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Review and Development of Common Nomenclature for Naming and Labeling Schemes for Probabilistic Risk Assessment

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Prepared for
U.S. Nuclear Regulatory Commission

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ABSTRACT

This report describes the review and development of common nomenclature for naming and labeling schemes for probabilistic risk assessments (PRAs) conducted by the Idaho National Engineering Laboratory (INEL). Based on the review, the INEL recommends using an existing basic event labeling scheme and existing naming schemes for systems, component types, and component failure modes. The review showed no adequate accident sequence labeling schemes currently exist. Therefore, the INEL developed a scheme that would meet the review requirements of not exceeding 16 characters and being highly descriptive of the accident sequence involved. As parts of the developed accident sequence labeling scheme, the INEL also developed transient and loss-of-coolant accident initiating event codes, a sequence naming scheme, and accident type codes. Applications of the accident sequence labeling scheme are presented along with tables to allow changes from other schemes to the recommended naming schemes. The review and development were conducted to provide the Nuclear Regulatory Commission with the means to coordinate and integrate their internal activities through a common nomenclature for their many data bases.

FIN A6860—Common System and Component Nomenclature

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EXECUTIVE SUMMARY

This report documents a review of selected naming and labeling schemes employed throughout the nuclear industry conducted by the Idaho National Engineering Laboratory (INEL) for the Nuclear Regulatory Commission (NRC). The objective of the review was to recommend the use of existing naming and labeling schemes that are the most informative and easiest to understand. If no existing scheme in an area of interest could be considered a candidate, a new scheme was developed to meet the NRC's information requirements.

Naming schemes are abbreviated names or codes used to identify systems, component types, and component failure modes. Labeling schemes are codes used to describe basic events or accident sequences and are primarily associated with probabilistic risk assessment (PRA) activities requiring the use of computer codes such as the Integrated Reliability and Risk Assessment System, the System Analysis and Risk Assessment, and the Set Equation Transformation System.

Seven nuclear industry sources were reviewed for candidate naming schemes for systems, component types, and component failure modes. The NUREG/CR-4550, *Analysis of Core Damage Frequency: Internal Events Methodology*, naming schemes for systems (with added differentiation by plant type, component types, and component failure modes) were recommended to meet the NRC's needs.

Six PRA-related nuclear industry sources were reviewed for candidate basic event and accident sequence labeling schemes. A candidate basic event labeling scheme, also from NUREG/CR-4550, uses the previously recommended naming schemes and was recommended to meet the NRC's needs.

The review did not find any accident sequence labeling schemes that met both the NRC's and the current PRA software's requirements. As a result, an accident sequence labeling scheme was developed that consists of an initiating event name, a sequence name, and, if the sequence remains dominant, an accident type classifier.

If implemented, these naming and labeling schemes will provide the NRC with the means to present data from its data bases in a common nomenclature and will aid in both the review of PRAs and in the comparison of their results.

ACRONYMS

BWR Boiling Water Reactor

FW Feedwater

IEEE Institute of Electrical and Electronic Engineers

INEL Idaho National Engineering Laboratory

IRRAS Integrated Reliability and Risk Assessment System

LER Licensee Event Report

LOCA Loss-of-Coolant Accident

NPRDS Nuclear Plant Reliability Data System

NRC Nuclear Regulatory Commission

NSSS Nuclear Steam Supply System

NUCLARR Nuclear Computerized Library for Assessing Reactor Reliability

PCS Power Conversion System

PRA Probabilistic Risk Assessment

PWR Pressurized Water Reactor

SARA System Analysis and Risk Assessment

SETS Set Equation Transformation System

Review and Development of Common Nomenclature for Naming and Labeling Schemes for Probabilistic Risk Assessment

1. INTRODUCTION

Numerous naming and labeling schemes have been developed for use with different data bases to identify plant systems, component types, component failure modes, and event-related data. With the integration of its many data bases, the Nuclear Regulatory Commission (NRC) recognized a need for a common nomenclature for naming and labeling schemes. Such schemes would aid in the use of these data bases through the NRC's Safety Information Network.

This report documents a review of selected naming and labeling schemes employed throughout the nuclear industry conducted by the Idaho National Engineering Laboratory (INEL) for the NRC. The objective of the review was to investigate possible options and to recommend the use of one of several existing naming and labeling schemes that would be the most informative and easiest to understand. If no existing scheme in an area of interest could be considered a candidate, a new scheme was developed to meet the NRC's information requirements.

Naming schemes are abbreviated names or codes used to identify systems, component types, and component failure modes. Labeling schemes are codes used to describe basic events or accident sequences and are primarily associated with probabilistic risk assessment (PRA) activities requiring the use of computer codes such as the Integrated Reliability and Risk Assessment System (IRRAS),[1] the System Analysis and Risk Assessment (SARA),[2] or the Set Equation Transformation System (SETS).[3]

The following seven nuclear industry data sources were selected for the system, component type, and component failure mode reviews:

1. *Analysis of Core Damage Frequency: Internal Events Methodology* (NUREG/CR-4550, Vol. 1)[4]
2. Institute of Electrical and Electronic Engineers (IEEE) Recommended Practice for System Identification in Nuclear Power Plants and Related Facilities (IEEE Standard 805-1984)[5]
3. IEEE Recommended Practice for Unique Identification in Power Plants and Related Facilities-Component Function Identifiers (IEEE Standard 803A-1983)[6]
4. *Licensee Event Report System, Description and Guidelines for Reporting*[7]
5. Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR)[8]
6. Nuclear Plant Reliability Data System (NPRDS)[9]
7. *Sequence Coding and Search System for Licensee Event Reports, Coding Manual* (NUREG/CR-3905).[10]

The following six nuclear industry data sources were selected for the PRA-related labeling schemes review:

1. *ATWS: A Reappraisal, Part 3: Frequency of Anticipated Transients* (EPRI NP-2230)[11]
2. *Development Of Transient Initiating Event Frequencies for Use in Probabilistic Risk Assessments* (NUREG/CR-3862)[12]
3. *Interim Reliability Evaluation Program Procedures Guide* (NUREG/CR-2728)[13]

4. *Probabilistic Safety Analysis Procedures Guide* (NUREG/CR-2815)[14]

5. *Analysis of Core Damage Frequency: Internal Events Methodology* (NUREG/CR-4550)[4]

6. *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants* (WASH-1400).[15]

The system naming schemes of IEEE Standard 805, NPRDS, NUREG/CR-4550 and NUREG/CR-3905 are discusse[illegible]. The component type naming schemes [illegible] Standard 803A, NPRDS, NUCLA[illegible] NUREG/CR-4450 are rev[illegible] component failure mode nar[illegible] NUCLARR and NUREG/CR-4550 are discussed in Section 4. PRA-related labeling schemes for basic events and accident sequences from various sources are discussed in Section 5. Section 6 gives the review recommendations for candidate naming and labeling schemes. The references used in the review are listed in Section 7. Tables for converting to the common nomenclature from other naming and labeling schemes are found in Appendix A.

Common nomenclature recommendations given herein are designed for other uses—not just for use in PRAs. Thus, these naming and labeling schemes can assist any analyst in such activities as data searches, trend analyses, safety studies, as well as PRAs.

2. SYSTEM NAMING SCHEMES REVIEW

This section presents a review of system naming schemes from selected data sources. The purpose of the review was to see if a system naming scheme existed wherein the code or acronym used would readily identify the system to the user and not require the use of a table or list for interpretation. If the existing naming schemes were found to be inadequate, a new system naming scheme would be developed.

Each data source was reviewed in detail for candidate system naming schemes. To simplify the presentation and to provide a means of comparison among the sources reviewed, 10 systems were selected from the analyses done for *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants* (NUREG-1150).[16] The systems chosen represent a sample of the systems whose components are important to the overall plant models for the five NUREG-1150 power plants. The 10 systems used in the following comparisons are:

1. ac electrical power
2. Automatic depressurization in boiling water reactor (BWR)
3. dc electrical power
4. High pressure coolant injection (BWR)
5. High pressure safety injection in pressurized water reactor (PWR)
6. High pressure recirculation
7. Low pressure coolant injection (BWR)
8. Low pressure safety injection (PWR)
9. Low pressure recirculation
10. Service water.

The following subsections present the reviews of the selected sources for candidate system naming schemes

2.1 IEEE Standard 805-1984

The IEEE Standard 805 system naming scheme uses a two-character code to represent the systems in nuclear facilities. These same system codes are used by the Licensee Event Report (LER) System and NUCLARR. The IEEE Standard 805 systems codes are not abbreviations or acronyms of the system names, and the user must refer to a list of code definitions to determine the system. The IEEE Standard 805 system codes for the selected systems are shown in Table 1. As Table 1 shows, IEEE Standard 805 only has codes for 7 of the 10 systems.

2.2 NPRDS

NPRDS uses three- and six-letter codes to represent plant systems. The system codes used are based on the nuclear steam supply system (NSSS) vendor. Thus, there are different codes for each NSSS vendor for the same system. For example, as shown in Table 2, the code for the ac electrical power system is EEC for a Babcock & Wilcox plant, EED for a Combustion Engineering plant, EEA for a General Electric plant, and EEB at a Westinghouse plant. A system naming scheme such as this introduces an additional confusion factor beyond the system not being readily identified by the code because the NSSS vendor must also be known to identify the system. Table 2 also shows NPRDS only has codes for 7 of the 10 systems.

2.3 NUREG/CR-4550

The NUREG/CR-4550 system naming scheme uses three-letter acronyms to represent plant systems. Because acronyms of the systems are used, there is less need to refer to a list of descriptions to interpret them than with previously discussed system naming schemes. However, this naming scheme does not characterize the system by plant type (BWR versus PWR). The NUREG/CR-45450 acronyms for the selected systems are given in Table 3.

Table 1. IEEE Standard 805-1984 system codes for 10 selected systems.

System descriptions	IEEE Standard 805 system codes
ac electrical power	EK
Automatic depressurization	—
dc electrical power	EJ
High pressure coolant injection (BWR)	BJ
High pressure safety injection (PWR)	BQ
High pressure recirculation	—
Low pressure coolant injection (BWR)	BO
Low pressure safety injection (PWR)	BP
Low pressure recirculation	—
Service water	BI

Table 2. NPRDS system codes by NSSS vendor for 10 selected systems.

System descriptions	NPRDS system codes			
	B&W[a]	CE[b]	GE[c]	W[d]
ac electrical power	EEC	EED	EEA	EEB
Automatic depressurization	—	—	—	—
dc electrical power	ECD	ECE	ECB	—
High pressure coolant injection (BWR)	—	—	SFC	—
High pressure safety injection (PWR)	SFD	SFG	—	SFK
High pressure recirculation	—	—	—	—
Low pressure coolant injection (BWR)	—	—	CFA	—
Low pressure safety injection (PWR)	CFC	CFD	—	CFF
Low pressure recirculation	—	—	—	—
Service water	WAB	WAC	WAA	WAD

a. Babcock & Wilcox

b. Combustion Engineering

c. General Electric

d. Westinghouse

Table 3. NUREG/CR-4550 system codes for 10 selected systems.

System descriptions	NUREG/CR-4550 system codes
ac electrical power	ACP
Automatic depressurization	ADS
dc electrical power	DCP
High pressure coolant injection (BWR)	HCI
High pressure safety injection (PWR)	HPI
High pressure recirculation	HPR
Low pressure coolant injection (BWR)	LCI
Low pressure safety injection (PWR)	LPI
Low pressure recirculation	LPR
Service water	SWS

2.4 NUREG/CR-3905

The NUREG/CR-3905 system naming scheme also uses a two-character code similar to, but different from, the IEEE Standard 805 codes to represent the systems in nuclear facilities. The systems codes are not abbreviations or acronyms of the system names, and the user must refer to a list of code definitions to determine the system. NUREG/CR-3905 system codes for the selected systems are shown in Table 4. Table 4 only has codes for 7 of the 10 systems and some systems have multiple codes.

Table 4. NUREG/CR-3905 system codes for 10 selected systems.

System descriptions	NUREG/CR-3905 system codes
ac electrical power	EA, EB, EC
Automatic depressurization	—
dc electrical power	EE
High pressure coolant injection (BWR)	BU, DB
High pressure safety injection (PWR)	BO, BK, BT, BL, BT, DB
High pressure recirculation	—
Low pressure coolant injection (BWR)	BH, DB
Low pressure safety injection (PWR)	BF, BS, CD, DB
Low pressure recirculation	—
Service water	CB, DB

3. COMPONENT TYPE NAMING SCHEMES REVIEW

Component type naming schemes from selected data sources are reviewed in this section. The purpose of this review, like the system naming scheme review, was to see if a component type naming scheme existed wherein the component code used would readily identify the component to the user and not require a description list for interpretation. If the existing naming schemes were found to be inadequate, a new scheme would be developed.

Each data source was examined in detail for candidate component type naming schemes. To simplify the presentation and to provide a means of comparison among the sources reviewed, 10 component types were selected from the analyses done for NUREG-1150. The component types chosen represent a sample of the components that are important to the overall plant models for the five NUREG-1150 power plants. The 10 component types used in the following comparisons are:

1. Air operated valve
2. Battery
3. Check valve
4. Circuit breaker
5. Diesel generator
6. Motor driven pump
7. Motor operated valve
8. Transformer
9. Turbine driven pump
10. Ventilation fan.

The following subsections describe the reviews of the selected data sources for candidate component type naming schemes.

3.1 IEEE Standard 803A-1983

The IEEE Standard 803A component identifier is based on the normal or characteristic action of the component within the system of which it is a part rather than on the component type used by the other data sources. The IEEE Standard 803A naming scheme uses one- to four-character codes to represent the component functions in nuclear and related facilities. These component function codes are used by the LER System and NUREG/CR-3905. The IEEE Standard 803A component function codes are, in most cases, combinations of the abbreviations of the component function and the component name. Thus, the component and its function can be easily determined from the code, and the analyst does not have to refer to a list for interpretation. The IEEE Standard 803A component codes for the 10 selected components are shown in Table 5. Table 5 shows that IEEE Standard 803A only has codes for 5 of the 10 components, and there is no differentiation of motive force for pumps. This may lead to confusion as to which pump is of interest in a PRA.

3.2 NPRDS

The NPRDS component type naming scheme uses four-, five-, and six-letter abbreviations to identify nuclear plant components. In some cases, the component type code is not an abbreviation at all but is the component type name. These component type codes are very descriptive and do not require any interpretation. The NPRDS component type codes for the 10 selected components are shown in Table 6. Table 6 shows that the NPRDS only has codes for 7 of the 10 components and, like IEEE Standard 803A, there is no differentiation of pump or valve motive force.

3.3 NUCLARR

The component type naming scheme for NUCLARR uses five-letter abbreviations and acronyms as codes to identify plant components. The first three letters of the code classify the component as one of the 42 general types of mechanical or 33 general types of electrical components. The two additional characters of the five-letter

Table 5. IEEE Standard 803A-1983 component function codes for 10 selected components.

Component type descriptions	IEEE Standard 803A component codes
Air operated valve	—
Battery	BTRY
Check valve	—
Circuit breaker	BKR
Diesel generator	DG
Motor driven pump	P
Motor operated valve	—
Transformer	XFMR
Turbine driven pump	P
Ventilation fan	FAN

Table 6. NPRDS component type codes for 10 selected components.

Component type descriptions	NPRDS component codes
Air operated valve	VALVE
Battery	BATTRY
Check valve	VALVE
Circuit breaker	CKTBRK
Diesel generator	GENERA
Motor driven pump	PUMP
Motor operated valve	VALVE
Transformer	TRANSF
Turbine driven pump	PUMP
Ventilation fan	BLOWER

Table 7. NUCLARR component type codes for 10 selected components.

Component type descriptions	NUCLARR component codes
Air operated valve	VLP
Battery	BAT
Check valve	VLC
Circuit breaker	CBH/CBP
Diesel generator	GND
Motor driven pump	PPM
Motor operated valve	VLM
Transformer	XTP
Turbine driven pump	PPT
Ventilation fan	FVNFN

code classify the component in further detail. For example, in NUCLARR, the general code for a motor operated valve is VLM_ _. If the type of valve (e.g., ball, gate, or globe) is unknown, the complete code for the valve is VLMXX. The NUCLARR component type codes for the 10 selected components are given in Table 7.

3.4 NUREG/CR-4550

The component type naming scheme for NUREG/CR-4550 uses a combination of three-letter component type abbreviations and acronyms as component type codes. Some of the component type abbreviations and acronyms used are identical to those used by IEEE Standard 803A. This naming scheme allows the analyst to identify plant component types without referring to a list for interpretation. For example, the acronym AOV readily identifies an air-operated valve, and the abbreviation BAT readily identifies a battery. The NUREG/CR-4450 component type codes are given in Table 8.

Table 8. NUREG/CR-4550 component type codes for 10 selected components

Component type descriptions	NUREG/ CR-4550 component codes
Air operated valve	AOV
Battery	BAT
Check valve	CKV
Circuit breaker	CRB
Diesel generator	DGN
Motor driven pump	MDP
Motor operated valve	MOV
Transformer	TFW
Turbine driven pump	TDP
Ventilation fan	FAN

4. COMPONENT FAILURE MODE NAMING SCHEMES REVIEW

Component failure mode naming schemes from the selected sources are discussed in this section. The purpose of this review, like those of the system and component type reviews, was to determine if a component failure mode naming scheme existed wherein the failure mode code used would readily identify the failure mode to the user without requiring a list for interpretation. If the existing naming schemes were found to be inadequate, a new scheme would be developed.

Of all the data sources reviewed, only two, NUCLARR and NUREG/CR-4450, had detailed component failure naming schemes. Each data source was examined in detail for candidate component failure mode naming schemes. To simplify the presentation and to provide a means of comparison among the sources reviewed, 10 failure modes were selected from the analyses done for NUREG-1150. The failure modes chosen represent a sample of the component failure modes that are important to the overall plant models for the five NUREG-1150 power plants. The ten component failure modes used in the following comparisons are:

1. Fail to start
2. Fail to continue running
3. Fail to restore from test or maintenance
4. General hardware failure
5. Loss of power
6. Out of service due to maintenance
7. Normally closed, fail closed
8. Normally closed, fail open
9. Normally open, fail open
10. Plugged.

The following two subsections describe the reviews of the selected data sources for candidate component failure mode naming schemes.

4.1 NUCLARR

The NUCLARR component failure mode naming scheme uses two- and three-letter acronyms to represent component failure modes. The NUCLARR naming scheme divides the component failure modes into main categories and subcategories. The main categories, represented by three-letter acronyms, are fail to operate, spurious operation, leakage, and blockage. The subcategories describe each main category in further detail. The NUCLARR failure mode codes for the 10 selected failure modes are given in Table 9. Table 9 shows NUCLARR only has codes for 7 of the 10 failure modes.

4.2 NUREG/CR-4550

The NUREG/CR-4550 component failure mode naming scheme uses two-letter acronyms or abbreviations as failure mode codes. As acronyms or abbreviations, the codes are much easier to understand than the other failure mode naming scheme codes. The NUREG/CR-4550 component failure mode codes are given in Table 10.

Table 9. NUCLARR component failure mode codes for 10 selected component failure modes.

Component failure mode descriptions	NUCLARR failure mode codes
Fail to start	FTS
Fail to continue running	FTR
Fail to restore from test or maintenance	—
General hardware failure	—
Loss of power	SD
Out of service due to maintenance	—
Normally closed, fail closed	FTP
Normally closed, fail open	SP
Normally open, fail open	FTC
Plugged	PL

Table 10. NUREG/CR-4550 component failure mode codes for 10 selected failure modes.

Component failure mode descriptions	NUREG/CR-4550 failure mode codes
Fail to start	FS
Fail to continue running	FR
Fail to restore from test or maintenance	RE
General hardware failure	HW
Loss of power	LP
Out of service due to maintenance	MA
Normally closed, fail closed	CC
Normally closed, fail open	CO
Normally open, fail open	OO
Plugged	PG

5. PRA-RELATED LABELING SCHEMES REVIEW

In PRAs, labeling schemes are used to convey basic event and accident sequence information. Labeling schemes are generally associated with activities involving computer codes, but they also appear in the PRA final results as well. A basic event labeling scheme provides information about the system involved, the type of component involved, the component failure mode, and the unique component identifier. An accident sequence labeling scheme conveys information about (a) the sequence initiating event, (b) the event sequence involved, and, ideally, (c) the overall effect on the plant, if any, of the occurrence of that particular sequence.

The purpose of the review was to determine if any existing basic event and accident sequence labeling schemes meet the above criteria. If the existing labeling schemes proved to be inadequate, a new labeling scheme would be developed. A standard basic event and accident sequence labeling scheme would be of great benefit to the NRC as a means of integrating existing data bases and providing a common ground for all future NRC PRA-related activities.

5.1 Basic Event Labeling Schemes

A basic event labeling scheme has been developed over the years that reflects the flexibility of the systems modeling approach. The basic event label identifies the level to which each event is modeled (e.g., train, pipe segment, individual component, or human error) and the nature of the failure involved (specific, general, or detailed as appropriate for each system and each basic event). Today, PRA-related computer codes such as IRRAS, SARA, and SETS allow the use of up to 16 characters in the basic event labeling scheme to identify basic events for fault tree or accident sequence analyses.

Of the six PRA-related data sources reviewed, only one, NUREG/CR-4550, suggested a specific basic event labeling scheme. The NUREG/CR-4550 basic event labeling scheme consist of 16 characters in the following form: XXX-YYY-ZZ-AAAAA. In the basic event labeling scheme, three characters are used for the system code (XXX), three characters for the component type (YYY), two characters for the component failure mode (ZZ), and five characters for the unique component identifier (AAAAA). A basic event labeling scheme such as this meets the labeling scheme requirements and is readily understood by the user without the need to refer to lists for interpretation.

5.2 Accident Sequence Labeling Schemes

An accident sequence is a combination of events characterized by the occurrence of an initiating event followed by the subsequent success or failure of systems or actions that are required to mitigate the effects of the initiating event. Accident sequences are developed using event trees to denote what systems or actions must function in a given set of circumstances. An accident sequence labeling scheme should, therefore, clearly denote not only the initiating event but also the subsequent events. In addition, it should also indicate the effect, if any, of the occurrence of the sequence on the total plant model. A labeling scheme based upon total plant effects (accident types) may allow direct comparisons of different accident sequences at different plant types (BWR and PWR) as well as at different plants of the same type. Such a labeling scheme would be of great benefit to the NRC in the integration of its data bases as well as with future work.

The purpose of this review was to determine if there are any existing accident sequence labeling schemes that would meet the above criteria. If no candidate sequence labeling schemes could be found, then we would look at labeling schemes for the constituent parts of the ideal accident sequence labeling scheme: initiating events, sequence labels, and a accident type identifier. If no labeling schemes could be found for all ... or any of the parts of the desired scheme, a scheme or schemes would be developed to meet the information requirements.

In this section, accident sequence labeling schemes in general are reviewed along with naming schemes for the constituent parts of the ideal labeling scheme.

5.2.1 Accident Sequence Labeling Schemes. The *Interim Reliability Evaluation Program Procedures Guide* (NUREG/CR-2728), the *Probabilistic Safety Analysis Procedures Guide* (NUREG/CR-2815), NUREG/CR-4550, and the Reactor Safety Study (WASH-1400) all use a similar accident sequence labeling scheme. The basic composition of the label is the initiating event identifier followed by the system identifiers for the front-line systems that have failed in the sequence. An accident sequence name using this type of scheme has the general form IE_iF_j—F_n. The dissimilarities among the schemes occur in the identifiers used for the front-line systems. Such schemes are useful tools to identify the sequences in event trees, but they have three major drawbacks:

First, most computer codes used today to quantify accident sequences allow only 16 characters for the sequence name. In the large event tree/small fault tree PRA analysis approach, it is possible to have an accident sequence name that is not only longer than 16 characters, but is not unique in the first 16 characters. Such sequence name occurrences may cause some sequences to be overlooked and inaccurate results to be generated.

Second, because each source used its own identifiers for the initiating events and the front-line systems, identical sequences occurring at different plants would look completely different. This makes comparisons of sequences among plants very difficult, if not impossible.

Third, from an ideal sequence labeling viewpoint, none of the labeling schemes in any of the four sources listed above gives the slightest clue, from either the initiating event names or the lists of the front-line systems involved, as to the effect of the sequences on the overall plant. Not even when the dominant accident sequences are binned by similar effects is there a clear indication of a sequence's effect on the total plant from the sequence's name alone. That information can only be found by looking elsewhere in the PRA. Again, this makes interplant comparisons difficult at best.

5.2.2 Accident Sequence Labeling Scheme Component Parts. Because no candidate accident labeling scheme exists, we had to search for candidate naming schemes for the following component parts of the ideal accident sequence labeling scheme: initiating event names, sequence names, and accident type names.

5.2.2.1 Initiating Event Names. Initiating events represent those events that will result in undesired plant conditions. Initiating events include both transients, events that require rapid shutdown of the reactor because of the undesired condition, and loss-of-coolant accidents (LOCAs), events that result in a loss of reactor coolant inventory. In a PRA, initiating events applicable to the plant must be identified. The purpose of the initiating events review was to determine if any existing initiating event naming schemes provided unambiguous and consistent detail for initiating events. The review consisted of two parts: a review of transient event naming schemes and a review of LOCA naming schemes.

PRAs typically differentiate and group transients based on similarity of plant response. A transient event naming scheme must contain sufficient detail and consistency between plant types so that the applicable transients for a plant may be identified and grouped accordingly.

WASH-1400 grouped all likely and unlikely BWR and PWR transients into a single group, T, for each plant type. Because the plant does not respond the same to all transients, the analyst must either subdivide T into smaller groups with like responses or develop a generic transient event tree with the accompanying loss of detail. The WASH-1400 T transient lists for BWRs and PWRs are given in Tables 11 and 12, respectively.

Table 11. WASH-1400 BWR transient initiating events (T).

Likely initiating events

1. Rod withdrawal at power
2. Feedwater controller failure (maximum demand)
3. Recirculation flow control failure (increasing flow)
4. Start-up of idle recirculation pump
5. Loss of feedwater heating
6. Inadvertent high pressure coolant injection pump start
7. Loss of auxiliary power
8. Loss of feedwater flow
9. Electric load rejection (turbine valve closure)
10. Turbine trip (stop valve closure)
11. Main steam line isolation valve closure
12. Recirculation flow control failure (decreasing flow)
13. Recirculation pump trip (one pump)
14. Recirculation pump seizure
15. T-G pressure regulator failure rapid opening

Unlikely initiating events

1. Rod ejection accident
2. Rod drop accident
3. Compound initiating events such as seizure of two recirculation pumps, start-up of idle recirculation pump simultaneously with turbine trip, and rod withdrawal and simultaneous start-up of idle recirculation loop.

Table 12. WASH-1400 PWR transient initiating events (T).

Likely initiating events

1. Turbine trip
2. Spurious trip
3. Loss of condenser vacuum
4. Inadvertent closure of main steam line isolation valves
5. Loss of main station generator with failure to relay auxiliary loads (e.g., main feedwater pumps and condensate pumps) to ac power incoming from offsite network
6. Loss of main circulating water pumps for condenser cooling
7. Loss of main feedwater pumps
8. Loss of condensate pumps
9. Loss of ac power incoming from offsite network
10. Inadvertent opening of steam generator power-operated relief valves (10% sudden demand)
11. Increase in main feedwater flow; malfunction in feedwater flow control
12. Malfunction of control resulting in inadvertent opening of all turbine steam bypass valves (40% sudden load demand)
13. Uncontrolled rod withdrawal (a) at full power and (b) at start-up
14. Control rod assembly drop
15. Boron dilution by malfunction in chemical volume and control system
16. Start-up of inactive reactor coolant loop (in PWR with no reactor coolant system loop isolation valves)
17. Accidental opening of pressurizer safety or relief valves
18. Loss of reactor coolant system coolant flow (main reactor coolant system circulating pump malfunctions)

Unlikely initiating events

1. Rupture of high energy piping in secondary coolant system
2. Rupture of steam generator
3. Rupture of control rod mechanism housing on reactor vessel leading to small LOCA and control rod drive ejection
4. Abrupt seizure of all main reactor cooling system recirculation pumps
5. Start-up of inactive reactor coolant loop with abrupt opening of both isolation valves in one reactor coolant system loop in PWR plants employing reactor coolant system isolation valves

The Electric Power Research Institute characterized a number of BWR and PWR transient types and developed actual statistics based on plant experience in EPRI NP-2300. EPRI NP-2230 transient categories provide more detail than WASH-1400; however, the detail in the categories is not consistent between BWRs and PWRs when similar systems exist. The NP-2230 transient event categories for BWRs and PWRs are given in Tables 13 and 14, respectively.

NUREG/CR 4550 uses the transient categories of NP-2230 and groups them into four categories for BWRs and three categories for PWRs. This provides the same number of transients as NP-2230 and more transient groupings than WASH-1400; however, the groupings are still too broad to be useful without further work. For example, grouping BWR feedwater transients as both T2A and [illegible] transients does not allow the analyst to study feedwater events as a separate functional transient grouping without additional effort. The NUREG/CR-4550 BWR and PWR transient event groups are given in Tables 15 and 16, respectively.

The suggested BWR and PWR transient categories given in NUREG/CR-3862 groups the transients by functional effect and demonstrates a consistent level of detail between plant types in the transient groupings. This functional grouping allows the analyst to determine whether or not an event is applicable to the particular plant, thereby ensuring that only the necessary transients are grouped for event tree modeling. However, the grouping of transients by functional effect in NUREG/CR-3862 may or may not agree with groupings used in actual PRAs. For example, the initiator group for a loss of feedwater event tree may include only those initiators affecting the entire feedwater system. Other initiators that involve only partial feedwater failures may be included in an initiator group such as transient with power conversion system (PCS) available. (This type of grouping was used in NUREG/CR-4550.) However, NUREG/CR-3862 includes all feedwater related initiators in the feedwater functional group. The NUREG/CR-3862 transient event categories for both plant types are given in Table 17.

PRAs typically differentiate LOCAs into groups for which plant response, in terms of required system operability, is the same or very similar. To be useful, a LOCA naming scheme must not only provide a range of break sizes for each LOCA category, but it must also state the break size in the same terms that the mitigating systems capacities are commonly expressed. For example, it is not immediately obvious to an analyst whether or not a charging system rated for 1500 gpm is capable of maintaining reactor coolant system inventory against an S2 LOCA defined as a break of 4 to 5 in.^{2}. Only two of the sources reviewed had LOCA naming schemes, and their review is presented below.

WASH-1400 classified LOCAs by their location and equivalent break diameter. There are six PWR and five BWR LOCA size categories:

1. BWR/PWR large LOCA (A), > 6 in. equivalent diameter
2. BWR/PWR small LOCA (S1), 2 to 6 in. equivalent diameter
3. BWR/PWR small LOCA (S2), 1/2 to 2 in. equivalent diameter
4. BWR/PWR reactor vessel rupture
5. PWR steam generator tube rupture
6. BWR/PWR interfacing system LOCA (V).

In NUREG/CR-4550, the LOCA initiating events are grouped according to common success criteria. The following BWR LOCA groups were identified:

- Large LOCA (A), steam or liquid break sizes of 0.1 ft^2 or larger
- Intermediate LOCA (S1), liquid breaks of 0.004 to 0.1 ft^2 and steam breaks of 0.05 to 0.1 ft^2
- Small LOCA (S2), liquid breaks < 0.004 ft^2 and steam breaks < 0.05 ft^2

Table 13. NP-2230 BWR transient initiating events.

1. Electric load rejection
2. Electric load rejection with turbine bypass valve failure
3. Turbine trip
4. Turbine trip with turbine bypass valve failure
5. Main steam isolation valve closure
6. Inadvertent closure of one main steam isolation valve
7. Partial main steam isolation valve closure
8. Loss of normal condenser vacuum
9. Pressure regulator fails open
10. Pressure regulator fails closed
11. Inadvertent opening of a safety/relief valve (stuck)
12. Turbine bypass fails open
13. Turbine bypass or control valves increase pressure (closed)
14. Recirculation control failure increasing flow
15. Recirculation control failure decreasing flow
16. Trip of one recirculation pump
17. Trip of all recirculation pumps
18. Abnormal start-up of idle recirculation pump
19. Recirculation pump seizure
20. Feedwater-increasing flow at power
21. Loss of feedwater heater
22. Loss of all feedwater
23. Trip of one feedwater pump (condensate pump)
24. Feedwater-low flow
25. Low feedwater flow during start-up or shutdown
26. High feedwater flow during start-up or shutdown
27. Rod withdrawal at power
28. High flux due to rod withdrawal at start-up
29. Inadvertent insertion of rod or rods
30. Detected fault in reactor protection system
31. Loss of offsite power
32. Loss of auxiliary power (loss of auxiliary transformer)
33. Inadvertent start-up of high pressure coolant injection/high pressure core spray systems
34. Scram due to plant occurrences
35. Spurious trip via instrumentation, reactor protection system fault
36. Manual scram, not out of tolerance condition
37. Cause unknown

Table 14. NP-2230 PWR transient initiating events.

1. Loss of reactor coolant system flow (one loop)
2. Uncontrolled rod withdrawal
3. Control rod drive mechanism problems and/or rod drop
4. Leakage from control rods
5. Leakage in primary system
6. Low pressure pressurizer
7. Pressurizer leakage
8. High pressurizer pressure
9. Inadvertent safety injection signal
10. Containment pressure problems
11. Chemical and volume control system malfunction—boron dilution
12. Pressure, temperature, power imbalance—rod position error
13. Start-up of inactive coolant pump
14. Total loss of reactor coolant system flow
15. Loss or reduction in feedwater flow (one loop)
16. Total loss of feedwater flow all loops
17. Full or partial closure of main steam isolation valve (one loop)
18. Closure of all main steam isolation valves
19. Increase in feedwater flow (one loop)
20. Increase in feedwater flow (all loops)
21. Feedwater flow instability—operator error
22. Feedwater flow instability—miscellaneous mechanical causes
23. Loss of condensate pumps (one loop)
24. Loss of condensate pumps (all loops)
25. Loss of condenser vacuum
26. Steam generator leakage
27. Condenser leakage
28. Miscellaneous leakage in secondary system
29. Sudden opening of steam relief valves
30. Loss of circulating water
31. Loss of component cooling
32. Loss of service water system
33. Turbine trip, throttle valve closure, electro-hydraulic control problems
34. Generator trip or generator caused faults
35. Loss of all offsite power
36. Pressurizer spray failure
37. Loss of power to necessary plant systems
38. Spurious trips—cause unknown
39. Automatic trip—no transient condition
40. Manual trip—not transient condition
41. Fire within plant

Table 15. NUREG/CR-4550 BWR transient initiating event groups.

T1—LOSP

Loss of offsite power
Loss of auxiliary power

T2A—Loss of PCS and feedwater

Electric load rejection with turbine bypass valve failure
Turbine trip with turbine bypass valve failure
Main steam isolation valve closure
Inadvertent closure of one main steam isolation valve
Partial main steam isolation valve closure
Loss of condenser vacuum
Pressure regulator fails open
Pressure regulator fails closed
Turbine bypass fails open
Turbine bypass or control valves increase pressure (closed)
Cause unknown
Electric load rejection with turbine bypass valve failure

T2B—IROV

Inadvertent open relief valve

T3A—PCS available

Electric load rejection
Turbine trip
Recirculation control failure, increasing flow
Recirculation control failure, decreasing flow
One recirculation pump trip
Recirculation pump trip (all)
Abnormal start-up of idle recirculation pump
Recirculation pump seizure
Feedwater—increasing flow at power
Loss of feedwater heater

Table 15. (continued).

Trip of one feedwater or condensate pump
Rod withdrawal at power
Inadvertent insertion of rods
Detected fault in reactor protection system
Inadvertent start-up of high pressure coolant injection/high pressure core spray systems
Scram due to plant occurrences
Spurious trip via instrumentation, reactor protection system fault
Manual scram, not out-of-tolerance condition
Cause unknown
T3B—FW lost but condenser available
Loss of all feedwater flow
Feedwater, low flow
Low FW flow during startup or shutdown
High FW flow during startup or shutdown
High flux due to rod withdrawal at startup

Table 16. NUREG/CR-4550 PWR transient initiating event groups.

T1—LOSP
Loss of offsite power
T2—loss of PCS
Full or partial closure of MSIV (one loop) Condenser leakage Miscellaneous leakage in secondary system Sudden opening or stream relief valves Loss of circulating water Loss of component cooling Loss of service water system Inadvertent safety injection signal Total loss of feedwater flow (all loops) Closure of all main steam isolation valves Increase in feedwater flow (all loops) Feedwater flow instability—operator error Feedwater flow instability—miscellaneous mechanical causes Loss of condensate pumps (all loops) Loss of condenser vacuum

Table 16. (continued).

T2—loss of PCS (continued)

Loss of circulating water
Steam generator leakage

T3—PCS available

Loss of reactor coolant system flow (one loop)
Uncontrolled rod withdrawal
Control rod drive mechanical problems and/or rod drop
Leakage from control rods
Leakage in primary system
Low pressure pressurizer
Pressurizer leakage
High pressurizer pressure
Containment pressure problems
Chemical and volume control system malfunction—boron dilution
Pressure, temperature, power imbalance—rod position error
Start-up of inactive coolant pump
Total loss of reactor coolant system flow
Loss or reduction in feedwater flow (one loop)
Full or partial closure of main steam isolation valve (one loop)
Increase in feedwater flow (one loop)
Loss of condensate pumps (one loop)
Generator trip or generator caused faults
Turbine trip, throttle valve closure, electro-hydraulic control problems
Generator trip or generator caused faults
Pressurizer spray failure
Spurious trips—cause unknown
Auto trip—no transient condition
Manual trip—no transient condition

Table 17. NUREG/CR-3862 suggested BWR and PWR transient initiating event categories.

Function	Suggested BWR category	Suggested PWR category
Main turbine/generator	Generator trip or generator related faults	Generator trip or generator related faults
	Generator trip or generator related faults with bypass valve failure	Generator trip or generator related faults with bypass valve failure
	Turbine trip, throttle/stop valve closure, electro-hydraulic control faults	Turbine trip, throttle/stop valve closure, electro-hydraulic control faults
	Turbine trip, throttle/stop valve closure, electro-hydraulic control faults with bypass valve failure	Turbine trip, throttle/stop valve closure, electro-hydraulic control faults with bypass valve failure

Table 17. (continued).

Function	Suggested BWR category	Suggested PWR category
Condenser vacuum	Loss of main condenser vacuum	Loss of main condenser vacuum
	Main condenser tube leakage	Main condenser tube leakage
	Loss of circulating water flow	Loss of circulating water flow
Condensate	Partial loss of condensate flow	Partial loss of condensate flow
	Total loss of condensate flow	Total loss of condensate flow
	Condensate system leakage	Condensate system leakage
Feedwater	Low or decreasing feedwater flow at power	Low or decreasing feedwater flow at power
	Total loss of feedwater flow at power	Total loss of feedwater flow at power
		High or increasing feed water flow at power (one loop)
	High or increasing feedwater flow at power	High or increasing feedwater flow at power (all loops)
	Loss of one feedwater pump at power	Loss of one feedwater pump at power
	Loss of feedwater heater(s)	Loss of feedwater heater(s)
	Feedwater system leakage	Feedwater system leakage
	Low or decreasing feedwater flow during start-up or shutdown	Low or decreasing feedwater flow during start-up or shutdown
	High or increasing feedwater flow during start-up or shutdown	High or increasing feedwater flow during start-up or shutdown
Reactor system flow	Loss of one recirculation pump	Loss of reactor coolant system flow (one loop)
	Loss of all recirculation pumps	Total loss of reactor coolant system flow
	Start-up of an inactive recirculation pump	Start-up of an inactive coolant pump
	Increasing recirculation flow	
	Decreasing recirculation flow	

Table 17. (continued).

Function	Suggested BWR category	Suggested PWR category
	Recirculation pump seizure	
Reactor pressure control	Pressure regulator fails open	Low pressurizer pressure
	Pressure regulator fails closed	High pressurizer pressure
	Turbine bypass/control valves fail open	Pressurizer spray fails open
	Turbine bypass/control valves fail closed	Pressurizer spray fails closed
Reactivity control	Inadvertent rod withdrawal at power	Inadvertent rod withdrawal at power
	Inadvertent insertion of control rod(s) at power	Inadvertent insertion of control rod(s) at power
	Pressure/temperature/power imbalance due to rod(s) out of position	Pressure/temperature/power imbalance due to rod(s) out of position
	Control rod problems	Control rod problems
		Chemical and volume control system malfunction—boron dilution
	High flux due to rod withdrawal at start-up	High flux due to rod withdrawal at start-up
Steam/reactor pressure	Inadvertent closure of one main steam isolation valve	Inadvertent closure of one main steam isolation valve
	Partial closure of one main steam isolation valve	Partial closure of one main steam isolation valve
	Inadvertent closure of all main steam isolation valves	Inadvertent closure of all main steam isolation valves
Safety injection	Inadvertent start-up of high pressure coolant injection/high pressure core spray systems	Inadvertent start-up of safety injection
	Primary containment pressure problems	Primary containment pressure problems

Table 17. (continued).

Function	Suggested BWR category	Suggested PWR category
Electrical power	Loss of offsite power	Loss of offsite power
	Loss of auxiliary power	Loss of auxiliary power
	Loss of power to necessary plant systems	Loss of power to necessary plant systems
Reactor integrity	Leakage from control rods	Leakage from control rods
	Leakage in the primary system	Leakage in the primary system
		Pressurizer leakage
		Steam generator leakage
Miscellaneous scrams	Detected fault in the reactor protection system	Detected fault in the reactor protection system
	Scram due to plant occurrences	Scram due to plant occurrences
	Loss of component cooling water	Loss of component cooling water
	Loss of service water	Loss of service water
	Fire within plant	Fire within plant
Spurious scrams	Automatic scram from instrumentation or reactor protection system fault—no out-of-tolerance condition	Automatic scram from instrumentation or reactor protection system fault—no out-of-tolerance condition
	Manual scram—no out-of-tolerance condition	Manual scram—no out-of-tolerance condition
	Spurious scram—cause unknown—no out-of-tolerance condition	Spurious scram—cause unknown—no out-of-tolerance condition

- Small-small LOCA (S3), 50 to 100 gpm per coolant pump.
- Interfacing system LOCA (V).

The PWR LOCA groups were identified as follows:

- Large LOCAs (A), > 6 in. equivalent diameter
- Intermediate LOCAs (S1), 2 to 6 in. equivalent diameter
- Small LOCAs (S2), 1/2 to 2 in. equivalent diameter
- Small-small LOCA (S3), < 1/2 in. equivalent diameter or 50 to 100 gpm flow rate
- Interfacing system LOCA (V).

The NUREG/CR-4550 LOCA groupings are based on common definitions of LOCA sizes with the BWR groupings defined by break area in square feet, while the PWR LOCA groupings are defined by equivalent break diameter in inches. The grouping are more detailed than those given in WASH-1400, but they do not include some of the WASH-1400 special LOCAs.

5.2.2.2 Sequence Names. The sequence names referred to here are the combinations of system and event identifiers used to denote the system failures/events that have occurred subsequent to the initiating event. The system/event identifiers are used as top events in event trees and typically vary from one to five characters in length. The purpose of the review was to determine if any event tree top event naming schemes existed that, like our criteria for system codes, clearly and unambiguously identify the systems or events represented by the identifiers.

NUREG/CR-2815 distinguishes between the system/event identifiers for BWRs and PWRs. The NUREG/CR-2815 event naming scheme uses a two character system/event identifier. A letter is the first character and represents the system/event; the second character is an index that denotes different operating modes of the same system that have different success criteria. Indices can also be used to denote functional and operational peculiarities and associated support system failures. The NUREG/CR-2815 front-line system/event identifiers are given in Table 18.

There does not appear to be any correlation between the system/event identifiers and the systems/events represented nor is there any coordination between system identifiers for BWRs and PWRs. For example, the identifier "L" denotes the failure of the auxiliary feedwater system for PWRs while "L" for BWRs represents failure to limit reactor vessel high water level. BWRs use the identifier "Q" to represent failure of the feedwater system to provide core make-up water.

The NUREG/CR-4550 event naming scheme uses one to four characters for the system/event identifiers. The system/event identifiers contain a large amount of detail in both the number of systems and events used and in the different operating modes of some of the systems. As was done in NUREG/CR-2815, the system/event identifiers are differentiated by plant type. The NUREG/CR-4550 system/event identifiers for BWRs and PWRs are given in Tables 19 and 20, respectively.

NUREG/CR-4550 exhibits the same shortcomings as NUREG/CR-2815; there appears to be very little correlation between the system or event names and their event tree identifiers. This makes translating a system/event identifier into a system or event very difficult unless one is either very familiar with the naming scheme or has a description list at hand.

WASH-1400 alphabetically identifies the event tree events by using a single letter designator starting with the large break LOCA tree and ending with the transient tree. The system/event identifiers are also differentiated by plant type. The WASH-1400 BWR and PWR system/event identifiers are given in Tables 21 and 22, respectively.

The WASH-1400 event naming scheme shares the same shortcomings exhibited by NUREG/CR-2815 and NUREG/CR-4550: there is no correlation between the system and its identifier and there is very little correlation of identifiers for similar systems at BWRs and PWRs.

5.2.2.3 Accident Type Names. The dominant accident sequences of PRAs are typically grouped by similar accident types. This grouping is done for several reasons, one of which is to identify which accident types are the major contributors to core damage for the plant.

To determine the accident type groups that were typically used in PRAs, we reviewed the five PRAs presented in NUREG/CR-1150. NUREG-1150 presents the results of the internally initiated accidents summarized and grouped by accident types for the five plants. The general classes of accident types used in NUREG-1150 are given in Table 23.

These accident type groups are typical of those used in other PRAs and are based primarily on the initiating event. However, while some accident sequences result from one type of initiating event,

Table 18. NUREG/CR-2815 BWR and PWR event tree system/event identifiers.

System identifier	Description
BWRs	
K	Reactor protection system
L	Reactor vessel high water level
M	Overpressure protection system
P	Reactor vessels reclose after opening
Q	Feedwater system provides core make-up water
R	Recirculation pump trip
V	Low pressure
U	High pressure core cooling system
W	Containment heat removal system
X	Depressurization system
PWRs	
C	Containment spray system
G	Containment heat removal system
D	Low pressure emergency core cooling system
K	Reactor protection system
L	Auxiliary feedwater system
M	Power conversion system
N	Secondary system steam relief valves
Q	Pressure operated relief valves reclose after opening
R	Massive rupture of the reactor vessel
U	High pressure core cooling system
Y	Reactor building cooling system

Table 19. NUREG/CR-4550 BWR event tree system/event identifiers.

System identifier	Description
ARI	Alternate rod insertion
B	Onsite electrical power
C	Reactor protection system
C1	Automatic and manual reactor scram
DEP	Operator depressurizes reactor
FW	Feedwater
HPIN	High pressure injection
INJ	Continued injection
L	Operator isolates leak
LEV	Level control
LPIN	Low pressure injection
M	Safety relief valves open

Table 19. (continued).

System identifier	Description
MSIV	Main steam isolation valves open
NADS	Reactor at high pressure
P	Safety relief valves close
P1	One safety relief valve recloses
P2	Two safety relief valves reclose
P3	Three safety relief valves reclose
Q	Power conversion system
R	Rupture of primary containment
ROD	Manual rod insertion
RPS	Reactor protection system
RPSE	Reactor protection system electrical
RPSM	Reactor protection system mechanical
RPT	Recirculation pump trip
RXHP	Reactor at high pressure
SCRM	Manual scram
SLC	Standby liquid control
SPC	Suppression pool cooling
SRVs	Safety relief valves reclose after opening
U1	High pressure core spray/high pressure coolant injection
U2	Reactor core isolation cooling
U3	Control rod drive—2-pump mode
U4	Control rod drive—1-pump mode
V1	Condensate
V2	Low pressure core spray
V3	Low pressure coolant injection
V4	Service water cross-tie
W1	Residual heat removal—suppression pool cooling
W2	Residual heat removal—shutdown cooling
W3	Residual heat removal—containment spray
X	Primary system depressurization
Y	Containment venting
Z	Suppression pool makeup

Table 20. NUREG/CR-4550 PWR event tree system/event identifiers.

System identifier	Description
C	Containment spray injection
D1	High pressure safety injection
D2	High pressure safety injection for feed and bleed
D3	High pressure safety injection for seal injection
D4	High pressure safety injection for emergency boration
D5	Accumulators
D6	Low pressure safety injection
F1	Containment spray recirculation—inside containment
F2	Containment spray recirculation—outside containment
H1	Low pressure recirculation
H2	High pressure recirculation
K	Reactor protection
L	Auxiliary feedwater
L2	Auxiliary feedwater for anticipated transient without scram
M	Power conversion system
N	Charging from U2 for U1 seal injection
N2	Charging from U2 for U1 high pressure injection system
P	Pressure operated relief valves for feed and bleed
PL	Power level
P1	Reactor coolant for anticipated transient without scram
P2	Reactor coolant pressure relief for anticipated transient without scram
Q	Pressurizer pressure operated relief valves close
R	Manual reactor trip
S	Steam generator steam relief for primary depressurization
T	Turbine trip for anticipated transient without scram
W	Residual heat removal—suppression pool cooling

Table 21. WASH-1400 BWR event tree system/event identifiers.

System identifier	Description
B	Electric power to engineered safety features
C	Reactor protection system
D	Vapor suppression
E	Emergency coolant injection
F	Emergency cooling functionability
G	Containment leakage
H	Core spray recirculation
I	Low pressure coolant recirculation
J	High pressure service water
M	Safety/relief valves open
P	Safety/relief valves reclose
Q	Feedwater
U	High pressure coolant injection/reactor core isolation cooling
W	Residual heat removal and high pressure service water or power conversion system

Table 22. WASH-1400 PWR event tree system/event identifiers.

System identifier	Description
B	Electric power to engineered safety features
C	Containment spray injection
D	Emergency coolant injection
E	Emergency cooling functionability
F	Containment spray recirculation
G	Containment heat removal
H	Emergency coolant recirculation
I	Sodium hydroxide
K	Reactor protection system
L	Secondary system steam relief and auxiliary feedwater
M	Secondary system steam relief and power conversion system
P	Reactor coolant system safety/relief valves open
Q	Reactor coolant system safety/relief valves reclose
U	Chemical and volume control
W	Residual heat removal

Table 23. NUREG-1150 accident types.

Description
Anticipated transient without scram
Interfacing system LOCA
LOCAs other than seal LOCAs and steam generator tube ruptures
Loss of offsite power
Reactor coolant pump seal LOCA
Station blackout
Steam generator tube rupture
Transients other than loss of offsite power transients

they are named by the final result. Examples of this naming scheme are station blackout and anticipated transient without scram accident types. The first is the result of an loss of offsite power initiator, and the second is the result of any transient with a subsequent failure of the reactor to scram. These accident types would be useful in an accident sequence naming scheme.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 System Naming Schemes. The review showed that three characters are the best for system codes. This allows the codes to be either acronyms or abbreviations of the system names or a combination of the two with no loss of understanding of the codes. NUREG/CR-4550 has the most complete list of system codes of the four sources reviewed; however, the system codes are not sorted by plant type.

6.1.2 Component Type Naming Schemes. As with system codes, three characters are the best for component type codes. Again, this allows the codes to be either acronyms or abbreviations of the component type names or a combination of the two with no loss of understanding of the codes. Of the four sources reviewed for component type naming schemes, NUREG/CR-4550 has the most descriptive list of component type codes.

6.1.3 Component Failure Mode Naming Schemes. Two characters are adequate to capture a component failure mode. NUREG/CR-4550 had the most complete list of component failure modes of the two sources reviewed.

6.1.4 Basic Event Labeling Schemes. The PRA computer codes in use today allow up to 16 character basic event labels. Of the six sources reviewed for basic event labeling schemes, only NUREG/CR-4550 had a specific basic event labeling scheme. The general form of the NUREG/CR-4550 labeling scheme meets both the information requirements of a basic event labeling scheme and the size restraints of the computer codes.

6.1.5 Accident Sequence Labeling Schemes. Over the years an accident sequence labeling scheme has evolved that consists of the initiating event identifier and the system identifiers for the systems that have failed to function as required for the plant response to the initiating event. This labeling scheme can present problems because different PRAs use different initiating event and system identifiers. This results in identical sequences at similar plants not having the same accident sequence label when they should. The general accident sequence labeling scheme also faces the same 16 character size limitation as the basic event labeling scheme, and it is possible to have a sequence label that is not unique in the first 16 characters. None of the sources reviewed contained an accident sequence labeling scheme that could be considered a candidate for our purposes.

6.1.6 Initiating Event Naming Schemes.

6.1.6.1 Transient Initiating Event Naming Schemes. Both the number of transients identified and the number of transient groupings varied among the four sources reviewed for candidate transient initiating event naming schemes.

6.1.6.2 LOCA Initiating Event Naming Schemes. While the LOCA naming schemes in both sources differentiated LOCAs by plant type, the NUREG/CR-4550 group definitions were more detailed than those of WASH-1400. However, WASH-1400 had some special LOCAs that were not listed in NUREG/CR-4550.

6.1.7 Sequence Names. The level of detail, the amount of plant type differentiation, and the ambiguity of the system/event identifiers used for sequence names varied among the three sources reviewed. The major drawback among the three schemes was the lack of correlation between the system/event identifiers and the system or event they represented. This lack of definition makes interpreting the sequence name very difficult unless one is intimately familiar with the naming scheme. Even given that prior knowledge, comparisons with identical sequences done under yet another naming scheme requires still further knowledge.

6.1.8 Accident Type Names. The accident type names reviewed are typical of those used in

PRAs and would be useful in an accident sequence naming scheme.

6.2 Recommendations

The purpose of this review was to find candidate naming and labeling schemes for systems, component types, component failure modes, basic events, and accident sequences that would assist the NRC's efforts to integrate their data bases. In this section, we recommend both existing and developed candidate naming and labeling schemes.

6.2.1 Basic Event Labeling Scheme. We recommend the NUREG/CR-4550 basic event labeling scheme discussed in Section 5.1 for use by the NRC for its data base integration efforts and in future NRC-directed PRAs. In conjunction with the recommended basic event labeling scheme, the following naming schemes are recommended for use as the labeling scheme constituent parts. While the labeling scheme recommended here is primarily in tended for use in PRAs, the system, component type, and failure mode naming schemes are intended for other uses.

6.2.1.1 System Naming Scheme. The NUREG/CR-4550 basic system naming scheme, with system differentiation by plant type added, is recommended for use by the NRC as part of the basic event labeling scheme. Differentiating the system by plant type will add even more detail and clarity to the existing scheme. With minor revisions, the recommended system codes for BWR and PWR plant systems are provided in Tables 24 and 25, respectfully.

6.2.1.2 Component Type Naming Scheme. The NUREG/CR-4550 component type naming scheme is recommended for use by the NRC as the second part of the recommended basic event labeling scheme. The recommended component type codes are given in Table 26.

6.2.1.3 Component Failure Mode Naming Scheme. The NUREG/CR-4550 component failure mode naming scheme is recommended for use by the NRC as the third part of the recommended basic event labeling scheme. The recommended component failure mode codes are shown in Table 27.

6.2.2 Accident Sequence Labeling Scheme. Because no existing accident sequence labeling scheme met the review criteria, we recommend the accident sequence labeling scheme described below.

Our criteria for an accident sequence labeling scheme discussed in Section 5.2 stated that an ideal accident sequence label would indicate the initiating event, the subsequent events, and the plant damage state if any.

Our accident sequence labeling scheme consists of 16 characters in the form of XXX-YYY-ZZZZZ-AA. Three characters represent the initiating event (XXX), three characters represent the sequence number (YYY), five characters represent the plant function as failures (ZZZZZ), and two characters represent the accident type (AA) for that sequence. The code representing the accident type need only to be applied to a sequence when it has been determined to be a dominant sequence. Using an identifier in this manner allows shorter sequence labels to be used during event tree quantification and sequence processes.

To fully develop our proposed sequence labeling scheme, we recommend the following naming schemes for the initiating event, sequence name, and accident type.

6.2.2.1 Initiating Events. As indicated in Section 5.2.2, initiating events are classified as transients and LOCAs. Because no transient or LOCA naming schemes were deemed satisfactory, we developed and recommend the following initiating event naming schemes. There were no candidate transient initiating event naming schemes in the sources reviewed. Our immediate approach was to develop codes for some of the different transient categories and for the major functions/systems typical to both plant types. Also, additional codes were developed for special initiators (loss of ac and dc bus) that have become an issue in recent PRAs. The recommended BWR

Table 24. Recommended BWR system codes and descriptions.

Recommended BWR system codes	System descriptions
ACP	Plant ac power system
ADS	Automatic depressurization system
ARF	Air return fan system
CDS	Condensate system
CGC	Containment combustible gas control
CHR	Containment heat removal
CHW	Chilled water system
CIS	Containment isolation system
CLS	Consequence limiting control system
CPS	Containment penetration system
CRD	Control rod drive system
CSC	Closed cycle cooling system
CSS	Containment spray mode of residual heat removal
DCP	dc power system
DGN	Diesel generator system
DGX	Diesel cross–tie system
DWS	Drywell (wetwell) spray mode of residual heat removal system
EHV	Emergency heating, ventilation, and air conditioning
ESF	Engineered safety feature actuation system
ESW	Emergency/essential service water system
FHS	Fuel handling system
FWS	Firewater system
HCI	High pressure coolant injection system
HCS	High pressure core spray system
HSW	High pressure service water system
IAS	Instrument air system
IPS	Instrument ac power system
ISO	Isolation condenser system
LCI	Low pressure coolant injection system
LCS	Low pressure core spray system
LPR	Low pressure coolant recirculation
MCW	Main circulating water system
MFW	Main feedwater system
MSS	Main steam system
NHV	Normal heating, ventilation, and air conditioning
NSS	Nuclear steam supply shutoff system
NSW	Normal service water
OEP	Offsite electrical power system
PCS	Power conversion system
PPR	Primary pressure relief system (safety relief valves)
PSW	Plant service water system

Table 24. (continued).

Recommended BWR system codes	System descriptions
RBC	Reactor building cooling water system
RCI	Reactor core isolation cooling system
RGW	Radioactive gaseous waste system
RHR	Residual heat removal system
RLW	Radioactive liquid waste system
RMT	Recirculation mode transfer system
RPS	Reactor protection system
RRS	Reactor recirculation system
RWC	Reactor water cleanup system
SDC	Shutdown cooling mode of residual heat removal
SGT	Standby gas treatment system
SIS	Safety injection actuation system
SLC	Standby liquid control system
SPC	Suppression pool cooling mode of residual heat removal
SPM	Suppression pool makeup system
SSW	Standby service water system
SXT	Standby service water cross-tie system
TBC	Turbine building cooling water system
VSS	Vapor suppression system

Table 25. Recommended PWR system codes and descriptions.

Recommended PWR system codes	System descriptions
ACP	Plant ac power system
AFW	Auxiliary feedwater system
ARF	Air return fan system
AVS	Annulos ventilation system
CAC	Containment atmosphere clean up
CCS	Containment cooling system
CFS	Core flood system
CDS	Condensate system
CCW	Containment emergency fan cooler system
CGC	Containment combustible gas control
CHP	Charging pump system
CWS	Chilled water system
CIS	Containment isolation system
CLS	Consequence limiting control system
CPC	Charging pump cooling system
CPS	Containment penetration system
CRD	Control rod drive system
CSC	Closed cycle cooling system

Table 25. (continued).

Recommended PWR system codes	System descriptions
CSR	Containment spray recirculation system
CVC	Chemical volume and control system
DCP	dc power system
DGN	Diesel generator system
DGX	Diesel cross- tie system
EHV	Emergency heating, ventilation, and air conditioning
EPS	Emergency power system
ESF	Engineered safety features actuation system
ESW	Essential service water system
FHS	Fuel handling system
FWS	Fi[illegible] water system
HPR	High pressure coolant recirculation system
HPI	High pressure injection
HWS	High pressure service water system
IAS	Instrument air system
ICS	Ice condenser system
IGS	Integrated control system
IPS	Instrument ac power system
ISR	Inside containment spray recirculation system
LMS	Let down purification and makeup system
LPI	Low pressure injection system
LPR	Low pressure recirculation system
LSW	Low pressure service water system
MCW	Main circulating water system
MFW	Main feedwater system
MSS	Main steam system
NHV	Normal heating, ventilation, and air conditioning
NSW	Normal service water
NWS	Nuclear service water system
OEP	Offsite electrical power system
OSR	Outside containment spray recirculation system
PCS	Power conversion system
PPR	Primary pressure relief system (pressure operated relief valves)
PSW	Plant service water system
PVS	Penetration room ventilation system
RBP	Reactor building penetration system
RCS	Reactor coolant system
RBS	Reactor building spray system
RCW	Reactor building cooling water system
RGW	Radioactive gaseous waste system
RHR	Residual heat removal system
RLW	Radioactive liquid waste system
RMT	Recirculation mode transfer system

Table 25. (continued).

Recommended PWR system codes	System descriptions
RPS	Reactor protection system
RWC	Reactor water cleanup system
SIS	Safety injection actuation system
SLB	Steam line break control subsystem
SPR	Secondary pressure relief system
SSW	Standby service water system
SXT	Standby service water cross-tie system
TBC	Turbine building cooling water system

Table 26. Recommended component type codes and descriptions.

Recommended component codes	Component descriptions
ACS	Actuation segment
ACT	Actuation train
ACU	Air cleaning unit
ACX	Air cooling heat exchanger
AHU	Air heating unit
AOV	Air operated valve
ASD	Physical position sensor/transmitter
ASF	Flow sensor/transmitter
ASL	Level sensor/transmitter
ASP	Pressure sensor/transmitter
ASR	Radiation sensor/transmitter
AST	Temperature sensor/transmitter
ASX	Flux sensor/transmitter
BAC	Electrical bus—ac
BAT	Battery
BCH	Battery charger
BDC	Electrical bus—dc
CAL	Calculational unit
CBL	Electrical cable
CCF	Common cause failure event
CKD	Nonreturn damper
CKV	Check valve
CND	Signal conditioner
CRB	Circuit breaker
CRH	Control rod hydraulically driven
CRM	Control rod motor driven
DCT	Ducting
DGN	Diesel generator
EDP	Engine driven pump
EPV	Explosive valve

Table 26. (continued).

Recommended component codes	Component descriptions
FAN	Motor driven fan
FCV	Flow control valve
FLT	Filter
FUS	Fuse
HDV	Hydraulic valve
HRU	Hydrogen recombiner unit
HTR	Heater element
HTX	Heat exchanger
ICC	Instrumentation and control circuit
INV	Inverter
ISO	Electrical isolation device
LOD	Load/relay unit
LOG	Logic unit
LPS	Local power supply
MDC	Motor driven compressor
MDP	Motor driven pump
MGN	Motor generator unit
MOD	Motor operated damper
MOV	Motor operated valve
PHN	Phenomenological event
PND	Pneumatic/hydraulic damper
PSF	Pipe segment
PTF	Pipe train
REC	Rectifier
SMP	Sump
SOV	Solenoid operated valve
SRV	Safety/relief valve
STR	Strainer
TAC	ac electrical train
TCV	Testable check valve
TDC	dc electrical train
TDP	Turbine driven pump
TFM	Transformer
TNK	Tank
TSA	Traveling screen assembly
TSW	Transfer switch
TXX	Bistable trip unit
VCF	Miscellaneous aggregation of events
XDM	Manual damper
XHE	Operator action
XSW	Manual control switch
XVM	Manual valve

Table 27. Recommended component failure mode codes and descriptions.

Recommended component failure mode codes	Failure code descriptions
CA	Common cause fail to close
CC	Normally closed, fail in the closed position
CF	Common cause failure
CL	Common cause internal leakage
CM	Common cause miscalibration
CO	Normally closed, fail in the open position
CR	Common cause fail to run
CS	Common cause fail to start
CT	Common cause fail to transfer
FA	Actuation failure
FC	Loss of function
FO	Failure to operate
FR	Failure to continue running
FS	Failure to start
FT	Failure to transfer
HI	Fails high
HW	Hardware failure
LF	Local fault
LK	Leak
LO	Fails low
LP	No power—loss of power
MA	Maintenance
MC	Miscalibration
MF	Minimum flow
NF	No flow or loss of flow
NO	No output
OC	Normally open, failure in closed position
OO	Normally open, failure in open position
OP	Open electrical circuit
PG	Plugged
RE	Failure to restore after test or maintenance
RP	Rupture
ST	Short
TE	Component unavailable due to test
TM	Component unavailable due to test and maintenance
VF	Miscellaneous failures
XA	Human error to align
XE	Human error failure
XM	Operator fails to manually actuate
XO	Operator fails to operate
XR	Operator fails to restore from test or maintenance

and PWR transient codes and descriptions are shown in Table 28. This list has a sufficient level of detail and consistency between plant types.

We recommend combining the two lists of LOCAs from WASH-1400 and NUREG/CR-4550 and adding any other special LOCA types to make an inclusive list of the commonly defined LOCAs. To meet the accident labeling scheme requirements, the LOCA type codes are restricted to two characters. We also recommend using the NUREG/CR-4550 LOCA break size definitions given in Section 5.2.2.2.2 of this report. The recommended list of LOCA types is give in Table 29.

6.2.2.2 Sequence Names. We recommend the sequence number and function codes to be part of the sequence naming scheme. However, this method does require access to the event tree and the sequence of interest and converting front-line systems in that sequence to plant functions in the form of codes. The relationship of different plant systems to a particular function are shown in Tables 30 and 31. A unique singular letter code that will be used in our sequence name is associated with each safety function.

6.2.2.3 Accident Type Names. For accident type groups, we recommend using the typical accident types used to report PRA results as found in NUREG-1150. These accident types are broad classifications and serve to convey the effects of the sequences of the total plant model. The recommended accident type codes are given in Table 32.

To demonstrate our recommended accident sequence labeling scheme, we have included an example of a large LOCA event tree for BWR and a loss of main feedwater for a PWR. Depending on the event tree and which sequences are analyzed, different front-line systems are necessary to prevent core damage. Our accident sequence labeling scheme proposed in Section 6.2.2 will be applied to the following examples and will contain codes for the initiating event, sequence name, and accident type.

A large LOCA event tree for a BWR is shown in Figure 1 and our recommended sequence labeling scheme has been applied to sequence 6. The initiating event is a large LOCA. Referring to Table 29, the code for a large LOCA is LGA. The sequence number and plant function codes are required for the sequence name. The front-line systems in sequence 6 for the BWR must be converted in the form of codes. Sequence 6 of the event tree indicates that the low pressure injection system, residual heat removal system, and containment venting have failed. Referring to Table 30, the relationship between the failed front line systems are associated with the appropriate plant function. The plant functions which failed are emergency core cooling (low pressure) decay heat removal, and containment overpressure protection. The plant function codes for system failures to be used for our accident sequence label are L, R and C. We realize that several systems may provide a similar plant function. Therefore to use the codes, all systems which provide a similar plant function must fail. The remaining code required to complete our accident sequence labeling scheme is the accident type name. Referring to Table 32, our accident type code is LO. This code represents a LOCA other than a seal LOCA or a steam generator tube rupture. Our recommended accident sequence label from the above description would be LGA-006-LCRXX-LO.

The same methodology applied in our first example will be applied to Figure 2, a loss of feedwater event tree for a PWR. Our recommended sequence labeling scheme has been applied to sequence 9. The initiating event is a loss of feed water. Referring to Table 19, the transient code for the loss of feedwater is TFW. Again, the sequence number and function codes are required for the sequence name, so the front-line systems in sequence 9 for the PWR must be converted to plant functions in the form of codes. Sequence 9 of the event tree indicates that the auxiliary feedwater system, containment systems, and low pressure recirculation system have failed.

Table 28. Recommended transient codes and descriptions for a BWR and PWR.

Transient codes	Transient event descriptions
TAC	Loss of ac power
TA1	loss of ac bus –[a]
TA2	loss of ac bus –[a]
TA3	loss of ac bus –[a]
TA4	loss of ac bus –[a]
TAI	Loss of ac instrumentation
TCP	Partial loss of component cooling water
TCS	Loss of condensate
TCW	Loss of component cooling water
TDC	Loss of dc power
TD1	loss of dc bus –[a]
TD2	loss of dc bus –[a]
TD3	loss of dc bus –[a]
TD4	loss of dc bus –[a]
TFW	Loss of feedwater
THV	Loss of heating, ventilation, and air conditioning
TIA	Loss of instrument air
TOP	Loss of offsite power
TPC	Core power excursion
TRT	Reactor trip
TSB	Station blackout
TSI	Spurious safety injection actuation
TSP	Partial loss of service water
TSW	Loss of service water
TTG	Turbine generator trip/general transient
TUP	Transient with PCS unavailable
TWP	Transient with PCS available

a. A specific component identifier.

Table 29. Recommended BWR and PWR LOCA initiating event codes and descriptions.

Recommended BWR/PWR LOCA code	LOCA group description
LGA	BWR/PWR large LOCA
IMA	BWR/PWR intermediate LOCA
SMA	BWR/PWR small LOCA
SSA	BWR/PWR small–small LOCA
POV	PWR power operated relief valve fails to reclose
PRV	BWR/PWR reactor pressure vessel rupture
PSF	BWR recirculation pump/PWR reactor coolant pump seal failure
SGR	PWR steam generator tube rupture
SLB	BWR/PWR steam line break
SRV	BWR safety relief valve fails to reclose
ISA	BWR/PWR interfacing system LOCA

Table 30. Recommended list of plant functions and codes for a BWR.

Plant function	Function codes	System descriptions
Reactor subcriticality	K	Reactor protection system Control rod drive system Alternate rod insertion Standby liquid control system Reactor level control only during ATWS
Reactor coolant system over pressure protection	O	Safety relief valves Code safety valves
Emergency core cooling (high pressure)	H	High pressure coolant injection High pressure core spray system Main feedwater system Reactor core isolation cooling system Control rod drive pumps Standby liquid control pumps via test tank
Emergency core cooling (low pressure)	L	Low pressure coolant injection system Low pressure core spray system Condensate system Service water system Fire water system
Depressurization	D	Automatic depressurization system Main turbine bypass valves
Decay heat removal	R	Residual heat removal system Shut down cooling mode of residual heat removal Isolation condenser

Table 30. (continued).

Plant functions	Function codes	System descriptions
Containment overpressure protection	C	Vapor Suppression System Drywell/wetwell spray mode of residual heat removal system Containment venting Suppression pool cooling
Containment isolation	I	Containment isolation system
Post accident radioactivity control	P	Containment combustible gas control system
Plant support	S	Electrical power a. ac power system b. dc power system
	S1	Emergency power a. Diesel generator system b. Diesel cross tie system c. Vital ac/dc
	S2	Plant cooling systems a. Reactor building cooling water system b. Turbine building cooling water system c. Chilled water system d. Main condenser circ water system e. Service water system f. Emergency service water system
	S3	Instrument air
	S4	HVAC
	S5	Emergency safeguard feature

Table 31. Recommended list of plant functions and codes for a PWR

Plant functions	Function codes	System descriptions
Reactor subcriticality	K	Control rod drive system Reactor protection system Emergency boration system
Core heat removal (High pressure)	H	High pressure injection system High pressure recirculation Chemical volume and control system

Table 31. (continued).

Plant functions	Function codes	System descriptions
Core heat removal (low pressure)	L	Core flood system Accumulators Low pressure coolant injection system Low pressure recirculation system
Decay heat removal	R	Auxiliary feedwater system Emergency feedwater system Residual heat removal system Main feedwater system Condensate system Power operated relief valves for feed and bleed Fire water system
RCS integrity	V	Safety relief valves Reactor coolant system point vents Reactor coolant system Primary pressure relief system
Containment pressure suppression/ atmospheric heat removal	C	Containment spray system Containment emergency fan cooler system Ice condenser system Hydrogen recombiner/purge system
Containment isolation	I	Containment isolation system
Plant support	S	Electrical power a. ac power system b. dc power system
	S1	Emergency power a. Diesel generator system b. Diesel cross tie system c. Vital ac/dc
	S2	Plant cooling systems a. Chilled water system b. Component cooling water system c. Service water system
	S3	Instrument air
	S4	HVAC
	S5	Emergency safeguard feature

Table 32. Recommended accident type codes and descriptions

Recommended accident type code	Accident type description
AW	Anticipated transient without scram
IS	Interfacing system LOCA
LI	LOCA caused by injection failure
LO	LOCA other than a seal LOCA or a steam generator tube rupture
LR	LOCA caused by recirculation failure
LS	Loss of offsite power (emergency power available)
LP	Loss of the power conversion system
PS	Reactor coolant pump seal LOCA
SB	Station blackout
SG	Steam generator tube rupture
TR	Transient other than loss of offsite power transient

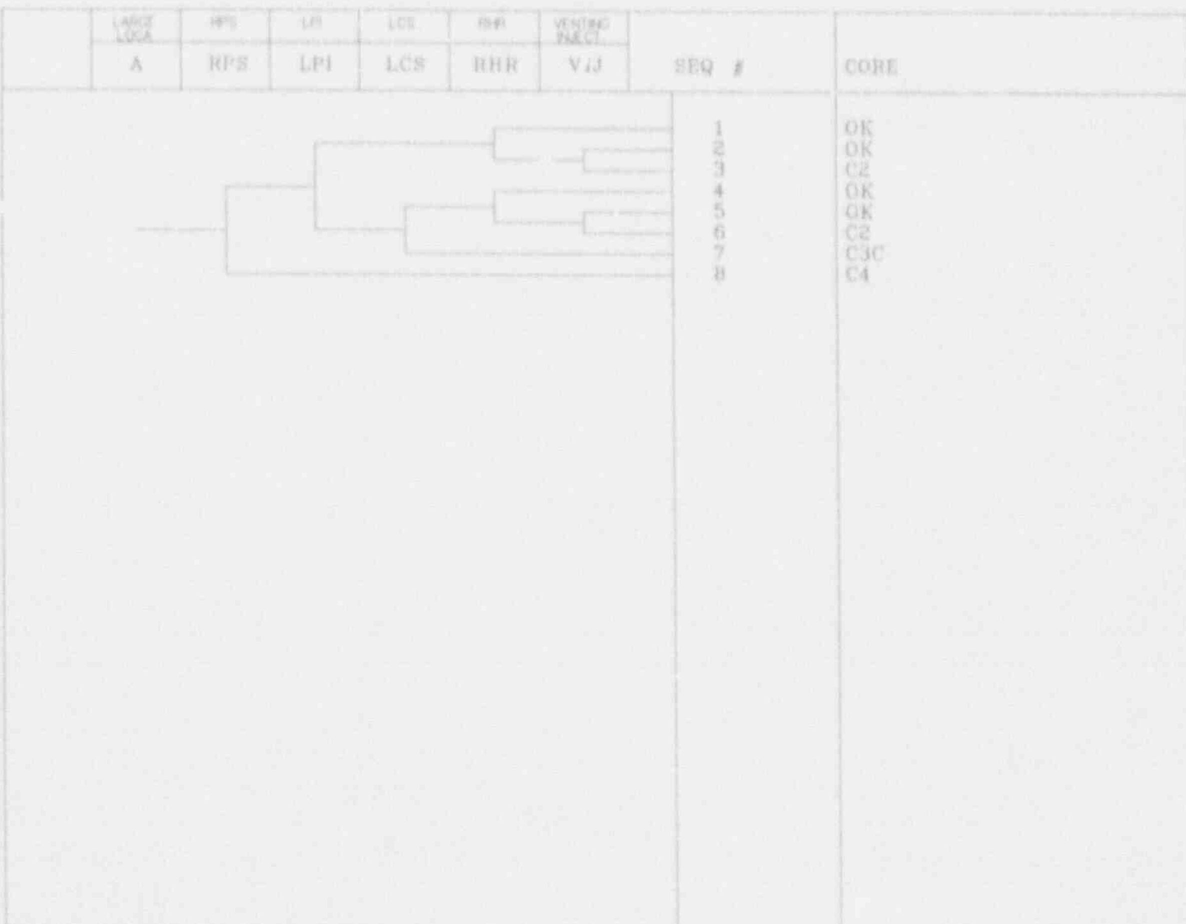

Figure 1. Large LOCA event tree.

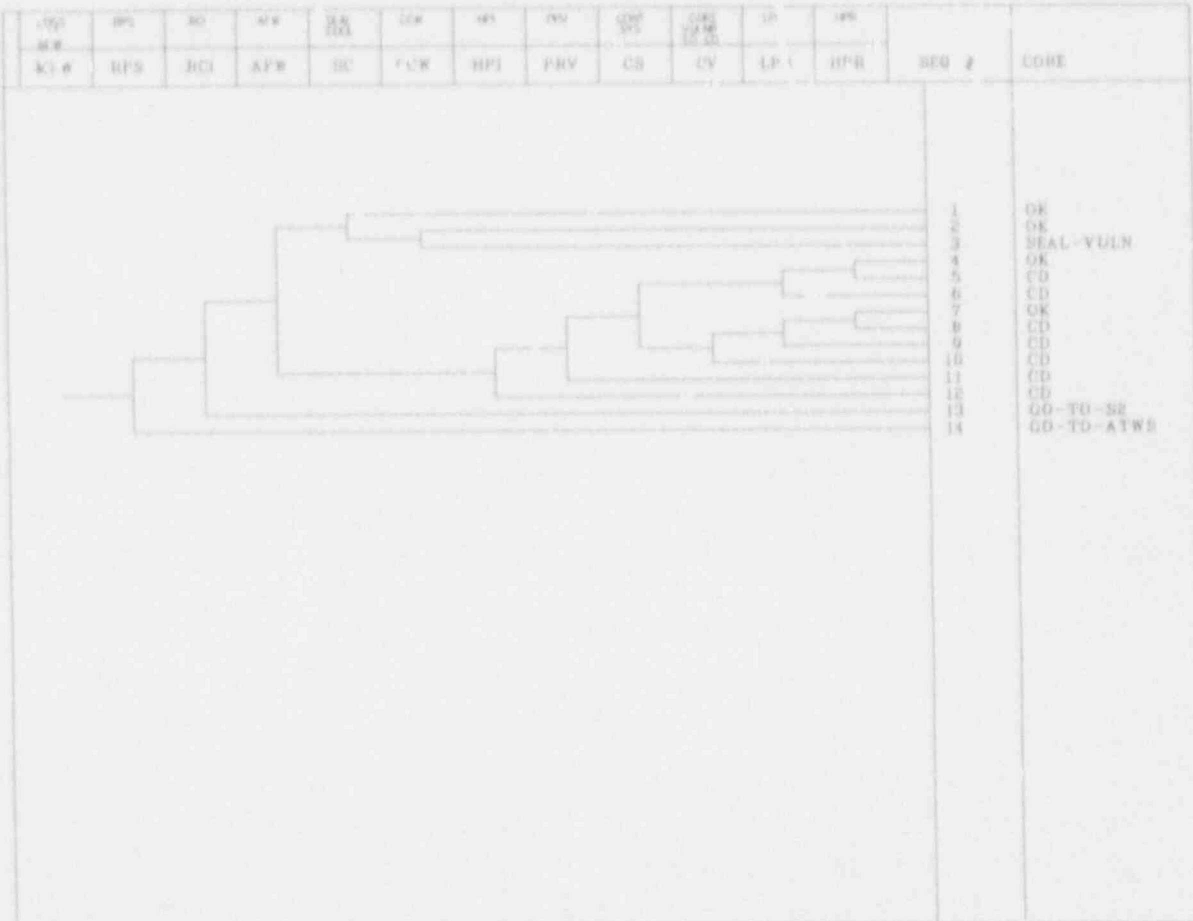

Figure 2. Loss of main feedwater.

Reierring to Table 31, the relationship between the failed front line system are associated with the appropriate plant function. The plant functions that failed are decay heat removal, and containment overpressure suppression/atmospheric heat removal. The plant function codes for system failures to be used for our accident sequence label are R, C, and L. The remaining code required to complete our accident sequence labeling scheme is the accident type name. Referring to Table 32, the remaining code required for our accident type code is TR. This code represents a transient, other than a loss of offsite power. Based on the above description, our recommended accident sequence label would be TFW-009-RCLXX-TR.

The basic event and accident sequence labeling schemes proposed herein, in conjunction with the recommended system, component type, failure mode, initiating event, and accident type naming schemes should provide the NRC with the common nomenclature needed to integrate their various data bases and make them easier to understand and use. Appendix A contains tables to expedite conversion of data coded under the other naming schemes reviewed to the recommended system and component type codes.

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Appendix A

System Naming Scheme Conversion Tables

Appendix A

System Naming Scheme Conversion Tables

This appendix presents tables that will allow the user to convert data coded under the other naming schemes reviewed to the recommended system and component type codes.

Table A-1. BWR system descriptions for converting from other naming schemes to the recommended system naming scheme

Recommended system codes	System descriptions	IEEE Standard-805 system codes	NPRDS system codes	NUREG/CR-3905 system codes
ACP	Plant ac power system	EK	EBA	EB
ADS	Automatic depressurization system	—	—	—
CCU	Component cooling water	CC	—	CA
CCW	Component cooling power	CC	—	CA
CDS	Condensate system	SD	HHD	CF
CGC	Containment combustible gas control	BB	SCAREC/SCADIL	—
CHR	Containment heat removal	—	SBA	—
CHW	Chilled water system	KM	—	—
CIS	Containment isolation system	—	—	SD
CLS	Consequence limiting control system	—	—	—
CPS	Containment penetration system	—	SAG	—
CRD	Control rod drive system	AA	RBA	AB
CSC	Closed cycle cooling system	—	—	CA
CSS	Containment spray mode of residual heat removal	—	CFASCK	—
DCP	dc power system	EI/EJ	ECB	EE
DGN	Diesel generator system	—	EEA	EH
DGX	Diesel cross-tie system	—	—	—
DWS	Drywell/wetwell spray mode of residual heat removal system	—	—	—
EHV	Emergency heating, ventilation, and air conditioning system	—	—	—
ESF	Engineered safety feature actuation system	JE	—	IW
ESW	Emergency/essential service water system	BI	WAA	CB
FHS	Fuel handling system	—	—	FD
FWS	Firewater system	KP	—	—
HCI	High pressure coolant injection system	BJ	SFC	BN
HCS	High pressure core spray system	BG	SFB	BW
HSW	High pressure service water system	—	—	—
IAS	Instrument air system	LD	—	—
IPS	Instrument ac power system			
ISO	Isolation condenser	BL	—	BB
LCI	Low pressure coolant injection system	BO	—	—
LCS	Low pressure core spray system	BM	SFA	BX

Table A-1. (continued).

Recommended system codes	system descriptions	IEEE Standard-805 system codes	NPRDS system codes	NUREG/CR-3905 system codes
LPR	Low pressure coolant recirculation	—	—	—
MCW	Main circulating water system	—	—	FR
MFW	Main feedwater system	SJ	EBA	FI
MSS	Main steam system	SB	CCA	FA
NHV	Normal heating, ventilation, and air conditioning system	—	—	—
NSS	Nuclear steam supply shutoff system	—	SDC	—
NSW	Normal service water	—	—	—
OEP	Offsite electrical power system	—	—	—
PCS	Power conversion system	—	—	—
PPR	Primary pressure relief system (safety relief valves)	—	—	BR
PSW	Plant service water system	—	—	—
RBC	Reactor building closed cooling water system	—	WBA	—
RCI	Reactor core isolation cooling system	BN	CEA	BC
RGW	Radioactive gaseous waste system	—	—	WD
RHR	Residual heat removal system	BO	CFA	BH
RLW	Radioactive liquid waste system	—	—	WA
RMT	Recirculation mode transfer system	—	—	—
RPS	Reactor protection system	—	IBA	—
RWC	Reactor water cleanup system	CE	—	—
RRS	Reactor recirculation system	AD	—	AI
SDC	Shutdown cooling mode of residual heat removal	—	—	—
SGT	Standby gas treatment system	—	SEA	—
SIS	Safety injection actuation system	—	—	—
SLC	Standby liquid control system	BR	—	—
SPC	Suppression pool cooling mode of residual heat removal	—	—	—
SPM	Suppression pool makeup system	BT	SAA	—
SSW	Standby service water system	—	—	—
SXT	Standby service water cross-tie system	—	—	—
TBC	Turbine building cooling water system	KB	—	—

Table A–2. PWR system descriptions for converting from other naming schemes to the recommended system naming scheme.

Recommended system codes	System descriptions	IEEE Standard 805 system codes	NPRDS system codes	NUREG/CR-3905 system codes
ACP	Plant ac power system	—	EBE/EBF/EBI	—
AFW	Auxiliary feedwater system	BA	HHC/HHJ/HHB	—
ARF	Air return fan system	—	—	AA
AVS	Annulus ventilation system	—	SCB/SCF	—
CAC	Containment atmosphere clean up	—	—	—
CCS	Containment cooling system	BK	—	—
CCW	Component cooling water system	—	WBB/WBD/WBC	—
CDS	Condensate system	SD	HGA/HHD/HHE	HG
CFC	Containment emergency fan cooler system	BK	—	SBG
CFS	Core flood system	—	CFCSFE	BS
CGC	Containment combustible gas control	BB	SEDDIL/SECDIL	SE
CHP	Charging pump system	—	—	—
CHW	Chilled water system	KM	—	—
CIS	Containment isolation system	JM	SDA/SDE/SDB	SD
CLS	Consequence limiting control system	—	—	—
CPC	Charging pump cooling system	—	—	—
CPS	Containment penetration system	—	—	—
CRD	Control rod drive system	AA	REB/RBK	RB
CSC	Closed cycle cooling system	—	—	—
CSR	Containment spray recirculation system	BE	SCI/SCD/SCC	—
CVC	Chemical volume and control system	CB	PCF/PCG	PC
DCP	dc power system	EI/EJ	ECC/ECD/ECE	EC
DGN	Diesel generator system	—	—	EE
DGX	Diesel cross-tie system	—	—	—
EHV	Emergency heating, ventilation, and air conditioning	—	—	—
EPS	Emergency power system	—	EEC/EED/EEB	—

Table A-2. (continued).

Recommended system codes	System descriptions	IEEE Standard-805 system codes	NPRDS system codes	NUREG/CR-3905 system codes
ESF	Engineered safety feature actuation system	JE	IBE/IBB/IBK	IB
ESW	Essential service water system	BI	WAB/WAD/WAC	WA
FHS	Fuel handling system	—	—	FD
FWS	Firewater system	KP	—	AB
HPI	High pressure safety injection system	BQ	SFD/SFG/SFF	—
HPR	High pressure coolant recirculation system	—	—	—
HWS	High pressure service water system	—	—	—
IAS	Instrument air system	LD	—	—
ICS	Ice condenser system	BC	SBF	—
IGS	Integrated control system	—	IEC	—
IPS	Instrument ac power system	—	EBG/EBH/EBK	—
ISR	Inside containment spray recirculation system	—	—	—
LCI	Low pressure coolant injection system	—	CFD/CFF	—
LMS	Letdown purification and makeup system	—	PCB	—
LPR	Low pressure recirculation system	—	—	—
LSW	Low pressure service water system	—	WAB	—
MCW	Main circulating water system	—	—	HF
MFW	Main feedwater system	SJ	HHA/HBG/HHF	CH
MSS	Main steam system	SB	HBA/HBB/HBC	CC
NHV	Normal heating, ventilation, and air conditioning system	—	—	AA
NSW	Normal service water	—	—	—
NWS	Nuclear service water system	—	WAC/WAD	—
OEP	Offsite electrical power system	—	—	EA
OSR	Outside spray recirculation system	—	—	—
PCS	Power conversion system	—	—	HJ
PPR	Primary pressure relief system (pressure operated relief valve)	—	—	—

Table A-2. (continued).

Recommended system codes	System descriptions	IEEE Standard 805 system codes	NPRDS system codes	NUREG/CR-3905 system codes
PSW	Plant service water system	—	—	—
PVS	Penetration room ventilation system	—	SDA/SHA/SHB	—
RBC	Reactor building cooling water system	—	—	WB
RBP	Reactor building penetration system	—	SAB/SAC	—
RBS	Reactor building spray system	—	SCC	—
RCS	Reactor coolant system	AB	CBD/CBG/CBH	CG
RGW	Radioactive gaseous waste system	WE	—	MB
RHR	Residual heat removal system	BO	CFP/CFC	CF
RLW	Radioactive liquid waste system	WD	—	MA
RPS	Reactor protection system	JD	IBB/IBD/IBG	JU
RMT	Recirculation mode transfer system	—	—	—
RWC	Reactor water cleanup system	CE	—	—
SIS	Safety injection actuation system	—	—	—
SPR	Secondary pressure relief system	—	—	—
SSW	Standby service water system	—	—	—
SXT	Standby service water cross-tie system	—	—	—
TBC	Turbine building cooling water system	KB	—	—

Table A–3. Component type descriptions for converting from other naming schemes to the recommended component type naming scheme.

Recommended component codes	Component descriptions	IEEE Standard-803A component codes	NPRDS component codes	NUCLAR component codes
ACU	Air cleaning unit	—	—	—
ACX	Air cooling heat exchanger	—	—	—
AHU	Air heating unit	EHTR	—	—
AOV	Air operated valve	—	—	—
ASF	Flow sensor/transmitter	FT	IXMITR	SEN
ASL	Level sensor/transmitter	LT	IXMITR	SEN
ASO	Physical position sensor/transmitter	ZT	INSTRU	SEN
ASP	Pressure sensor/transmitter	PT	IXMITR	SEN
ASR	Radiation sensor/transmitter	RT	IXMITR	SEN
AST	Temperature sensor/transmitter	TIT	INSTRU	SEN
ASX	Flux sensor/transmitter	—	—	SEN
BAC	Electrical bus—ac	BDSSBU	ELECON	CNDBS
BAT	Battery	BTRY	BATTRY	BAT
BCH	Battery charger	BYC	BATTRY	BCH
BDC	Electrical bus—dc	BDSSBU	ELECON	CNDBS
CAL	Calculational unit	—	—	—
CBL	Electrical cable	CBL	ELECON	CNDCC/ CNPC
CKD	Nonreturn damper	DMP	VALVE	DPX
CKV	Check valve	—	VALVE	VLC
CRB	Circuit breaker	BKR	CKTBRK	CBM/CBP
CRH	Control rod hydraulically driven	—	CRDRVE	CRD
CRM	Control rod motor driven	—	CRDRVE	CRD
DCT	Ducting	DUCT	—	—
DGN	Diesel generator	DG	GENERA	GND
EDP	Engine driven pump	P	PUMP	GNG
EPV	Explosive valve	EP	VALVE	VLE
FAN	Motor driven fan	FAN	BLOWER	FVNFN
FCV	Flow control valve	FCV	VALVE	—
FLT	Filter	FLT	FILTER	FLT
FUS	Fuse	FU	—	FUS

Table A-3. (continued).

Recommended component codes	Component descriptions	IEEE Standard-803A component codes	NPRDS component codes	NUCLAR component codes
HDV	Hydraulic valve	—	VALVOP	VLV
HRU	Hydrogen recombiner unit	—	RECOMB	REC
HTR	Heater element	EHTR	HEATER	HTR
HTX	Heat exchanger	HX	HTEXCH	HTX
ICC	Instrumentation and control circuit	—	INSTRU	—
INV	Inverter	INVT	GENERA	—
ISV	Electrical isolation device	—	ISODEV	—
LOD	Load/relay unit	—	—	RLP/RLC
LOG	Logic unit	—	—	LOG
LPS	Local power supply	JX	IPWSUP	PWSUP
MDC	Motor driven compressor	CMP	BLOWER	BLC
MDP	Motor driven pump	P	PUMP	PPM
MGU	Motor generator unit	MG	—	—
MOD	Motor operated damper	—	VALVE	DPM
MOV	Motor operated valve	—	VALVOP	VLM
PND	Pneumatic/hydraulic damper	DMP	VALVE	DPX
REC	Rectifier	RECT	—	—
SMP	Sump	—	—	—
SOV	Solenoid operated valve	CSV	VALVOP	VLS
SRV	Safety/relief valve	RV	VALVE	VLR
STR	Strainer	STR	FILTER	STR
TCV	Testable check valve	—	VALVE	VLC
TDP	Turbine driven pump	P	PUMP	PPT
TFW	Transformer	XFMR	TRANSF	XTP
TNK	Tank	TK	—	TAN/ TANKS
TSA	Traveling screen assembly	—	FILTER	STRST
TSW	Transfer switch		CKTBRK	SWC/SWP
TXX	Bistable trip unit	—	IBISSW	—
XDM	Manual damper	DMP	VALVE	DPO
XSW	Manual control switch	—	CKTBKR	SWC
XVM	Manual valve	HCV	VALVOP	VLO

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11. ABSTRACT (200 words or less)

This report describes the review and development of common nomenclature for naming and labeling schemes for probabilistic risk assessments (PRAs) conducted by the Idaho National Engineering Laboratory (INEL). Based on the review, the INEL recommends using an existing basic event labeling scheme and existing naming schemes for systems, component types, and component failure modes. The review showed no adequate accident sequence labeling schemes currently exist. Therefore, the INEL developed a scheme that would meet the review requirements of not exceeding 16 characters and being highly descriptive of the accident sequence involved. As parts of the developed accident sequence labeling scheme, the INEL also developed transient and loss-of-coolant accident initiating event codes, a sequence naming scheme, and accident type codes. Applications of the accident sequence labeling scheme are presented along with tables to allow changes from other schemes to the recommended naming schemes. The review and development were conducted to provide the Nuclear Regulatory Commission with the means to coordinate and integrate their internal activities through a common nomenclature for their many data bases.

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