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

Joan Oylear Heaberlin

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Joan O. Heaberon, Author
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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 sections 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


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

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

![Knowledge-Based System Components](image)

**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 straightforward 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 is 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.

![Diagram of knowledge base structure]

**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:

\[
\text{IF} \ (\text{ESF}) \ \\
\text{THEN} \ (\text{CLASS} = "\text{Unusual Event}"
\]

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 EmergencyDeclared", "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

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

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

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Update</td>
<td>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 &quot;REVIEW&quot; function.)</td>
</tr>
<tr>
<td>Record</td>
<td>Provide a written record of data input and the emergency classification selected. (Capability exists in PCPlus as a &quot;PLAYBACK&quot; function that can be stored as a text file or printed as hardcopy.)</td>
</tr>
<tr>
<td>Explain</td>
<td>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.)</td>
</tr>
<tr>
<td>Help</td>
<td>Ability to provide additional information to 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.)</td>
</tr>
</tbody>
</table>
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:

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Straight</th>
<th>Branching</th>
<th>Single</th>
<th>Multiple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 2</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 3</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 4</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 5</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 6</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Module 7</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 8</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 9</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 10</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
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<tr>
<td>Module 11</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 12</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 13</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 14</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Module 15</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

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 NOTIFICATION 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.
REFERENCES


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 :: SINGLEVALED
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 :: SINGLEVALED
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 :: SINGLEVALED
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 :: SINGLEVALED
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 :: SINGLEVALED
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? Answer YES if any one of the following is true -- Loss of all three AFW Pumps, Modes 1, 2 and 3 OR 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? MPC for iodine: 1 E-8 microCi/cc MPC for particulate: 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)
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 [Pasquill 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-H11

TRANSLATION :: (ARMS 1-5, 7-10, or 12-14 >2.5R/hr)
PROMPT :: (Are any of the following ARMs measuring > 2.5 R/hr? :left 3 :line 2 :left 3 ARM 1-5 :line ARM 7-10 :line ARM 12-14)

TYPE :: YES/NO
USED-BY :: (RULE200)

ARMS-H12

TRANSLATION :: (ARMS 6, 16, or 17 >100 R/hr)
PROMPT :: (Are any of the following ARMs measuring > 100 R/hr? :left 3 :line 2 :left 3 ARM 6 :line ARM 16 :line ARM 17)

TYPE :: YES/NO
USED-BY :: (RULE201)

ARMS-H13

TRANSLATION :: (ARM-11 exposure rate > 10 mR/hr)
PROMPT :: (Is ARM-11 measuring > 10 mR/hr?)

TYPE :: YES/NO
USED-BY :: (RULE202)

ARMS-H14

TRANSLATION :: (ARMS 18, 19, or 25 > 15 R/hr)
PROMPT :: (Are any of the following ARMs measuring > 15 R/hr? :left 3 :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-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 (white) LIMIT B :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 (yellow) if :attr (cyan) 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 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? Answer: YES if ANY ONE of the following is true -- Toxic or flammable gas release of a magnitude that threatens personnel, as determined by the Shift Supervisor. OR 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? Answer: YES if ANY ONE of the following is true -- Indications by observations or warning from outside the plant of toxic or flammable gases entering a vital area. OR Detection of gases in a vital area in concentrations which exceed either the limits of flammability 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? Answer: YES if ALL of the following are true -- 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. Lack of access to the area renders a safety-related system inoperable or potential for fire or explosion in the area is great.

TYPE : YES/NO

USED-BY : RULE097 RULE098

HELP : Ammonia : 100 ppm, SO-2 : 5 ppm, Chlorine : 15 ppm

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?)

ANY ONE of the following is true -- Observation of fire lasting > 10 minutes. 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 safety systems)
PROMPT :: (In the judgement 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? Answer: YES if ANY ONE of the following is true: Loss or imminent loss of fuel cladding OR Loss or imminent loss of RCS pressure boundary resulting in leakage >50 GPM OR 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? Answer: YES if ANY TWO of the following is true: Loss of fuel cladding OR Loss or imminent loss of RCS pressure boundary resulting in leakage >50 GPM OR 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]. [Press "F1" for help.])
TYPE :: SINGLEVALUED
EXPECT :: POSITIVE-NUMBER
USED-BY :: (RULE165 RULE166 RULE183)
HELP :: (:attr (cyan) Enter a positive integer value. Example: 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 >2.4E-4 Ci/sec for 0.5 hr or >2.4E-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? Answer: YES if ANY ONE of the following is true -- Require plant shutdown under Technical Specification requirements. 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 discretion
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 discretion 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 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
: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 :: (Emergency class for Mod 4, entry Step 5&6)
TYPE :: SINGLEVALUED
UPDATED-BY :: (RULE026 RULE027 RULE028 RULE029 RULE030 RULE031)
USED-BY :: (RULE032)

MOD5-STEP1

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

MOD5-STEP5

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

MOD5-STEP7

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

MOD7-STEP1

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

MOD7-STEP2

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

MOD7-STEP3

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

MOD7-STEP4

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

MOD7-STEP5

TRANSLATION :: (Emergency 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 "Fl" 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 "Fl" 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 instrumentation 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 :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 RULE151 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)

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)

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? Answer: YES if ALL of the following are true:
- DC bus undervoltage alarms on all buses
- Loss of 12.47-kV and 4.16-kV position indicator lamps
- 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?

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 alarm 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 alarm 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)

BHR

TRANSLATION :: (BHR 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 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? [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 RULE130 RULE134)

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 :: "Module 1, 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? If any one of the following is true -- Reactor pressure is greater than safety valve setpoint OR Containment pressure is rapidly increasing OR 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? If both of the following are true -- Plant conditions indicate required conditions for reactor trip OR Required coincidence of bistables have tripped OR Trip is manually actuated OR Control rods do not drop into core Reactor returns to criticality after trip)

TYPE :: YES/NO
UPDATED-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
UPDATED-BY :: (RULE209 RULE210)

RT-LOW-P

TRANSLATION :: (Manual or automatic reactor trip)
PROMPT :: (Is there a manual or automatic reactor trip?)
TYPE :: YES/NO
UPDATED-BY :: (RULE198)
RVLIS

TRANSLATION :: (RVLIS 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-01

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-02

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? [Can SIS be verified with redundant instrumentation?] )
TYPE :: YES/NO
USED-BY :: (RULE132 RULE136)

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 :: (RULE132 RULE136)

ST-FLOW-INC

TRANSLATION :: (Steam flow increase)
PROMPT :: (Is there an increase in the steam flow?)
TYPE :: YES/NO
USED-BY :: (RULE132 RULE136)

ST-HIGH-SIS

TRANSLATION :: (High steam flow safety injection signal)
PROMPT :: (Is there a High steam flow safety injection signal?)
TYPE :: YES/NO
USED-BY :: (RULE132 RULE136)

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 :: (RULE132 RULE136)
USED-BY :: (RULE132 RULE136)
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 :: (Psorz 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 :: SINGLEVALED
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 ET-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.
RULE001

SUBJECT :: GENERAL-RULES
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
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
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-FPPBARRIER

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 )
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-LIMIT2)
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 :: (FRM-1C = >9.9E3 cpm)
THEN :: (RLS-EXC-1HR)

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

RULE132
==========
SUBJECT :: MODULE-01-RULES
UTILITY :: 58
IF :: (FRM-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 :: (FRM-1C = >9.9E4 cpm)
THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE135
==========
SUBJECT :: MODULE-01-RULES
UTILITY :: 60
IF :: (FRM-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 :: (FRM-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-6C)
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)
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)
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-02)
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)
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)
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-BCCS)

RULE200
======
SUBJECT :: MODULE-07-RULES
IF :: (ARMS-H11)
THEN :: (LMT-ACTIVITY)

RULE201
======
SUBJECT :: MODULE-07-RULES
IF :: (ARMS-H12)
THEN :: (LMT-ACTIVITY)

RULE202
======
SUBJECT :: MODULE-07-RULES
IF :: (ARMS-H13)
THEN :: (LMT-ACTIVITY)

RULE203
======
SUBJECT :: MODULE-07-RULES
IF :: (ARMS-H14)
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)
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)
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 = "Fuel Building" AND (PRM2-HI OR PRM3-HI OR ARM12/13-HI ) AND FUEL-NUMBER )
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)
==

**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)
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 ) ) ) ) ) )
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)
(VALL FRAME MOD15-STEP3 ) ) ) ) )}
<table>
<thead>
<tr>
<th>Rule No.</th>
<th>Subject</th>
<th>Condition</th>
<th>THEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRULE001</td>
<td>META-RULES</td>
<td>(! (TOPICS = All) AND (TOPICS = &quot;Radiological Effluent Release&quot;) )</td>
<td>(01-RELEASE = NOT CONSIDERED)</td>
</tr>
<tr>
<td>MRULE002</td>
<td>META-RULES</td>
<td>(! (TOPICS = All) AND (TOPICS = &quot;Loss of Fission Product Barrier&quot;) )</td>
<td>(02-PPBARRIER = NOT CONSIDERED)</td>
</tr>
<tr>
<td>MRULE003</td>
<td>META-RULES</td>
<td>(! (TOPICS = All) AND (TOPICS = &quot;Steam Line Break&quot;) AND (TOPICS = &quot;Main Steam Safety or Relief Valve Failure&quot;) )</td>
<td>(03-STEAM = NOT CONSIDERED)</td>
</tr>
<tr>
<td>MRULE004</td>
<td>META-RULES</td>
<td>(! (TOPICS = All) AND (TOPICS = &quot;Primary or Primary-to-Secondary Leakage&quot;) AND (TOPICS = &quot;Pressurizer Safety or Relief Valve Failure&quot;) )</td>
<td>(04-PRIMARY = NOT CONSIDERED)</td>
</tr>
<tr>
<td>MRULE005</td>
<td>META-RULES</td>
<td>(! (TOPICS = All) AND (TOPICS = &quot;Loss of Power or Alarms&quot;) )</td>
<td>(05-POWER = NOT CONSIDERED)</td>
</tr>
<tr>
<td>MRULE006</td>
<td>META-RULES</td>
<td>(! (TOPICS = All) AND (TOPICS = &quot;Loss of Feedwater&quot;) )</td>
<td>(06-FEEDWATER = NOT CONSIDERED)</td>
</tr>
<tr>
<td>MRULE007</td>
<td>META-RULES</td>
<td>(! (TOPICS = All) AND (TOPICS = &quot;Other Limiting Conditions&quot;) )</td>
<td>(07-OTHER = NOT CONSIDERED)</td>
</tr>
<tr>
<td>MRULE008</td>
<td>META-RULES</td>
<td>(! (TOPICS = All) AND (TOPICS = &quot;Reactor Protection System Failure&quot;) )</td>
<td>(08-RPS-FAIL = NOT CONSIDERED)</td>
</tr>
<tr>
<td>MRULE009</td>
<td>META-RULES</td>
<td>(! (TOPICS = All) AND (TOPICS = &quot;Fuel Handling Accident&quot;) )</td>
<td>(09-FUEL = NOT CONSIDERED)</td>
</tr>
</tbody>
</table>
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)
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

\texttt{runexp \textasciitilde em2-2}

To load and start the extended memory version, enter

\texttt{runext \textasciitilde 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**.