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Title: Human Events Reference for ATHEANA (HERA) Database Description and Preliminary User's Manual

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Los Alamos
NATIONAL LABORATORY

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Human Events Reference for ATHEANA (HERA)

Database Description and Preliminary User's Manual

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Prepared for: United States Nuclear Regulatory Commission

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Abbreviations

ACM	Action Characterization Matrix
AEOD	Office of Analysis and Evaluation of Operational Data
AIT	augmented inspection team
ATHEANA	A Technique for Human Error Analysis
CR	control room
db	database
EFC	error-forcing context
EOC	error of commission
EOO	error of omission
FOR	frame-of-reference
HACS	Human Action Classification Scheme
HERA	Human Events Reference for ATHEANA
HPIP	Human Performance Investigation Process
HRA	human reliability analysis
HSECS	Human-System Event Classification Scheme
IG	Implementation Guidelines
LANL	Los Alamos National Laboratory
LERS	licensee event reports
NPP	nuclear power plant
NRC	Nuclear Regulatory Commission
NUCLARR	Nuclear Computerized Library for Assessing Reactor Reliability
PSF	performance shaping factor
PRA	probabilistic risk assessment
PZR	pressurizer
RAM	random access memory
RCS	reactor coolant system
SG	steam generator
UA	unsafe action

1 Introduction

The Technique for Human Error Analysis (ATHEANA) is a newly developed human reliability analysis (HRA) methodology that aims to facilitate better representation and integration of human performance into probabilistic risk assessment (PRA) modeling and quantification by analyzing risk-significant operating experience in the context of existing behavioral science models. The fundamental premise of ATHEANA is that *error-forcing contexts*[1] (EFCs), which refer to combinations of *equipment/material conditions* and *performance shaping factors* (PSFs), "set up" or create the conditions under which *unsafe actions* (UAs) can occur. (See the ATHEANA Frame-of-Reference [FOR] Manual [Taylor et. al., 1997] and Implementation Guidelines [IG; Bley et. al., 1997] for further information.)

Because ATHEANA relies heavily on the analysis of operational events that have already occurred as a mechanism for generating creative thinking about possible EFCs, a database (db) of analytical operational events, called the Human Events Reference for ATHEANA (HERA), has been developed to support the methodology. This report documents the initial development efforts for HERA.

1.1 Background

The HERA development effort is a follow-on activity to two earlier db development projects. The first db, the Human Action Classification Scheme (HACS) (Barriere, Luckas, Whitehead, and Ramey-Smith, 1994) pre-dates ATHEANA. It was patterned on existing dbs, including the Human Performance Investigation Process (HPIP) (Paradies, Unger, Haas, and Terranova, 1993) and the Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR) (Gilbert, Gertman, and Gilmore, 1990), so represented the commonly accepted aspects of human performance such as PSFs, event time phases, and error types. This strong link between HACS and the prevailing assumptions and conventions of HRA/PRA, however, rendered the db incapable of supporting the multidisciplinary HRA framework of ATHEANA. Thus, a second evolution of the db, this time called the Human-System Event Classification Scheme or HSECS, was undertaken in parallel with the development of ATHEANA. (See Cooper, Luckas, and Wreathall, 1995.)

[1]Italics indicate that a definition for the highlighted term is available in the glossary. Italics appear only upon first use of the term.

HSECS efforts focused on incorporating the ATHEANA terminology and concepts into a db structure and fields. Analyses of three operational events (Salem Unit 1, Wolf Creek, and Davis-Besse) were used to refine the db fields and to develop a report format. The output of this effort was a db prototype containing three detailed "records" (one each for the three aforementioned operational events).

Los Alamos National Laboratory's (LANL) Human Factors Group has recently joined the ATHEANA project team; LANL is responsible for further developing the db structure and for analyzing additional exemplar operational events for entry into the db. Modifying HSECS was defined as the starting point for the LANL effort.

1.2 HERA Improvements

At the initiation of this project, the HSECS db that was to become HERA suffered from several weaknesses. First, HSECS db development efforts preceded completion of the development of the ATHEANA methodology. As a result, the conceptual links between the existing db and the ATHEANA framework were not as obvious as desired.

Second, although it was intended that the db be the repository for a set of examples that would aid ATHEANA analysts, entry of events into the db did not keep pace with generation of other ATHEANA-related documents. Thus, there were many events used as examples in these documents that were not available in the db.

Third, structural issues with HSECS necessitated substantial redesign. There were numerous cases in which a single field contained multiple pieces of information or in which the same information was repeated in several fields. More desirable is a normalized data structure, in which the structure is atomic and fields are non-repetitious (first normal), redundant data are eliminated (second normal), and fields that can be derived from other fields are eliminated (third normal). In addition, the db structure did not facilitate easy discrimination between information that could be considered a factual representation of the event (facts and data) and the recasting of that event into ATHEANA language (analysis and interpretation). As such, it was somewhat difficult for a user to trace the lessons of the ATHEANA analysis.

Finally, ATHEANA is being developed in the context of nuclear power plant (NPP) PRAs, and much of the language used to describe the method and provide examples of its application are specific to that industry. However, it is hoped that the method will be equally applicable in other high-risk/high-consequence areas, such as transportation, chemical processing, medicine, etc. However, although ATHEANA documents use events from other industries (especially transportation and chemical processing) as examples, the db was not structured to accept non-NPP events in a meaningful way, nor was there a way to "equate" events from different industries such that learning about EFCs in one industry could be generalized to stimulate thoughts about similar EFCs in another.

Correction of these deficiencies, then, became the driving force for improvements to HERA. Specifically, the version of HERA described in this documentation provides a db structure that:

- provides fields that are accurate representation of the current ATHEANA methodology,
- is at least quasi-normal,
- partitions the data into two sections: facts/data and analysis/ interpretation, and
- provides a generic language for understanding the <u>analysis</u> of events across industries.

2 Database Objectives

The principal objective of the HERA db is to support the application of the ATHEANA methodology. To accomplish this objective, HERA must provide examples of a sufficiently representative set of the EFCs revealed through the diligent application of ATHEANA to stimulate appropriate lines of thought for each new analysis. These examples should be drawn both from existing events analyzed using the ATHEANA methodology and predictive applications of ATHEANA.

3 Database Development Approach

Although the primary focus of this section is on the approach to the development of the db itself, it is important to note that a precursor activity was required to allow the development effort that led to the ability to include a generic language for understanding events across industries. The precursor activity, development of an Action Characterization Matrix (ACM), is documented briefly in Section 3.1. Section 3.2 is devoted to db development.

3.1 Action Characterization Matrix

The ACM was developed as a bridge between the HERA db structure and ATHEANA. Specifically, the ACM allows each UA to be characterized according to its representation along each of six different dimensions: system status, initiator status, UA mechanism, information processing stage, equipment/material conditions, and performance shaping factors. While these dimensions have direct correlates in the ATHEANA methodology as well as direct representation in the original HSECS db structure, in both cases, the information required (in the case of ATHEANA) or provided (in the case of the db) is too detailed to provide a snapshot of the UA that allows it to be quickly placed in context (such as an EFC or a combination of UA mechanism and information processing stage) and too NPP-specific to allow for cross-industry generalization.

The intention of the ACM is to provide a taxonomic description of an UA in a short-hand form that:

1. uses generic language, so that UAs having a particular constellation of characteristics can be understood as fitting into a similar context regardless of the industry from which they were derived,
2. uses simple language, that makes the links between the complex ideas expressed in ATHEANA and the (of necessity) equally complex entries contained in the db more explicit, and
3. is comprehensive enough to allow for a rapid understanding of the coverage of the possible exemplar space provided by a set of analyzed or predicted events.

For these reasons, development of the ACM was viewed as the necessary first step in resolving the problems with the HSECS db described above. The development approach for ACM as well as a detailed description of and rationale for the ACM matrix structure is documented in Hahn (March, 1998). Briefly, the development approach involved deriving ACM dimensions from ATHEANA documents using content analysis to derive categories. The category constituents were then defined in generic language and named. Relevant HRA literature (especially Reason, 1990) was consulted when clarification was required.

Given the reliance on the HRA literature in developing the ACM, the reader may wonder why commonly used terms such as "errors of omission" (EOO) and "errors of commission" (EOC) are not seen in HERA's current cognitive activity characterization. Initially, the ATHEANA team felt that such judgments could not be made reliably by the typical analyst, who could not be "inside the head" of the operator, especially when it came to determining the type of EOC (slip, lapse, mistake, or circumvention). For example, although one might observe an operator press an incorrect button (an error of commission, involving an action that should not have been performed but was), it would be difficult to determine whether the action was a mistake (i.e., the operator thought he[2] was pressing the correct button) or a circumvention (i.e., the operator intentionally pressed the button) without being able to question him explicitly (and even then, his recall/report might not be accurate). However, the ATHEANA team revisited this issue and decided that EOC and EEO were viable terms in any specific analysis. So, the current version of HERA contains two additional fields for EOOs and EOCs, but those fields are not yet populated with data and they are not included in any of HERA's underlying queries, forms, macros, or reports.

A high-level view of the ACM is shown in Figure 1 below. Note that the ACM is a six-dimensional quasi-hierarchical matrix. As depicted by the three levels of the hierarchy, three general types of questions must be answered for each UA being categorized:

- Describe the top-level conditions. What state was system in at the time the UA occurred? Did the UA occur before or after the event initiator or was the UA the initiator?
- What was the cognitive state of the operator as he took the UA? What were the cognitive demands and what was the mechanism for the resultant UA? Both parts of the latter question must be answered to characterize the cognitive activity.
- What was the EFC? Describe both the equipment/material conditions and the PSFs.

In the interest of consistency with ATHEANA, the UA, rather than the overall event (which is the unit used for records in the db), was selected as the usual unit to be described by the matrix entries: ATHEANA's language regarding EFCs is specific to UAs. (One exception to this is that equipment conditions are described in ATHEANA at the event level; the db assigned the event-level equipment conditions to all UAs.) Likewise, different UAs likely involve different information processing stages and mechanisms. Finally, because events progress over time, it is possible that system status

[2]Throughout this report, "he" and "his" are used to refer to persons of either gender.

Level 1: Top-Level Conditions

System Status	Initiator Status
Operating	Pre-Initiator
Maintenance/Testing	Initiating Event
Shut-Down/Stand-By	Post-Initiator
	Recovery

Level 2: Cognitive Activity Characterization

Unsafe Action Mechanism	Information Processing Stage
Disabling a running system/equipment	Monitoring/Detection
Starting a shut-down system	Situation Assessment
Equipment status inappropriately changed	Response Planning
Wrong action sequence	Response Implementation/Execution
Untimely action	
Depletion of resources	
Rate error	
Frequency error	
Quantity error	
Duration error	

3: Error-Forcing Context

Equipment/Material Condition	Performance Shaping Factors
Equipment availability	Procedures/Policies
Multiple equipment failures	Training/Knowledge
Instrumentation problems	Communication
Conditions not covered by procedures or otherwise unfamiliar or unanalyzed	Human-System Interface Design Environmental Conditions
History of equipment unreliability	Organizational Factors
Engineering safety features disabled or bypassed	Supervision Staffing
Latent equipment problems	Experience
Lack of equipment redundancy	Informal Rules/Practices
Hardware interactions/dependencies	Fatigue/Alertness
Environmental conditions	Shift Transition
	Workload
	Time Pressure

Figure 1: High-level view of the Action Characterization Matrix

changes over the course of an event. Take as an example the case of an event involving latent equipment problems induced by maintenance personnel. Here, the first UA may have occurred days or weeks before the event was triggered, and may have occurred when the system was in an entirely different configuration (i.e., maintenance versus operating). (For an example of such an event, see the augmented inspection team [AIT] report for Oconee Unit 3, 1991 [USNRC, 1991].) To describe an event, then, one would collate the information about each documented UA. Note that a particular UA may simultaneously trigger several cells in the equipment/material conditions and PSFs' dimensions.

The matrix is described as "quasi-hierarchical" in the sense that the levels are intended to convey relationships between dimensions at the same level (i.e., that equipment/material conditions and PSFs combine to produce an EFC) more so than to define a hierarchy of the dimensions.

The fields corresponding to the ACM are filled in using pull down menus, which limit the options to those described in the ACM (and an "other" option).

3.1.1 ACM Characterization of Events in HERA

To date, nine NPP events have been analyzed and entered into HERA. These include: Salem 1 (4/94), Wolf Creek (9/94), Davis-Besse 1 (6/85), Three Mile Island (TMI) 2 (3/79), Crystal River 3 (12/91), North Anna 2 (4/93), Oconne 3 (3/91), La Salle 2 (4/92), and Prairie Island 2 (4/92). These events provide examples of a fair fraction of the ACM dimension sub-categories. (One notable exception is the Maintenance/Testing sub-category of the System Status dimension; this result, however, is an artifact of the reality that most NPP maintenance is done during refueling outages (shut-downs).) However, because the interest is in combinations of, for example, equipment/material conditions and PSFs to form EFCs, a much larger set of example events will be needed to "cover the waterfront" – considering that there are 120 possible combinations of EFCs alone.

Tables 1 through 6 below provide an enumeration of the nine events currently captured in the db including ACM characteristics captured by that event. Blanks in the right hand column of each table indicate that none of the events yet analyzed possess the particular ACM characteristic.

Table 1 Mapping of Events by ACM System Status Dimension

System Status Sub-Category	Event
Operating	Salem 1 Davis-Besse 1 North Anna 2 TNI 2 Crystal River 3 La Salle 2
Maintenance/Testing	
Shut-down/Stand-by	Wolf Creek Oconne 3 Prairie Island 2

Table 2 Mapping of Events by ACM Initiator Status Dimension

Initiator Status Sub-Category	Event
Pre-Initiator	Salem 1 Wolf Creek North Anna 2 TMI 2 Oconee 3 Prairie Island 2 La Salle 2
Initiating Event	Wolf Creek Davis-Besse 1 TMI 2 Crystal River 3 Oconee 3 Prairie Island 2 La Salle 2
Post-Initiator	Salem 1 Wolf Creek North Anna 2 TMI 2 Crystal River 3 Oconee 3 Prairie Island 2
Recovery	Salem 1 Crystal River 3 Oconee 3 Prairie Island 2 La Salle 2

Table 3 Mapping of Events by ACM Unsafe Action Mechanism Dimension

Unsafe Action Mechanism Sub-Category	Event
Disabling a running system/ equipment	North Anna 2 TMI 2 Crystal River 3 La Salle 2
Starting a shut-down system	
Equipment status inappropriately changed	Wolf Creek Davis-Besse 1 Crystal River 3 Oconee 3 La Salle 2
Wrong action sequence	Davis-Besse 1 Oconee 3 La Salle 2
Untimely action	Salem 1 North Anna 2
Depletion of resources	Prairie Island 2
Rate error	Salem 1
Frequency error	
Quantity error	Prairie Island 2
Duration error	

Table 4 Mapping of Events by ACM Information Processing Stage Dimension

Information Processing Stage Sub-Category	Event
Monitoring/Detection	North Anna 2
Situation Assessment	Salem 1 North Anna 2 TMI 2 Crystal River 3 Oconee 3 Prairie Island 2 La Salle 2
Response Planning	Salem 1 Davis-Besse 1 North Anna 2 TMI 2 Crystal River 3 Oconee 3 Prairie Island 2 La Salle 2
Response Implementation/ Execution	Salem 1 Davis-Besse 1 North Anna 2
Other (Recognition)	Wolf Creek Davis-Besse 1

Table 5 Mapping of Events by ACM Equipment/Material Condition Dimension

Equipment/Material Condition Sub-Category	Event
Equipment availability	Salem 1 Davis-Besse 1 Prairie island 2 Las Salle 2
Multiple equipment failures	Crustal River 3 Prairie Island 2
Instrumentation problems	Salem 1 Davis-Besse 1 North Anna 2 Crystal River 3 Prairie Island 2
Conditions not covered by procedures or otherwise unfamiliar or unanalyzed	Wolf Creek La Salle 2
History of equipment unreliability	Salem 1 Wolf Creek La Salle 2
Engineering safety features disabled or bypassed	Wolf Creek Crystal River 3 La Salle 2
Latent equipment problems	Salem 1 Davis-Besse 1 Oconee 3 Prairie Island 2
Lack of equipment redundancy	
Hardware interactions/ dependencies	Wolf Creek Davis-Besse 1
Environmental conditions	Salem 1
Other	North Anna 2

Table 6 Mapping of Events by ACM Performance Shaping Factors Dimension

Performance Shaping Factors Sub-Category	Event
Procedures/Policies	Salem 1, Wolf Creek, North Anna 2, TMI 2, Crystal River 3, Oconee 3, Prairie Island 2, La Salle 2
Training/Knowledge	Salem 1, Wolf Creek, Davis-Besse 1, North Anna 2, TMI 2, Crystal River 3, Oconee 3, Prairie Island 2 La Salle 2
Communication	Salem 1, Wolf Creek, Davis-Besse 1, North Anna 2 Oconee 3
Human-System Interface Design	Davis-Besse 1, North Anna 2, TMI 2, Crystal River 3, Oconee 3, La Salle 2
Environmental Conditions	
Organizational Factors	Salem 1, Wolf Creek, Davis-Besse 1, Oconee 3 La Salle 2
Supervision	Salem 1, Wolf Creek, North Anna 2, Crystal River 3, Oconee 3, Prairie Island 2
Staffing	North Anna 2
Experience	TMI 2, Crystal River 3, La Salle 2
Informal Rules/Practices	Oconee 3, La Salle 2
Fatigue/Alertness	Crystal River 3, Oconee 3
Shift Transition	
Workload	Salem 1, North Anna 2, Prairie Island 2
Time Pressure	Wolf Creek, Davis-Besse 1, Crystal River 3, La Salle 2
Other	Davis-Besse 1, Crystal River 3

3.2 Database Development

A considerable amount of restructuring of the earlier HSECS db was required to create the current version of the HERA db. HSECS was developed using seven internal data tables. Six of these tables were linked to a main table, e.g. table "Events" that was comprised of about 55 different fields containing the bulk of the event data. In all seven tables, many of these individual fields were created as a "memo" type of data. This use of memo type data fields allowed the designers of HSECS to enter virtually unlimited amounts of text within individual fields. Large fields of text like this had a distinct advantage when one had to enter something like an event description which required much more than one or two brief sentences (e.g., the approximate maximum default size for fields of "text" data type). As a result, this allowed for the rapid entry of data and the deployment of the HSECS db prototype.

However, when doing this, each of the individual memo fields often contained several pieces of individual data. For example, when looking at the "Event Surprises" field in the HSECS "Events" table for the Salem 1 event, there are nine separate pieces of information contained in the one memo field. This contradicts the db developers' maxim of *one piece of data per individual field.* A more efficient db design would have had nine separate entries in nine separate fields. Because HERA is designed to be a relational db the underlying rules and symbols that define this db come from relational algebra and a branch of mathematics called *set theory* (Jennings, 1997). Relational algebra relies on a process of normalization, a formal process where data attributes are grouped into tables and the resulting tables are then grouped into a db. The process of db normalization seeks to eliminate duplicate information, accommodate any future changes in the structure of tables, and minimize the impact of those structural changes on user applications, which must then access the data. Typically, normalization is done in three basic steps or levels called normal form (see Figure 2 below.

To achieve first normal form all tables must be flat, i.e., two dimensional, and cannot contain data cells with more than one value. Second normal form is reached when the data in all non-primary key columns is fully dependent on the primary key, i.e, the data in each non-key column is determined by the primary key. A primary key is defined to be a column or columns, whose individual values uniquely identify a given row within a specific table. As such, primary keys are a field, or group of fields that uniquely identify each record stored in a table. Primary keys are important because they are used to establish the actual relationships between the various tables contained within any given db. Third normal form requires all tables to conform to first and second normal form, but also insists that all non-key columns of a table be dependent on the table's primary key and independent of one another. According to Gifford, et al. (1997), unnormalized dbs compromise data integrity, lead to

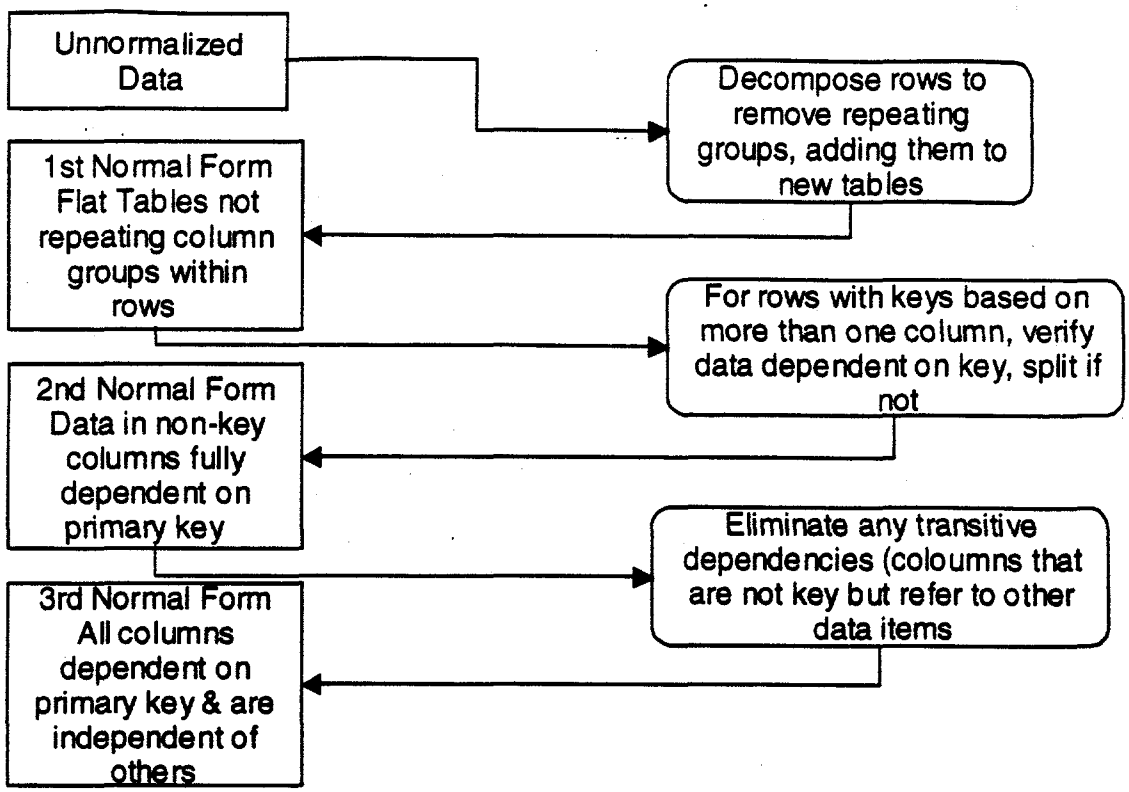


Figure 2: Database Normalization

poor performance with maintenance problems, and make some types of db reporting nearly impossible.

As HERA was being constructed, great care was taken to ensure that the structure and integrity of data complied with the process and rules of db normalization. This was primarily accomplished by changing most of the data fields' defaults to a text data type and limiting input to 250 characters or less (i.e., one to two brief sentences describing one piece of data). During creation of the data tables, and while entering actual data, normalization of HERA eliminated redundancy in the data while trying to accurately represent the human performance data required to support ATHEANA. Resulting output from the normalization activity created an optimized db that avoided anomalies in the data and simplified db maintenance and retrieval of information. The most recent edition of HERA (e.g., version 1.6) is now comprised of 12 separate tables and 25 related forms (see below, Section 4 Database Description). Tables are the db objects that contain the actual data and forms are used to organize and display that data to the user. As in the older HSECS db, nine of these tables are individually linked to one main normalized form. In addition, data were separated into two basic partitions, i.e., facts and ATHEANA interpretation. Data in the factual partition comes from the actual Nuclear Regulatory Commission (NRC) references written to explain each event in the db.

These include NRC documents such as licensee event reports (LERs), AIT reports, NUREG contractor reports, or other NRC documentation. Examples of "Facts" include reactor temperature, hardware failures, etc., that were not necessarily derived from any interpretative activity.

By comparison, the ATHEANA partition is specifically devoted to data that were derived from the factual partition using the ATHEANA method. Examples of this interpretive data include topics like EFC, cognitive activity, PSFs, event surprises, and other latent errors, which contributed to the reported event.

4 Database Description

4.1 General Database Design and Structure

Beyond the technical aspects of db design discussed above, the current version of HERA had several other design considerations. First, HERA was designed to mimic the functionality of the earlier HSECS db, after HERA was normalized. Specifically, the design of HERA incorporated as output, each of the 11 different data reports within HSECS. Second, the design of HERA included some basic human factors considerations for the end user. Keeping the structure of the db as simple as possible, as well as establishing simple relationships between the tables, forms and reports accomplished this. Finally, by using default Microsoft Windows screen colors (i.e., blues and grays), along with graphics, HERA was created to be much more visually attractive and accessible to the end user.

HERA is now comprised of 10 different data tables in conjunction with 25 forms, and 11 pre-defined reports. As seen in Figure 3, below, nine tables are individually linked to a main table

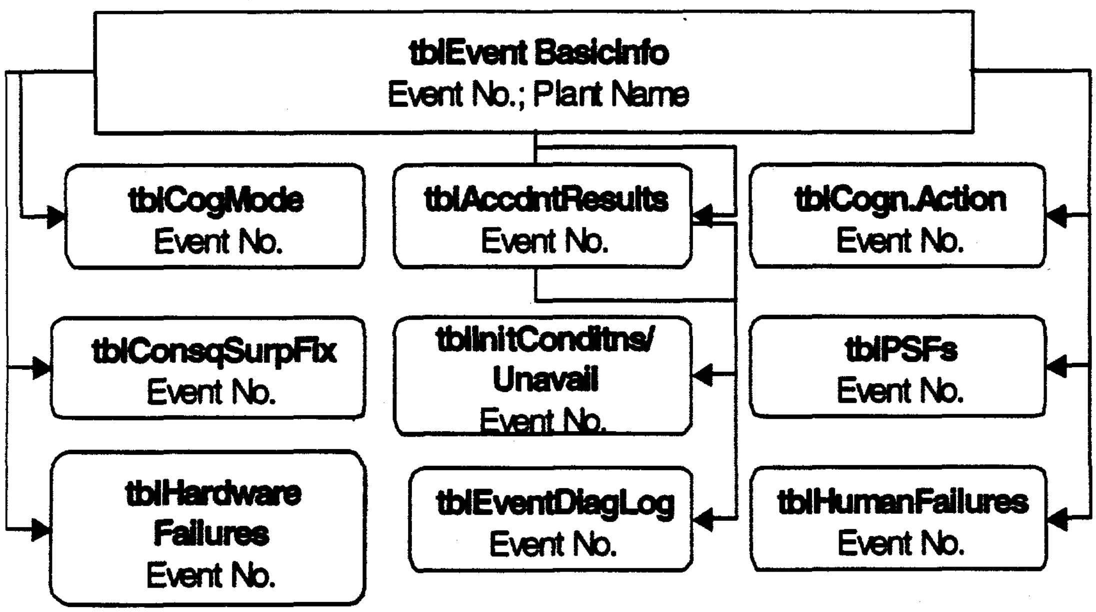


Figure 3: HERA's Structure

(tblEventBasicInfo[3]) based on the primary keys of "Event Number." Recall that a primary key was defined to be a column or columns whose individual values uniquely identify a given row (i.e., a record) within a specific table. In addition, each linked table was established as a "many to one relationship" where many instances of related data were all linked to one Event Number. In the event that any pieces of data must be deleted, the many-to-one relationship and enforced referential integrity allows for cascading deletes/updates of data, which in turn prevent any orphaned records (i.e., pieces of related data left behind because of an incomplete deletion) within the remainder of the data. As used here, referential integrity is the set of implicit rules used by the db engine to ensure that relationships between tables are properly maintained. In other words, deleting a hypothetical event "X" will cause the deletion of all related pieces of data associated with event "X."

4.2 Tables and Table Structure

As in any relational db, HERA is comprised of a number of related tables, each of which contains varying numbers of fields that in turn contain the actual bits of data. The following listings are included to show the structure for each of HERA's tables, along with information on the respective fields of data.

4.2.1 TblEventBasicInfo

TblEventBasicInfo is the primary data table and is linked to the 10 other HERA tables. TblEventBasicInfo is comprised of 28 fields of data containing the basic information for each event in the db. This basic information includes such things as Event No., Industry, Plant Name, references, and pre- or post-accident engineering parameters. It has three primary keys (shown in bold italics in the tables below), Event No., Industry, and Plant Name, which are the basis for the links to the other HERA tables. A detailed listing of the 28 fields in tblEventBasicInfo follows in Table 7 below.

[3]All database objects in HERA have been named following the Leszynski naming convention referenced in Balter's 1997 book. For example, tables all start with the nemonic letters "tbl"; forms with "frm," etc.

Table 7 Structure of tblEventBasicInfo

Field Name	Description	Data Type	Field Size
Event no.	Unique identification number for each event	Number (Integer)	2 bytes
Plant Name	Name of facility/plant	Text	40 characters
Event Date/Time	Date and Time of Event	Date/Time	8 bytes
Document ID	Brief Document Reference	Text	250 characters
Data Source	Reference items	Text	250 characters
Plant Type	For NPP data - PWR, BWR	Text	9 characters
Vendor	Plant Builder	Text	25 characters
System Status	Operating, shutdown, etc.	Text	250 characters
Unit Status	Full power, shutdown, etc.	Text	20 characters
Primary Event	1st initiating event	Text	80 characters
Secondary Event	2nd initiating event	Text	80 characters
Other Event	Other contributing event	Text	250 characters
Event Description	Brief summary of event	Memo	65,535 characters
Init Power	Initial reactor power level	Text	30 characters
Init Temp	Initial RCS temperature	Text	60 characters
Init Press	Initial RCS pressure	Text	30 characters
Init Level	Initial Pressurizer (PZR) level	Text	60 characters
Init SG	Initial Steam Generator (SG)	Text	36 characters
Init Other	Other significant conditions	Text	60 characters
Acc Power	Accident reactor power level	Text	30 characters
Acc Temp	Accident RCS temperature	Text	60 characters
Acc Press	Accident RCS pressure	Text	30 characters
Acc Level	Accident PZR level	Text	60 characters
Acc SG	Accident Steam Generator	Text	36 characters
AnalystID	Name- contact information	Text	250 characters
Acc Other	Accident Other conditions	Text	60 characters

4.2.2 TblCogMode

HERA's next table contains data pertaining ATHEANA derived information with respect to cognitive action numbers, error descriptions, cognitive mode (ACM), description, error mode and error type. It has three primary keys, ID#, Event no and Cognitive Action Number. "ID# or Item#" in this and all following tables, simply provides the db with a unique index number for each entry within each respective table. Table 8 below, shows the field names, descriptions, data type, and field size for the data fields in tblCogMode.

Table 8 Structure of tblCogMode

Field Name	Description	Data Type	Field Size
ID#	Unique index number for each entry	Number (Long)	4 bytes
Event no.	Event no (tied to tblEventBasicInfo)	Number (Integer)	2 bytes
Cognitive Action Number	Unique identifier assigned to each cognitive action	Text	50 characters
Error Text	Brief description of the error	Text	250 characters
Cognitive mode	Taxonomic classification derived from the ACM	Text	40 characters
Description	Cognitive action description	Text	250 characters
Error Mode	New field to capture error of omission/commission	Text	50 characters
Error Type	Slip, lapse, mistake, etc	Text	50 characters

4.2.3 TblAccdntResults

Table #3 in HERA is called TblAccdntResults. It contains fields that describe various result occurring from the event, i.e., lost inventory, plant damage, radiation releases, personnel injuries, off-site damage, and other (notes). "Table Entry ID#" and "Event No." are the two primary keys where Table Entry ID# is the unique index item number for this table. Details are shown in Table 9 below.

Table 9 Structure for tblAccdntResults

Field Name	Description	Data Type	Field Size
Table entry ID#	Unique index number for each item entered	Number (Long)	4 bytes
Event no.	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes
Inventory Loss	Lost plant inventory resulting from event	Text	250 characters
Plant Damage	Event's damage to plant	Text	250 characters
Radiation	Radiological releases occurring from event	Text	250 characters
Personnel injuries	List of injuries resulting from event	Text	250 characters
Off-site damage	List of damages spreading off-site	Text	250 characters
Other	Field for notes/comments	Memo	unlimited

4.2.4 TblCognitiveAction

This is the fourth of the 11 tables in HERA. It contains data related to the various operator cognitive activities arising from the event, i.e., Action no, action description, UA mechanism (ACM), etc. "Item#," "Event No.," "Plant Name," and "Actno" are the primary keys. Details are shown in Table 10 below.

Table 10 Structure for tblCognitiveAction

Field Name	Description	Data Type	Field Size
Item#	Unique index number	Number	4 bytes
Event no.	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes
Plant Name	Name of facility	Text	50 characters
Actno	Cognitive action number	Text	20 characters
Action description	Cognitive action	Text	250 characters
UAActionMech	UA mechanism	Text	250 characters
Systems-components lost	List of all components or systems lost from event	Text	250 characters
Plant conditions	List of unusual plant conditions at time of event	Text	250 characters
Initiator status	ACM taxonomic listing of Initiator status	Text	25 characters
System Status	ACM - system status	Text	50 characters
Equipment/material condition	ACM - condition of equipment and material	Text	50 characters
Plant Impact	Event's impact on plant	Text	250 characters
Location	Location of event	Text	250 characters
Activity	Description of operator/ plant activity	Text	250 characters
PersType	Unused field for type of personnel involved, i.e., operators, maintenance, etc.	Text	40 characters

4.2.5 TblConsqSurpFix

TblConsqSurpFix is next, the fifth of HERA's 11 tables. This table contains data related to ATHEANA analysis of the event, e.g., the event's surprises, consequences and the fixes. Data fields include Item#, Event no, significance, positive/negative influences, etc.

Table 11 Structure of TblConsqSurpFix

Field Name	Description	Data Type	Field Size
Item#	Unique index number for each item entered	Number (Long)	4 bytes
Event no	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes
Significance	ATHEANA summary of event's underlying significance	Text	250 characters
Event surprises	ATHEANA data concerning unusual-surprising aspects of event	Text	250 characters
Negative Influences	ATHEANA description of unusual negative activities	Text	250 characters
Positive Influences	ATHEANA description of unusual positive influences	Text	250 characters
Corrective acts	List of plant fixes put in place to correct discrepancies from the event	Text	250 characters
Other	Notes	Memo	Unlimited

4.2.6 TblPSFs

This is another table created to handle PSFs identified in an ATHEANA analysis. As can be seen in Table 12 below, it has three primary keys (Item#, Event no., and CogAct no) along with two other fields (PSF type and PSF description) that provide descriptive information for each PSF.

Table 12 Structure of tblPSFs

Field Name	Description	Data Type	Field Size
Item#	Unique index number for each item entered	Number (Long)	4 bytes
Event no	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes
CogAct no.	E#=equipment failure; U#=UA; R# =successful recovery act; H#=successful non-error or recovery	Text	5 characters
PSF type	PSF categories per ACM	Text	35 chars.
PSF Description	PSF descriptions	Text	250 chars.

4.2.7 TblHardwareFailures

As can be seen in Table 13 below, the seventh table in HERA, i.e., TblHardwareFailures contains two primary keys (Item# and Event no. as before) and other data fields related to specific hardware failures arising from a given event.

Table 13 Structure of TblHardwareFailures

Field Name	Description	Data Type	Field Size
Item#	Unique index number for each item entered	Number (Long)	4 bytes
Event no	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes
HrdwreFail	Specific listing of hardware/component failures	Text	250 characters
SafEquipAct	Event's safety equipment actuations	Text	250 characters
Common Cause Failure	Event's common cause failures	Text	250 characters
Missing Indication	List of missing indicators contributing to the event	Text	250 characters
Dependencies	As used now, listing of dependent hardware failures	Text	250 characters
Other Hardware	Field for brief notes or other failures	Text	250 characters

4.2.8 TblEventDiagLog

In Table 14 below, data was entered referencing each event's diagnostic log, i.e., the play-by-play description as the event unfolded. TblEventDiagLog contains two primary keys (i.e., LogID, and the usual Event No.) along with three remaining fields, i.e., LogTime, Symptoms, and Responses. Details are contained in the following table.

Table 14 Structure of tblEventDiagLog

Field Name	Description	Data Type	Field Size
LogID	Automatically Numbered listing for each log entry	Autonumbe r	4 bytes
Event no	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes
LogTime	Date and time of entry; Format is -month, day, year and hour: minutes;(AM/PM) i.e., 11-12-77 01:32 PM	Date/Time	8 bytes
Symptoms	Numbered listing of individual symptoms of event	Text	250 characters
Responses	Numbered listing of responses to event	Text	250 characters

4.2.9 TblHumanFailures

This next table was created as the repository for data used in both the factual and ATHENA partitions, specifically containing human failure data. It has 7 data fields that contain two primary keys (i.e., Item No, and Event no), explained in Table 15 below.

Table 15 Structure of tblHumanFailures

Field Name	Description	Data Type	Field Size
Item no	Unique index number for each item entered	Integer	2 bytes
Event no	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes
Latent Failures.	ATHEANA data identifying latent human failures	Text	250 characters
Defeated Defenses	List of event's defenses defeated by inappropriate human action	Text	250 characters
Aggravating Actions	Event's human action(s) contributing to/aggravating the situation	Text	250 characters
Things left undone	Potential human actions that were not accomplished and which might have helped mitigate the event	Text	250 characters
Other Human Failures	Field for brief notes or additional human failure data	Text	250 characters

4.2.10 TblInitConditns/Unavail

HERA's last table contains 11 data fields pertaining the plant conditions at the time of or briefly preceding the initiating event(s). It has the usual two primary keys of Item# and Event No., with the remaining fields devoted to Evolutions and Activities, Configuration, Operational Problems, Administrative Controls, and Temporary Fixes, etc. Details are presented in the following table, i.e., Table 16, below.

Table 16 Structure of tblInitConditns/Unavail

Field Name	Description	Data Type	Field Size
Item#	Unique index number for each item entered	Number (Long)	4 bytes
Event no	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes
Evolution/ Activity	Plant evolutions and/or activities	Text	250 characters
Configuration	Plant configuration	Text	250 characters
OpPrblms	Pre-existing operational problems	Text	250 characters
AdminCotrls	Listing of administrative controls in effect	Text	250 characters
TempFix	List of temporary fixes	Text	250 characters
Containment	Problems with containment	Text	250 characters
Alarms	Alarm problems, unavailability, or failures	Text	250 characters
Instruments	Instrument unavailabilities	Text	250 characters
CRIndic	Control room indicator unavailabilities	Text	250 characters
Notes	Field for brief notes	Text	250 characters

5 Guidance on Use of HERA Version 1.6

5.1 HERA - Requirements for Use

The current release of HERA was created using Microsoft's db development tool, ACCESS '97, Service Release 1. This is an integrated db development tool to be specifically used with the Microsoft Windows '95 or Windows NT operating systems. Following Microsoft's suggested recommendations for use, HERA's end users should also have a minimum of 12-16 megabytes of random access memory (RAM) installed on their computer, which, in turn, should have at least a 486 PC processor. In addition, HERA was developed on a system that had a 17," high-resolution monitor (800 x 600 resolution) and used 16 bit color. End users that do not have comparable systems may notice some aspects of decreased performance pertaining to screen colors, clarity, or processing speed.

In its original form, HERA was a Microsoft Access db file (i.e., a .mdb file) that allowed the designer to create and modify HERA's tables, forms, visual basic code, data, and other db objects. Because this ability to modify HERA's underlying structure was deemed inappropriate for the intended end user, HERA.mdb can be translated into a HERA.MDE file.[4] This conversion would compile all Visual Basic code, remove all editable source code, and actually compact the db, thereby reducing its size and improving memory usage and processor performance. In addition, once HERA becomes HERA.MDE, end users will be prevented from doing the following actions:

- viewing, modifying, or creating forms, reports, or modules in Design View (e.g., in Access 97, Design View is that functionality used to create various tables forms, reports, etc.);
- adding, changing, or deleting any references to various Access object libraries or dbs;
- changing or modifying the Visual Basic code or modules within the db; and
- exporting or importing forms, reports, or modules (but users can still import/export tables, queries and macros to or from other dbs).

Having HERA in a MDE format simply prevents the end users from altering the underlying structure or functionality of the db as designed, but still permits the addition, deletion, or modification of the data.

4 The actual conversion to a..mde file is accomplished through the use of a built-in Access Wizard found as an option. With HERA1-6.mdb open, click "Tools," then "Database Utilities," and then "Make MDE File." Access will automatically create the conversion.

5.2 Distribution

HERA's current version, i.e. version 1.6, is being distributed in a 1 disk self-installing, version that requires the use of Microsoft Access '97. Please note: all installation options require users to be using either MS Windows 95 or Windows NT 4. HERA and the underlying MS Access '97 files require a 32-bit operating system. Earlier 16-bit versions of MS Windows, Windows NT, or MS Access are not compatible with HERA.

5.3 Installation

Windows '95 offers several different ways to install new software programs. The following instructions take the user through the recommended installation path using the Windows *Control Panel* and the *Add/Remove Programs* utility. While this is only one way to install HERA, this method helps insure that HERA and the run-time files are correctly recorded in the Windows Registry, the file that helps Windows locate, initialize, and run all software installed on a given machine. Where possible, pictures are included to help guide less experienced users of Windows through the installation process.

To begin installation of HERA, use your mouse to move the cursor to the bottom left-hand corner of your screen where you should see the *"Start"* button. When the cursor is on top of this control, click the left-hand mouse button once. This will display a default menu. Next, while this menu is displayed, move your mouse upwards and click once on the *"Settings"* icon. Then move the mouse to the right and click once on the *"Control Panel"* icon. This will cause the Control Panel window to be displayed on your monitor. Typically, you should see a number of new icons displayed alphabetically (the default mode). Now, move your cursor to the *"Add/Remove Programs"* icon within the Control Panel and double-click the mouse.

As you can see, this window is displayed with the *"Install / Uninstall"* tab already opened. Following the instructions at the top of this window, move your cursor to the *"Install"* button and click once. Next, follow the displayed instructions and insert HERA's only floppy disk into the 3.5" floppy drive (usually Drive A:) on your machine. Then click the mouse once on the *"Next"* button. Windows will automatically start searching for the correct installation program and should find the setup file on this disk. You can also type "A:\HERA1-6.exe" (when 3.5 floppy is A: drive) and then click *"Finish."* Clicking *"Finish"* starts the installation program for HERA. HERA installation then gives you the option of installing HERA into some other directory, other than the specified default location (i.e., c:\Program Files\HERA). Please note however, that HERA will not work properly unless the user has installed the full version of Access '97. Just follow the on-screen directions. HERA's installation should successfully complete itself by installing the HERA db into the default C:\Program Files\HERA directory or whatever other directory you may have specified.

5.4 Installation Testing

HERA's installation program was tested on both Macintosh and PC computers. On the Macintoshes, HERA was successfully installed on an 8100 Power Mac NuBus System with an OrangePC 586 adapter card, a Macintosh PowerMac 5300 laptop, and a Macintosh Power PC 8600/200 with the "Virtual PC" emulation software. These configurations allowed the machines to run Windows '95 and related PC software. The first two Mac systems had Windows '95 and Access '97 already installed. However, the second Mac computer only had Windows '95 installed. In all instances, HERA was fully functional.

For the PC installations, HERA was successfully installed and run on the following computers:
(1) Two 486 DX computers with Windows '95 and Access '97.
(2) 133 MHz Pentium with Windows '95 (OSR2) and Access '97 SR-1.
(3) A 233 MHz Pentium II with Windows '95 (OSR2) and Access '97.
(4) A Pentium Pro machine with Windows NT version 4.0 and Access '97.
(5) A 166 MHz Pentium with Windows NT 4.0 and NO ACCESS '97, and
(6) An IBM Pentium laptop with Windows '95 and Access '97.
As before, there were no reported problems with the 586 Pentium PC installations.

5.5 Using HERA - Forms and Reports

As mentioned earlier, the HERA db was specifically designed to mimic the functionality of the HSECS db. In the prior HSECS db, users jumped between loosely connected forms and then viewed one of 10 basic reports. (Note: forms show data on the screen while reports obtain printed hard copies of that data). Users could only look at one form or report at a time and had to either print it out or close it before looking at the next section of data.

In contrast to this, HERA now has basically the same data (now normalized) accessed through one main form, i.e., form Event Basic Information, and nine new forms (as described in Section 4 above), all of which are actuated from the main form. An end user can now display one report/form at a time, print it, or can have several (or all) of the reports/forms open at the same time. This permits the windowing of selected forms, which, in turn, allows the user to compare/contrast various pieces of a specific event's data while being simultaneously displayed on the same screen. As anyone begins to use HERA (instructions are presented in the following sections), he/she will see the main form by default. From this display, the user will have the ability to view an event's related data, examine the ATHEANA analyses of this event, or use HERA's limited querying ability[5]. Also note that each

[5]Because HERA's data and forms are now "normalized," users can generate effective queries on their own or they can utilize the default querying capability programmed into the current version. Querying ability in the earlier HSECS db was extremely limited because of its extensive use of non-normalized memo type data fields.

form was designed using a 17" high-resolution monitor to accommodate a report with a standard 8.5" x 11" or 8.5" x 14" inch page. To fully examine all data on a given form, users with smaller monitors may have to rely on the use of both the horizontal and vertical scroll bars that should automatically appear when individual forms are opened for display.

5.6 Basic User Instructions

In the following sections, step-by-step instructions are provided to guide the user through the basic uses of HERA. As an aid, images are also provided where appropriate. Please note that these instructions are only designed to be rudimentary, generic guidelines to help a new user begin using the functionality contained within the db.

5.6.1 Starting HERA

To start HERA, you must first start the Access program. As it initializes you will see a screen listing the last four or five dbs opened by Access on that particular computer. If this is your first opening of HERA, click on the more files option and then use the default capabilities to "Browse" or locate the C:\Programs File\HERA directory. Then select the HERA1-6.mde file and click "OK." In a moment or two, you will see HERA's start-up (i.e., "splash") screen, which contains a visual introduction to HERA. It is called a splash screen because it "splashes" onto your monitor for a few moments and then disappears without any action on the part of the end user. Information on this screen includes the title, the sponsor (i.e., the U. S. Nuclear Regulatory Commission), and the designer (i.e., the Human Factors Group at Los Alamos National Laboratory).

5.6.2 HERA's Switchboards

As the introductory splash screen fades out, it is replaced by the first of HERA's two switchboard displays (see Figure 4 below). This is HERA's main control center for providing navigational paths between groups of forms and reports. Clicking one of the button controls on the main switchboard will take you to a different part of the HERA db. As you can see from Figure 4 HERA's main switchboard currently contains six different control buttons with differing functionality. These controls will do the following:

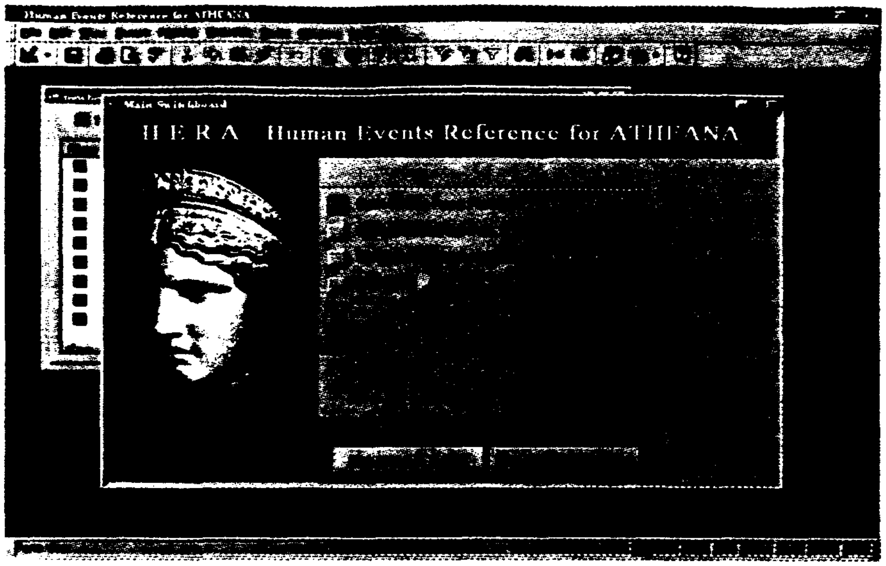


Figure 4: HERA's Main Switchboard

(1) Starting with the two controls at the bottom of the switchboard- These two controls were provided as demonstrations of HERA's hyperlink capability. In the event that HERA migrates onto a server and the Internet, hyperlink buttons like these could take the user to almost any form of on-line documentation via the Internet. For example, if the full incident reports and other documentation for ATHEANA/HERA were placed on a dedicated server, HERA's users would be able to view and print the documents after clicking these controls and accessing an appropriate server. However, this hyperlink capability also requires users to have a good web browser installed on their computers. In HERA's current run-time version, clicking on these controls will automatically look for the default web browser on that machine, access the Internet and take the user to the NRC's home page or LANL's Human Factors Group Home page. Remember that this is only a demonstration of HERA's future potential.

(2) Moving upward on the main switchboard, you will see the next control with the label "*Exit HERA*." Clicking that button will shut down the HERA/Access and return you to your computer desktop.

(3) Another step upward will bring you to the button "*Generating Human Error Probabilities*." At this point, HERA has no ability to generate any probabilistic estimates for human failures. As before, this control was established only to demonstrate potential future capabilities. This is only a demonstration, but this partition in the db could eventually be used to create a quantification ability, based on rules derived from ATHEANA and all validation studies of ATHEANA.

(4) The next button above "*Generate Human...*" is entitled "*Open Chemical Plant Data*." Clicking on this control will again take you to a form intended as a display. As originally envisioned, HERA was to contain human failure data derived from ATHEANA analyses in non-nuclear power operational environments like critical events from petro-chemical plants. Other potential domains suggested for inclusion include nuclear medicine, aviation, and fossil fuel power plants, to name a

few.
(5) Finally, moving to the first button at the top of the main switchboard, you should see a label *"Open Nuclear Power Plant Data."* At this point, this is the only truly functional button in HERA. Clicking here will take you into a partition of the db that currently contains the data from several critical incidents at nuclear power plants (NPP).

At this point, the main switchboard will disappear and you should be viewing the second switchboard. This form looks like Figure 5 below.

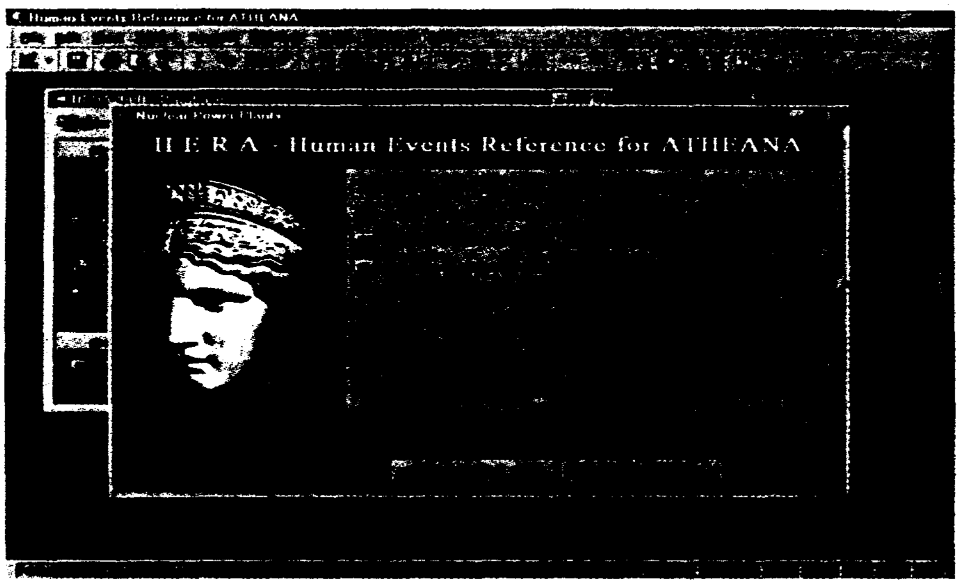


Figure 5: HERA's Second Switchboard

As you can see, the second switchboard resembles the main control (i.e., has the same image, color, layout, and same two hyperlink controls at the bottom). However, now at the top of the form, there are three control buttons. For now, this discussion will focus on the controls entitled *"Select Event Basic Information..."* and *"Return to Main Switchboard."* Clicking on the *"Return to Main Switchboard"* button will return you to the main switchboard. So, move your cursor to the *"Select Event..."* button and click to begin viewing HERA's NPP data.

5.6.3 Event Basic Information Form

As explained earlier (see Section 5.5 and Figure 6) HERA's functionality is now tied to one basic form, i.e, the *"Event Basic Information"* form. It should now be displayed on your monitor and is shown in Figure 6 below. As its name implies, the form you are now viewing contains one individual event's basic information. It also contains the controls to select other events and/or view other sections of data that are related to the selected event. By default, HERA will display the first event in the db, i.e., the Salem 1 incident. Also as a default function, the viewing of all other related data is tied to the event selected and displayed on the *Event Basic Information* Form. This means for example, that if a user has selected Salem 1 as the event of interest, clicking on the "*Initial/Accident Parameters*" button will display various bits of data that are associated with the Salem 1 event only. Users are unable to view other parcels of information from other events without first closing the open form and returning to the "*Event Basic Information*" form where a new event can then be selected and that event's associated data can then be examined.

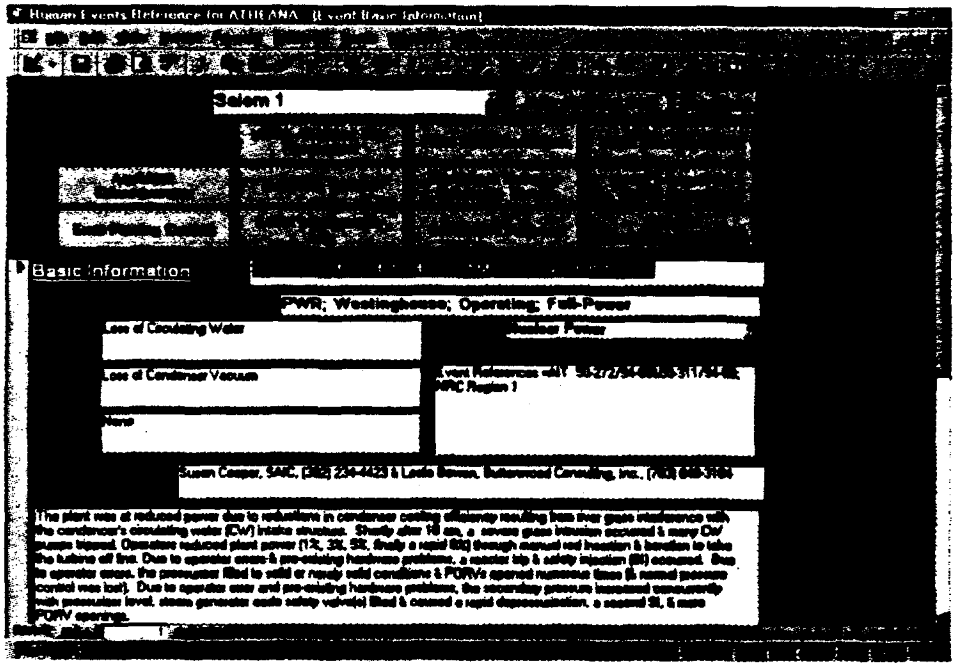


Figure 6: Event Basic Information Form

The "*Event Basic Information*" form is comprised of two separate areas, each of which contains a different HERA functionality. Let us start with the major portion of this form which displays the actual basic event data. This part of the main form is shown in Figure 7 above and is found on the bottom half of the Event's Basic Information main form. As you can see, this portion of the main form contains 9 separate fields that individually display basic bits of event data.

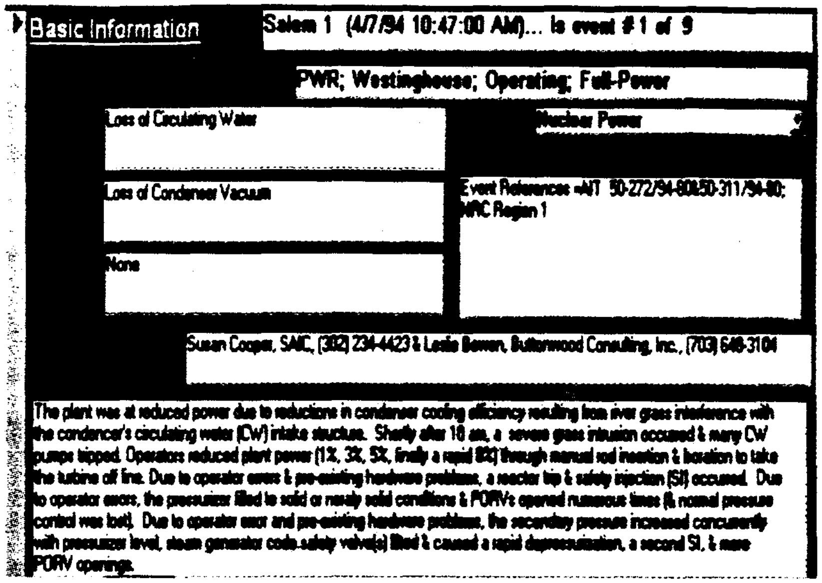


Figure 7: HERA's Main Data Form

Specifically, these fields include: 1-the event name, date and time of event, and a statement that the selected event is "Salem 1 (4/7/94 10:47:00 AM)...is event #1 of 9";[6] 2-type of power plant, operating state, and the plant's vendor; 3-Industry; 4-Document references; 5-primary or initiating event; 6-secondary event; 7-other important contributing event; 8-analyst ID; 9-event description. (Please refer to Table 4 in Section 4.2.1 for details on individual fields). Note that the "*Description*" field is actually a memo data type. So it can display a very large document or event description. Clicking in this field should actuate both horizontal and vertical scroll bars if the size of text exceeds the size of the "*Description*" field. Users can then scroll through all of the displayed text.

Next, at the top of the "*Event Basic Information*" form, you will find the main group of db controls. You should see a large title, i.e., "*#1 Select Event*" and a field with "Salem 1" being displayed (Salem 1 is the default). Clicking on this field will display a drop-down menu listing all of the events contained in the db. This is shown in Figure 8 below. While the drop-down menu is displayed, you can move your cursor over one of the events to select it. This will result in the display of that event's basic data within the middle of the main form, as discussed in the preceding section.

[6]This second box is actually a programmed control that sometimes does not work when this form first opens. When this happens, it displays "# Name" instead of the default information. Closing and re-opening the main form generally causes this field to work as designed.

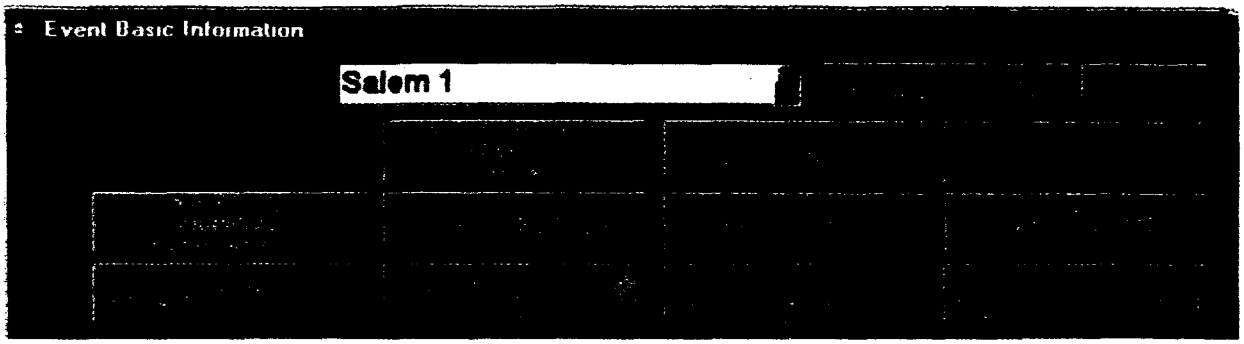


Figure 8: Top Portion of HERA's Main Form

Just to the right of the Select Event field you will see two buttons, i.e., "*Print Event Data* and *Close Form.*" *Print Event Data* will automatically print out the basic event information that is displayed for the currently selected event. *Close Form* will close the "*Event Basic Information*" form and return you to the second switchboard, discussed in Section 5.6.2 above. From there, the user can either re-enter the NPP data, or back up to the main switchboard to access other partitions or exit HERA. Next, just below the Select Event field, you will see a second collection of controls lying to the right of another large title, i.e., "***#2 - View Event Data***."

These individual controls were placed on the main form, primarily to enhance the user's ability to select and view other important event data without having to jump through several loosely linked forms while trying to decipher cryptic acronyms to gain access to the data. As mentioned earlier, this was one of the major limitations found in the earlier HSECS db. It should be re-emphasized that the functioning of each of these individual controls is tied in a one-way relationship to the event that is selected and displayed on the "*Event Basic Information*" form. After selecting an event, users can click on one or more of these controls to view that portion of the selected event's related data. This can be done by viewing one related form at a time, opening and minimizing several forms at once, or by opening several forms and displaying them in windows on the same screen at the same time. Doing this will allow users to compare and contrast pieces of data related to the selected event. Each of the controls in Figure.9 will be discussed below.

5.6.4 Accessing the Initial and Accident Key Parameters Form

From the main form, i.e., the "*Event Basic Information*" form, clicking on the "*Initial-Accident Key Parameters*" button will display the form shown in Figure 9 below.

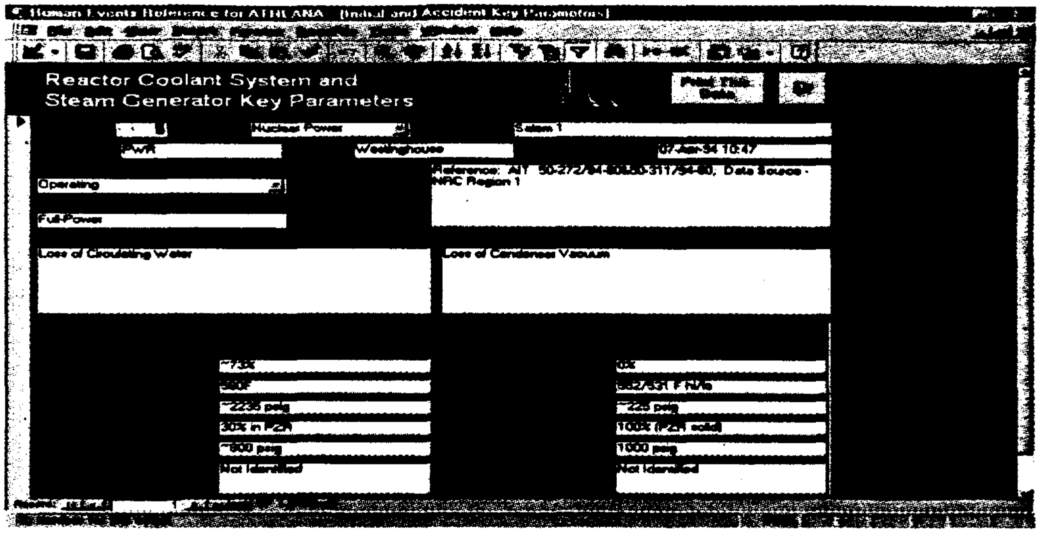


Figure 9: Key Parameters Form

After selecting this control, the Plant's Initial and Accident Key Parameters form shows data pertaining to the system and unit status, primary and secondary events, and a listing of both initial and accident parameters for Power level, Temperature, Pressurizer Level, Steam Generator, and Other. Basic heading information comes directly from the "*Event Basic Information*" main form and is provided on each of HERA's displays as an aid to help users refresh their memory with respect to the event that is being viewed. Information in the header part of these forms includes: event number, plant name, date and time of the event, plant type and vendor, and primary and secondary events.

It is important to note the controls on the bottom left-hand corner of each tab's display. Here you will see Figure 10 below.

Figure 10: Record Navigation Controls

This figure indicates that you are now viewing Record... 1... of 8. As standard Windows defaults, most users should know that if they want to see record #2 on the selected tab, they should click on the single right pointing arrow found just to the right of the displayed number "1." If you click on the button with the right pointing arrow and vertical bar, you will find yourself viewing Record #8 (e.g., the last record) for the selected tab. Next, if you should click on the last button on the right, the one with the right pointing arrow and box, you will find yourself at record #9. Since there are only 8 records found on this tab, you must realize that #9 is a new data field that only contains default information, in this case "N/A." Conversely, if you want to see the preceding record, click on the control to the left of the displayed number "1," i.e., the control with the single left pointing arrow. Clicking on the control with the left pointing arrow and vertical bar will return you to the first record.

Utilizing these record controls is very important because it is one of only two ways one can view all of the individual records associated with the field on each folder's tabs. Printing a form's data (see discussion below) is the other optimal method to view a tab's entire data. One may see the default data entry of "N/A" while scrolling through the records. This is an artifact arising from the db developer's mandate of "one piece of data per cell," the way the original table was constructed, and the requirement that information is entered in all empty cells. Data was entered in each cell for each field, but if there was no further information available for that field, the default "N/A" was entered instead. This same basic process applies to all of HERA's forms and tables. So please be sure to scroll through ALL of the data by using the appropriate scrolling controls or print out the data for each folder's tabs.

Printing - On the top right of this (and all other forms) you will see a control to "Print This Data." Clicking on this button will print all of the records for this event that pertain to the displayed fields, in this case the Initial and Accident Key Parameters. In Access terminology, this is a print form function where the data displayed in the current form is formatted and sent to the default printer. Clicking this button, or similar controls on each of the other forms, will print out all of the data on that form (i.e., the form currently being displayed). Because of this functionality, printing the form is an optimal method to see all of a tab's data at one time.

5.6.5 Accessing the Plant Initial Conditions Form

From the main form, i.e., the "*Event Basic Information*" form, clicking on the "*Plant Initial Conditions*" button will show Figure 11 below. This particular form displays basic engineering parameters for the facility's Initial conditions and other key parameters. Fields contained include: event number, Industry, plant name; primary initiating event; evolution and activity, per-existing problems, configuration, administrative controls, and temporary fixes. Details for the individual fields on this form can be found in Section 4.2.1 above. Clicking on "*Close Form*" will close this

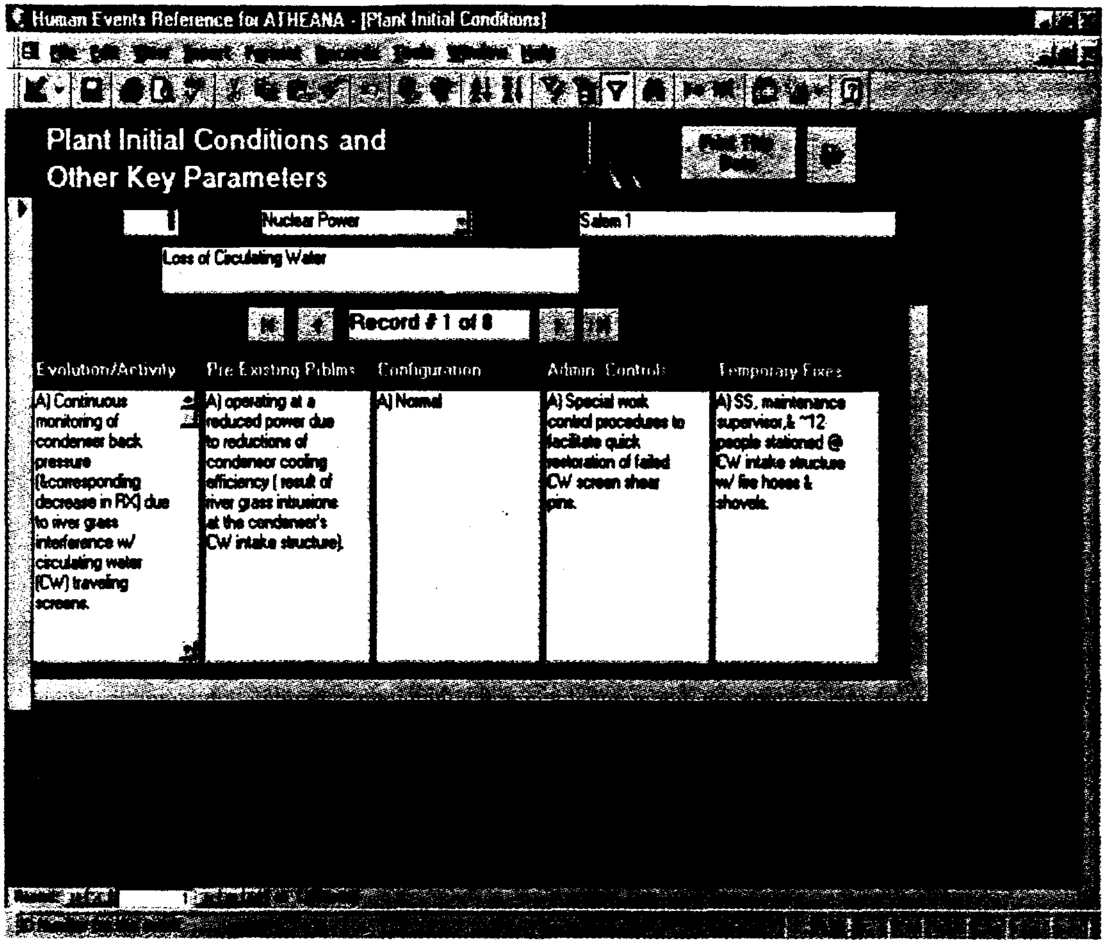


Figure 11: Initial Conditions Form

form and return you to the "*Event Basic Information*" form, i.e. HERA's main form for NPP data. Recall that this and all other HERA forms are linked to the event selected on the "*Event Basic Information*" main form. As a result of this, users will only be able to view the RCS/SG data from that selected event. Users can however, simultaneously display this form along with other open forms, simply by moving the cursor to the top of the form where Windows has its "Menu Bar." Clicking on "*Window*" will display three options, i.e., "*Tile Horizontally, Tile Vertically, or Cascade*." Selecting any one of these three options will create a display where each of the open forms in HERA will be contained in a separate window within one larger window. "Windowing" like this allows users to see several different aspects of the data related to the same event, at the same time.

However, if one wants to see other data for another event, he/she must close this form (or click the "Preview Report" or "Print All Events" controls) which automatically returns the user to the main form where a new event can be selected for display. After selecting the new event, the user can then click on one of the buttons on the "*Event Basic Information*" main form, thereby displaying the desired data linked to the selected event.

5.6.6 Initial Unavailability Form

Next, actuating the "Initial Unavailability" button on HERA's main form will display the following form, i.e., Figure 12.

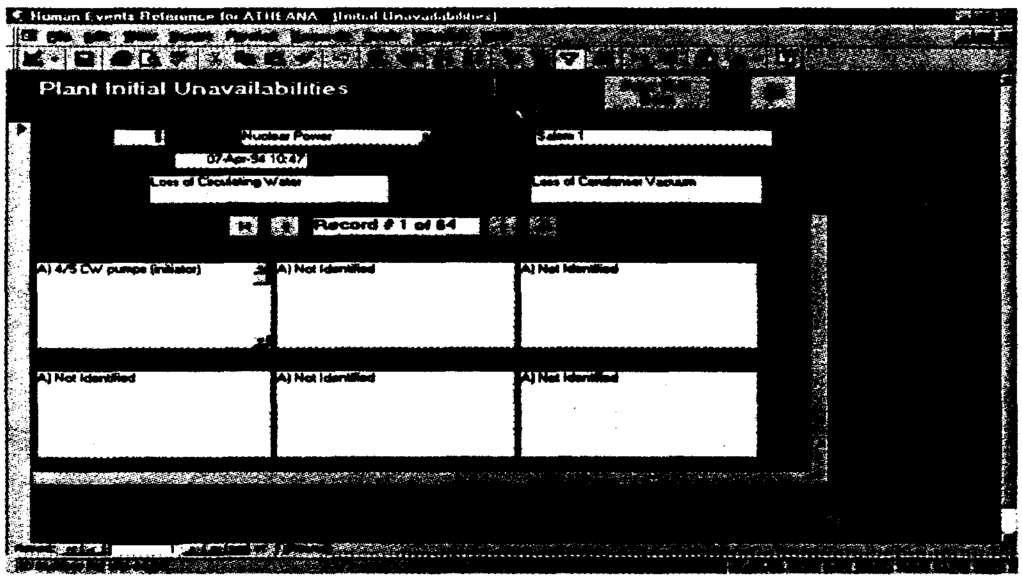


Figure 12: Initial Unavailabilities Form

As can be seen in this figure, this form displays the selected event's system and component unavailability data. Specifically, the individual fields contain lost system-component, containment, alarms, instruments, control room (CR), and other plant unavailabilities arising from the primary event and secondary events (see 4.2.11 above). Printing and close form functions are the same as those discussed in the preceding section, i.e., Section 5.6.4 above.

5.6.7 Accident Consequences

Clicking data control button four (i.e., the "*Accident Conditions*" Control) will show a form like that seen in Figure 13 below.

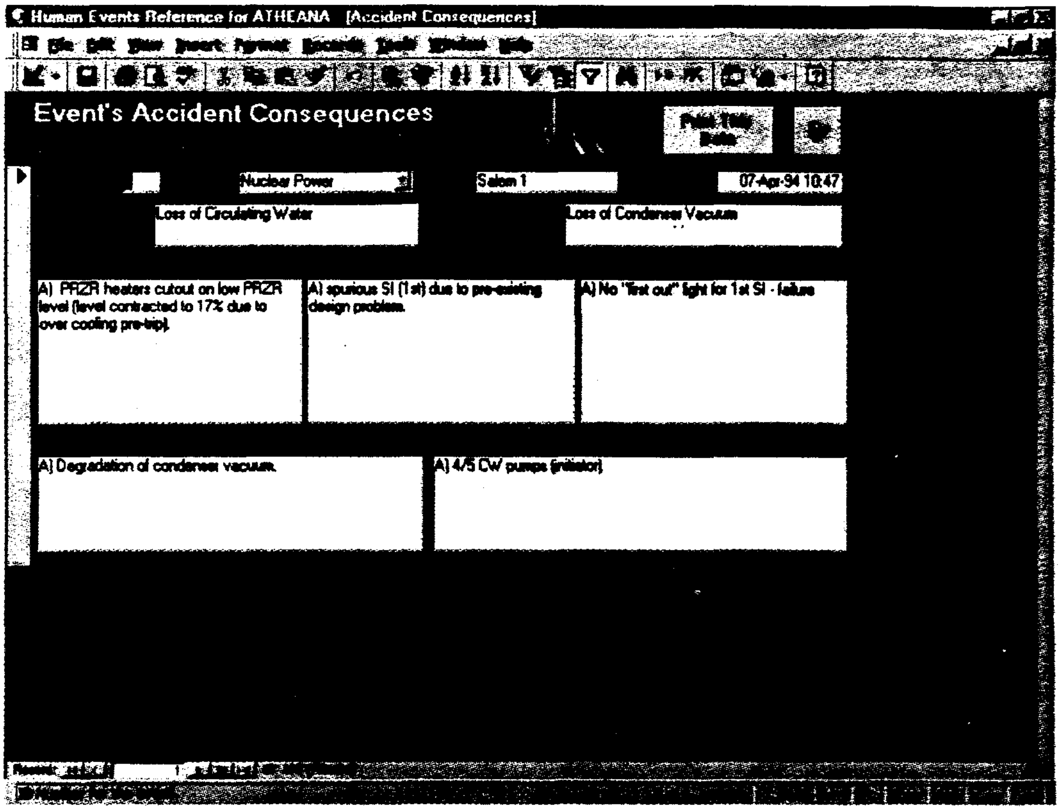


Figure 13: Accident Consequences Form

This "*Plant Accident Conditions and Consequences*" form has five distinct fields to display related data in conjunction with the basic header information from the main form. Specifically the fields include: safety equipment actuations, missing indications, lost functions, systems and components lost, and hardware failures. Specific details for each field can be found in a preceding section, Section 4.2.2. The tabs, record controls, scrolling and printing functions all work in the same manner as described the previous sections above.

5.6.8 Accident Results

The following figure, Figure 14 is displayed after the user clicks the "*Accident Results*," the sixth view event data control button on HERA's "*Event Basic Information*" main form.

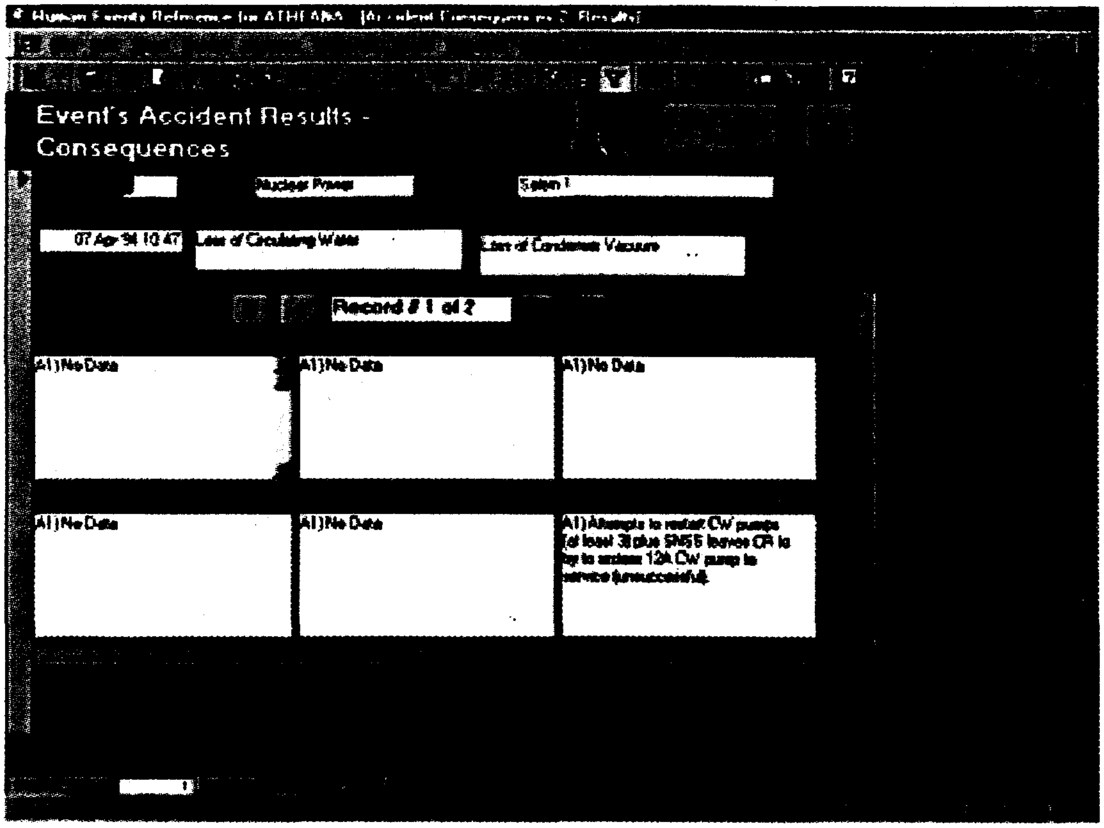


Figure 14: Accident Result and Consequences Form

This form once again uses a design where six different data fields describe inventory losses, plant damage, radiological damage, injuries to personnel, off-site damage, and other related information. Details on the six data fields can be found in Section 4.2.4 above. The tabs, record controls, scrolling and printing functions all work in the same manner as described in Section 5.6.4 above.

5.6.9 Causes of Equipment/Plant Functional Failures Form

Next, clicking the fifth control, i.e., the "Significant Failures Hardware and Human" button on HERA's main form (the Event Basic Information form) will initialize and display the "Significant Failures Hardware and Human" form, as seen in Figure 15 below. As can be seen in this figure, this form only has two separate groupings of data; one for hardware failures and the other for human-system interactions and failures. Clicking in any of the hardware fields will display the selected event's common cause failure, dependencies, and other data. Clicking the human-system interactions fields shows latent failure, defeated defenses, aggravating actions, things left undone, and other human failures. Specific details for these fields can be found in Section 4.2.3 and above. As before, the tabs, record controls, scrolling, and printing functions all work in the same manner as described in Section 5.6.4 above.

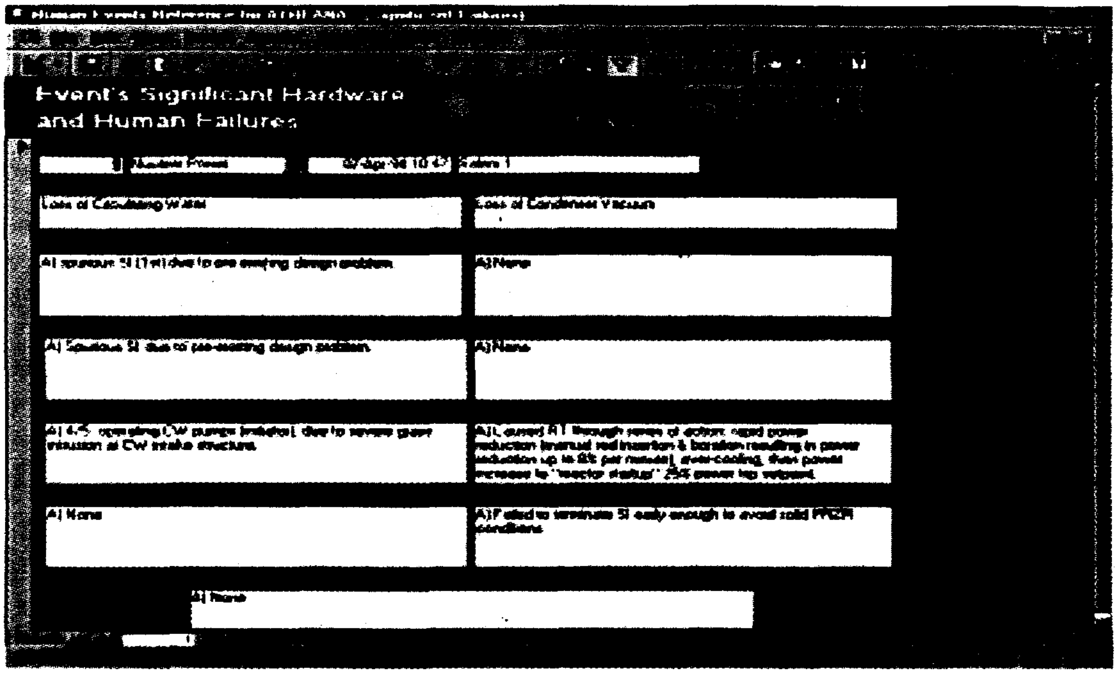


Figure 15: Significant Hardware and Human Failures Form

5.6.10 Cognitive Action Summary

When a user actuates the "Event's Cognitive Action Summary" control by clicking the mouse/cursor on it, the "HERA Cognitive Action Summary" form is displayed on the monitor (see Figure 16 below).

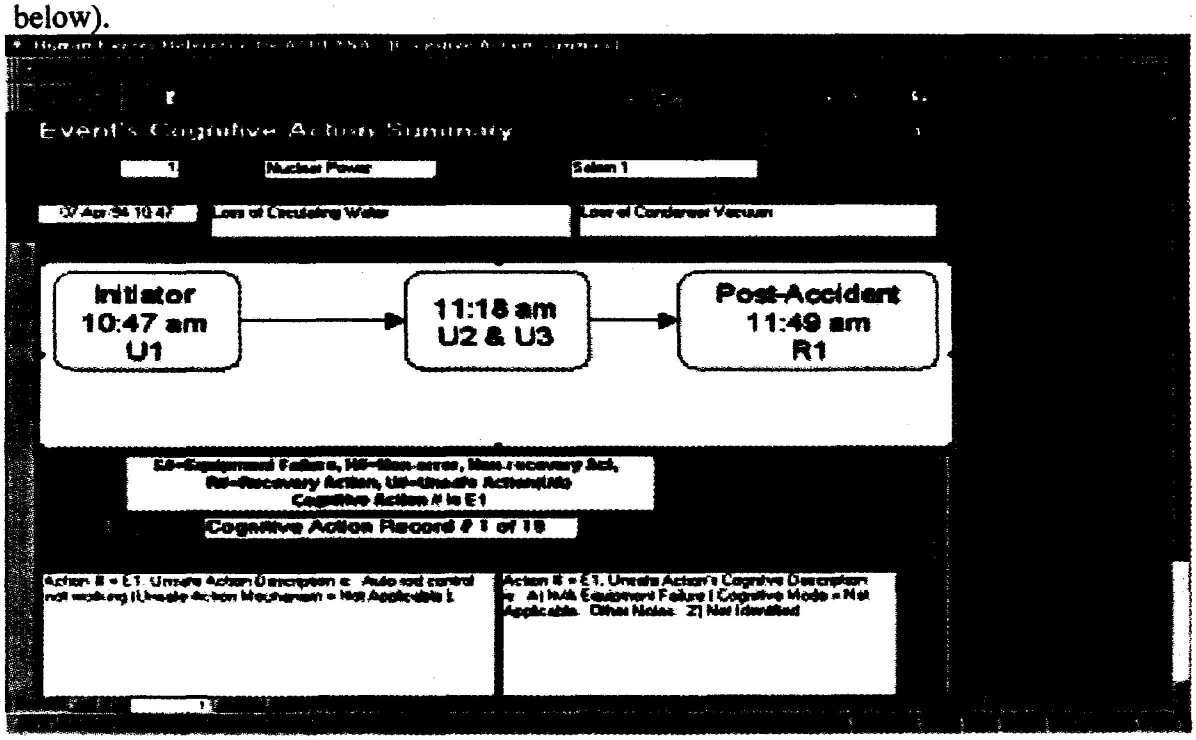


Figure 16: Cognitive Action Summary Form

In particular, this complex form is comprised of several sub-forms that integrate and display data from several differingtables, includingthe event basic information, the diagnostictime line, the event diagnosticlog and, at several other data fields. Because of its size, users will have to use the vertical and possibly horizontal, scroll bars to view all of the data, or will use the "Print This Data" to print a hard copy of the data.

At the top of this form, users will see a slightly reduced display of the accustomed headingdata (i.e., event number, plant name, event date and time, and primary and secondary initiating events). Just below this data, you should notice an image of the event's diagnostic time line which is a graphic portrayal of critical actions within the event. In Figure 17, the Salem 1 time line indicates that the initiating event occurred at 10:47 am and was the first action of type "U," i.e., "U1." Looking just below the time line, on the left hand side, you can see that U1 indicates an UA. (Other action types include "E" for equipment failure, "R" for a successful recovery action, and "H" for a successful non-error non-recovery action).

Moving on the time line to the right, at 11:18 am two other significant unsafe acts occurred, i.e., U2 and U3. This was followed at 11:49 am with a post-accident R1, or the first successful recovery action. If, and only if, the cognitive action is labeled as an UA, i.e., listed as a "U#," the "UA Mechanism" field will display information from the ACM. In all other cases, i.e., where the action has been defined as an equipment failure (E#), recovery action (R#), or other action (H#), this will show "Not Applicable." Actual action numbers are displayed in the field just below the "UA Mechanism" field. For example, in Figure 17 above, you can see that "Not Applicable" is displayed in the "UA Mechanism" field because the "Action" is E1 (first equipment failure, not an unsafe act). This is also Record 1 of 19 possible cognitive actions records for the Salem 1 event. In the bottom half of this form (use your horizontal scroll bars!) you will also see the action's description, plant conditions, activity, plant impact, and notes related to the selected cognitive action.

Just above this informationyou should see five navigationcontrol buttons, with right or left pointing arrows. These controls mimic the record navigation controls found on the bottom of all HERA forms. Clicking on one of the four buttons will take you to the next record (action), the previous record (action), the first record, or the last record respectively. Actuating the "Print This Data" button will print all of the CognitiveAction data from this event in the db. "Close Form" closes this form and takes you back to HERA's main display.

5.6.11 Error Forcing Context Form

Figure 17 below shows a representation of the current EFC form. This particular form mimics the earlier HSECS db and contains three major fields of data:

1-Cognitive Action Number, UA Mechanism, and action description;
2- Lost systems or components, the equipment material condition, and lost functions; and
3- The event's performance shaping factors or PSFs.

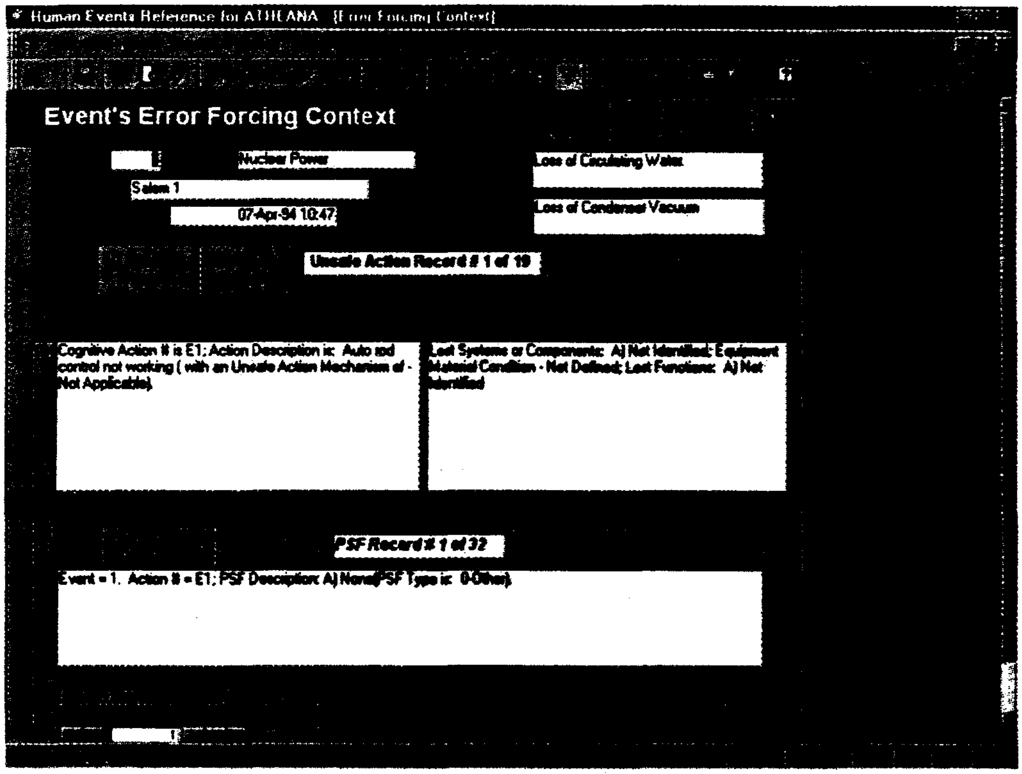


Figure 17: Error Forcing Context Form

Because this form is comprised of two sub-forms users can scroll through the combined data from the first two displayed boxes or can individually scroll through the PSFs associated with this event and the error forcing context. "Print This Data" will provide an on-line preview of the data or the user can print a hard copy if desired.

5.6.12 Event's Diagnostic Log and Time Line Form

The next control on HERA's main form takes the user to the Event's Diagnostic Log and Time Line form where that user can examine the diagnostic time line as well as the event's step by step unfolding as captured by the Log Time field (includes the date and time for each notable step), plant symptoms and responses. This is shown in Figure 18 below.

Users can also use the record navigation buttons in the middle of the form or on the bottom left, to scroll through each individuallog time record. For example, Figure 18 shows how this form will look for the Salem 1 event. Note that there are 56 individual time line entries associated with this event. Clicking on of the controls with right or left facing arrows will permit users to view each individual data point. Using the "Print This Data" button will lead to where one can then print out the entire compilation of time line data for this event.

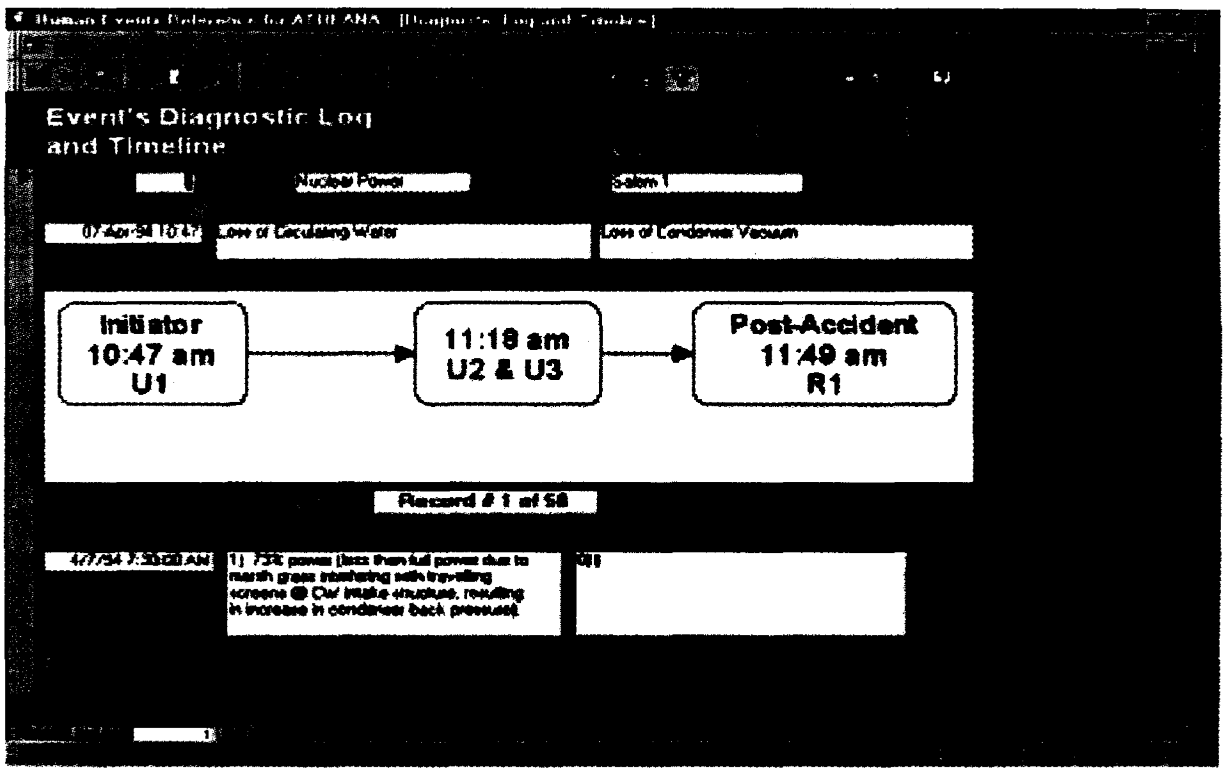


Figure 18: Diagnostic Log Form

5.6.13 ATHEANA Summary

The next to the last of HERA's control buttons on the main form (Figure 19 below) will actuate a query and open a new form where the db portrays an ATHEANA Summary form.

As in the earliercase, this is a complex form where lots of data have been combinedand programmed to appear in succinct summary fields. Basic header information is again displayed at the top of the form. This is followed by a mid-sectionwith record navigationbuttons, the cognitiveaction number, action description, UA mechanism, cognitive error description and other notes, as well as the cognitive mode. Within the bottom two display fields additional data is presented for the event

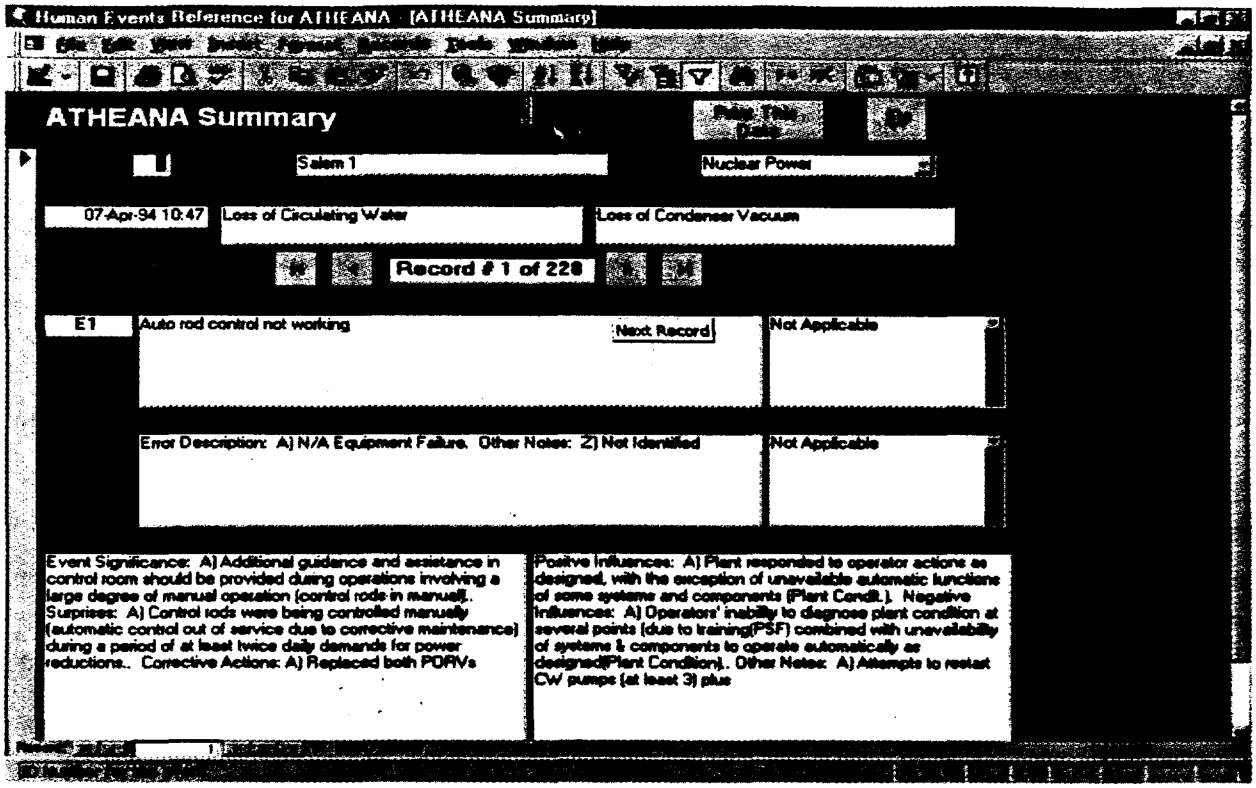


Figure 19: ATHEANA Summary Form

significance, surprises, and licensee corrective actions, or both positive and negative influences and other important notes. Users can use the navigation buttons to scroll through individual summary records or they can print out a hard copy containing all of the relevant records.

5.7 Action Characterization Matrix and Querying

At the simplest level, queries are formal requests to either retrieve data from a db or to manipulate that data in some manner. As such, queries are essential tools used to select records, add or delete records, or update tables, etc. Fortunately, for users of HERA that want to learn how to utilize the full querying capability, Microsoft has provided a unique, flexible, and powerful graphical user interface for queries called Query by Example, or QBE. In addition to this, Microsoft has provided some excellent querying "Wizards" and help functions as aids to bring neophytes up to experienced user levels.

5.7.1 Using the Action Characterization Control

Because the creation and use of querying within a Microsoft Access db can be so complex, LANL's developer of HERA has included some built-in or pre-defined querying capability. This relies on the important ACM discussed in an earlier section. Recall that the ACM is the essential taxonomic backbone of descriptive terms that empower the use of queries within HERA. If there were no such taxonomy, and the current db had not been normalized, thereby limiting the use of non-indexed memo fields, end users would not be able to create or use any simple queries. The ACM provides a number of descriptor fields, or tags, which can now be used in that pursuit. Those fields include:

1. Plant Name
2. Industry
3. System Status
4. Initiator Status
5. UA Mechanism
6. PSF Type
7. Equipment-Material Condition, and
8. Cognitive Mode.

Please refer to Section 4 for a detailed discussion of the ACM. It is these eight fields that provide the minimal, but necessary and sufficient taxonomic structure so essential for querying capabilities in any db.

For this discussion, clicking on the "Action Characterization Matrix " button on the main form will bring up the last of HERA's linked forms, displaying data for the selected event as it pertains to each of the ACM tags. This is shown in Figure 20, following.

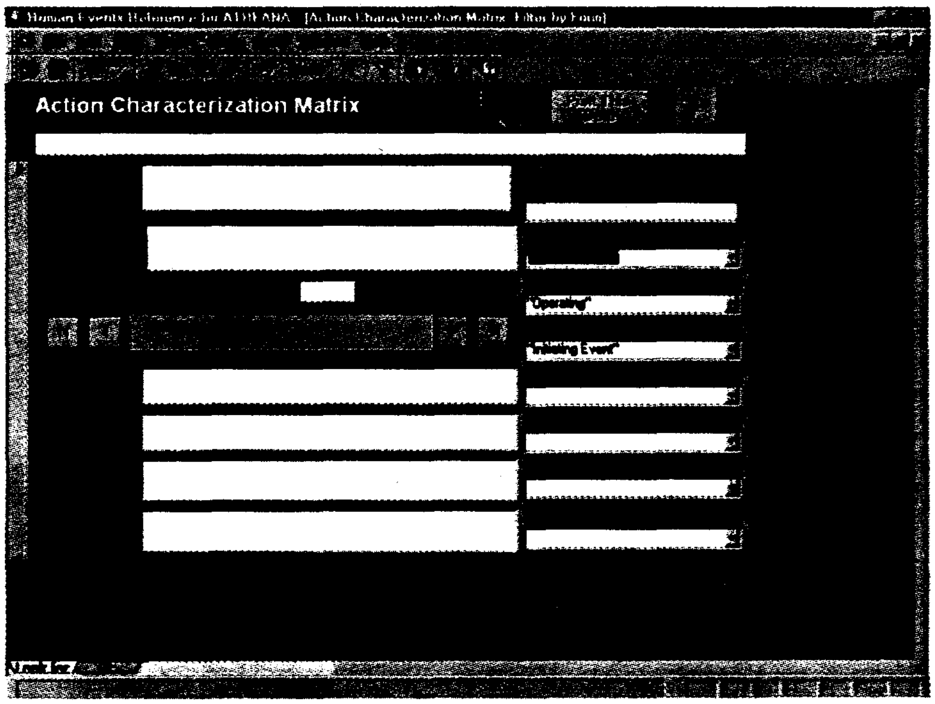


Figure 20: Action Characterization Matrix Form

As you can see in this form, there is some basic header information in the first box, i.e., event number, plant name, and event date and time. This is followed by the primary and secondary events, the cognitive action numbers for this event and the ability to scroll through all of the individual action numbers. One can also see the action description, PSF description, lost systems -components and cognitive error description as well. NOTE that the ACM fields are shown contained within a light blue box on the right-hand side of this form.

The example seen in this figure would occur when the user select the Salem 1 (default) event on the main form and then clicked on the red ACM button, opening this form. As you can see, there are 986 individual records existing in the dynaset that was created when the underlying ACM queries ran and were then displayed on this form.

The ACM form is filled with data after the ACMMain query runs. That query is comprised of tblBasicEventInformation and query ACMb. Query ACMb in turn is derived from links between tblCognitiveAction and query ACMa. You can begin to see that querying can be complex. Also note that you can explore, by way of examples, each of the queries used in the current version of HERA. Simply minimize all opened forms until you see the HERA db table, e.g., like that in Figure 21, below.

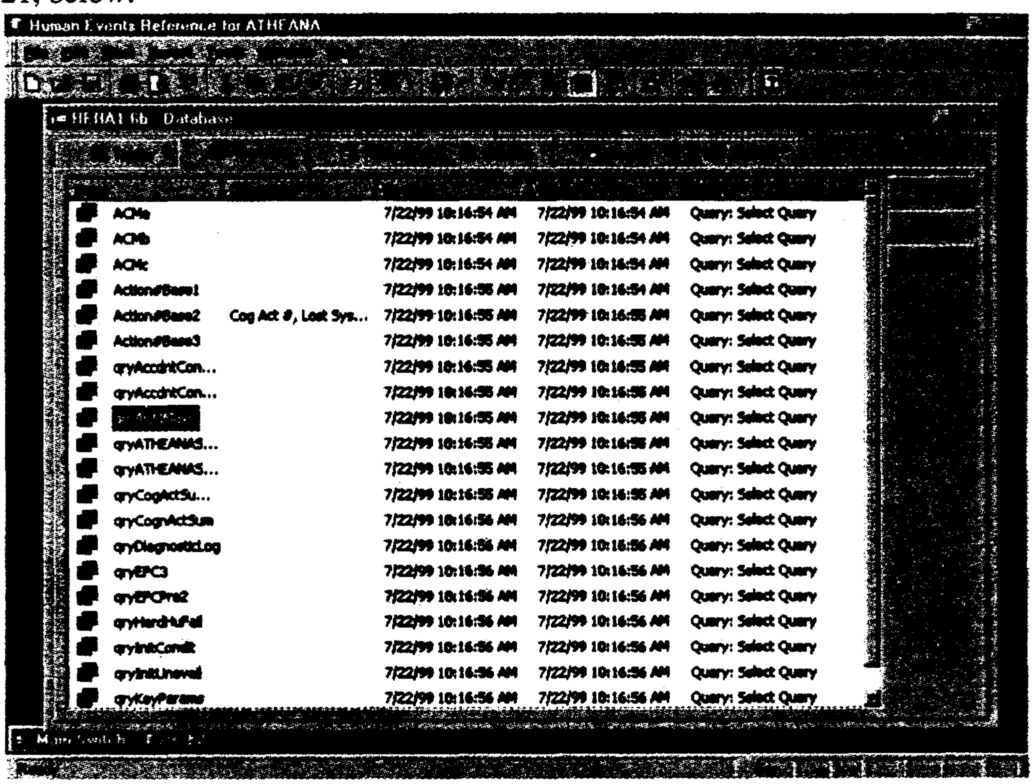


Figure 21: HERA's Main Database Display

When you get to this table, click on the Queries tab and you should see some semblance of what is presented here. By opening individual queries in Design View, you can see how this author created specific queries that now drive the functionality of HERA. BE CAREFUL THAT YOU **DO NOT CHANGE ANYTHING** IN THESE QUERIES BECAUSE IF YOU DO, YOU WILL ALTER OR DESTROY THE FUNCTIONING OF HERA!

5.7.2 Using the ACM to "Filter by Form"

While the neophyte querier may find the creation of queries daunting, if not thoroughly intimidating, Microsoft Access and the ACM can bail you out. By any standard it is a confusing process involving several different types of queries and different types of "joins," coupled with the option to create cascading deletes and updates of linked records. Because this process may not necessarily be necessary for the intended end user, HERA contains a pre-defined "filter-by-form" utility relying on the ACM, as described in the following steps.

First, while you have the ACM form open in Form View, i.e., the view you see in Figure 21 above, move your cursor to the menu bar at the top of this form. Here you should see a collection of controls to change views, save the form, print, etc. Towards the right hand side of this menu bar, you should see three icons that appear to contain an inverted funnel, like those seen in Figure 22.

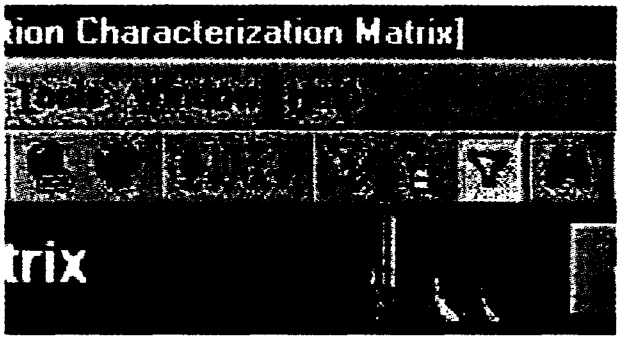


Figure 22: Filter Control Buttons

These funnel like icons are actually the filtering control buttons that can be used to "automatically" generate new queries based on the ACM. Notice that the filter button on the right appears to already be depressed, e.g., activated. This is a result of the default programming that links each sub-form to the main form and then selects only that data which pertains to the selected event. In this case, we had selected the Salem 1 event, so what you are seeing results form running an embedded query selecting all ACM properties related to the Salem 1 event. Move your cursor over this single funnel icon and click on it once to deactivate it. You have removed the filter, e.g., de-selected the Salem 1 event. Now after the query runs again, you will see that there are 1749 records to view, i.e., the unfiltered query returns all of the records in the db. If you click on the single funnel icon again, it will reinstall the original filter and then return the 986 Salem 1 ACM records. For now leave it off, in the unfiltered state where we have 1749 records in the dynaset. Now, look at the middle icon, which appears to be a funnel/filter with a page or form on it. If you move your cursor over this icon and just leave it there for a second or two, Access will display a small message box saying "filter by form." Go ahead and click on the middle icon. The ACM form suddenly has blanks in all of the associated displayed fields. You have now entered the "Query by Form" zone where you can simply generate various Boolean AND or OR queries by simply making selections using your mouse and cursor. You will also notice that your menu bar has changed as well to reflect that you are about to generate a new query that can be saved as a query or table if you so desire. For now, move your cursor over to the "System Status" field in the ACM box on the right side of the form. Click on the drop down arrow and select "Operating" from the three choices contained there. This should look like Figure 23 just below.

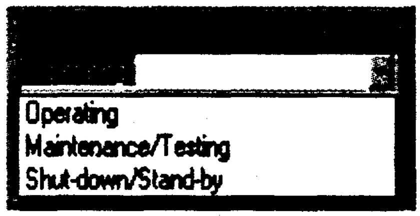


Figure 23: ACM System Status Field

Now click on the single funnel, e.g., the Apply Filter button and run the "AND" query. The new query begins to run and is searching all the db records for the specified conditions, i.e., "select only those records that have the System Status = Operating AND the Initiator Status = Initiating Event. When the query finishes, you should have a new display where there are only 17 records in the dynaset.

Now, deselect the filter button and reapply the Query by Form control. Click on the depressed single funnel icon and then click a second time on the icon with the funnel and form (the middle control). This will take you back to the query you just ran. Both the System Status and Initiator Status fields will retain your previous selections.

However, we are now going to generate a Boolean "OR" query. First look at the bottom left of your Query by Form display. You will see at least two tabs there, like that shown in the following figure. One tab says "Look for" and the other says "OR." Click on the "OR" tab.

Figure 24: Boolean OR Queries Tab

The fields on the form again become blank. Now go over to the Initiator Status box and select "Pre-

Initiator" from the drop-down menu. You have actually now created a simple query that says: "Select only those records from the db where System Status = Operating AND Initiator Status is either = Pre-Initiator OR Initiating Event. Click on the Apply Filter icon and you will see that you now have 89 filtered records.

You now have the ability to generate all sorts of sophisticated queries if you use the built-in query by form functions and the pre-defined ACM taxonomy. Please know that this will only work when you are using the ACM fields, displayed in the light blue box on the right side of the ACM form. You can also create meaningless queries if by accident you click into one of the gray boxes on the left side. So be careful and limit your querying to the ACM boxes with the white fields.

Note that you can also use a query by selection function by clicking on the icon that looks like a funnel with a lightening bolt (i.e., the first of the three query button controls). Here you would first deselect the depressed Apply Filter button and then click on the Query by Selection button. Your clicking on one of the ACM drop-down menu fields and dragging the cursor to select ant item would follow this. Then, clicking on the Apply Filter icon would generate your query in the same manner as described above.

It is also important to note that after you select/click on the filter by Form Button, you also have the option of saving your newly defined query as an actual query within the HERA operational environment. To do this, you simply click on the Save as Query Icon, found on the left hand side of the Filter by Form Menu Bar. It is the second button from the left and looks like a 3.5-inch floppy disk with the inverted funnel. This is shown in the following figure.

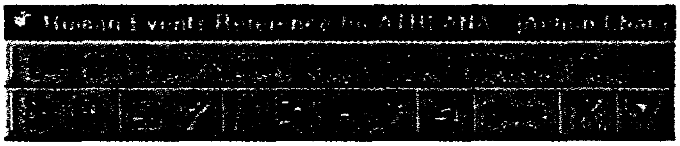


Figure 25: Save as Query Control

You can also load another previously saved query by clicking on the first icon, i.e., the button that looks like an open folder with the funnel on top. With respect to creating queries, it must be re-emphasized that this topic quickly becomes very complex and, as such, truly lies outside of the scope of this simple guidance. However as one does progress from the simple, novice levels, Microsoft Access provides a unique graphical Query by Example functionality. This allows users to simply drag fields from tables on to the query grid, establish links-relationships, and then run the query. Fortunately, Access also provides some outstanding help in this area. Simply click on "Help" on the menu bar or press the "F1" function key. Then proceed to search for help on queries.

5.8 Adding or Modifying Data

As you may have noticed while viewing any of the forms discussed earlier, one cannot alter or modify any of the data seen in the various text boxes on a given form. Earlier NRC project managers felt that some mechanism had to be used to protect the validated data in HERA from inadvertent or deliberate alteration by end users. So, HERA's designer implemented the use of locks to prevent data alterations while viewing HERA's forms. You may also have noticed that these locks are automatically removed while using the filter-by-form functions just discussed in the preceding section. If the locks were not removed, users would not be able to select any options from the drop-down menus and they would be prevented from typing anything in any of the text boxes/controls while trying to use filter-by-form, thereby defeating the process. However, after running the query, those locked text box controls are again automatically reinstated so that no inadvertent changes could be made to the underlying data.

To enter or modify the existing data, you must close or minimize any of HERA's form that you have currently open. Doing so will take you to the main HERA db form (as seen in Figure 21 above). This main db table has several tabs starting with "Tables," "Queries," and so on. You must now click on the "Tables" tab where you will a list of the individual data tables contained in the db (see Figure 26, below).

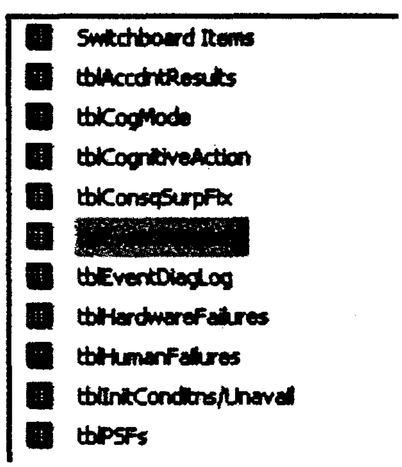
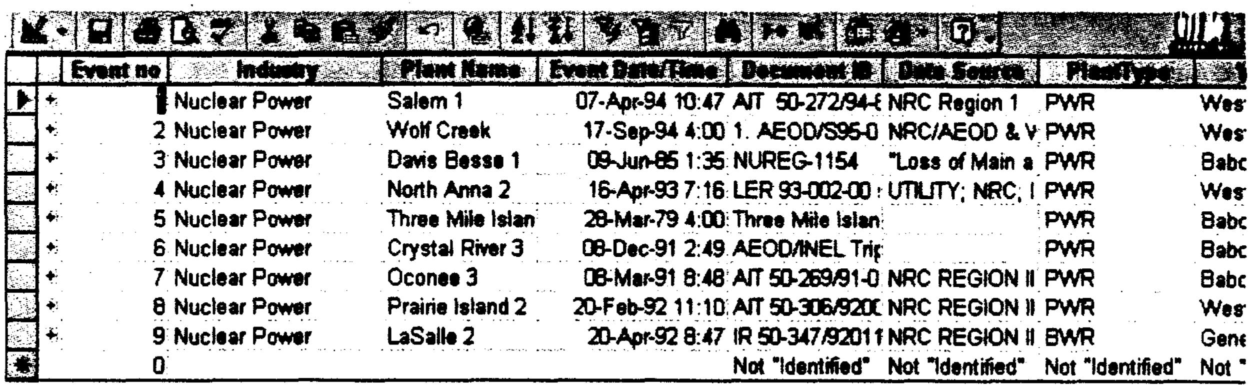


Figure 26: HERA's Tables

Recall that tblEventBasicInfo is the main data table and that each of the remaining tables is linked to it by one or more key fields. This was discussed earlier in Sections 4.1 and 4.2.1. Because this table is the foremost data table, it is where one should start to enter new events and corresponding data. A sequential listing of tblEventBasicInfo's fields was also provided in Table 7, Section 4.2.1 above.

The first seven of these fields is also displayed in Figure 27, below.



	Event no	Industry	Plant Name	Event Date/Time	Document ID	Data Source	PlantType	
+	1	Nuclear Power	Salem 1	07-Apr-94 10:47	AIT 50-272/94-{	NRC Region 1	PWR	Wes
+	2	Nuclear Power	Wolf Creek	17-Sep-94 4:00	1. AEOD/S95-0	NRC/AEOD & V	PWR	Wes
+	3	Nuclear Power	Davis Besse 1	09-Jun-85 1:35	NUREG-1154	"Loss of Main a	PWR	Babc
+	4	Nuclear Power	North Anna 2	16-Apr-93 7:16	LER 93-002-00 :	UTILITY; NRC, I	PWR	Wes
+	5	Nuclear Power	Three Mile Islan	28-Mar-79 4:00	Three Mile Islan		PWR	Babc
+	6	Nuclear Power	Crystal River 3	08-Dec-91 2:49	AEOD/INEL Trip		PWR	Babc
+	7	Nuclear Power	Oconee 3	08-Mar-91 8:48	AIT 50-269/91-0	NRC REGION II	PWR	Babc
+	8	Nuclear Power	Prairie Island 2	20-Feb-92 11:10	AIT 50-306/920C	NRC REGION II	PWR	Wes
+	9	Nuclear Power	LaSalle 2	20-Apr-92 8:47	IR 50-347/92011	NRC REGION II	BWR	Gene
*	0				Not "Identified"	Not "Identified"	Not "Identified"	Not "

Figure 27: tblEventBasicInfo's First Seven Fields

To enter a new hypothetical event ten, simply move your cursor into the last line in the table where you will see a "*" followed by a "0" in the Event no field. You would then click in this field and enter 10 for the new event. Then use the tab key once to move into the next field for Industry. Either enter Nuclear Power or select it from the drop-down menu. Then tab into the Plant Name field and enter the plant's name. Continue with this process until you have entered the appropriate data in all of the fields in this table. Please note that several of the fields have pre-defined masks, like the Event Date/Time field, that only allows data to be entered if it is formatted in accordance with the mask. For example, Event no will only accept a numerical value, Industry will only accept one of the values from the drop-down menu, and Event Date/Time will only accept data if it is formatted as (dd-mmm-yy hh:nn) or two digit day with a three letter abbreviation for month, followed by a two digit hour (24 hour clock) and a two digit minutes.

It is also very important to note that once you use the tab key to leave a field or once you click on a new field, Access automatically saves that data in the record you are working on. This becomes increasingly important when you are actually modifying entries in any of a table's specific fields. For example, suppose you decided to modify event #6's Document ID field and in the modification you mistyped AEOD as ADOE or something similar. When you moved your cursor out of that field, Access automatically saved the mistyped entry as part of that event's record. That would then become significant if you decided to create a simple query for that table to find all AEOD records. The query would run, but would fail to find any data for event #6 because you had mistyped it as ADOE. So the lesson here is be careful when you enter new data or modify the existing data. Modifying data by the way, would be best accomplished by first finding the appropriate field within one of the tables (e.g., use Section 4.2 above as your guide). Then open the table in Form View (Design View will display the various fields and options used to define those fields). Select the data to be modified by clicking in that box. Make your changes and click in a new field, or save and close that table.

There is one final significant note of caution with respect to the deletion of records or in this case entire events and associated data. As explained in Section 4 above, HERA's structure first created tblEventBasicInfo and linked subsequent tables in a one-to-many relationship based on the Event no field. This simply means that for each unique event number, there are many other related records found in the linked tables. Establishing this type of relationship between that main table and its dependent tables also allowed the designer to enforce referential integrity through the use of cascading updates and deletions of records. Again, even though this is a complex topic, it simply means that if you delete or update one or more records that are linked to the main table, Access will automatically delete or update all other linked records in the db. The major usage for this function is when the user wants to delete an entire event, for example, event #6. Deleting that record in tblEventBasicInfo would cause a cascading deletion of all of event #6's related data, because of the enforced referential integrity within the db. So once again, please be careful. Simple or inadvertent mistakes could have large and significant consequences with respect to HERA's data.

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Appendix A: Glossary[7]

Error-forcing context	**The situation that arises when particular combinations of *performance shaping factors* and *equipment/material conditions* create an environment in which *unsafe actions* are more likely to occur.**
Human failure event	**A basic event that is modeled in the logic models of a PRA (event and fault trees) and that represents a failure of a function, system, or component that is the result of one or more *unsafe actions*. A human failure event reflects the PRA systems modeling perspective.**
Performance shaping factors	**A set of influences on the performance of an operating crew resulting from the human-related characteristics of the plant, crew, and the individual operators. The characteristics include procedures, training, and human factors aspects of the displays and control facilities of the plant.**
Equipment/ material conditions	**The plant state defined by combinations of its physical properties and equipment conditions, including the measurement of parameters.**
Unsafe action	**Actions inappropriately taken, or not taken when needed, by plant personnel that results in a degraded plant safety condition.**

[7]Many glossary entries were taken from the ATHEANA FOR Manual or IG.