINDOUT 02-FPBARRIER AND FINDOUT
                03-STEAM AND FINDOUT 04-PRIMARY AND FINDOUT 05-POWER AND
                FINDOUT 06-FEEDWATER AND FINDOUT 07-OTHER AND FINDOUT
                08-RPS-FAIL AND FINDOUT 09-FUEL AND FINDOUT 10-CR-EVAC AND
                FINDOUT 11-FIRE AND FINDOUT 12-SECURITY AND FINDOUT 13-NATURAL
                AND FINDOUT 14-EXTERNAL AND FINDOUT 15-INTERNAL )
      THEN :: (STATUS = (E (SEVERE-CLASS (LIST (VAL1 FRAME 01-RELEASE) (VAL1
                FRAME 02-FPBARRIER ) (VAL1 FRAME 03-STEAM) (VAL1 FRAME
                04-PRIMARY ) (VAL1 FRAME 05-POWER) (VAL1 FRAME 06-FEEDWATER) (
                VAL1 FRAME 07-OTHER ) (VAL1 FRAME 08-RPS-FAIL) (VAL1 FRAME
                09-FUEL ) (VAL1 FRAME 10-CR-EVAC) (VAL1 FRAME 11-FIRE) (VAL1
                FRAME 12-SECURITY ) (VAL1 FRAME 13-NATURAL) (VAL1 FRAME
                14-EXTERNAL ) (VAL1 FRAME 15-INTERNAL) ) ) ) )

    RULE108
    =======
      SUBJECT :: GENERAL-RULES
      ANTECEDENT :: YES
      IF    :: (NOTIFY)
      THEN :: (LEVEL = 0)

    RULE110
    =======
      SUBJECT :: GENERAL-RULES
      ANTECEDENT :: YES
      IF    :: (NOTIFY AND LEVEL < 1 AND (01-RELEASE = "Unusual Event" OR
                02-FPBARRIER = "Unusual Event" OR 03-STEAM = "Unusual Event"
                OR 04-PRIMARY = "Unusual Event" OR 05-POWER = "Unusual Event"
                OR 06-FEEDWATER = "Unusual Event" OR 07-OTHER = "Unusual Event"
                OR 08-RPS-FAIL = "Unusual Event" OR 09-FUEL = "Unusual Event"
                OR 10-CR-EVAC = "Unusual Event" OR 11-FIRE = "Unusual Event"
                OR 12-SECURITY = "Unusual Event" OR 13-NATURAL = "Unusual Event"
                OR 14-EXTERNAL = "Unusual Event" OR 15-INTERNAL = "Unusual
                Event" ) )
      THEN :: (LEVEL = 1 AND PRINT (TEXTNAME PRE) :LINE 2 :TAB 30 :ATTR (
                QUOTE (CYAN) ) "UNUSUAL EVENT" :LINE 2 (TEXTNAME UE) :LINE 2
                :ATTR (QUOTE (WHITE)) (TEXTNAME CONTINUE) :LINE 8 )

    RULE111
    =======
      SUBJECT :: GENERAL-RULES
      ANTECEDENT :: YES
      IF    :: (NOTIFY AND LEVEL < 2 AND (01-RELEASE = "Alert" OR 02-FPBARRIER
                = "Alert" OR 03-STEAM = "Alert" OR 04-PRIMARY = "Alert" OR
                05-POWER = "Alert" OR 06-FEEDWATER = "Alert" OR 07-OTHER = "
                Alert" OR 08-RPS-FAIL = "Alert" OR 09-FUEL = "Alert" OR
                10-CR-EVAC = "Alert" OR 11-FIRE = "Alert" OR 12-SECURITY = "
                Alert" OR 13-NATURAL = "Alert" OR 14-EXTERNAL = "Alert" OR
                15-INTERNAL = "Alert" ) )
      THEN :: (LEVEL = 2 AND PRINT (TEXTNAME PRE) :LINE 2 :TAB 34 :ATTR (
                QUOTE (YELLOW) ) "ALERT" :LINE 2 (TEXTNAME AL) :LINE 2 :ATTR (
                QUOTE (WHITE) ) (TEXTNAME CONTINUE) :LINE 9 )
```

```
RULE112
=======
  SUBJECT :: GENERAL-RULES
  ANTECEDENT :: YES
  IF    :: (NOTIFY AND LEVEL < 3 AND (01-RELEASE = "Site Area Emergency"
           OR 02-FPBARRIER = "Site Area Emergency" OR 03-STEAM = "Site
           Area Emergency" OR 04-PRIMARY = "Site Area Emergency" OR
           05-POWER = "Site Area Emergency" OR 06-FEEDWATER = "Site Area
           Emergency" OR 07-OTHER = "Site Area Emergency" OR 08-RPS-FAIL
           = "Site Area Emergency" OR 09-FUEL = "Site Area Emergency" OR
           10-CR-EVAC = "Site Area Emergency" OR 11-FIRE = "Site Area
           Emergency" OR 12-SECURITY = "Site Area Emergency" OR
           13-NATURAL = "Site Area Emergency" OR 14-EXTERNAL = "Site Area
           Emergency" OR 15-INTERNAL = "Site Area Emergency" ) )
  THEN :: (LEVEL = 3 AND PRINT (TEXTNAME PRE) :LINE 2 :TAB 27 :ATTR (
           QUOTE (PURPLE) ) "SITE AREA EMERGENCY" :LINE 2 (TEXTNAME SAE)
           :LINE 2 :ATTR (QUOTE (WHITE)) (TEXTNAME CONTINUE) :LINE 9 )

RULE113
=======
  SUBJECT :: GENERAL-RULES
  ANTECEDENT :: YES
  IF    :: (NOTIFY AND LEVEL < 4 AND (01-RELEASE = "General Emergency" OR
           02-FPBARRIER = "General Emergency" OR 03-STEAM = "General
           Emergency" OR 04-PRIMARY = "General Emergency" OR 05-POWER = "
           General Emergency" OR 06-FEEDWATER = "General Emergency" OR
           07-OTHER = "General Emergency" OR 08-RPS-FAIL = "General
           Emergency" OR 09-FUEL = "General Emergency" OR 10-CR-EVAC = "
           General Emergency" OR 11-FIRE = "General Emergency" OR
           12-SECURITY = "General Emergency" OR 13-NATURAL = "General
           Emergency" OR 14-EXTERNAL = "General Emergency" OR 15-INTERNAL
           = "General Emergency" ) )
  THEN :: (LEVEL = 4 AND PRINT (TEXTNAME PRE) :LINE 2 :TAB 28 :ATTR (
           QUOTE (RED) ) "GENERAL EMERGENCY" :LINE 2 (TEXTNAME GEN) :LINE
           2 :ATTR (QUOTE (WHITE)) "The consultation will continue in
           order to determine if additional problem areas exist." :LINE 9
           )

RULE128
=======
  SUBJECT :: GENERAL-RULES
  ANTECEDENT :: YES
  IF    :: (PRM-1D = >8.0E1 cpm, High alarm (PRESSURE RELIEF MODE))
  THEN :: (PRM1-HI)

RULE129
=======
  SUBJECT :: GENERAL-RULES
  ANTECEDENT :: YES
  IF    :: (PRM-2C = >4.7E3 cpm, High alarm)
  THEN :: (PRM2-HI)
```

```
RULE212
=======
  SUBJECT :: GENERAL-RULES
  ANTECEDENT :: YES
  IF    :: (STATUS IS KNOWN)
  THEN :: (PRINT :LEFT 9 :TAB 22 "S U M M A R Y" :LINE 2 :ATTR (QUOTE (
           WHITE ) ) "Module  1-Radiological Release:" :TAB 7 01-RELEASE
           :LINE "Module  2-Fission Product Barrier:" :TAB 4 02-FPBARRIER
           :LINE "Module  3-Steam Line Break:" :TAB 11 03-STEAM :LINE "
           Module  4-Primary/Secondary System:" :TAB 3 04-PRIMARY :LINE "
           Module  5-Loss of Power or Alarms:" :TAB 4 05-POWER :LINE "
           Module  6-Loss of Feedwater:" :TAB 10 06-FEEDWATER :LINE "
           Module  7-Other Limiting Conditions:" :TAB 2 07-OTHER AND
           PRINT :LEFT 9 :ATTR (QUOTE (WHITE)) "Module  8-Reactor
           Protection System:" :TAB 2 08-RPS-FAIL :LINE "Module  9-Fuel
           Handling/Storage:" :TAB 6 09-FUEL :LINE "Module 10-Control Room
           Evacuation:" :TAB 4 10-CR-EVAC :LINE "Module 11-Fire:" :TAB 23
           11-FIRE :LINE "Module 12-Security Threat:" :TAB 12 12-SECURITY
           :LINE "Module 13-Natural Phenomena:" :TAB 10 13-NATURAL :LINE "
           Module 14-External Hazards:" :TAB 11 14-EXTERNAL :LINE "Module
           15-Internal Hazards:" :TAB 11 15-INTERNAL :LINE )

RULE213
=======
  SUBJECT :: GENERAL-RULES
  ANTECEDENT :: YES
  IF    :: (STATUS = Alert)
  THEN :: (PRINT :TAB 9 "The most severe emergency class is" :ATTR (QUOTE
           (YELLOW ) ) "ALERT" :LINE )

RULE214
=======
  SUBJECT :: GENERAL-RULES
  ANTECEDENT :: YES
  IF    :: (STATUS = Site Area Emergency)
  THEN :: (PRINT :TAB 9 "The most severe emergency class is" :ATTR (QUOTE
           (PURPLE ) ) "SITE AREA EMERGENCY" :LINE )

RULE215
=======
  SUBJECT :: GENERAL-RULES
  ANTECEDENT :: YES
  IF    :: (STATUS = General Emergency)
  THEN :: (PRINT :TAB 9 "The most severe emergency class is" :ATTR (QUOTE
           (RED ) ) "GENERAL EMERGENCY" :LINE )

RULE216
=======
  SUBJECT :: GENERAL-RULES
  ANTECEDENT :: YES
  IF    :: (STATUS = Unusual Event)
  THEN :: (PRINT :TAB 9 "The most severe emergency class is" :ATTR (QUOTE
           (CYAN ) ) "UNUSUAL EVENT" :LINE )
```

```
=====================
MODULE-01-RULES
=====================

    RULE002
    =======
      SUBJECT :: MODULE-01-RULES
      IF    :: (! RLS-EXC-1HR)
      THEN :: (MOD1-STEP1 = No Emergency Declared)

    RULE003
    =======
      SUBJECT :: MODULE-01-RULES
      IF    :: (RLS-EXC-1HR AND ! RLS-NOT-CNTRL)
      THEN :: (MOD1-STEP1 = Unusual Event)

    RULE004
    =======
      SUBJECT :: MODULE-01-RULES
      IF    :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND ! RLS-LIMIT1-1)
      THEN :: (MOD1-STEP1 = Alert)

    RULE005
    =======
      SUBJECT :: MODULE-01-RULES
      IF    :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1 AND !
                RLS-LIMIT2 )
      THEN :: (MOD1-STEP1 = Site Area Emergency)

    RULE006
    =======
      SUBJECT :: MODULE-01-RULES
      IF    :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1 AND RLS-LIMIT2)
      THEN :: (MOD1-STEP1 = General Emergency)

    RULE007
    =======
      SUBJECT :: MODULE-01-RULES
      IF    :: (! RLS-EAB)
      THEN :: (MOD1-STEP4 = No Emergency Declared)

    RULE008
    =======
      SUBJECT :: MODULE-01-RULES
      IF    :: (RLS-EAB AND ! RLS-LIMIT1-2)
      THEN :: (MOD1-STEP4 = Alert)

    RULE009
    =======
      SUBJECT :: MODULE-01-RULES
      IF    :: (RLS-EAB AND RLS-LIMIT1-2 AND ! RLS-LIMIT2)
      THEN :: (MOD1-STEP4 = Site Area Emergency)

    RULE010
    =======
      SUBJECT :: MODULE-01-RULES
      IF    :: (RLS-EAB AND RLS-LIMIT1-2 AND RLS-LIMIT2)
      THEN :: (MOD1-STEP4 = General Emergency)
```

```
RULE011
=======
  SUBJECT :: MODULE-01-RULES
  IF    :: (FINDOUT MOD1-STEP1 AND FINDOUT MOD1-STEP4)
  THEN :: (01-RELEASE = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD1-STEP1) (
          VAL1 FRAME MOD1-STEP4 ) ) ) ) )

RULE130
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 90
  IF    :: (PRM-1C = >9.9E3 cpm)
  THEN :: (RLS-EXC-1HR)

RULE131
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 62
  IF    :: (PRM-9 = > High alarm setpoint AND IV-FTC)
  THEN :: (RLS-EXC-1HR)

RULE132
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 58
  IF    :: (PRM-10 = >3.7E3 cpm, High alarm AND SGB-RIVER AND BIV-FTC)
  THEN :: (RLS-EXC-1HR)

RULE133
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 54
  IF    :: (I-131 = > Tech Spec limits AND I-131-RLS)
  THEN :: (RLS-EXC-1HR)

RULE134
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 88
  IF    :: (PRM-1C = >9.9E4 cpm)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE135
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 60
  IF    :: (PRM-9 = > 10 times High alarm setpoint AND IV-FTC)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE136
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 56
  IF    :: (PRM-10 = >3.7E4 cpm AND SGB-RIVER AND BIV-FTC)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE137
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 52
  IF    :: (I-131 = > 10 times Tech Spec limits AND I-131-RLS)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)
```

```
RULE138
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 86
  IF    :: (PRM-1C = "Off-scale" AND (PRM-1D = ">2.0E2 cpm for 0.5 hr
            (PURGE MODE)" OR PRM-1D = ">2.0E3 cpm for 2 minutes (PURGE
            MODE)" ) )
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1)

RULE139
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 80
  IF    :: (PRM-1D = ">7.0E4 cpm for 0.5 hr (PRESSURE RELIEF MODE)" OR
            PRM-1D = ">7.0E5 cpm for 2 minutes (PRESSURE RELIEF MODE)" )
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1)

RULE140
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 72
  IF    :: (PRM-2C = Off-scale AND PRM-2D)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1)

RULE141
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 30
  IF    :: (ARM-15-LK = LIMIT B)
  THEN :: (RLS-EAB)

RULE142
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 28
  IF    :: (ARM-15-LK = LIMIT C OR ARM-15-LK = LIMIT D)
  THEN :: (RLS-EAB AND RLS-LIMIT1-2)

RULE143
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 22
  IF    :: (EAB-LMT = LIMIT E)
  THEN :: (RLS-EAB AND RLS-LIMIT1-2 AND RLS-LIMIT2)

RULE144
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 23
  IF    :: (EAB-CALC)
  THEN :: (RLS-LIMIT2)

RULE145
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 84
  IF    :: (PRM-1D = >8.0E1 cpm, High alarm (PRESSURE RELIEF MODE))
  THEN :: (RLS-EXC-1HR)
```

```
RULE146
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 76
  IF    :: (PRM-2C = >4.7E3 cpm, High alarm)
  THEN :: (RLS-EXC-1HR)

RULE147
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 70
  IF    :: (PRM-6B = >1.8E2 cpm, High alarm)
  THEN :: (RLS-EXC-1HR)

RULE148
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 82
  IF    :: (PRM-1D = >8.0E2 cpm (PRESSURE RELIEF MODE))
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE149
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 74
  IF    :: (PRM-2C = >4.7E4 cpm)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE150
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 68
  IF    :: (PRM-6B = >1.8E3 cpm)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE151
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 78
  IF    :: (PRM-1E)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1)

RULE152
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 66
  IF    :: (PRM-6B = ">1.8E5 cpm for 0.5 hr" OR PRM-6B = "Off-scale for 2
            minutes" )
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1)

RULE153
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 64
  IF    :: (PRM-6C)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1)

RULE154
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 50
  IF    :: (I-131-RR)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1)
```

```
RULE155
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 26
  IF    :: (EAB-LMT = LIMIT B)
  THEN :: (RLS-EAB)

RULE156
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 20
  IF    :: (ARM22/23 = >1.0 mR/hr)
  THEN :: (RLS-EAB)

RULE157
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 14
  IF    :: (EAB-I-131 = >1.0E-10 microCi/cc)
  THEN :: (RLS-EAB)

RULE158
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 24
  IF    :: (EAB-LMT = LIMIT C OR EAB-LMT = LIMIT D)
  THEN :: (RLS-EAB AND RLS-LIMIT1-2)

RULE159
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 18
  IF    :: (ARM22/23 = ">50 mR/hr for 0.5 hr" OR ARM22/23 = ">500 mR/hr for
           2 minutes" )
  THEN :: (RLS-EAB AND RLS-LIMIT1-2)

RULE160
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 12
  IF    :: (EAB-I-131 = ">1.0E-7 microCi/cc [>250 mrem/hr] for 0.5 hr" OR
           EAB-I-131 = ">1.0E-6 microCi/cc [>2500 mrem/hr] for 2 minutes"
           )
  THEN :: (RLS-EAB AND RLS-LIMIT1-2)

RULE161
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 16
  IF    :: (ARM22/23 = >1000 mR/hr)
  THEN :: (RLS-EAB AND RLS-LIMIT1-2 AND RLS-LIMIT2)

RULE162
=======
  SUBJECT :: MODULE-01-RULES
  UTILITY :: 8
  IF    :: (EAB-DOSE)
  THEN :: (RLS-EAB AND RLS-LIMIT1-2 AND RLS-LIMIT2)
```

```
=====================
MODULE-02-RULES
=====================

    RULE012
    =======
      SUBJECT :: MODULE-02-RULES
      IF    :: (! FPB-FUEL AND ! FPB-COOLANT)
      THEN :: (MOD2-STEP1/2 = No Emergency Declared)

    RULE013
    =======
      SUBJECT :: MODULE-02-RULES
      IF    :: ((FPB-FUEL OR FPB-COOLANT) AND ! FPB-FUEL-DMG)
      THEN :: (MOD2-STEP1/2 = Unusual Event)

    RULE014
    =======
      SUBJECT :: MODULE-02-RULES
      IF    :: ((FPB-FUEL OR FPB-COOLANT) AND FPB-FUEL-DMG AND ! FPB-CORE)
      THEN :: (MOD2-STEP1/2 = Alert)

    RULE015
    =======
      SUBJECT :: MODULE-02-RULES
      IF    :: ((FPB-FUEL OR FPB-COOLANT) AND FPB-FUEL-DMG AND FPB-CORE)
      THEN :: (MOD2-STEP1/2 = General Emergency)

    RULE016
    =======
      SUBJECT :: MODULE-02-RULES
      IF    :: (FINDOUT MOD2-STEP1/2 AND FINDOUT MOD2-STEP5)
      THEN :: (02-FPBARRIER = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD2-STEP1/2
                ) (VAL1 FRAME MOD2-STEP5) ) ) ) )

    RULE163
    =======
      SUBJECT :: MODULE-02-RULES
      IF    :: (PCT-TP > 80)
      THEN :: (I-LIMIT = 60)

    RULE164
    =======
      SUBJECT :: MODULE-02-RULES
      IF    :: (PCT-TP <= 80)
      THEN :: (I-LIMIT = (380 - (4 * PCT-TP)))

    RULE165
    =======
      SUBJECT :: MODULE-02-RULES
      UTILITY :: 90
      IF    :: (I-131-PC > 300)
      THEN :: (FPB-FUEL AND FPB-FUEL-DMG)

    RULE166
    =======
      SUBJECT :: MODULE-02-RULES
      UTILITY :: 89
      IF    :: (I-131-PC > I-LIMIT)
      THEN :: (FPB-FUEL)
```

```
RULE167
=======
  SUBJECT :: MODULE-02-RULES
  UTILITY :: 80
  IF    :: (LAB-FF = increased 0.1% in 30 minutes AND PRM-13)
  THEN :: (FPB-FUEL)

RULE168
=======
  SUBJECT :: MODULE-02-RULES
  UTILITY :: 79
  IF    :: (LAB-FF = "increased 1% in 30 minutes" OR LAB-FF = "increased to
           a total fraction of 5%" )
  THEN :: (FPB-FUEL AND FPB-FUEL-DMG)

RULE169
=======
  SUBJECT :: MODULE-02-RULES
  UTILITY :: 70
  IF    :: (RCS-P = > 2385 psig)
  THEN :: (FPB-COOLANT)

RULE170
=======
  SUBJECT :: MODULE-02-RULES
  UTILITY :: 69
  IF    :: (RCS-P = > 1835 psig AND 5-CE-TC = > 620 degrees F)
  THEN :: (FPB-COOLANT)

RULE171
=======
  SUBJECT :: MODULE-02-RULES
  UTILITY :: 65
  IF    :: (5-CE-TC = > 700 degrees F)
  THEN :: (FPB-COOLANT AND FPB-FUEL-DMG)

RULE172
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (5-CE-TC = > 1200 degrees F)
  THEN :: (FPB-COOLANT AND FPB-FUEL-DMG AND FPB-LOSS-3 AND FPB-CORE)

RULE173
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (RCS-T-HI)
  THEN :: (FPB-COOLANT)

RULE174
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (SM-ALARM)
  THEN :: (FPB-COOLANT)

RULE175
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (FPB-FUEL-DMG AND CONT-P = "Approaching 60 psig" AND
           LOCA-CHG-PMP )
  THEN :: (FPB-LOSS-3)
```

```
RULE176
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (CONT-P = Approaching 60 psig AND ARM-15 = > 2.0E3 mrem/hr)
  THEN :: (FPB-LOSS-3)

RULE177
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (FPB-FUEL-DMG AND SG-TB-R AND MSIV-F-SG)
  THEN :: (FPB-LOSS-3)

RULE217
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (! FPB-LOSS-1)
  THEN :: (MOD2-STEP5 = No Emergency Declared)

RULE218
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (FPB-LOSS-1 AND ! FPB-LOSS-2)
  THEN :: (MOD2-STEP5 = Alert)

RULE219
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (FPB-LOSS-1 AND FPB-LOSS-2 AND ! FPB-LOSS-3)
  THEN :: (MOD2-STEP5 = Site Area Emergency)

RULE220
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (FPB-LOSS-1 AND FPB-LOSS-2 AND FPB-LOSS-3)
  THEN :: (MOD2-STEP5 = General Emergency)

RULE221
=======
  SUBJECT :: MODULE-02-RULES
  IF    :: (5-CE-TC = > 700 degrees F AND ! RCP-OP AND RVLIS)
  THEN :: (FPB-CORE)

RULE222
=======
  SUBJECT :: MODULE-02-RULES
  ANTECEDENT :: YES
  IF    :: (FPB-FUEL-DMG OR LMT-CONT-INTEG)
  THEN :: (FPB-LOSS-1)

RULE223
=======
  SUBJECT :: MODULE-02-RULES
  ANTECEDENT :: YES
  IF    :: (FPB-FUEL-DMG AND LMT-CONT-INTEG)
  THEN :: (FPB-LOSS-2)
```

```
=====================
MODULE-03-RULES
=====================

    RULE017
    =======
      SUBJECT :: MODULE-03-RULES
      IF    :: (! ST-SEC-DEPRES AND ! ST-VLV-RESEAT)
      THEN :: (03-STEAM = No Emergency Declared)

    RULE018
    =======
      SUBJECT :: MODULE-03-RULES
      IF    :: ((ST-SEC-DEPRES OR ST-VLV-RESEAT) AND ! ST-LKG)
      THEN :: (03-STEAM = Unusual Event)

    RULE019
    =======
      SUBJECT :: MODULE-03-RULES
      IF    :: ((ST-SEC-DEPRES OR ST-VLV-RESEAT) AND ST-LKG AND ! ST-LKG-FD)
      THEN :: (03-STEAM = Alert)

    RULE020
    =======
      SUBJECT :: MODULE-03-RULES
      IF    :: ((ST-SEC-DEPRES OR ST-VLV-RESEAT) AND ST-LKG AND ST-LKG-FD)
      THEN :: (03-STEAM = Site Area Emergency)

    RULE178
    =======
      SUBJECT :: MODULE-03-RULES
      IF    :: (ST-FLOW-INC AND RCS-T&P AND OUTSIDE-BK)
      THEN :: (ST-SEC-DEPRES)

    RULE179
    =======
      SUBJECT :: MODULE-03-RULES
      IF    :: (SG-VLV-01)
      THEN :: (ST-VLV-RESEAT)

    RULE180
    =======
      SUBJECT :: MODULE-03-RULES
      IF    :: (SG-FLOW-EXC)
      THEN :: (ST-VLV-RESEAT)

    RULE181
    =======
      SUBJECT :: MODULE-03-RULES
      IF    :: (ST-PD-SIS AND CONT-P = "> 3.5 psig, High alarm" AND PRM1-HI
                AND (PRM-6B = ">1.8E2 cpm, High alarm" OR PRM-10 = ">3.7E3 cpm,
                High alarm" OR PRM-16 ) )
      THEN :: (ST-LKG)

    RULE182
    =======
      SUBJECT :: MODULE-03-RULES
      IF    :: (ST-HIGH-SIS AND MSIV-F-SL AND (PRM-6B = ">1.8E2 cpm, High alarm"
                OR PRM-10 = ">3.7E3 cpm, High alarm" OR PRM-16 ) )
      THEN :: (ST-LKG)
```

```
RULE183
=======
  SUBJECT :: MODULE-03-RULES
  IF    :: (ST-LKG AND I-131-PC > I-LIMIT)
  THEN :: (ST-LKG-FD)

RULE184
=======
  SUBJECT :: MODULE-03-RULES
  IF    :: (ST-LKG AND PRM-13 AND (LAB-FF = "increased 1.0% in 30 minutes"
           OR LAB-FF = "increased to a total fraction of 5%" ) )
  THEN :: (ST-LKG-FD)
```

```
====================
MODULE-04-RULES
====================

    RULE021
    =======
      SUBJECT :: MODULE-04-RULES
      IF    :: (! LKG-P/S-TS)
      THEN :: (MOD4-STEP1 = No Emergency Declared)

    RULE022
    =======
      SUBJECT :: MODULE-04-RULES
      IF    :: (LKG-P/S-TS AND ! LKG-SGT)
      THEN :: (MOD4-STEP1 = Unusual Event)

    RULE023
    =======
      SUBJECT :: MODULE-04-RULES
      IF    :: (LKG-P/S-TS AND LKG-SGT AND ! LKG-SGT-LOP AND ! LKG-SGT-SVFR)
      THEN :: (MOD4-STEP1 = Alert)

    RULE024
    =======
      SUBJECT :: MODULE-04-RULES
      IF    :: (LKG-P/S-TS AND LKG-SGT AND ! LKG-SGT-LOP AND LKG-SGT-SVFR)
      THEN :: (MOD4-STEP1 = Site Area Emergency)

    RULE025
    =======
      SUBJECT :: MODULE-04-RULES
      IF    :: (LKG-P/S-TS AND LKG-SGT AND LKG-SGT-LOP)
      THEN :: (MOD4-STEP1 = Site Area Emergency)

    RULE026
    =======
      SUBJECT :: MODULE-04-RULES
      IF    :: (! LKG-P-TS AND ! ST/P-VLV-RESEAT)
      THEN :: (MOD4-STEP5/6 = No Emergency Declared)

    RULE027
    =======
      SUBJECT :: MODULE-04-RULES
      IF    :: ((LKG-P-TS OR ST/P-VLV-RESEAT) AND ! LKG-COOLANT)
      THEN :: (MOD4-STEP5/6 = Unusual Event)

    RULE028
    =======
      SUBJECT :: MODULE-04-RULES
      IF    :: ((LKG-P-TS OR ST/P-VLV-RESEAT) AND LKG-COOLANT AND !
                LOCA-CHG-PMP )
      THEN :: (MOD4-STEP5/6 = Alert)

    RULE029
    =======
      SUBJECT :: MODULE-04-RULES
      IF    :: ((LKG-P-TS OR ST/P-VLV-RESEAT) AND LKG-COOLANT AND LOCA-CHG-PMP
                AND ! LOCA-CHR-FAIL AND ! LOCA-ECCS-FAIL )
      THEN :: (MOD4-STEP5/6 = Site Area Emergency)
```

```
RULE030
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: ((LKG-P-TS OR ST/P-VLV-RESEAT) AND LKG-COOLANT AND LOCA-CHG-PMP
           AND LOCA-CHR-FAIL )
  THEN :: (MOD4-STEP5/6 = General Emergency)

RULE031
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: ((LKG-P-TS OR ST/P-VLV-RESEAT) AND LKG-COOLANT AND LOCA-CHG-PMP
           AND ! LOCA-CHR-FAIL AND LOCA-ECCS-FAIL )
  THEN :: (MOD4-STEP5/6 = General Emergency)

RULE032
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (FINDOUT MOD4-STEP1 AND FINDOUT MOD4-STEP5/6)
  THEN :: (04-PRIMARY = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD4-STEP1) (
           VAL1 FRAME MOD4-STEP5/6 ) ) ) ) )

RULE187
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (PRV-OPEN)
  THEN :: (ST/P-VLV-RESEAT)

RULE188
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (RT-LOW-P AND (PRM-10 = ">3.7E3 cpm, High alarm" OR PRM-16 OR
           PRM-6B = ">1.8E2 cpm, High alarm" ) )
  THEN :: (LKG-SGT)

RULE189
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (LKG-SGT AND PWR-UV-1 AND CR-LIGHTS)
  THEN :: (LKG-SGT-LOP)

RULE190
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (LKG-SGT AND PRV-OPEN)
  THEN :: (LKG-SGT-SVFR)

RULE191
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (LKG-SGT AND SG-VLV-O2)
  THEN :: (LKG-SGT-SVFR)

RULE192
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (LOCA-CHG-PMP AND ECCS AND CONT-COOL AND CONT-P = "Approaching
           60 psig" )
  THEN :: (LOCA-CHR-FAIL)
```

```
RULE193
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (LOCA-CHG-PMP AND ECCS-FAIL AND (ARM-15 = "> 100 R/hr, High
            alarm" OR ARM-20 = "> 10 R/hr, High alarm" ) AND (5-CE-TC = ">
            1200 degrees F" OR (5-CE-TC = "> 700 degrees F" AND ! RCP-OP
            AND RVLIS ) ) )
  THEN :: (LOCA-ECCS-FAIL)

RULE224
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (PB-LEAK)
  THEN :: (LKG-P-TS)

RULE225
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (LKG-UNID)
  THEN :: (LKG-P-TS)

RULE226
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (LKG-VER)
  THEN :: (LKG-P-TS)

RULE227
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (RT-LOW-P AND SG-P-EQ)
  THEN :: (LOCA-CHG-PMP)

RULE228
=======
  SUBJECT :: MODULE-04-RULES
  IF    :: (RT-LOW-P AND CONT-HIGH AND SG-P-W100)
  THEN :: (LOCA-CHG-PMP)
```

```
=====================
MODULE-05-RULES
=====================

    RULE033
    =======
      SUBJECT :: MODULE-05-RULES
      IF    :: (! PWR-LOSS-TS)
      THEN :: (MOD5-STEP1 = No Emergency Declared)

    RULE034
    =======
      SUBJECT :: MODULE-05-RULES
      IF    :: (PWR-LOSS-TS AND ! PWR-OFF/AC)
      THEN :: (MOD5-STEP1 = Unusual Event)

    RULE035
    =======
      SUBJECT :: MODULE-05-RULES
      IF    :: (PWR-LOSS-TS AND PWR-OFF/AC AND ! PWR-LOSS-30)
      THEN :: (MOD5-STEP1 = Alert)

    RULE036
    =======
      SUBJECT :: MODULE-05-RULES
      IF    :: (PWR-LOSS-TS AND PWR-OFF/AC AND PWR-LOSS-30 AND ! PWR-LOSS-FW)
      THEN :: (MOD5-STEP1 = Site Area Emergency)

    RULE037
    =======
      SUBJECT :: MODULE-05-RULES
      IF    :: (PWR-LOSS-TS AND PWR-OFF/AC AND PWR-LOSS-30 AND PWR-LOSS-FW)
      THEN :: (MOD5-STEP1 = General Emergency)

    RULE038
    =======
      SUBJECT :: MODULE-05-RULES
      IF    :: (! PWR-ON-DC)
      THEN :: (MOD5-STEP5 = No Emergency Declared)

    RULE039
    =======
      SUBJECT :: MODULE-05-RULES
      IF    :: (PWR-ON-DC AND ! PWR-ON-DC-15)
      THEN :: (MOD5-STEP5 = Alert)

    RULE040
    =======
      SUBJECT :: MODULE-05-RULES
      IF    :: (PWR-ON-DC AND PWR-ON-DC-15)
      THEN :: (MOD5-STEP5 = Site Area Emergency)

    RULE041
    =======
      SUBJECT :: MODULE-05-RULES
      IF    :: (! ALARM-LOSS)
      THEN :: (MOD5-STEP7 = No Emergency Declared)

    RULE042
    =======
      SUBJECT :: MODULE-05-RULES
      IF    :: (ALARM-LOSS AND ! TRANSIENT)
      THEN :: (MOD5-STEP7 = Alert)
```

```
RULE043
=======
  SUBJECT :: MODULE-05-RULES
  IF    :: (ALARM-LOSS AND TRANSIENT)
  THEN :: (MOD5-STEP7 = Site Area Emergency)

RULE044
=======
  SUBJECT :: MODULE-05-RULES
  IF    :: (FINDOUT MOD5-STEP1 AND FINDOUT MOD5-STEP5 AND FINDOUT
           MOD5-STEP7 )
  THEN :: (05-POWER = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD5-STEP1) (
           VAL1 FRAME MOD5-STEP5 ) (VAL1 FRAME MOD5-STEP7) ) ) ) )

RULE194
=======
  SUBJECT :: MODULE-05-RULES
  IF    :: (PWR-UV-2)
  THEN :: (PWR-LOSS-TS)

RULE195
=======
  SUBJECT :: MODULE-05-RULES
  IF    :: (! PWR-ESF AND TS-3811)
  THEN :: (PWR-LOSS-TS)

RULE196
=======
  SUBJECT :: MODULE-05-RULES
  IF    :: (! PWR-ESF AND PWR-UV-2 AND PWR-UV = > 5 minutes)
  THEN :: (PWR-OFF/AC)

RULE197
=======
  SUBJECT :: MODULE-05-RULES
  IF    :: (! PWR-ESF AND PWR-UV-2 AND PWR-UV = > 30 minutes)
  THEN :: (PWR-OFF/AC AND PWR-LOSS-30)

RULE231
=======
  SUBJECT :: MODULE-05-RULES
  IF    :: (PWR-DG-LOSS)
  THEN :: (PWR-LOSS-TS)
```

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====================
MODULE-06-RULES
====================

    RULE045
    =======
      SUBJECT :: MODULE-06-RULES
      IF    :: (! AFW-NO-PUMPS)
      THEN :: (06-FEEDWATER = No Emergency Declared)

    RULE046
    =======
      SUBJECT :: MODULE-06-RULES
      IF    :: (AFW-NO-PUMPS AND ! AFW-RT1)
      THEN :: (06-FEEDWATER = Unusual Event)

    RULE047
    =======
      SUBJECT :: MODULE-06-RULES
      IF    :: (AFW-NO-PUMPS AND AFW-RT1 AND ! AFW-RT2)
      THEN :: (06-FEEDWATER = Alert)

    RULE048
    =======
      SUBJECT :: MODULE-06-RULES
      IF    :: (AFW-NO-PUMPS AND AFW-RT1 AND AFW-RT2 AND ! AFW-RT3)
      THEN :: (06-FEEDWATER = Site Area Emergency)

    RULE049
    =======
      SUBJECT :: MODULE-06-RULES
      IF    :: (AFW-NO-PUMPS AND AFW-RT1 AND AFW-RT2 AND AFW-RT3)
      THEN :: (06-FEEDWATER = General Emergency)

    RULE198
    =======
      SUBJECT :: MODULE-06-RULES
      IF    :: (RT-M/A AND SG-LVL-DC AND AFW-NF)
      THEN :: (AFW-RT1)
```

```
=====================
MODULE-07-RULES
=====================

    RULE050
    =======
      SUBJECT :: MODULE-07-RULES
      IF    :: (! LMT-CONT-INTEG)
      THEN :: (MOD7-STEP1 = No Emergency Declared)

    RULE051
    =======
      SUBJECT :: MODULE-07-RULES
      IF    :: (LMT-CONT-INTEG)
      THEN :: (MOD7-STEP1 = Unusual Event)

    RULE052
    =======
      SUBJECT :: MODULE-07-RULES
      IF    :: (! LMT-ESF/FIREP)
      THEN :: (MOD7-STEP2 = No Emergency Declared)

    RULE053
    =======
      SUBJECT :: MODULE-07-RULES
      IF    :: (LMT-ESF/FIREP)
      THEN :: (MOD7-STEP2 = Unusual Event)

    RULE054
    =======
      SUBJECT :: MODULE-07-RULES
      IF    :: (! LMT-ECCS)
      THEN :: (MOD7-STEP3 = No Emergency Declared)

    RULE055
    =======
      SUBJECT :: MODULE-07-RULES
      IF    :: (LMT-ECCS)
      THEN :: (MOD7-STEP3 = Unusual Event)

    RULE056
    =======
      SUBJECT :: MODULE-07-RULES
      IF    :: (! LMT-INJURY)
      THEN :: (MOD7-STEP4 = No Emergency Declared)

    RULE057
    =======
      SUBJECT :: MODULE-07-RULES
      IF    :: (LMT-INJURY)
      THEN :: (MOD7-STEP4 = Unusual Event)

    RULE058
    =======
      SUBJECT :: MODULE-07-RULES
      IF    :: (! LMT-ACTIVITY)
      THEN :: (MOD7-STEP5 = No Emergency Declared)

    RULE059
    =======
      SUBJECT :: MODULE-07-RULES
      IF    :: (LMT-ACTIVITY)
      THEN :: (MOD7-STEP5 = Alert)
```

```
RULE060
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (! LMT-COLD-SD)
  THEN :: (MOD7-STEP6 = No Emergency Declared)

RULE061
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (LMT-COLD-SD)
  THEN :: (MOD7-STEP6 = Alert)

RULE062
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (! LMT-HOT-SD)
  THEN :: (MOD7-STEP7 = No Emergency Declared)

RULE063
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (LMT-HOT-SD)
  THEN :: (MOD7-STEP7 = Site Area Emergency)

RULE064
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (FINDOUT MOD7-STEP1 AND FINDOUT MOD7-STEP2 AND FINDOUT
            MOD7-STEP3 AND FINDOUT MOD7-STEP4 AND FINDOUT MOD7-STEP5 AND
            FINDOUT MOD7-STEP6 AND FINDOUT MOD7-STEP7 )
  THEN :: (07-OTHER = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD7-STEP1) (
            VAL1 FRAME MOD7-STEP2 ) (VAL1 FRAME MOD7-STEP3) (VAL1 FRAME
            MOD7-STEP4 ) (VAL1 FRAME MOD7-STEP5) (VAL1 FRAME MOD7-STEP6) (
            VAL1 FRAME MOD7-STEP7 ) ) ) ) )

RULE199
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (SIS AND SIS-FLOW)
  THEN :: (LMT-ECCS)

RULE200
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (ARMS-HI1)
  THEN :: (LMT-ACTIVITY)

RULE201
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (ARMS-HI2)
  THEN :: (LMT-ACTIVITY)

RULE202
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (ARMS-HI3)
  THEN :: (LMT-ACTIVITY)

RULE203
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (ARMS-HI4)
  THEN :: (LMT-ACTIVITY)
```

```
RULE204
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (ARM-15 = > 100 R/hr, High alarm)
  THEN :: (LMT-ACTIVITY)

RULE205
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (ARM-20 = "> 25 R/hr [Refueling]" OR ARM-20 = "> 200 R/hr [Power
           Operation]" )
  THEN :: (LMT-ACTIVITY)

RULE206
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (ARM-21)
  THEN :: (LMT-ACTIVITY)

RULE207
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (AIRBN-ACT)
  THEN :: (LMT-ACTIVITY)

RULE208
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (! RHR AND ! NAT-CIRC AND RCS-T-HI2)
  THEN :: (LMT-COLD-SD)

RULE209
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (RT AND ! HPI)
  THEN :: (LMT-HOT-SD)

RULE210
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (RT AND ! AFW)
  THEN :: (LMT-HOT-SD)

RULE211
=======
  SUBJECT :: MODULE-07-RULES
  IF    :: (! RHR AND MODE-4 AND ! AFW)
  THEN :: (LMT-HOT-SD)
```

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=====================
MODULE-08-RULES
=====================

    RULE065
    =======
      SUBJECT :: MODULE-08-RULES
      IF    :: (! RPS-RX-CRITICAL)
      THEN :: (08-RPS-FAIL = No Emergency Declared)

    RULE066
    =======
      SUBJECT :: MODULE-08-RULES
      IF    :: (RPS-RX-CRITICAL AND ! TRANSIENT)
      THEN :: (08-RPS-FAIL = Alert)

    RULE067
    =======
      SUBJECT :: MODULE-08-RULES
      IF    :: (RPS-RX-CRITICAL AND TRANSIENT AND ! RPS-CORE-DMG)
      THEN :: (08-RPS-FAIL = Site Area Emergency)

    RULE068
    =======
      SUBJECT :: MODULE-08-RULES
      IF    :: (RPS-RX-CRITICAL AND TRANSIENT AND RPS-CORE-DMG)
      THEN :: (08-RPS-FAIL = General Emergency)

    RULE229
    =======
      SUBJECT :: MODULE-08-RULES
      IF    :: (5-CE-TC = > 1200 degrees F)
      THEN :: (RPS-CORE-DMG)

    RULE230
    =======
      SUBJECT :: MODULE-08-RULES
      IF    :: (5-CE-TC = > 700 degrees F AND RVLIS)
      THEN :: (RPS-CORE-DMG)
```

```
=====================
MODULE-09-RULES
=====================

    RULE069
    =======
      SUBJECT :: MODULE-09-RULES
      IF    :: (! SF-POOL-LOW)
      THEN :: (MOD9-STEP1 = No Emergency Declared)

    RULE070
    =======
      SUBJECT :: MODULE-09-RULES
      IF    :: (SF-POOL-LOW)
      THEN :: (MOD9-STEP1 = Unusual Event)

    RULE071
    =======
      SUBJECT :: MODULE-09-RULES
      IF    :: (! FUEL-HANDLING)
      THEN :: (MOD9-STEP2 = No Emergency Declared)

    RULE072
    =======
      SUBJECT :: MODULE-09-RULES
      IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = "Containment" AND PRM1-HI AND
                ! FUEL-NUMBER )
      THEN :: (MOD9-STEP2 = Alert)

    RULE073
    =======
      SUBJECT :: MODULE-09-RULES
      IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = "Containment" AND PRM1-HI AND
                FUEL-NUMBER )
      THEN :: (MOD9-STEP2 = Site Area Emergency)

    RULE074
    =======
      SUBJECT :: MODULE-09-RULES
      IF    :: (FINDOUT MOD9-STEP1 AND FINDOUT MOD9-STEP2)
      THEN :: (09-FUEL = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD9-STEP1) (VAL1
                FRAME MOD9-STEP2 ) ) ) ) )

    RULE124
    =======
      SUBJECT :: MODULE-09-RULES
      IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = Containment AND ! PRM1-HI)
      THEN :: (MOD9-STEP2 = No Emergency Declared)

    RULE125
    =======
      SUBJECT :: MODULE-09-RULES
      IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = "Fuel Building" AND (PRM2-HI
                OR PRM3-HI OR ARM12/13-HI ) AND FUEL-NUMBER )
      THEN :: (MOD9-STEP2 = Site Area Emergency)

    RULE126
    =======
      SUBJECT :: MODULE-09-RULES
      IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = "Fuel Building" AND (PRM2-HI
                OR PRM3-HI OR ARM12/13-HI ) AND ! FUEL-NUMBER )
      THEN :: (MOD9-STEP2 = Alert)
```

```
RULE127
=======
  SUBJECT :: MODULE-09-RULES
  IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = "Fuel Building" AND ! PRM2-HI
            AND ! PRM3-HI AND ! ARM12/13-HI )
  THEN :: (MOD9-STEP2 = No Emergency Declared)
```

```
======================
MODULE-10-RULES
======================

    RULE075
    =======
      SUBJECT :: MODULE-10-RULES
      IF    :: (! CR-EVAC)
      THEN :: (10-CR-EVAC = No Emergency Declared)

    RULE076
    =======
      SUBJECT :: MODULE-10-RULES
      IF    :: (CR-EVAC AND ! CR-EVAC-NO-SD)
      THEN :: (10-CR-EVAC = Alert)

    RULE077
    =======
      SUBJECT :: MODULE-10-RULES
      IF    :: (CR-EVAC AND CR-EVAC-NO-SD)
      THEN :: (10-CR-EVAC = Site Area Emergency)
```

```
=====================
MODULE-11-RULES
=====================

    RULE078
    =======
      SUBJECT :: MODULE-11-RULES
      IF    :: (! FIRE)
      THEN :: (11-FIRE = No Emergency Declared)

    RULE079
    =======
      SUBJECT :: MODULE-11-RULES
      IF    :: (FIRE AND ! FIRE-SAFETY1)
      THEN :: (11-FIRE = Unusual Event)

    RULE080
    =======
      SUBJECT :: MODULE-11-RULES
      IF    :: (FIRE AND FIRE-SAFETY1 AND ! FIRE-SAFETY2)
      THEN :: (11-FIRE = Alert)

    RULE081
    =======
      SUBJECT :: MODULE-11-RULES
      IF    :: (FIRE AND FIRE-SAFETY1 AND FIRE-SAFETY2)
      THEN :: (11-FIRE = Site Area Emergency)
```

```
======================
MODULE-12-RULES
======================

    RULE082
    =======
      SUBJECT :: MODULE-12-RULES
      IF    :: (! SECURITY-ALERT)
      THEN :: (12-SECURITY = No Emergency Declared)

    RULE083
    =======
      SUBJECT :: MODULE-12-RULES
      IF    :: (SECURITY-ALERT AND ! SEC-ADV-ATTACK)
      THEN :: (12-SECURITY = Unusual Event)

    RULE084
    =======
      SUBJECT :: MODULE-12-RULES
      IF    :: (SECURITY-ALERT AND SEC-ADV-ATTACK AND ! SEC-CONTROL1)
      THEN :: (12-SECURITY = Alert)

    RULE085
    =======
      SUBJECT :: MODULE-12-RULES
      IF    :: (SECURITY-ALERT AND SEC-ADV-ATTACK AND SEC-CONTROL1 AND !
                SEC-CONTROL2 )
      THEN :: (12-SECURITY = Site Area Emergency)

    RULE086
    =======
      SUBJECT :: MODULE-12-RULES
      IF    :: (SECURITY-ALERT AND SEC-ADV-ATTACK AND SEC-CONTROL1 AND
                SEC-CONTROL2 )
      THEN :: (12-SECURITY = General Emergency)
```

```
=====================
MODULE-13-RULES
=====================

    RULE087
    =======
      SUBJECT :: MODULE-13-RULES
      IF    :: (! NAT-UNUSUAL)
      THEN :: (13-NATURAL = No Emergency Declared)

    RULE088
    =======
      SUBJECT :: MODULE-13-RULES
      IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Earthquake" AND NAT-EQUAKE =
                UNUSUAL )
      THEN :: (13-NATURAL = Unusual Event)

    RULE089
    =======
      SUBJECT :: MODULE-13-RULES
      IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Earthquake" AND NAT-EQUAKE =
                SERIOUS )
      THEN :: (13-NATURAL = Alert)

    RULE090
    =======
      SUBJECT :: MODULE-13-RULES
      IF    :: (NAT-UNUSUAL AND NAT-TYPE = Earthquake AND NAT-EQUAKE = SEVERE)
      THEN :: (13-NATURAL = Site Area Emergency)

    RULE114
    =======
      SUBJECT :: MODULE-13-RULES
      IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Flood or Wave Surge" AND NAT-FLOOD
                = UNUSUAL )
      THEN :: (13-NATURAL = Unusual Event)

    RULE115
    =======
      SUBJECT :: MODULE-13-RULES
      IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Flood or Wave Surge" AND NAT-FLOOD
                = SERIOUS )
      THEN :: (13-NATURAL = Alert)

    RULE116
    =======
      SUBJECT :: MODULE-13-RULES
      IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Flood or Wave Surge" AND NAT-FLOOD
                = SEVERE )
      THEN :: (13-NATURAL = Site Area Emergency)

    RULE117
    =======
      SUBJECT :: MODULE-13-RULES
      IF    :: (NAT-UNUSUAL AND NAT-TYPE = Tornado AND NAT-TORNADO)
      THEN :: (13-NATURAL = Alert)

    RULE118
    =======
      SUBJECT :: MODULE-13-RULES
      IF    :: (NAT-UNUSUAL AND NAT-TYPE = Tornado AND ! NAT-TORNADO)
      THEN :: (13-NATURAL = Unusual Event)
```

```
RULE119
=======
  SUBJECT :: MODULE-13-RULES
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = High Winds AND NAT-WINDS = UNUSUAL)
  THEN :: (13-NATURAL = Unusual Event)

RULE120
=======
  SUBJECT :: MODULE-13-RULES
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = High Winds AND NAT-WINDS = SERIOUS)
  THEN :: (13-NATURAL = Alert)

RULE121
=======
  SUBJECT :: MODULE-13-RULES
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = High Winds AND NAT-WINDS = SEVERE)
  THEN :: (13-NATURAL = Site Area Emergency)

RULE122
=======
  SUBJECT :: MODULE-13-RULES
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Volcano-related Events" AND
            NAT-VOLCANO = UNUSUAL )
  THEN :: (13-NATURAL = Unusual Event)

RULE123
=======
  SUBJECT :: MODULE-13-RULES
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Volcano-related Events" AND
            NAT-VOLCANO = SERIOUS )
  THEN :: (13-NATURAL = Alert)
```

```
=====================
MODULE-14-RULES
=====================

    RULE091
    =======
      SUBJECT :: MODULE-14-RULES
      IF    :: (! EXT-EXIST)
      THEN :: (MOD14-STEP1 = No Emergency Declared)

    RULE092
    =======
      SUBJECT :: MODULE-14-RULES
      IF    :: (EXT-EXIST AND ! EXT-SERIOUS-DMG)
      THEN :: (MOD14-STEP1 = Unusual Event)

    RULE093
    =======
      SUBJECT :: MODULE-14-RULES
      IF    :: (EXT-EXIST AND EXT-SERIOUS-DMG AND ! EXT-SEVERE-DMG)
      THEN :: (MOD14-STEP1 = Alert)

    RULE094
    =======
      SUBJECT :: MODULE-14-RULES
      IF    :: (EXT-EXIST AND EXT-SERIOUS-DMG AND EXT-SEVERE-DMG)
      THEN :: (MOD14-STEP1 = Site Area Emergency)

    RULE095
    =======
      SUBJECT :: MODULE-14-RULES
      IF    :: (! EXT-TOXIC1)
      THEN :: (MOD14-STEP4 = No Emergency Declared)

    RULE096
    =======
      SUBJECT :: MODULE-14-RULES
      IF    :: (EXT-TOXIC1 AND ! EXT-TOXIC2)
      THEN :: (MOD14-STEP4 = Unusual Event)

    RULE097
    =======
      SUBJECT :: MODULE-14-RULES
      IF    :: (EXT-TOXIC1 AND EXT-TOXIC2 AND ! EXT-TOXIC3)
      THEN :: (MOD14-STEP4 = Alert)

    RULE098
    =======
      SUBJECT :: MODULE-14-RULES
      IF    :: (EXT-TOXIC1 AND EXT-TOXIC2 AND EXT-TOXIC3)
      THEN :: (MOD14-STEP4 = Site Area Emergency)

    RULE099
    =======
      SUBJECT :: MODULE-14-RULES
      IF    :: (FINDOUT MOD14-STEP1 AND FINDOUT MOD14-STEP4)
      THEN :: (14-EXTERNAL = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD14-STEP1)
                (VAL1 FRAME MOD14-STEP4 ) ) ) ) )
```

```
=====================
MODULE-15-RULES
=====================

    RULE100
    =======
      SUBJECT :: MODULE-15-RULES
      IF    :: (! INT-TURBINE-SD)
      THEN :: (MOD15-STEP1 = No Emergency Declared)

    RULE101
    =======
      SUBJECT :: MODULE-15-RULES
      IF    :: (INT-TURBINE-SD AND ! INT-TURBINE-CP)
      THEN :: (MOD15-STEP1 = Unusual Event)

    RULE102
    =======
      SUBJECT :: MODULE-15-RULES
      IF    :: (INT-TURBINE-SD AND INT-TURBINE-CP)
      THEN :: (MOD15-STEP1 = Alert)

    RULE103
    =======
      SUBJECT :: MODULE-15-RULES
      IF    :: (! INT-OTHER1)
      THEN :: (MOD15-STEP3 = No Emergency Declared)

    RULE104
    =======
      SUBJECT :: MODULE-15-RULES
      IF    :: (INT-OTHER1 AND ! INT-OTHER2)
      THEN :: (MOD15-STEP3 = Unusual Event)

    RULE105
    =======
      SUBJECT :: MODULE-15-RULES
      IF    :: (INT-OTHER1 AND INT-OTHER2 AND ! INT-OTHER3)
      THEN :: (MOD15-STEP3 = Alert)

    RULE106
    =======
      SUBJECT :: MODULE-15-RULES
      IF    :: (INT-OTHER1 AND INT-OTHER2 AND INT-OTHER3)
      THEN :: (MOD15-STEP3 = Site Area Emergency)

    RULE107
    =======
      SUBJECT :: MODULE-15-RULES
      IF    :: (FINDOUT MOD15-STEP1 AND FINDOUT MOD15-STEP3)
      THEN :: (15-INTERNAL = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD15-STEP1)
                (VAL1 FRAME MOD15-STEP3 ) ) ) ) )
```

```
================
META-RULES
================

    MRULE001
    ========
      SUBJECT :: META-RULES
      IF    :: (! (TOPICS = All) AND ! (TOPICS = "Radiological Effluent Release"
                ) )
      THEN :: (01-RELEASE = NOT CONSIDERED)

    MRULE002
    ========
      SUBJECT :: META-RULES
      IF    :: (! (TOPICS = All) AND ! (TOPICS = "Loss of Fission Product
                Barrier" ) )
      THEN :: (02-FPBARRIER = NOT CONSIDERED)

    MRULE003
    ========
      SUBJECT :: META-RULES
      IF    :: (! (TOPICS = All) AND ! (TOPICS = Steam Line Break) AND ! (
                TOPICS = "Main Steam Safety or Relief Valve Failure" ) )
      THEN :: (03-STEAM = NOT CONSIDERED)

    MRULE004
    ========
      SUBJECT :: META-RULES
      IF    :: (! (TOPICS = All) AND ! (TOPICS = "Primary or
                Primary-to-Secondary Leakage" ) AND ! (TOPICS = "Pressurizer
                Safety or Relief Valve Failure" ) )
      THEN :: (04-PRIMARY = NOT CONSIDERED)

    MRULE005
    ========
      SUBJECT :: META-RULES
      IF    :: (! (TOPICS = All) AND ! (TOPICS = Loss of Power or Alarms))
      THEN :: (05-POWER = NOT CONSIDERED)

    MRULE006
    ========
      SUBJECT :: META-RULES
      IF    :: (! (TOPICS = All) AND ! (TOPICS = Loss of Feedwater))
      THEN :: (06-FEEDWATER = NOT CONSIDERED)

    MRULE007
    ========
      SUBJECT :: META-RULES
      IF    :: (! (TOPICS = All) AND ! (TOPICS = Other Limiting Conditions))
      THEN :: (07-OTHER = NOT CONSIDERED)

    MRULE008
    ========
      SUBJECT :: META-RULES
      IF    :: (! (TOPICS = All) AND ! (TOPICS = "Reactor Protection System
                Failure" ) )
      THEN :: (08-RPS-FAIL = NOT CONSIDERED)

    MRULE009
    ========
      SUBJECT :: META-RULES
      IF    :: (! (TOPICS = All) AND ! (TOPICS = Fuel Handling Accident))
      THEN :: (09-FUEL = NOT CONSIDERED)
```

```
MRULE010
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Control Room Evacuation))
  THEN :: (10-CR-EVAC = NOT CONSIDERED)

MRULE011
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Fire))
  THEN :: (11-FIRE = NOT CONSIDERED)

MRULE012
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Security Threat))
  THEN :: (12-SECURITY = NOT CONSIDERED)

MRULE013
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Natural Phenomena))
  THEN :: (13-NATURAL = NOT CONSIDERED)

MRULE014
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = External Hazards))
  THEN :: (14-EXTERNAL = NOT CONSIDERED)

MRULE015
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Internal Hazards))
  THEN :: (15-INTERNAL = NOT CONSIDERED)
```

APPENDIX C
EM-CLASS Operating Instructions

License Requirements

EM-CLASS was developed using the Personal Consultant Plus‰ software development package by Texas Instruments. A Runtime diskette for Personal Consultant Plus is required to use EM-CLASS.

Equipment Requirements

EM-CLASS requires an IBM-AT or compatible computer with a CGA or EGA video interface. 1 Mb of extended or expanded memory is also required.

Loading Instructions

To start EM-CLASS, place the diskette in a high-density disk drive. Change the default directory to that drive.

To load and start the expanded memory version, enter

runexp em2-2

To load and start the extended memory version, enter

runext em2-2

If the program is to be run from a hard drive, copy all files from the EM-CLASS diskette to a new directory and change the default to that new directory before entering the commands listed above.

It will require several minutes for the program to load. After loading, a title screen will appear. Press the RETURN/ENTER key to start the consultation.

Consultation Procedures

During the consultation, the user enters responses to questions posed by EM-CLASS. EM-CLASS will determine the applicable emergency classification level based on the input provided.

Most of the user input is limited to selection of one or more items from a menu or list. Some user input requires entering a number. Specific directions for entering information are listed at the bottom of each screen.

If a HELP screen is available, a notification is written in the text of the questions. The HELP screen is accessed by pressing the **F1** key. After viewing the information on the HELP screen, press the RETURN/ENTER key to continue the consultation.

If extended memory is being used and the consultation becomes slow and unresponsive, press the **F4** key. This causes a compacted garbage collection which results in an increase in speed.

Consultation Commands

A number of commands are available during the consultation:

CONTINUE	Erases the commands menu and returns to the consultation.

GET PLAYBACK FILE	Loads a partial or complete consultation record previously saved with the SAVE PLAYBACK FILE command.
HOW	Explains how values for parameters have been determined.
NEW START	Aborts the current consultation, and begins again.
PRINT CONCLUSIONS	Prints a record of responses to the prompts during the consultation. This record can be printed to the screen, a printer, or a disk file.
QUIT	Exits the current consultation and returns to DOS.
REVIEW	Displays the list of parameters prompted for so far in the consultation, along with the responses entered. This command allows you to modify selected responses and rerun the consultation.
SAVE PLAYBACK FILE	Saves a record of a partial or complete consultation.
TRACE ON/OFF	Turns on/off a trace feature, writing a copy of the trace file to the screen, a printer, or a disk file.
WHY	Explains why EM-CLASS needs the information being asked.

A menu listing the commands can be accessed at any time during the consultation by pressing the **F2** key. The

availability of the commands changes during the consultation; only those commands currently available will be listed in the commands menu when accessed.

A user familiar with these commands can access them by holding down the **ALT** key, than pressing the first letter of the command. For example, the Review screen can be called up by pressing **ALT-R**.