IPE DATA BASE: PLANT DESIGN, CORE DAMAGE FREQUENCY AND CONTAINMENT PERFORMANCE INFORMATION

J. Lehner  
C. C. Lin  
W. T. Pratt  
Brookhaven National Laboratory  
Upton, NY 11973  

T. Su  
L. Danziger  
U.S. Nuclear Regulatory Commission  
Rockville, MD 20852

ABSTRACT

A data base, called the IPE Data Base has been developed that stores data obtained from the Individual Plant Examinations (IPEs) which licensees of nuclear power plants have conducted in response to the Nuclear Regulatory Commission's (NRC) Generic Letter GL88-20. The IPE Data Base is a collection of linked files which store information about plant design, core damage frequency, and containment performance in a uniform, structured way. The information contained in the various files is based on data contained in the IPE submittals.

The information extracted from the submittals and entered into the IPE Data Base can be manipulated so that queries regarding individual or groups of plants can be answered using the IPE Data Base. The IPE Data Base supports detailed inquiries into the characteristics of individual plants or classes of plants.

Substantial progress has been made on the IPE Data Base over the last two years and it is largely complete. The recent focus of the work on the IPE Data Base has been the development of a user friendly version which is menu driven and allows the user to ask queries of varying complexity easily, and without the need to become familiar with particular data base formats or conventions such as those of dBase IV or Microsoft Access. The user can obtain the information he or she is interested in by quickly moving through a series of on-screen menus and "clicking" on the appropriate choices. In this way even a first time user can benefit from the large amount of information stored in the IPE Data Base without the need of a learning period.

*Work performed under the auspices of the U.S. Nuclear Regulatory Commission.
BACKGROUND

As previously reported, a database, called the IPE Data Base, has been developed that stores data obtained from the Individual Plant Examinations (IPEs) which licensees of nuclear power plants have conducted in response to the Nuclear Regulatory Commission's (NRC) Generic Letter GL88-20. The IPE Data Base is a collection of linked files which store information about plant design, core damage frequency (CDF), and containment performance in a uniform, structured way. The information contained in the various files is based on data contained in the IPE submittals.

The information extracted from the submittals and entered into the IPE Data Base can be manipulated so that queries regarding individual or groups of plants can be answered using the IPE Data Base.

There are two sections of the IPE Data Base, corresponding to the Level 1 analysis in the IPE submittals and the Level 2 analysis.

The titles of the Level 1 files, indicating the focus of the information contained in each, are the following: General Plant Information, Front-Line Systems, Support Systems, Dependency Table, Core Damage Prevention Strategies, Mission Success Paths, and the Accident Sequence Table. The link between these files is a basic list of BWR and PWR systems, in terms of which:

(a) the design of any BWR or PWR can be described with reasonable fidelity (General Plant Information, Front-Line Systems, Support Systems, Dependency Table),

(b) plant-specific dominant accident sequences can be described accurately (Accident Sequence Table), and

(c) the success paths assumed in the IPE (i.e., its mission success criteria) can be tabulated (Core Damage Prevention Strategies, Mission Success Paths).

The Level 1 portion of the IPE Data Base is connected to the Level 2 portion through the Plant Damage States. The Level 2 files in the IPE Data Base are the following: Plant Damage State Definitions, C-matrix, (containment performance), Source Terms, and Level 2 Analysis Parameters, (source term characteristics).

Another data file, containing high level information on CDF contributors, was added to the above structure and coupled to the rest of the IPE Data Base files. This additional file contains summary information found in each IPE submittal regarding initiating event frequencies and the total contribution to core damage from each initiating event. Because of the way information was reported in the submittals, the previously existing accident sequence files of the IPE Data Base contain only partial results regarding the contribution to core damage from various initiators. The summary information file remedies this situation.

The IPE Data Base supports detailed inquiries into the characteristics of individual plants or classes of plants. In particular, one can compare the core damage frequency and containment performance of BWRs and PWRs as a function of their design features, based on information which is contained in the IPE submittals.

The IPE Data Base is designed to provide helpful information for general questions like: What features does each submittal take credit for? How does this factor into the core damage frequency and/or containment performance of the plant? If two plants in basically the same class have markedly different CDF and/or containment performance, what is responsible for this? If a class of plants seems to share a particular contributor to core damage, what design features are responsible for this?
Substantial progress has been made on the IPE Data Base over the last two years and it is largely complete. Entries into the IPE Data Base from the IPE internal events examination have been finished with all IPEs entered.

FOCUS OF CURRENT DEVELOPMENT

The recent focus of the work on the IPE Data Base has been the development of a user friendly version which is menu driven and allows the user to ask queries of varying complexity easily, and without the need to become familiar with particular data base formats or conventions such as those of dBase IV or Microsoft Access. The user can obtain the information he or she is interested in by quickly moving through a series of on-screen menus and "clicking" on the appropriate choices. In this way even a first time user can benefit from the large amount of information stored in the IPE Data Base without the need of a learning period.

The development of this user friendly version is currently (October 1995) incomplete and will undoubtedly undergo substantial changes before being released next year. However, the following discussion and the accompanying figures show the direction of the development and indicate the ease with which a user will be able to manipulate the IPE Data Base. At the same time, what follows also serves to illustrate the kind of information available in the database and provides examples of some very simple queries.

One of the first menus a user will see will provide a choice of which IPE Data Base files to manipulate as well as choice of which plants to enquire about. Figure 1 shows the current scheme where the General Plant Information File has been chosen and some of the possible selection criteria are shown, i.e. plant name, vendor, reactor type, or containment type. Combinations of these criteria can be used and additional criteria are being added. Figure 2 shows the result of selecting a single plant by name. Figure 3 shows the result of selecting all BWRs with Mark I containments. Note that in the latter case the screen indicates that what is shown is the first of 18 records and the other records can be accessed by "clicking" on the "First," "Previous," "Next," or "Last" buttons. Subsequent development will allow viewing more than one record at a time.

Figure 4 shows a simple query regarding the information on core damage frequency. The left side of the screen shows that the query asks for all Westinghouse four loop plants with a CDF greater than 1.E-5. The right side of the screen indicates there are 20 such plants, with the fifth record shown, i.e. Comanche Peak 1&2. Again viewing more than one record per screen will be available in the future.

Figure 5 indicates the kind of information available in the Accident Sequence File of the IPE Data Base. A single plant, St. Lucie 1, has been selected and the screen indicates that the IPE submittal for this plant provided information on 109 accident sequences, with the fourth sequence shown on the screen. The screen shows the designation given this sequence in the IPE submittal, the plant damage state (PDS) it was assigned to, the initiator (S3: a small-small LOCA), and the CDF of the sequence along with the total plant CDF. The screen also indicates that high pressure recirculation (HPR) and another system, designated AR1 in the generic IPE Data Base nomenclature, have failed and led to core damage in this sequence. The "Notes" field on the right side of the screen provides additional information. To determine what system corresponds to AR1 in this plant the user can go to the Front Line Systems File and see, as indicated in Figure 6, that AR1 for St. Lucie refers to the Shutdown Cooling System.

If the user wants to see the success strategies used in the St. Lucie IPE for the S3 initiator, the Success Strategy File for this plant indicates, as shown in Figure 7, that there are four strategies with the first one indicated on the screen (Record 1 of 4). This strategy relies on high pressure injection (HPI), high pressure recirculation (HPR), secondary side heat removal (SSMU), and containment heat removal (CPSR). A look at the other strategies, such as feed and bleed for instance, would show that they all require HPR, and this correlates with the fact that HPR failure leads to core damage for this initiator, as indicated in the accident sequence shown in Figure 5.
Figures 8 and 9 illustrate part of the information on containment performance stored in the IPE Data Base. Figure 8 shows that for the Release Class designated B4-R in the St. Lucie Submittal fission product release fractions are provided for noble gases, iodine, cesium, and tellurium. Figure 9 indicates the properties associated with this release class in terms of a number of parameter designators. Currently the user would have to refer to an IPE Database dictionary to decipher these designators, but they will be replaced with readily understandable phrases in the near future.

SUMMARY AND CONCLUSION

In its present form, the IPE Data Base serves as a tool to store, examine and compare the enormous amount of information contained in the body of IPEs, and can enhance the future use of this information for various applications.

A user friendly version of the IPE Data Base is continuing to be developed. The above discussion indicates the general direction of this development but the final product will contain many additional features and will be optimized in terms of search parameters and screen appearance.

Besides completion of the user friendly database version, remaining work on the IPE Data Base involves updating the information contained in it, based on responses received from the licensees to requests for information generated during the NRC’s review of the individual submittals. In addition, information from the external events examination part of the IPE process, the IPEEE, may eventually be incorporated into the IPE Data Base.

REFERENCES


DISCLAIMER

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### General Plant Information

**Plant Name:**
- **CALLAWAY**

**Containment Type:**
- MK I
- MK II
- MK III

**Support Systems:**
- Shared
- Not Shared
- Neither

**Plant:**

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**Shared Supp Syst:**

- Crosstie
- Com Contr.

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**Figure 1** General Plant Information Screen

**Figure 2** General Plant Information Screen with Single Plant Selected
Figure 3  General Plant Information Screen with all Mark I Plants Selected

Figure 4  Example of Core Damage Frequency Query Screen
Figure 5 Example of Accident Sequence Screen

Figure 6 Example of Front-Line Systems Screen
### Figure 7 Example of Success Strategy Screen

**Plant Name:** ST. LUCIE 1  
**Challenge:** S3  
**Strategy:**  
**Containment Type:**  
**Notes:** SECONDARY HEAT REMOVAL, HIGH PRESSURE INJECTION AND RECRIRULATION

### Figure 8 Example of Fission Product Release Fraction Screen

**Plant Name:** ST. LUCIE 1  
**Release Class:** B4-R  
**Notes:**

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**Notes:**

LATCE CF INCLUDING BASEMAT MELT-THROUGH

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**Figure 9 Example of Release Class Parameter Screen**
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