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Title: HUMAN EVENTS REFERENCE FOR ATHEANA (HERA) DATABASE DESCRIPTION AND PRELIMINARY USER'S MANUAL

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

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Contents

Acronyms and 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
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
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
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, 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 database development projects. The first database, the Human Action Classification Scheme (HACS) (Barriere, Luckas, Whitehead, and Ramey-Smith, 1994) pre-dates ATHEANA. It was patterned on existing databases, 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 performance shaping factors (PSFs), event time phases, and error types. This strong link betweens HACS and the prevailing assumptions and conventions of HRA/PRA, however, rendered the database incapable of supporting the multidisciplinary HRA framework of ATHEANA. Thus, a second evolution of the database, 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.)

HSECS efforts focused on incorporating the ATHEANA terminology and

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

concepts into a database structure and fields. Analyses of three operational events (Salem Unit 1, Wolf Creek, and Davis-Besse) were used to refine the database fields and to develop a report format. The output of this effort was a database 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 database structure and for analyzing additional exemplar operational events for entry into the database. Modifying HSECS was defined as the starting point for the LANL effort.

1.2 HERA Improvements

At the initiation of this project, the HSECS database that was to become HERA suffered from several weaknesses. First, HSECS database development efforts preceded completion of the development of the ATHEANA methodology. As a result, the conceptual links between the existing database and the ATHEANA framework were not as obvious as desired. (Note that this issue has not been totally resolved in the current version of HERA either. ATHEANA is currently in the demonstration phase and, as the demonstrations progress, the need for slight modifications to ATHEANA are anticipated. Such modifications could also have implications for subsequent versions of HERA. However, it is not expected that the differences between the current and subsequent versions of HERA will be as dramatic as are the differences between HERA and HSECS.)

Second, although it was intended that the database be the repository for a set of examples that would aid ATHEANA analysts, entry of events into the database 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 database.

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 database 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 database was not structured to accept non-NPP events in a meaningful way, nor was there way to "equate" events from different industries such that learnings 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 database 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 database is to support the application of the ATHEANA methodology. To accomplish this objective, HERA must provide examples of a sufficiently representative set of the error forcing contexts 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 database 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 database development.

3.1 Action Characterization Matrix

The ACM was developed as a bridge between the HERA database structure and ATHEANA. Specifically, the ACM allows each unsafe action (UA) to be characterized according to its representation along each of six different dimensions: system status, initiator status, unsafe action 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 database structure, in both cases, the information required (in the case of ATHEANA) or provided (in the case of the database) is too detailed to provide a snapshot of the UA that allows it to be quickly placed in context (such as an error-forcing context or a combination of unsafe action 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 unsafe action in a short-hand form that:

- 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,

- uses simple language, that makes the links between the complex ideas expressed in ATHEANA and the (of necessity) equally complex entries contained in the database more explicit, and

- 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 database 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 <u>not</u> used in the cognitive activity characterization. This was a conscious decision on the part of the ATHEANA team, who 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 error of commission (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[1] 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). Because ATHEANA event analyses are performed retrospectively, it was determined that reliance on the EOO/EOC language could introduce reliability problems into the data and more observable descriptors were sought -- the result was the "Unsafe Action Mechanism" category described below.

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

A high-level view of the ACM is shown in Figure 3-1. 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 unsafe action? Both parts of the latter question must be answered to characterize the cognitive activity.

- What was the error-forcing context? Describe both the equipment/material conditions and the performance shaping factors.

In the interest of consistency with ATHEANA, the UA, rather than the overall event (which is the unit used for records in the database), 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 databse 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 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 <u>at the same level</u> (i.e., that equipment/material conditions and PSFs combine to produce an error-forcing context) 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).

Level 1: Top-Level Conditions

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

Level 2: Cognitive Activity Characterization

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

Figure 3.1. High-level view of the Action Characterization Matrix.

Level 3: Error-Forcing Context

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

Figure 3-1 (Continued). High-level view of the Action Characterization Matrix.

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 error-forcing contexts alone.

Tables 3.1 through 3.6 below provide an enumeration of which of the nine events currently captured in the database possess which ACM characteristics. Blanks in the right hand column of each table indicate that none of the events yet analyzed possess the particular ACM characteristic.

Table 3.1 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 3.2 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 3.3 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 3.4 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 3.5 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 3.6 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 database (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 database 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 database the underlying rules and symbols that define this database come from relational algebra and a branch of mathematics called *set theory* (Jennings, 1997). In addition to this, 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 database. The process of database 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 3.2.1 below. To

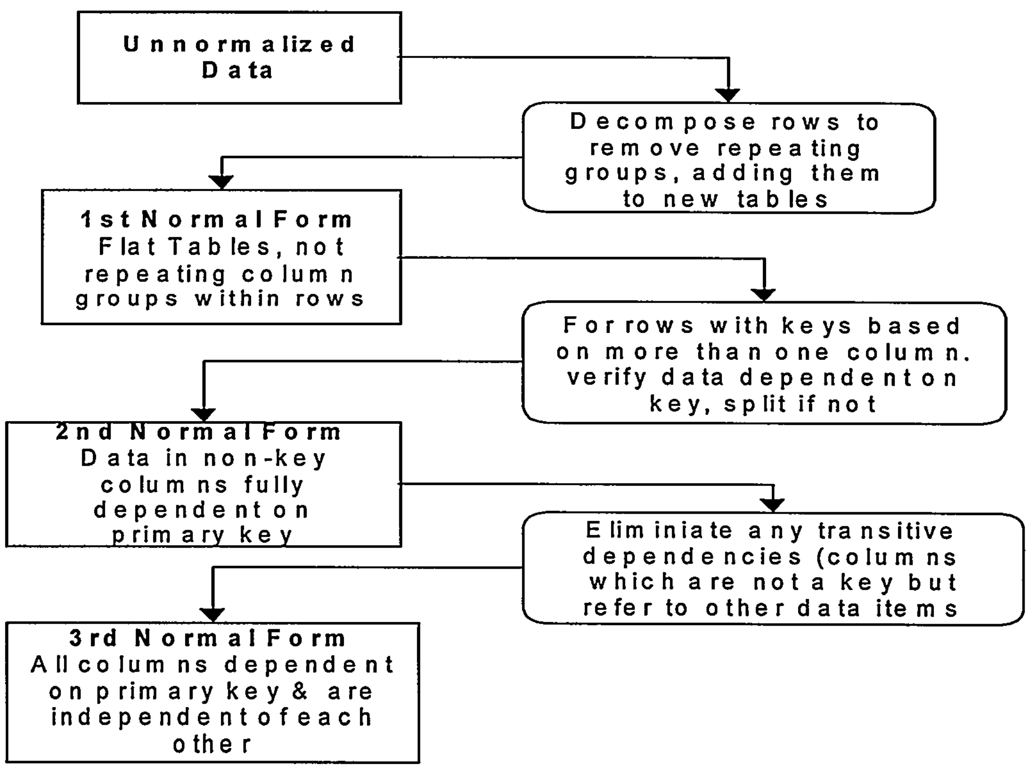

Figure 3.2 Process of Database Normalization

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 database. 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 databases compromise data integrity, lead to poor performance with maintenance problems, and make some types of database 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 database 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 database that avoided anomalies in the data and simplified database maintenance and retrieval of information.

HERA is now comprised of 13 separate tables and 73 related forms (see below, Section 4 Database Description). Tables are the database 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, 12 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 NRC references written to explain each event in the database. These include NRC documents such as licensee event reports (LERs), augmented inspections team (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 error forcing context, cognitive activity, performance shaping factors, 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 database 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. This was accomplished by keeping the structure of the db as simple as possible, as well as establishing simple relationships between the tables, forms and reports. Finally, by using default Microsoft Windows screen colors (i.e., blues and greys), along with graphics, HERA was created to be much more visually attractive and accessible to the end user.

HERA is now comprised of 13 different data tables in conjunction with 73 forms, and 28 pre-defined reports. As seen in Figure 2, below, 12 tables are individually linked to a main table

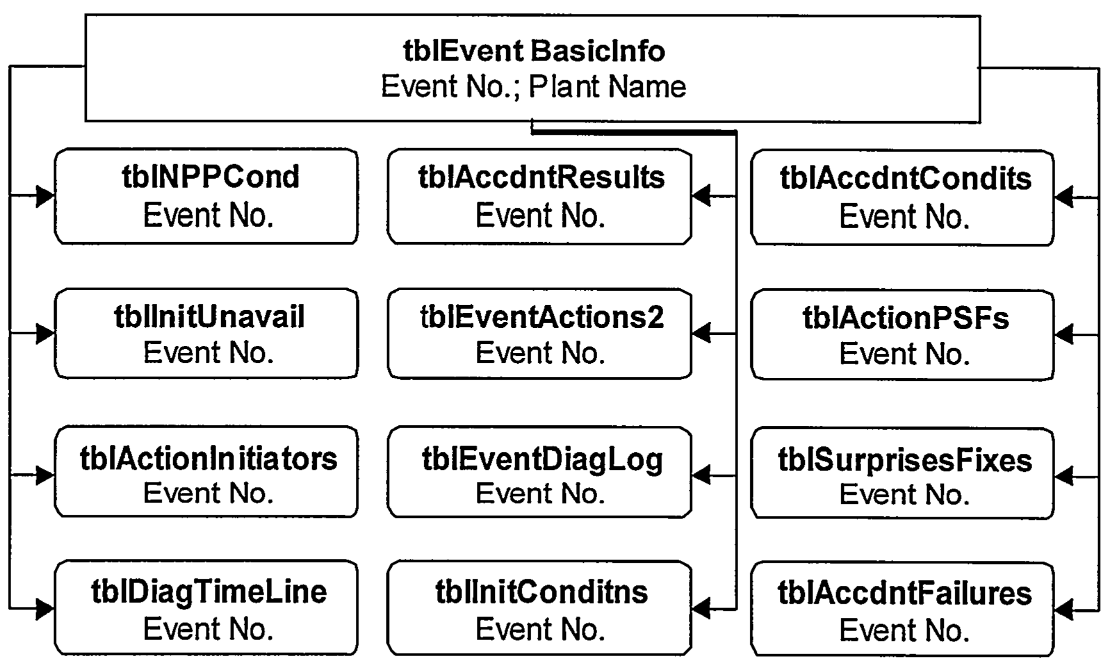

Figure 1: HERA's Tables and Relationships Based on the Event No. Primary Key

(tblEventBasicInfo[1]) based on the primary keys of "Event Number" and "Plant Name". 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 database 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 database, 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 12 other HERA tables. TblEventBasicInfo is comprised of 26 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 26 fields in tblEventBasicInfo follows in Table 4.1 below.

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[1]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"; queries with "qry" etc.

Table 4.1: Structure of tblEventBasicInfo			
Field Name	**Description**	**Data Type**	**Field Size**
Event no.	Unique identification number for each event	Number (Integer)	2 bytes
Industry	Industry Type, e.g., Nuclear, Chemical, etc.	Text	250 characters
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	Additional reference items like NRC Region, etc.	Text	250 characters
Plant Type	For NPP data - PWR, BWR, etc.	Text	9 characters
Vendor	Plant Builder	Text	25 characters
System Status	Operational status of plant when event occurred- operating; shutdown/standby; maintenance/testing	Text	250 characters
Unit Status	Status of unit, i.e., full power, hot shut down, 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

Table 4.1: Structure of tblEventBasicInfo			
Field Name	**Description**	**Data Type**	**Field Size**
Cond Init Power	Initial Conditions: reactor power level	Text	30 characters
Cond Init Temp	Initial Conditions: RCS temperature	Text	60 characters
Cond Init Press	Initial Conditions: RCS pressure	Text	30 characters
Cond Init Level	Initial Conditions: Pressurizer (PZR) level	Text	60 characters
Cond Init SG	Initial Conditions: Steam Generator (SG)	Text	36 characters
Cond Init Other	Initial Conditions: Other significant conditions	Text	60 characters
Cond Acc Power	Accident Conditions: reactor power level	Text	30 characters
Cond Acc Temp	Accident Conditions: RCS temperature	Text	60 characters
Cond Acc Press	Accident Conditions: RCS pressure	Text	30 characters
Cond Acc Level	Accident Conditions: PZR level	Text	60 characters
Cond Acc SG	Accident Conditions: Steam Generator	Text	36 characters
Cond Acc Other	Accident Conditions: Other conditions	Text	60 characters

4.2.2 TblAccdntCondits HERA's next table contains data pertaining to any safety system actuations, missing indicators, hardware failures, lost systems, components, or functions, etc. It has two primary keys, Item# and Event no. "Item#" in this and all following tables, simply provides the database with a unique index number for each entry within each respective table. Table 4.2 below, shows the field names, descriptions, data type, and field size for the data fields in tblAccdntCondits.

Table 4.2: Structure of tblAccdntCondits			
Field Name	**Description**	**Data Type**	**Field Size**
Item#	Unique index number for each entry	Number (Long)	4 bytes
Event no.	Event no (tied to tblEventBasicInfo)	Number (Integer)	2 bytes
SafEqAct	Plant safety equipment actuations	Text	250 characters
Missing Indication	Unavailable plant indicators	Text	250 characters
LostFunct	Plant functions lost from event	Text	250 characters
Sys-Complost	Lost systems or components	Text	250 characters
Equip/Material Condit	Equipment/Materia l Condition	Text	250 characters
HrdwreFail	Hardware failures	Text	250 characters

4.2.3 TblAccdntFailures Table #3 in HERA is called TblAccdntFailures. It contains fields that describe various hardware related failures, i.e., common cause failures, dependencies, etc., and human related failures like latent failures, defeated defenses, etc. "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 4.3 below.

Table 4.3: Structure for tblAccdntFailures			
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

Table 4.3: Structure for tblAccdntFailures			
Field Name	**Description**	**Data Type**	**Field Size**
Common Cause Failure	List hardware common cause failures	Text	250 characters
Dependencies	List hardware failure dependencies	Text	250 characters
Other Hardware	Other hardware failures	Text	250 characters
Latent Failures	Latent human failures	Text	250 characters
Defeated Defenses	Defenses defeated by operators	Text	250 characters
Aggravating Actions	Aggravating actions done by operators	Text	250 characters
Things left undone	Any/all actions not completed by operators	Text	250 characters
Other Human Failures	Other human failures	Text	250 characters

4.2.4 TblAccdntResults is the fourth of the 13 tables in HERA. It contains data related to the consequences arising from the event, i.e., inventory losses, damage, radiological contamination, injuries, etc. "Table Entry ID#" and "Event No." are once again the two primary keys where Table Entry ID# is the unique index item number for this table. Details are shown in Table 4.4 below.

Table 4.4: 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	Resulting inventory losses	Text	250 characters

Table 4.4: Structure for tblAccdntResults			
Field Name	**Description**	**Data Type**	**Field Size**
Plant Damage	Damage done to plant	Text	250 characters
Radiation	Radiological contamination done to plant	Text	250 characters
Personnel Injury	Injuries to personnel	Text	250 characters
Off-site Damage	Off-site damage	Text	250 characters
Other (notes)	Other damage or notes	Text	250 characters

4.2.5 TblActionInitiators TblActionInitiators is next, the fifth of HERA's 13 tables. This table was one of the new tables developed to contain data related to ATHEANA analysis of the event. Data fields include Act no., cognitive mode, cognitive text, and error text. TblActionInitiators has three primary keys, "item#", "Event", and Act no. Details are given in Table 4.5 below.

Table 4.5: Structure of tblActionInitiators			
Field Name	**Description**	**Data Type**	**Field Size**
Item#	Unique index number for each item entered	Number (Long)	4 bytes
Event	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes
Act no.	E#=equipment failure; U# = unsafe action; R# =successful recovery act H#=successful non-error or recovery act	Text	5 characters
Cognitive mode	Monitoring-detection; Response Planning; Response Implementation; Other	Text	40 characters
Cognitive text	Description of cognitive activity	Text	250 characters

Table 4.5: Structure of tblActionInitiators			
Field Name	**Description**	**Data Type**	**Field Size**
Error text	Description of errors	Text	250 characters

4.2.6 TblActionPSFs TblActionPSFs is another table created to handle performance shaping factors identified in an ATHEANA analysis. As can be seen in Table 4.6 below, it has four primary keys (Item#, Event no., Act no., and PSF ID) along with two other fields (PSF type and PSF description) that provide descriptive information for each PSF.

Table 4.6: Structure of tblActionPSFs			
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
Act no.	E#=equipment failure; U#=unsafe action; R# =successful recovery act; H#=successful non-error or recovery	Text	5 characters
PSF type	PSF categories per ACM	Text	35 chars.
PSF ID	Numerical PSF list	Number	1 byte
PSF Description	PSF descriptions	Text	250 chars.

4.2.7 TblDaigTimeLine As can be seen in Table 4.7 below, the seventh table in HERA, i.e., tblDaigTimeLine[2], contains two primary keys (Item# and Event no. as before) and only one other data field, i.e., TimeLine. This particular data filed is an OLE (Object Linking and Embedding) field that contains a graphical representation of each event's diagnostic time line. Individual time lines were created using a word processor with drawing capabilities and were then cut and pasted into this HERA table. OLE objects like this can come from spreadsheets, text documents, graphics, sounds, or just about any other type of binary data. They are limited in size only by the amount of currently available disk space up to one gigabyte.

Table 4.7: Structure of tblDaigTimeLine			
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
TimeLine	Event's diagnostic time line	OLE Object	up to 1 gigabyte

4.2.8 TblEventActions2 This next table was created as the repository for data used in both the factual and ATHENA partitions. It has 11 data fields that contain three primary keys (i.e., Item No, Event no, and Act no) and nine other fields, explained in Table 4.2 below.

Table 4.8: Structure of tblEventActions2			
Field Name	**Description**	**Data Type**	**Field Size**
Item no	Unique index number for each item entered	Number (Long)	4 bytes

[2]This table should actually be called tblDiagTimeLine, but the simple typing error that created it is NOT easy to fix once the db was created.

Table 4.8: Structure of tblEventActions2			
Field Name	**Description**	**Data Type**	**Field Size**
Event no	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes
Act no.	E#=equipment failure; U#=unsafe action; R# =recovery act; H#=non-error or recovery	Text	20 characters
UAMechanism	Unsafe Action Mechanism per ACM	Text	250 characters
Action Description	Brief description of each cognitive action	Text	250 characters
Initiator status	Pre-initiator, Initiator, Post-Initiator, Recovery, Other	Text	250 characters
Plant Impact	Description of error related consequences	Text	250 characters
Location	Location of action(s)	Text	250 characters
Activity	Operations, Recovery, Maintenance/testing	Text	250 characters
PersType	Personnel involved in the activity	Text	250 characters
Plant Conditions	Description of plant conditions resulting from actions	Text	250 characters
Notes	Memo space for any large notations	Memo	65,535 characters

4.2.9 TblInitConditns HERA's ninth table contains seven 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. Details are presented in the following table, i.e., Table 4.9, below.

Table 4.9: Structure of tblInitConditns			
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
Configuratio n	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

4.2.10 TblEventDiagLog In Table 4.10 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 4.10: Structure of tblEventDiagLog			
Field Name	**Description**	**Data Type**	**Field Size**
LogID	Automatically Numbered listing for each log entry	Autonumb er	4 bytes
Event no	Event no.- tied to tblEventBasicInfo	Number (Integer)	2 bytes

Table 4.10: Structure of tblEventDiagLog			
Field Name	**Description**	**Data Type**	**Field Size**
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

4.2.11 TblInitUnavail The eleventh of HERA's data tables, i.e., tblInitUnavail contains data fields pertaining to initial hardware unavailabilities at the time of the initiating event. This table has the usual two primary keys (i.e., Item# and Event No.) Along with six other data fields devoted to categories of potential unavailable hardware in the plant. Detailed information is presented in Table 4.11 below.

Table 4.11: Structure of tblInitUnavail			
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
Sys/compon	System or component unavailability	Text	250 characters
Containment	Containment unavailabilities	Text	250 characters
Alarms	Alarm unavailabilities	Text	250 characters

Table 4.11: Structure of tblInitUnavail			
Field Name	**Description**	**Data Type**	**Field Size**
Instruments	Instrument unavailabilities	Text	250 characters
CrIndic	Control room indication unavailability	Text	250 characters
Other	Other significant hardware unavailability	Text	250 characters

4.2.12 tblNPPCond In this next to last HERA table, i.e., tblNPPCond, there are 14 data fields that contain information about both initial and accident reactor parameters within the nuclear power plant. It has the same two primary keys (i.e., event no. and item#) with the 12 other data fields. This table is unique with respect to NPP data. When HERA expands to include other event data from non-nuclear applications, similar tables will have to be created specific data unique to that industry's operational environment. Details of tblNPPCond are shown below in Table 4.12.

Table 4.12: Structure of tblNPPCond			
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
InitPower	Initial Reactor power level	Text	250 characters
AccdntPower	Accident power level	Text	250 characters
InitTemp	Initial temperature	Text	250 characters
AccdntTemp	Accident temperature	Text	250 characters
InitPress	Initial pressure	Text	250 characters

Table 4.12: Structure of tblNPPCond			
Field Name	**Description**	**Data Type**	**Field Size**
AccdntPress	Accident pressure	Text	250 characters
InitLvl	Initial PZR level	Text	250 characters
AccdntLvl	Accident PZR level	Text	250 characters
InitSG	Initial Steam Generator	Text	250 characters
AccdntSG	Accident Steam Generator	Text	250 characters
InitOther1	Other initial parameter	Text	250 characters
AccdntOther1	Other accident parameter	Text	250 characters

4.2.13 TblSurprisesFixes HERA's final table, i.e., tblSurprisesFixes contains data from the ATHEANA partition relating to final ATHEANA summary of the event. It contains the usual two primary keys and five other data fields. Details are presented in Table 4.13 below.

Table 4.13: Structure of tblSurprisesFixes			
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
Event Surprises	Description of surprising details	Text	250 characters
Corrective Acts	Corrective actions taken	Text	250 characters
Negative Influences	Negative PSFs	Text	250 characters
Positive influences	Positive PSFs	Text	250 characters

Table 4.13: Structure of tblSurprisesFixes			
Field Name	**Description**	**Data Type**	**Field Size**
Significance	Significance of the event	Text	250 characters

4.3 Locating Action Characterization Matrix Parameters

Because the Action Characterization Matrix (ACM) provides the necessary, rudimentary taxonomic links for the HERA data, the following table is provided as guidance for location the ACM parameters within HERA's tables. Table 4.14 below contains the six ACM parameters, ACM description and table name where the ACM parameters can be found.

Table 4.14: Location of Action Characterization Matrix Parameters		
ACM Parameter	**Description**	**Location (Table)**
System Status	Operating; Maintenance/Testing; Shut-down/Standby	tblEventBasicInfo
Initiator Status	Pre-initiator; Initiating event; Post-initiator; Recovery; Other	tblEventActions2
Unsafe Action Mechanism	Disable running system/ equipment; Starting a shut-down system; Equipment status inappropriately changed; Wrong action sequence; Untimely action; Depletion of resources; Rate error; Frequency error; Quantity error; Duration error; other	tblEventActions2
Information Processing Stage (Cognitive Mode)	Monitoring/detection; Situation assessment; Response planning; Response implementation /execution; other	tblActionInitiators

Table 4.14: Location of Action Characterization Matrix Parameters		
Equipment/ Material Condition	Equipment availability; Multiple equipment failures; Instrumentation problems; Conditions not covered by procedures or otherwise unfamiliar or unanalyzed; History of equipment unreliability; Engineering safety features disabled or bypassed; Latent equipment problems; Lack of equipment redundancy; Hardware interactions/ dependencies; Environmental conditions; Other	tblAccdntCondits
Performance Shaping Factors (PSF Type)	Procedures/policies; Training/knowledge; Communication; Human-system interface design; Environmental conditions; Organizational factors; supervision; Staffing; Experience; Informal rules/ practices; Fatigue/ alertness; Shift transition; Workload; Time pressure; Other	tblActionPSFs

5 Guidance on Use of HERA version 1.0.1

5.1 HERA - Requirements for Use

The current release of HERA was created using Microsoft's database development tool, ACCESS `97, Service Release 1. This is an integrated database 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 database file (i.e., a .mdb file)that allowed the designer to create and modify HERA's tables, forms, visual basic code, data, and other database objects. Because this ability to modify HERA's underlying structure was deemed inappropriate for the intended end user, HERA.mdb was translated into a HERA.MDE file. This conversion compiled all Visual Basic code, removed all editable source code, and actually compacted the database, thereby reducing its size and improving memory usage and processor performance. In addition, once HERA became HERA.mde, end users were 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 databases;
- Changing or modifying the Visual Basic code or modules within the database;
- Exporting or importing forms, reports, or modules (but users can still import/export tables, queries and macros to or from other databases).

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

5.2 Distribution

HERA's current version, i.e. version 1.1, is being distributed in a 10 disk self-installing, stand-alone, run-time version of Microsoft Access `97[5]. HERA run-time was created by integrating HERA.mde into the installation software using the Microsoft Office Development Tools. This process gives users several options during the installation of HERA. First, if users do not have Microsoft Access `97 installed, they can choose to install the HERA.mde database and the stand-alone Access `97 run-time files. However, if users do have a copy of Access `97, they can choose to install only the HERA.mde database file. In both paths, the installation process also installs workgroup administration files that will permit users to install HERA on a network and then establish user and group level security, if needed. Please note: **all three 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 (see Figure 5.1 below).

[5] As the size of HERA increases due to the addition of new events and capabilities, the number of installation disks will also increase.

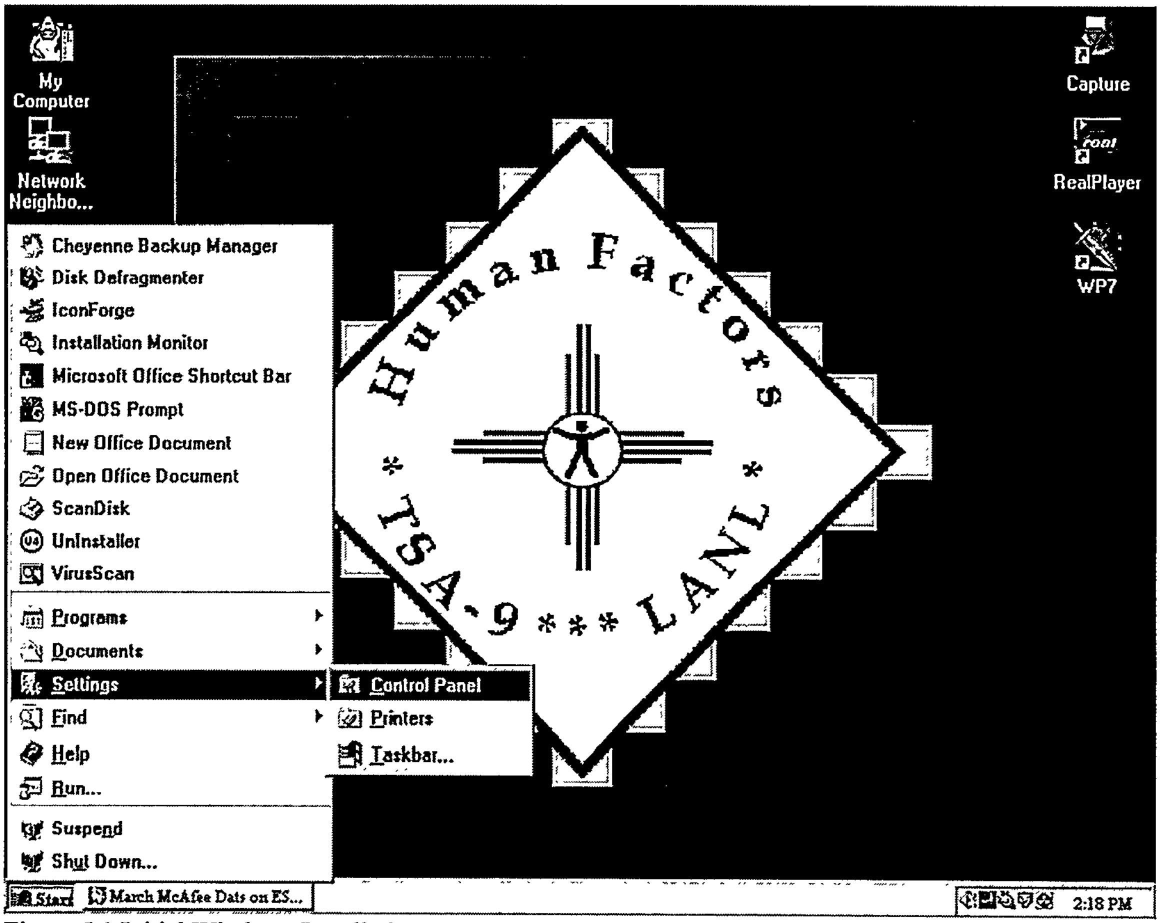

Figure 5.1 Initial Windows Installation Screen

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. This will open a new window resembling Figure 5.2 below.

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.

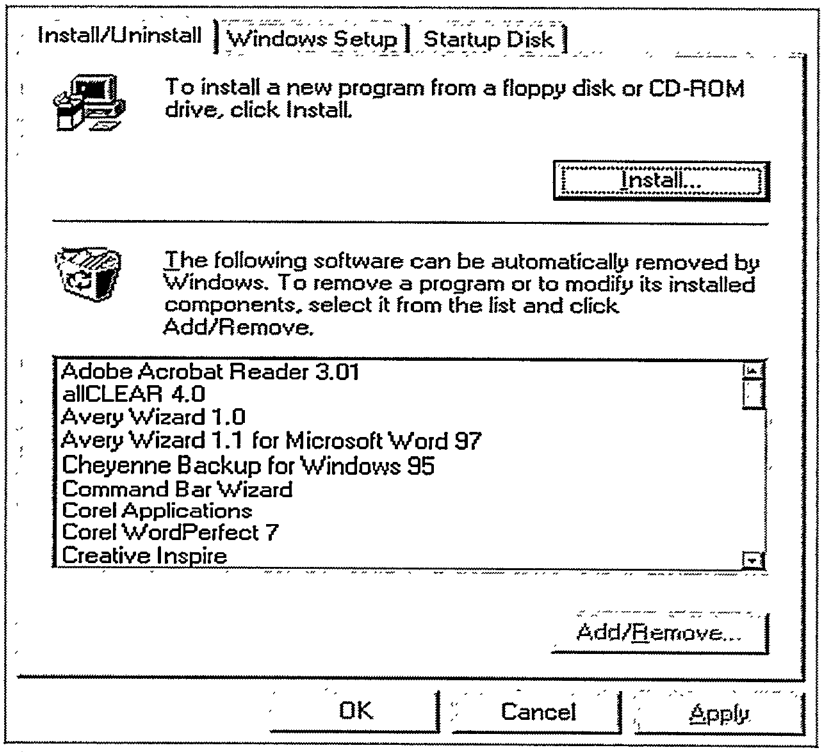

Figure 5.2 Installation Window Display

Next, follow the displayed instructions and insert HERA's first floppy disk, (i.e., disk #1) 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.exe** file on HERA Disk #1 (see Figure 5.3 below). You can also type **"A:\setup.exe" (when 3.5 floppy is A: drive)** and then click ***"Finish"***.

Clicking *"**Finish**"* starts the installation program for HERA After a welcome/close all other programs screen, you should see some semblance of the following window (i.e., Figure 5.4

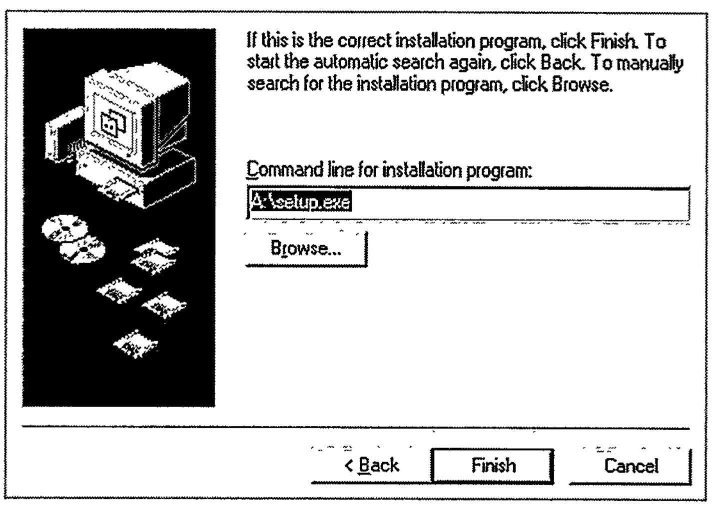

Figure 5.3 Second Installation Window

below). HERA installation then checks to see if your computer has any Microsoft Access `97 components already installed. Depending on what is found, you may be asked to next insert Disk #3 followed by a request to re-insert Disk

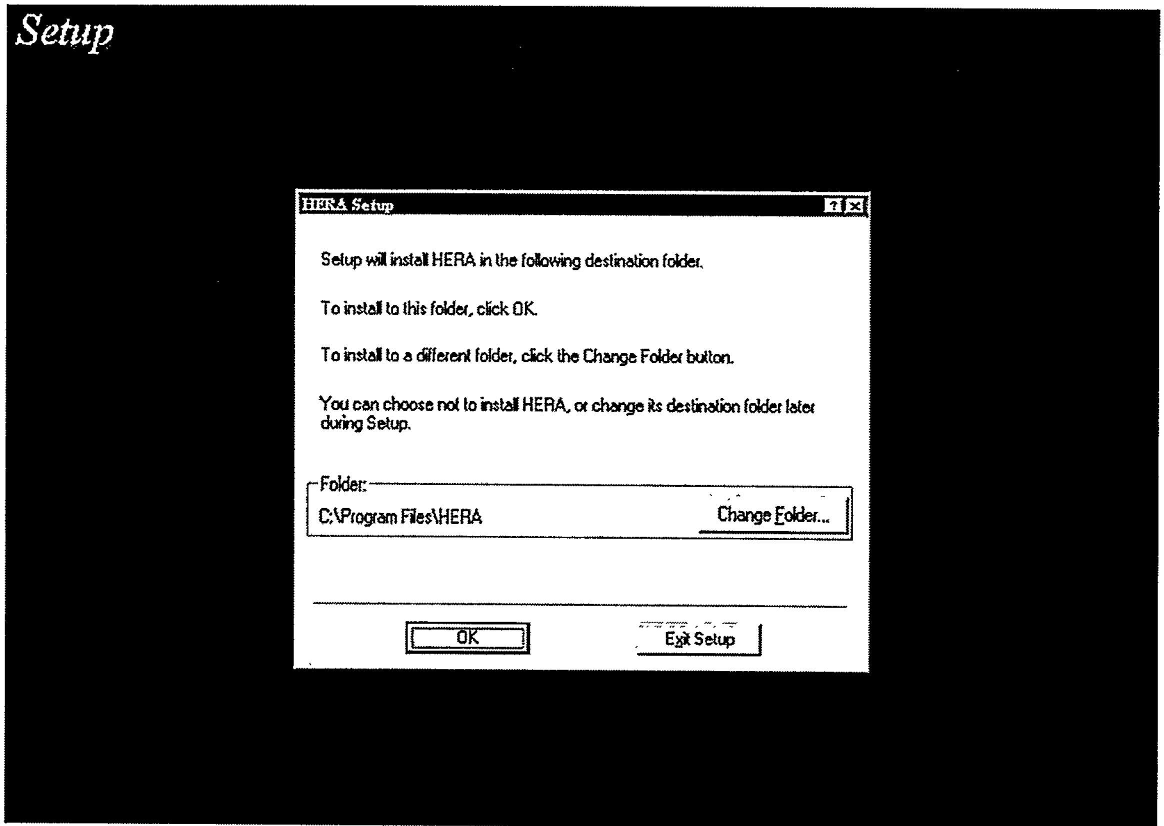

Figure 5.4 Choosing an Installation Folder

#1. This window gives you the option of installing HERA into some other directory, other than the specified default location (i.e., c:\Program Files\HERA).

After clicking *"OK"*, the operating system is ready to complete the installation, you should see the following window, Figure 5.5 below. At this point, you have three installation options: "Typical", "Compact", and "Custom". A typical installation will install the HERA.mde database, the Access `97 run-time version, and the workgroup administration files. Selecting a compact installation will also install everything. The "Custom" installation will allow you to choose which components to install on your hard

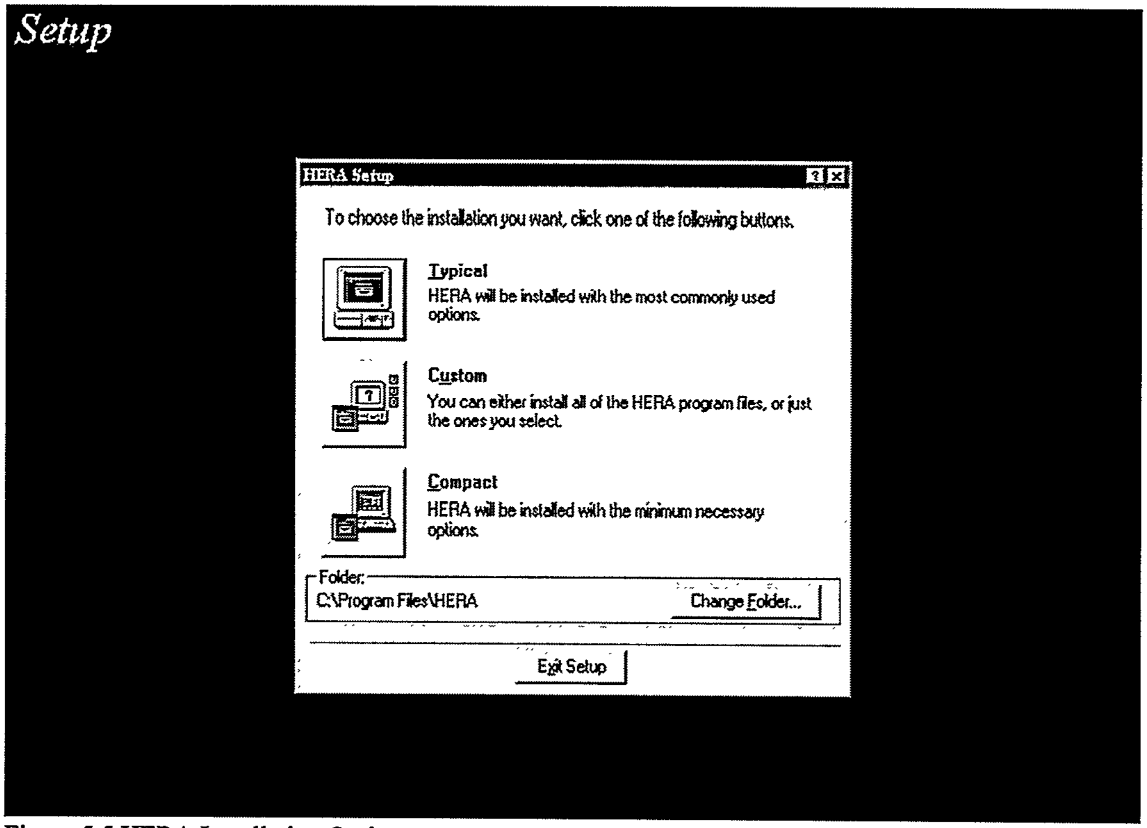

Figure 5.5 HERA Installation Options

drive. For, example, if the user already has installed the full version of Microsoft Access `97, he/she can select "Custom" installation and then, on the following window, choose to only install the HERA.mde file. Please note however, that HERA will not work properly unless the user has installed either the full version of Access `97 or the Access run-time version supplied on the HERA installation disks.

After choosing an installation option, the installation program will ask you to provide the remaining disks in a specific order. Just follow the on-screen directions. HERA's installation should successfully complete itself by installing the HERA database, Access run-time files, and by creating at least two HERA related icons within the HERA folder on the Windows start menu. To check this out, you can click on the ***"Start"*** button and then click on the ***"Programs"*** folder icon. You should see a new folder named HERA which, if you click on it, has two HERA icons, i.e, one to run HERA and the other to compact/repair the HERA database in the event that the file becomes corrupted.

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 A 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.
6 An IBM Pentium laptop with Windows `95 and Access `97.

As before, there were no reported problems with the 586 Pentium PC installations[6].

5.5 Using HERA - Forms and Reports

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[6]However, on an earlier release of HERA the installation apparently had problems writing to the Windows Registry file. Specifically, after copying all of the run-time and data base files, an error message appeared stating that *"comcat.dll was unable to write itself to the Registry"*. This was followed by a second message stating that *"HERA had not successfully completed the installation"*. This error was created by an "updated" comcat.dll file provided by Microsoft in the installation of their Internet Explorer 4. This updated file over wrote the existing comcat.dll file during the installation of IE4. As a result, any run-time Access `97 database that was converted using the MS Office Development Tools, included the "updated" file thereby requiring new users to install and use IE4 on their machines. Microsoft has fixed this problem and the fix was included in HERA 1.1.

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. Table 5.1, below, compares the older HSECS format with the newer HERA format for forms/reports.

Table 5.1 Comparison of Database Forms

HSECS Name	HERA Name
EVT SUM 1- Event Description Summary	Event Basic Information
EVT SUM 2- RCS & SG Init/Acc Parameters	RCS/SG Initial and Accident Parameters
EVT SUM 3- Plant Initial Conditions	Plant Initial Conditions
EVT SUM 4- Plant Initial Unavailabilities	Plant System/ Component Un-availabilities
EVT SUM 5- Plant Accident Consequences	Plant Accident Conditions and Consequences
EVT SUM 6- Plant Accident Failures	Causes of Equipment/Plant Functional Failures
EVT SUM 7- Plant Accident Results	Plant Accident Consequences and Results
ACT SUM 1- Significant Actions & Failures	HERA Action Summary #1
ACT SUM 2- Time Line	Time lines now included in Action Summary #1 and Event Accident Diagnostic Log forms.
ACCIDENT DIAGNOSTIC LOG	Event Accident Diagnostic Log (Time Line)
FINAL STATUS SUMMARY	ATHEANA Analyses

In contrast to this, HERA has basically the same data (now normalized) accessed through one main form, i.e., form Event Basic Information, and 10 new forms (see Figure 5.6 below), 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

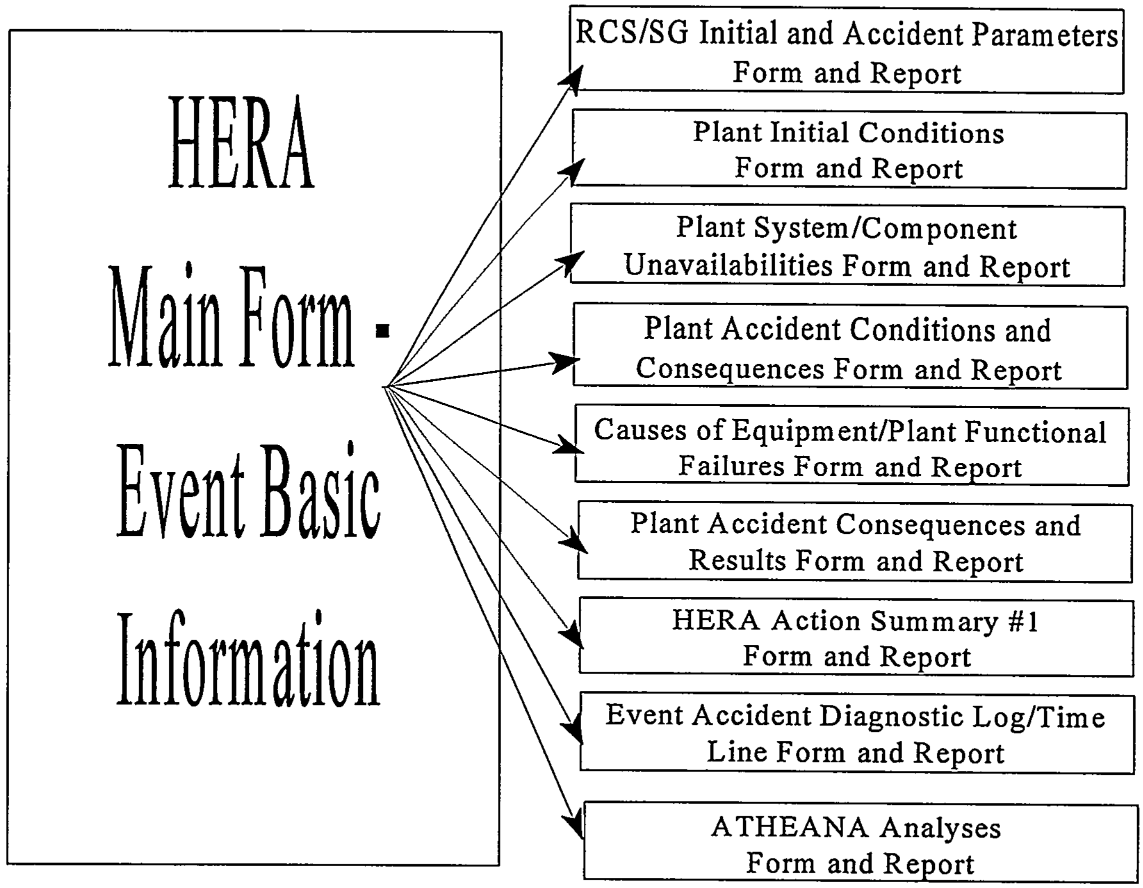

Figure 5.6 Connections Between HERA's Forms

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[7]. Also note that each

[7]Because HERA's data and forms are now "normalized", users can generate effective queries (if they are using the full version of Access `97)or they can utilize the default querying capability programmed into the run-time version.

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, personnel 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, move the cursor to the Windows ***Start*** Button and click once. Now, move the cursor up to the ***Programs*** folder, then over to the ***HERA folder*** clicking on the ***HERA ver. 1.1*** icon. You should also see at least one other icon in the HERA folder (Clicking on this will start an enclosed utility that will repair and/or compact the HERA db when the addition or deletion of data creates fragmented files). If HERA has been properly installed on your computer, clicking the ***HERA ver 1.1*** icon will begin the HERA/MS Access `97 run-time program. 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

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Querying ability in the earlier HSECS db was extremely limited because of its extensive use of non-normalized memo type data fields.

5.7 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[8]. As you can see from Figure 5.7 HERA's main switchboard currently contains six different control buttons with differing functionality. These controls will do the following:

- Starting with the two controls at the bottom of the switchboard- These two controls were provided as

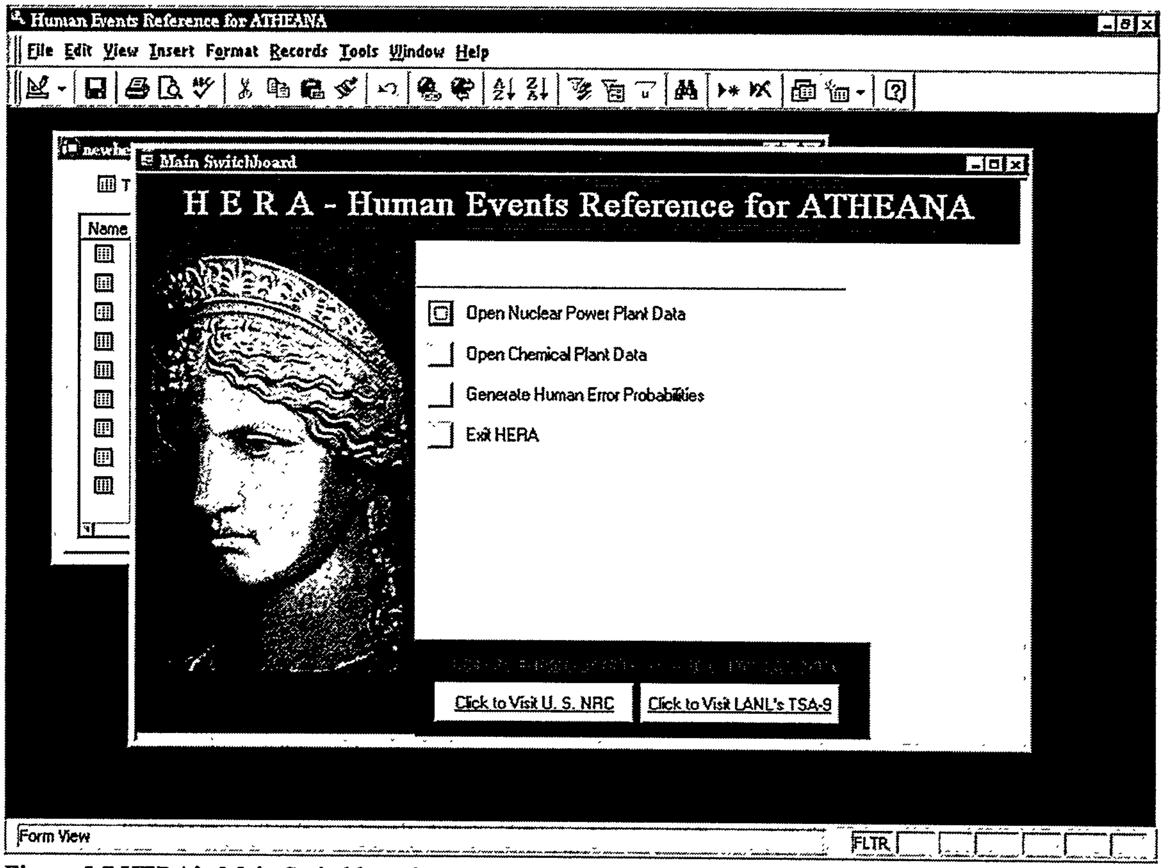

Figure 5.7 HERA's Main Switchboard

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

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[8]HERA is currently configured for nuclear power plant data only. However, as other non-nuclear power events are added to the db, HERA's configuration will change to display new data partitions.

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.

- 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 db run-time version and return you to your computer desktop.
- 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. Clicking on this button will take you to a form that contains one hyperlink control. This control is also intended to be only a demonstration of how HERA can display a large memo within a dedicated form. If you click on this button in HERA ver. 1.1, you will currently see a moderately sized document containing information about a human reliability-based expert system, developed at LANL. Once again, this is only a demonstration, but this partition in the database could eventually be used to create a quantification ability, based on rules derived from ATHEANA and all validation studies of ATHEANA.
- 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.
- 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 database 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 5.8 below. 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

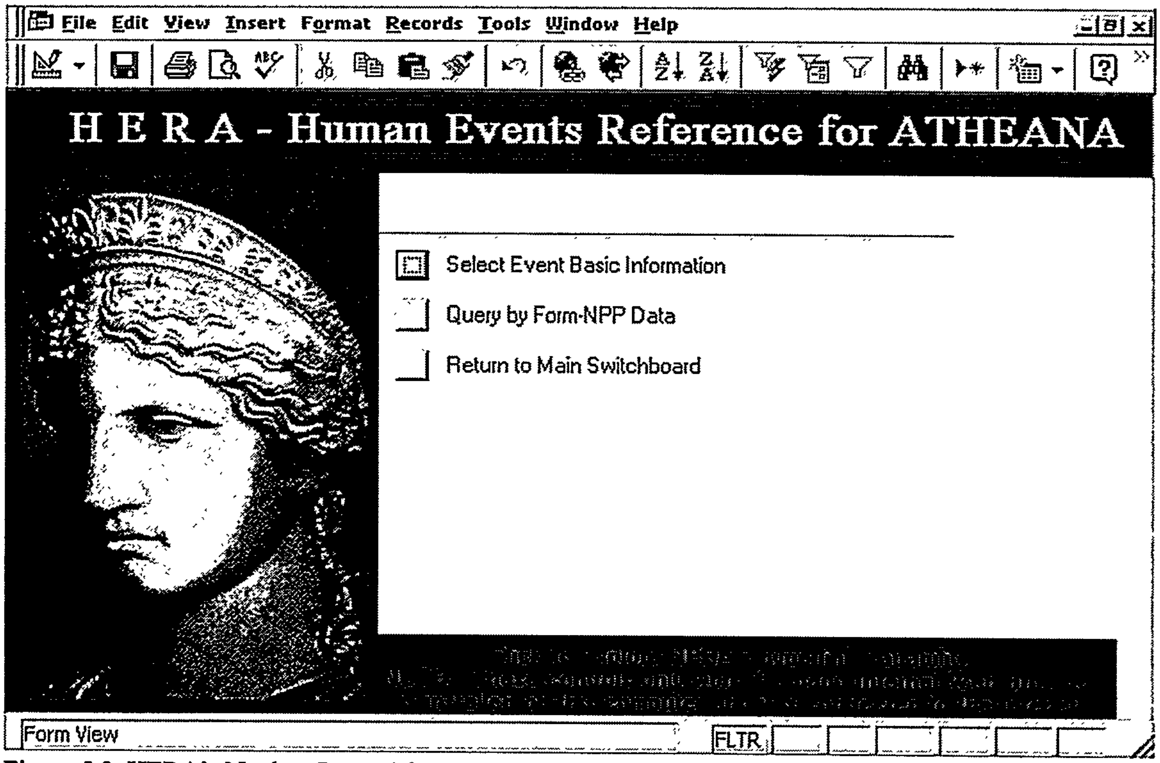

Figure 5.8: HERA's Nuclear Power Plant Data Switchboard

three control buttons. For now, this discussion will focus on the controls entitled ***"Select Event Basic Information..."*** and ***"Return to Main Switchboard"***[9]. 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 5.6) 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 5.9 below.

[9]For a discussion of queries see Section 5.8 below.

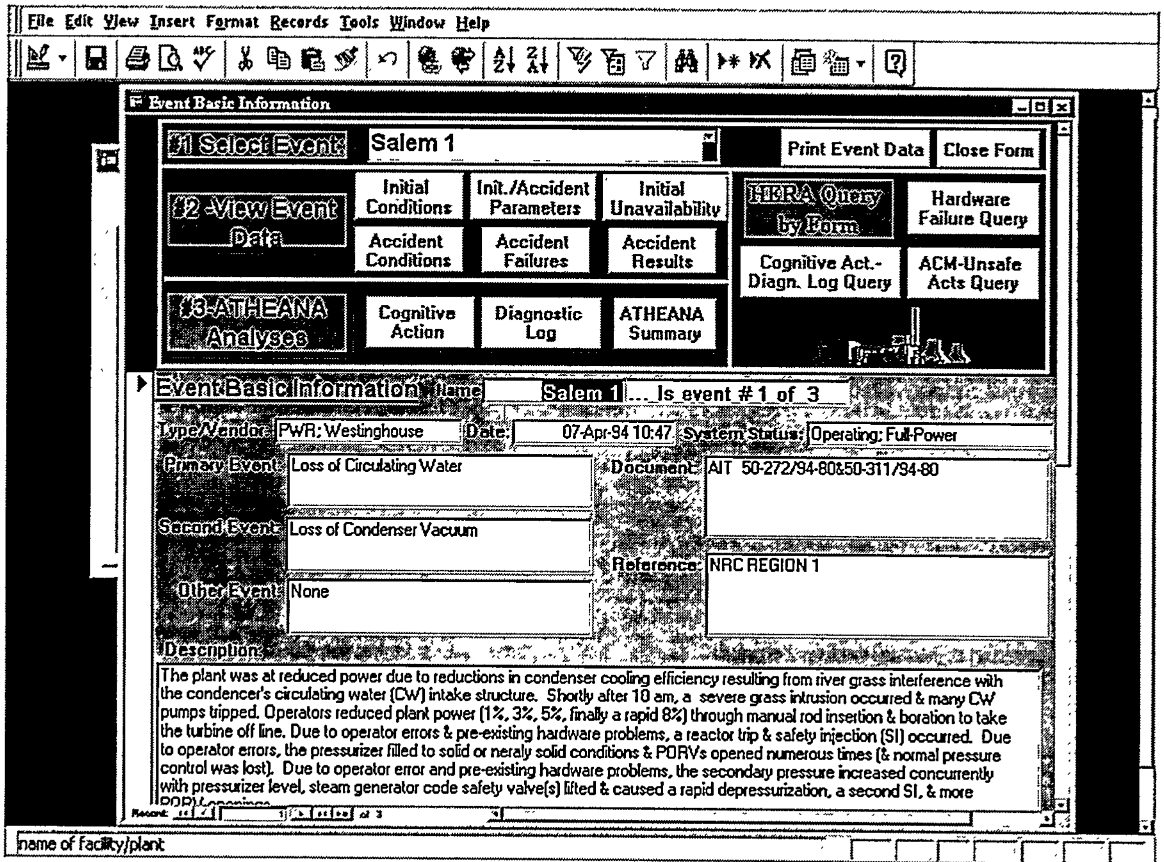

Figure 5.9: HERA's Main Form - Event Basic Information

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 database, 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.

The "***Event Basic Information***" form is comprised of three 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 5.10 below.

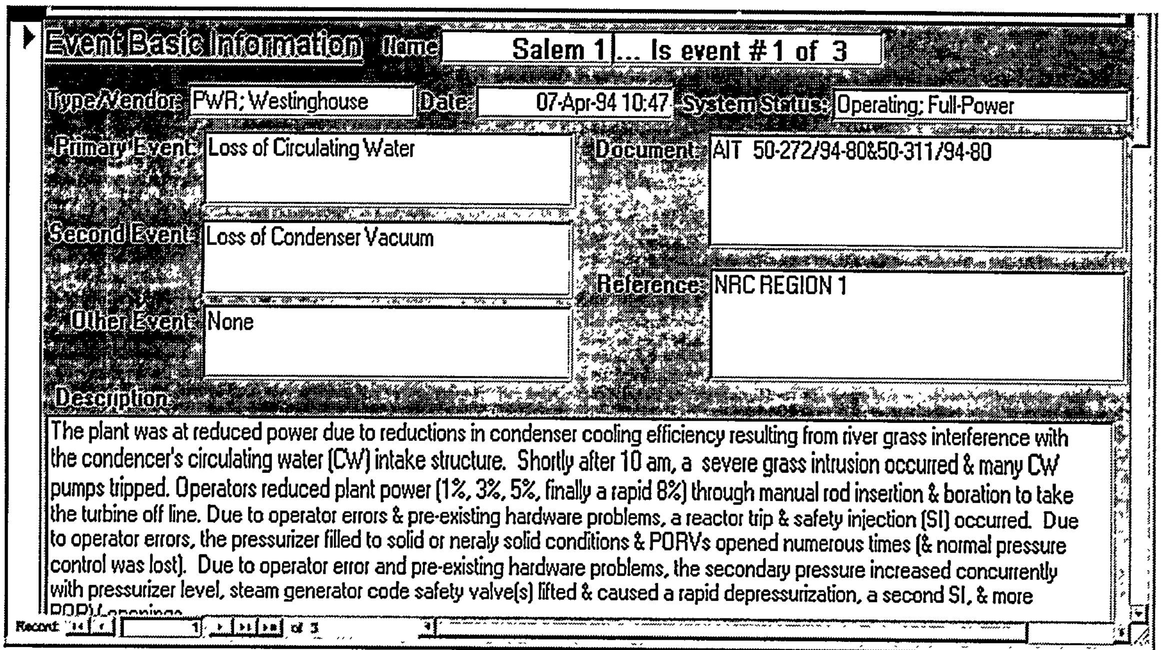

Figure 5.10: HERA Main Form, Basic Event Data

As you can see, this portion of the main form contains 11 separate fields that individually display basic bits of event data. Specifically, these fields include: 1-the event name; 2- a statement that the selected event "...is event #X of Y"[10]; 3-type of power plant and the plant's vendor; 4-event's date and time; 5-unit and system status; 6-primary or initiating event; 7-secondary event; 8-other important contributing event; 9-data source; 10-document references; and 11-event description. (Please refer to Table 4.1 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

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[10]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.

the "***Description***" field. Users can then scroll through all of the displayed text.

Next, at the top of the "***Event Basic Information***" form, just to the right of the title, you will find the second main group of database 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 the following figure, Figure 5.11 below.

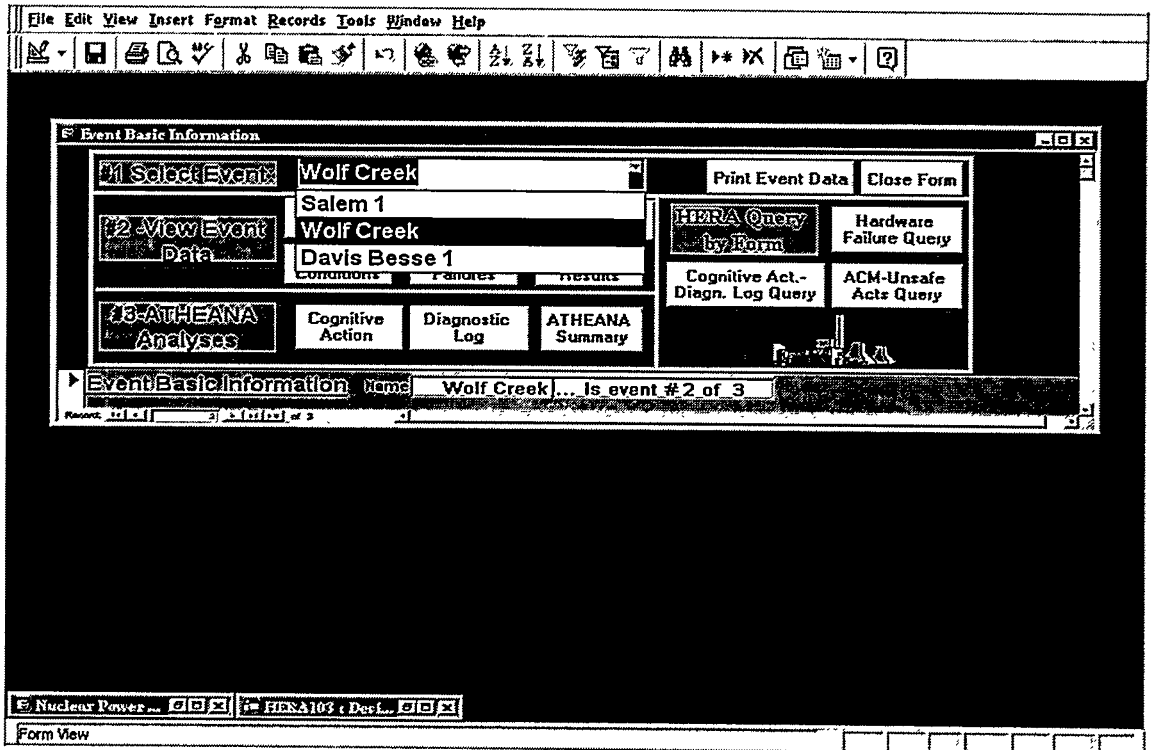

Figure 5.11: Main Form, Selecting an Event

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. For example, in Figure 5.11 above, the Wolf Creek event has been selected, causing the Name Field to display "Wolf Creek ...Is Event #2 of 3". After this selection is made all subsequent data is linked to the Wolf Creek event.

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 controls are shown in Figure 5.12 below.

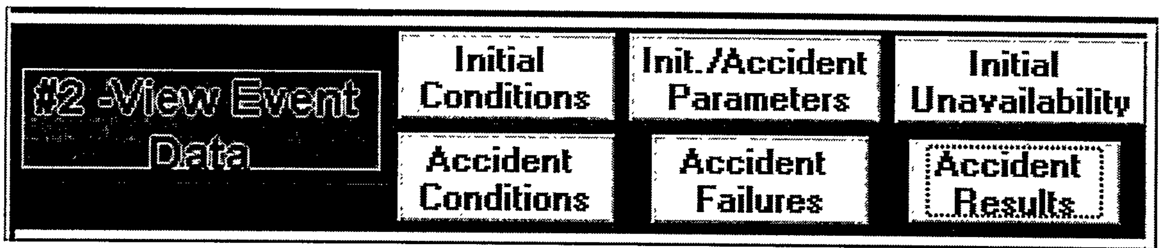

Figure 5.12: Main Form, View Event Data Control Buttons

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 six controls in Figure 5.12 will be discussed below.

5.6.4 Accessing the Plant Initial Conditions Form

From the main form, i.e., the "***Event Basic Information***" form, clicking on the "***Initial Conditions***" button will display the form shown in Figure 5.13 below.

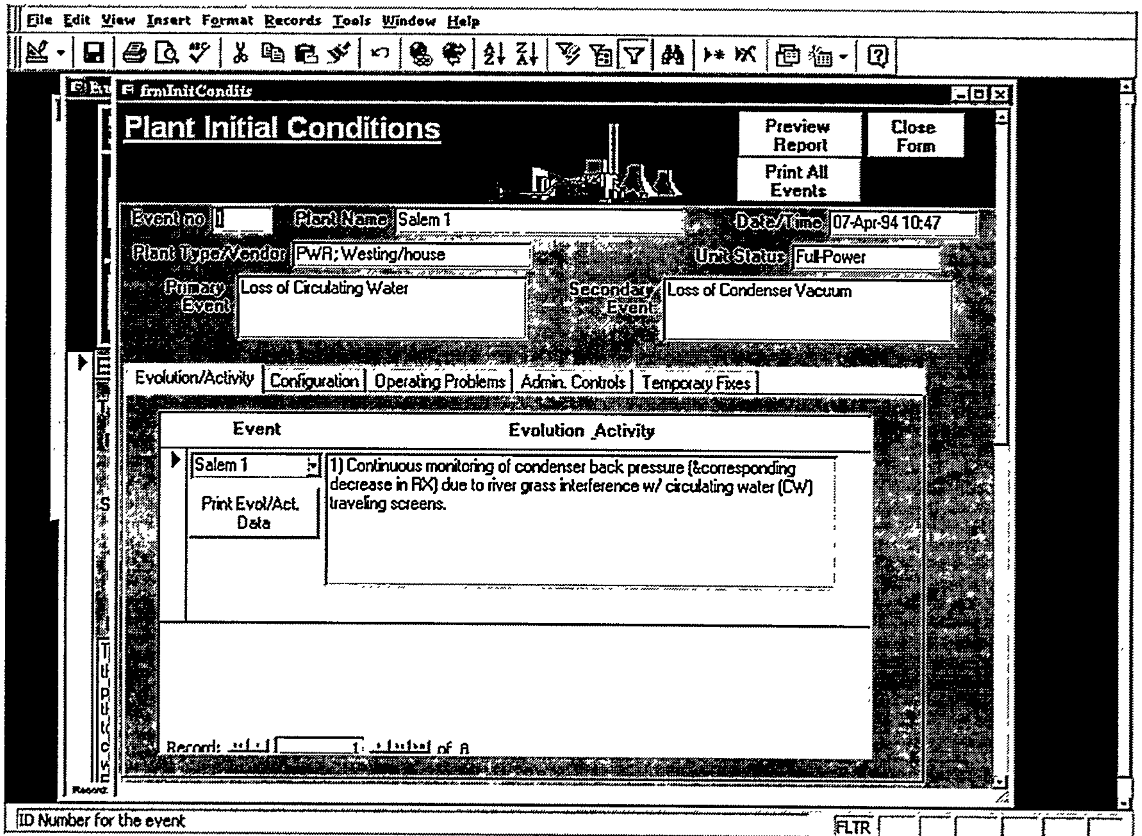

Figure 5.13: Plant Initial Conditions Form

After selecting this control, the Plant Initial Conditions form shows data pertaining to the plant's initial evolution/activity, plant configuration, any pre-existing operating problems, all administrative controls in effect at the time of the event, and any temporary fixes that were identified in the event reports. As you can see in Figure 5.13, this form has a different format and interface compared to the preceding forms. Actually, this form is comprised of a main form (displaying the header information) and several sub-forms (contained on the separate tabs within the folder on the mid and bottom parts of the form). Header 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.

Now look at the main body of the form which resembles a file folder with five separate tabs. Clicking on one of these tabs will display the information under that tab's heading which is associated with the selected event on the main form. For details on each of the five tab headings (e.g., fields) please refer to Table 4.9 and Section 4.2.9 above. Within the display on each tab you should see a reference to the event as well as part of the data. **It is important to note the controls on the bottom left-hand corner of each tab's display.** Here you will see Figure 5.14 below.

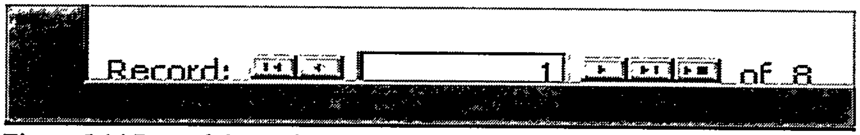

Figure 5.14 Record Control Buttons

This figure indicates that you are now viewing Record... 1... of 8. As standard Windows defaults, most users will 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. Because each of the folder's tabs is a sub-form deriving from the same table, 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. In this case, the Initial Conditions table was constructed as a five by eight matrix, e.g., 5 separate data fields where at least one field required eight separate pieces of data. 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.

For example, click on the ***Evolutions/Activity*** tab where you should see that you are viewing "Record 1 of 8". Now continue clicking on the ***Next Record*** button, i.e., the right facing arrow control. On the fourth record you will see "N/A". Now click the ***Operating Problems*** tab and once again start scrolling through the records. This time you will see that there are actually eight different records, none of which contained "N/A". Because the Operating Problems field required eight individual entries and the ***Evolutions/Activity*** field only required three individual entries (while eight were created), by default the remaining five empty cells were automatically filled with the specified default, "N/A".

Printing- Now once again click on the **Evolution/Activity** tab. You should see the Event (i.e., Salem 1) and the display of the Evolution/Activity. Just below the Event field, you will see a button control labeled **"Print Evol/Act. Data"**. Clicking on this button will result in the eight Evolution/Activity Records for the Salem 1 event to be printed out. 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 tabs, 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[11].

5.6.5 Accessing the Initial/Accident Parameters Form

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[11]This same printing capability exists on each form that utilized the folder and tab design (i.e., Initial Conditions, Initial Unavailabilities, Accident Conditions, Accident Failures, Accident Results, and the ATHEANA Summary), it will not be discussed in detail again.

From the main form, i.e., the "***Event Basic Information***" form, clicking on the "***Initial/Accident Parameters***" button will display the form shown in Figure 5.15 below. This is the second form and report created specifically to capture the functionality of the earlier HSECS db (refer back to Section 5.5 and Table 5.1 above).

This particular form displays basic engineering parameters for the Reactor Coolant System (RCS) and Steam Generator (SG) systems both before (Initial Conditions) and after

(Accident Conditions) the initiating event. Data fields on

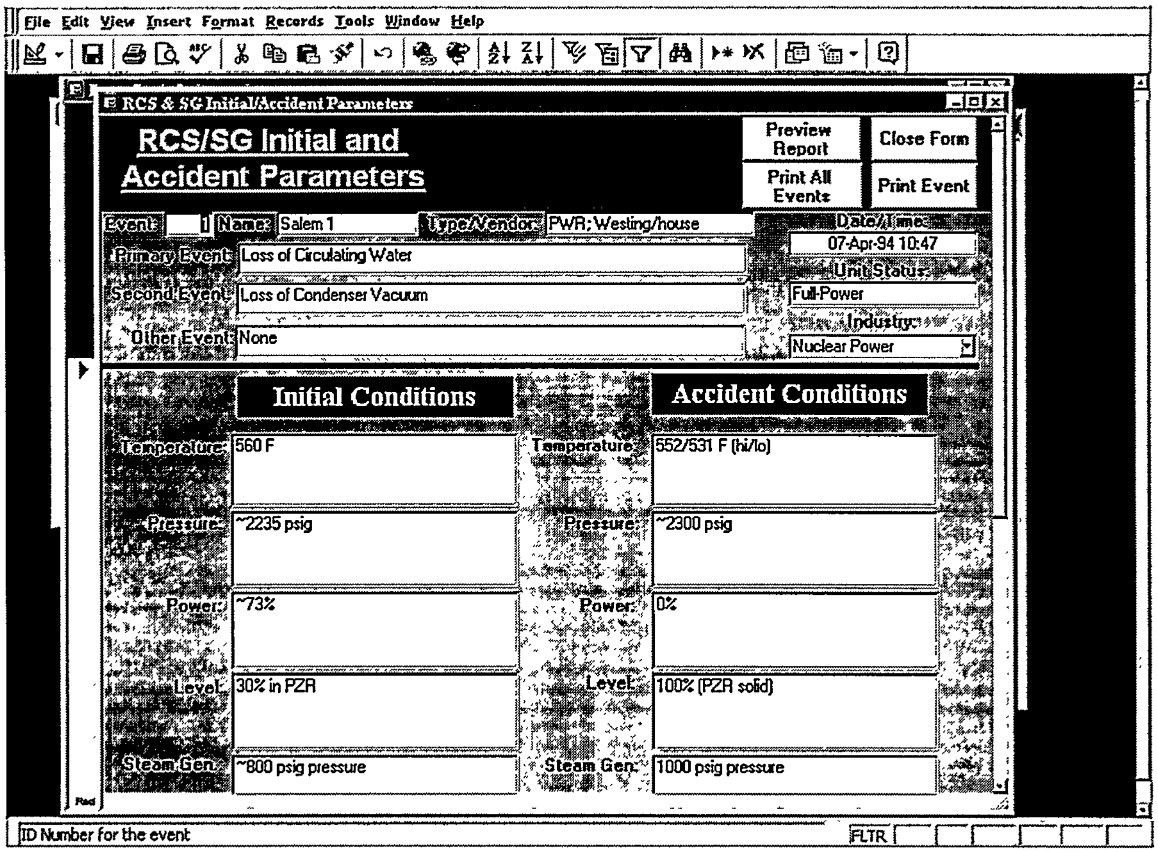

Figure 5.15: RCS/SG Initial and Accident Parameters Form

this form include: event number; event/plant name; plant type and vendor; primary, secondary, and other initiating events; event date/time; unit status; industry; and the engineering parameters of temperature, pressure, power level, and PZR level for both initial and accident conditions. Details for the individual fields on this form can be found in Table 4.1, Section 4.2.1 above.

At the top of this form, you will also see four other control buttons, "**Preview Report**", "***Close Form***", "**Print All Events**" and, "***Print Data***". "**Preview Report**" will open an RCS/SG Initial and Accident Parameter report that displays this forms data for all events. From here, users can either print all of the form's data for all events, or can choose selected portions of the data for printing. "**Print All Events**" will bypass opening the preview report and will print this form's data for all events. In contrast to this, "***Print Data***" will print this form's data for the selected event ONLY. Clicking on "***Close Form***" will close this 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 RCS/SG 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 5.16.

As can be seen in the figure above, this form also uses the folder and tab design to display the selected event's system and component unavailability data. Specifically, the tabs contain system-component, containment, alarms, instruments,

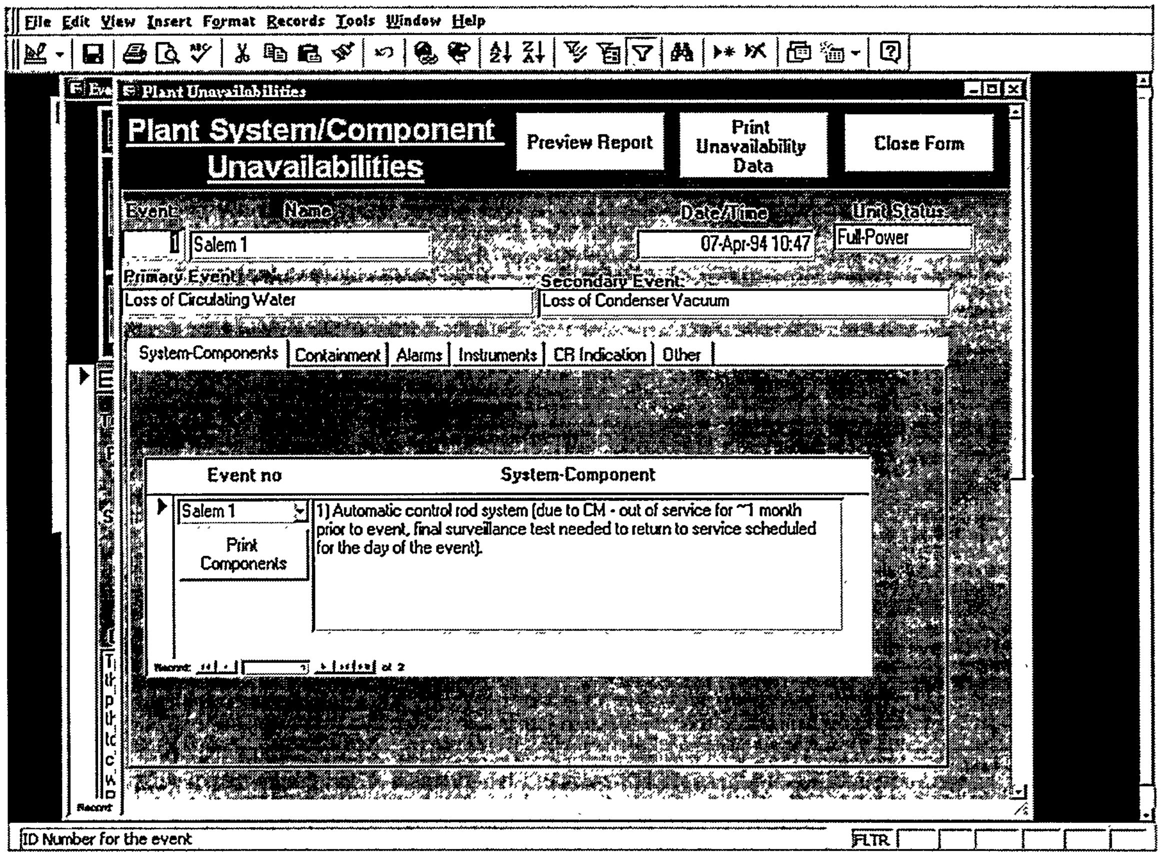

Figure 5.16: Plant System/Component Unavailabilities Form

control room (CR), and other plant unavailabilities arising from the primary event and secondary events (see 4.2.11 and Table 4.11 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 Conditions

Clicking data control button four (i.e., the "***Accident Conditions***" control) will show a form like that seen in Figure 5.17 below.

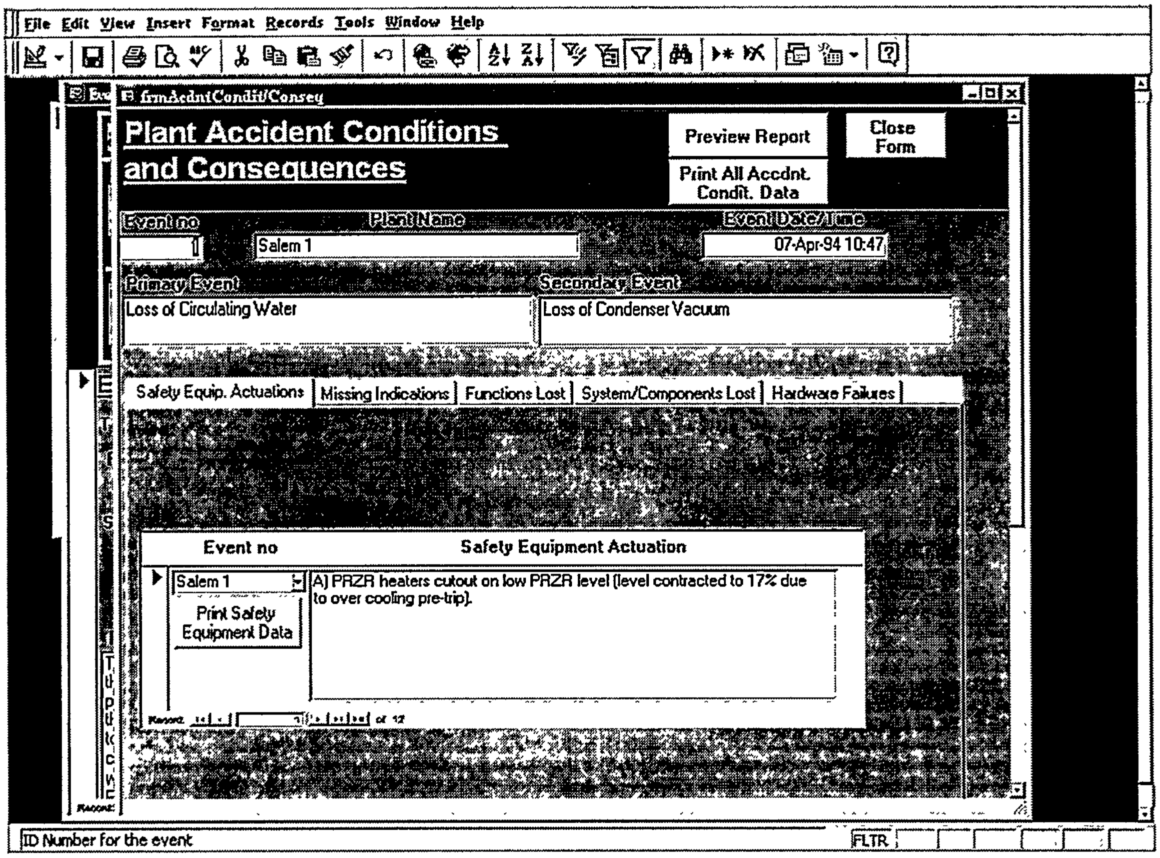

Figure 5.17: Form Displaying Plant Accident Conditions and Consequences

This "***Plant Accident Conditions and Consequences***" form has five distinct tabs to display related data. Specifically the fields contained on the tabs 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 and Table 4.2. The tabs, record controls, scrolling and printing functions all work in the same manner as described the previous sections above.

5.6.8 Causes of Equipment/Plant Functional Failures Form

Next, clicking the fifth control, i.e., the "**Accident Failures**" button on HERA's main form (the **Event Basic**

Information form) will initialize and display the "**Causes of Equipment and Plant Failures**" form, as seen in Figure 5.18 below.

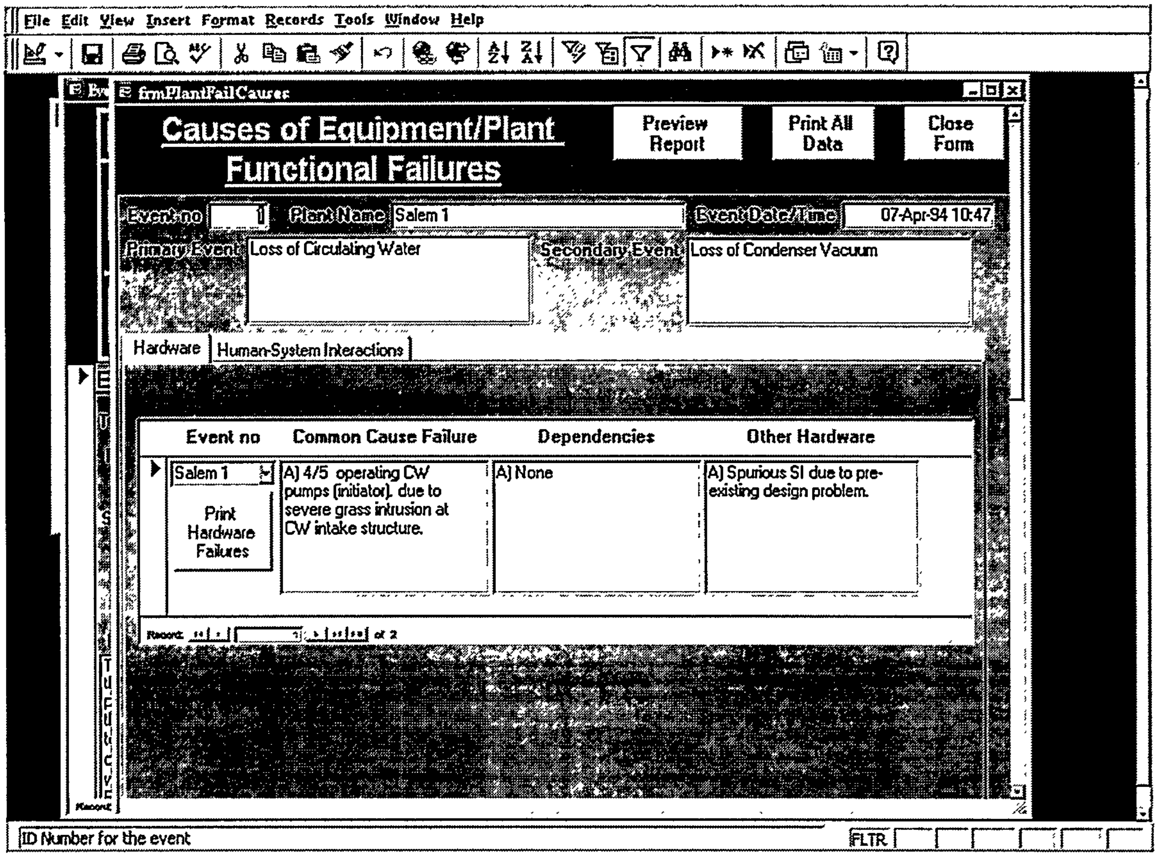

Figure 5.18: Cause of Equipment and Plant Functional Failures Form

As can be seen in the figure above, this folder only has two separate tabs; one for hardware and the other for human-system interactions. Clicking the hardware tab will display the selected event's common cause failure, dependencies, and other data. Clicking the human-system interactions tab 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 Table 4.3 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.

5.6.9 Accident Results

The following figure, Figure 5.19 is displayed after the user clicks the "***Accident Results***", the sixth view event data control button on HERA's "***Event Basic Information***" main form. This form once again uses a folder 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 and Table 4.4 above. The tabs, record controls, scrolling and printing functions all work in the same manner as described Section 5.6.4 above.

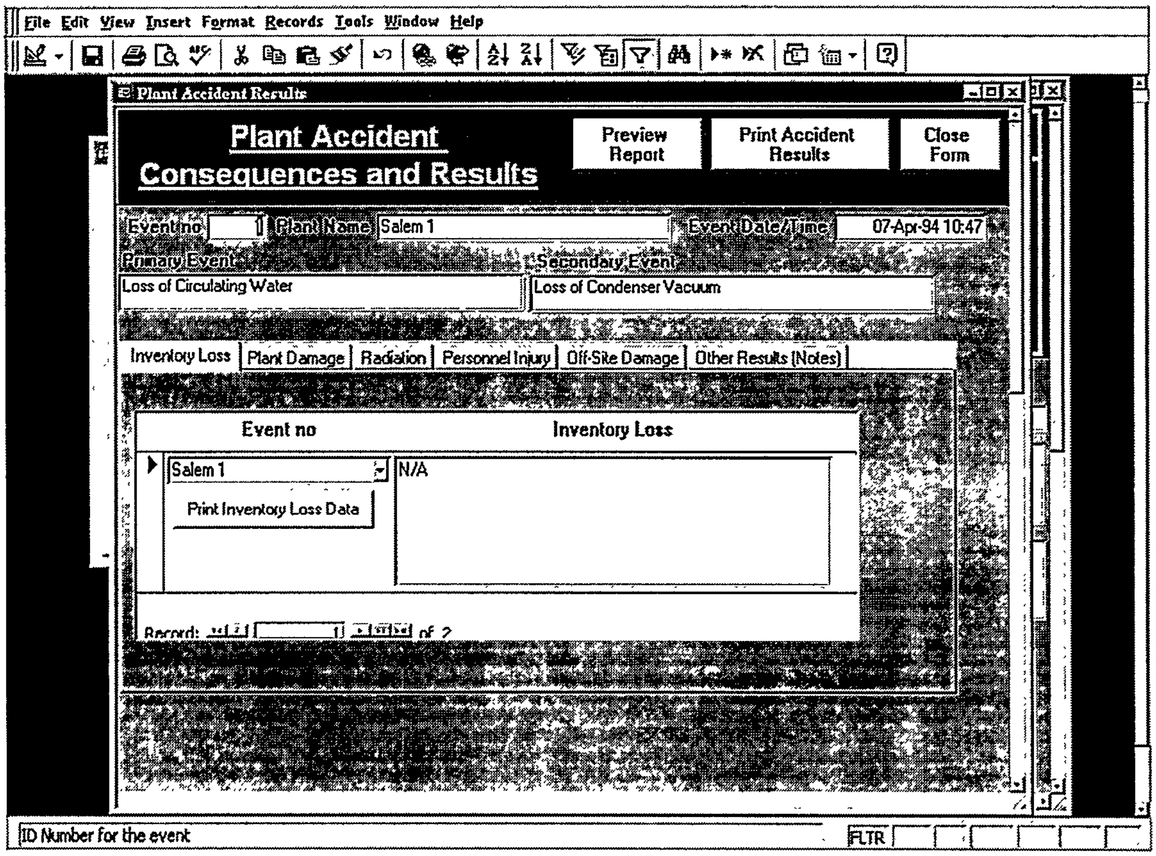

Figure 5.19: Accident consequences and Results Form

5.7 Using ATHEANA Analyses

This section discusses the three ATHEANA analysis control buttons that are found on the "**Event Basic Information**" main form, just to the right of the label "**#3-ATHEANA Analyses**". Recall that the ATHEANA analyses present interpretive data derived through the use of the ATHEANA technique, as contrasted to the factual data arising from official NRC documentation. Please close any other open HERA forms and return to the "**Event Basic Information**" main form. Figure 5.20 below shows how the three ATHEANA analyses controls appear on the main form.

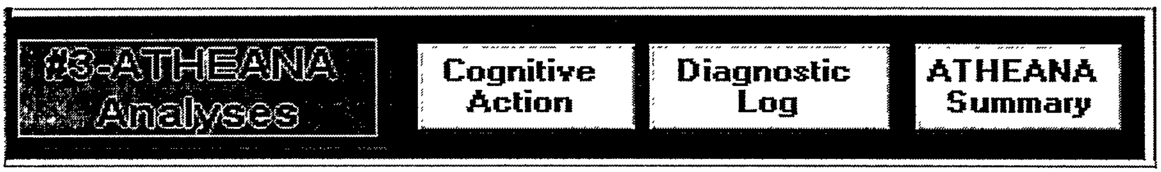

Figure 5.20: ATHEANA Analyses Control Buttons

5.7.1 Cognitive Action Summary

When a user actuates the "**Cognitive Action**" control by clicking the mouse/cursor on it, the "**HERA Cognitive Action Summary**" form is displayed on the monitor (see Figure 5.2 below).

In particular, this complex form is comprised of several sub-forms that integrate and display data from several differing tables, including the event basic information (Table 4.1 above), the diagnostic time line (Table 4.7 above), the event diagnostic log (Table 4.10 above)and, at least 10 data fields from tblEventActions2 (Table 4.8 above). 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 Record**" and/or "**Print Event Action Summary**" to print a hard copy of the data. At the top of this form, users will see a slightly reduced display of the accustomed heading data (i.e., event number, plant name, event date and time, and now just the initiating event). 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 5.21, 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

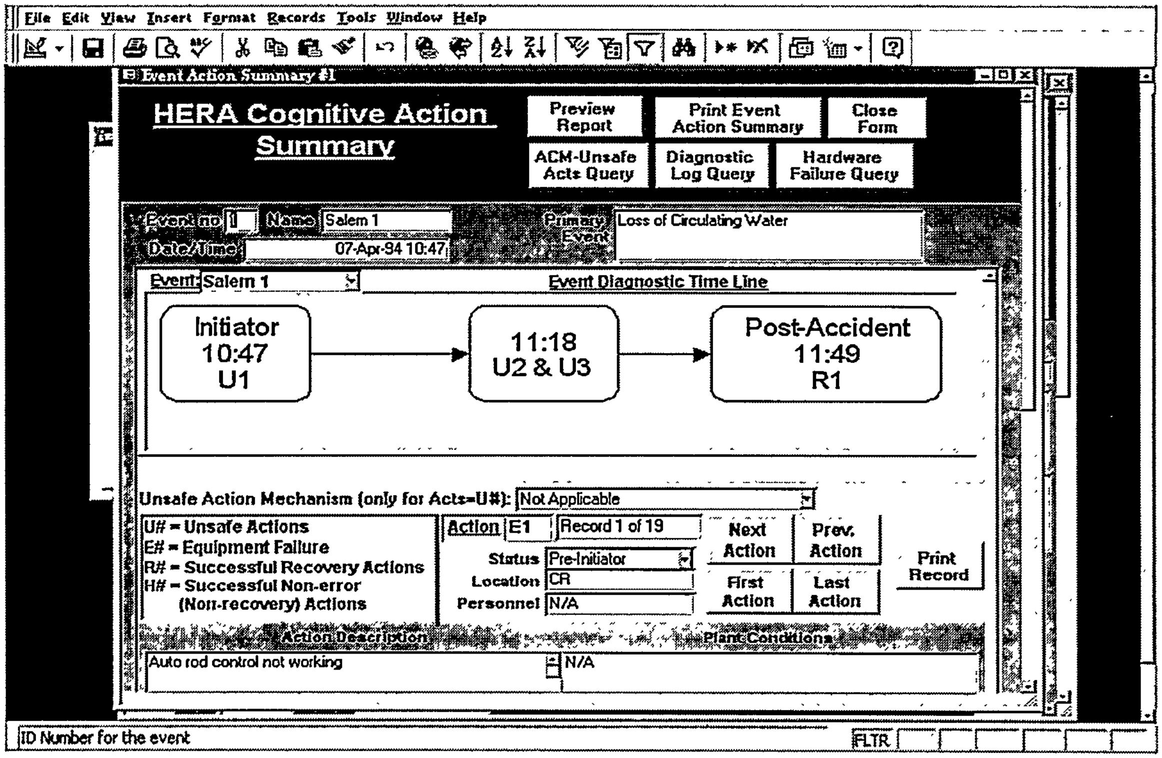

Figure 5.21: HERA Cognitive Action Summary Form

left hand side, you can see that U1 indicates an unsafe action. (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 unsafe action, i.e., listed as a "U#", the "**Unsafe Action Mechanism**" field will display information from the Action Characterization Matrix (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 "**Unsafe Action Mechanism**" field. For example, in Figure 5.21 above, you can see that "Not Applicable" is displayed in the "**Unsafe Action 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. You can also see that this record for E1 has: 1) a "Status" (from

ACM) of "Pre-Initiator"; 2) a "Location" of "CR" (control room), and a "Personnel" type of "N/A" - the ATHEANA analysts did not provide any data for this field. 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 to the right of this information you should see five navigation control buttons, i.e., "**Next Action**", "**Prev. Action**", "**First Action**", "**Last Action**" and, "**Print Record**". Clicking on one of the first four buttons will take you to the next record (action), the previous record (action), the first record, or the last record respectively. Click on "**Print Record**" to get a paper copy of the single record being displayed. This printed form will also contain the Action Description, Plant Conditions, Activity, Plant Impact, and other Notes for that particular cognitive act.

If a user wants to see all of the cognitive action data from this form, he/she will have to click on the "**Preview Report**" button at the top of this form and then select and print only those pages of interest, like, for example, all of the cognitive actions for the Wolf Creek event. Actuating the "**Print Event Action Summary**" button will skip the preview and print all of the data from this form for ALL events in the db. "**Close Form**" closes this form and takes you back to HERA's main display.

Just below the print and close control buttons, you will also see three other query related button controls with bold blue lettering. These three controls actuate the limited, pre-packaged HERA run-time querying capabilities. However, their functioning will not be discussed until Section 5.8, below.

5.7.2 Diagnostic Log

On the "**Event Basic Information**" main form, when one clicks on the second ATHEANA Analysis control button, i.e., the "**Diagnostic Log**" button, the user opens a second ATHEANA form entitled "**Event Accident Diagnostic Log**". As in the preceding discussion, this form integrates data from several other tables within HERA. Specifically, this form combines the header data from tblEventBasicInfo (Table 4.1 above), the event's diagnostic time line (Table 4.7 above) and, the event diagnostic log (Table 4.10 above). However, in contrast to the preceding form, the "**Event Accident Diagnostic Log**" form will display the step-by-step, moment-by-moment description of the accident in discrete steps as describe in the selected event's accident log and time line. This form is displayed in Figure 5.22 below.

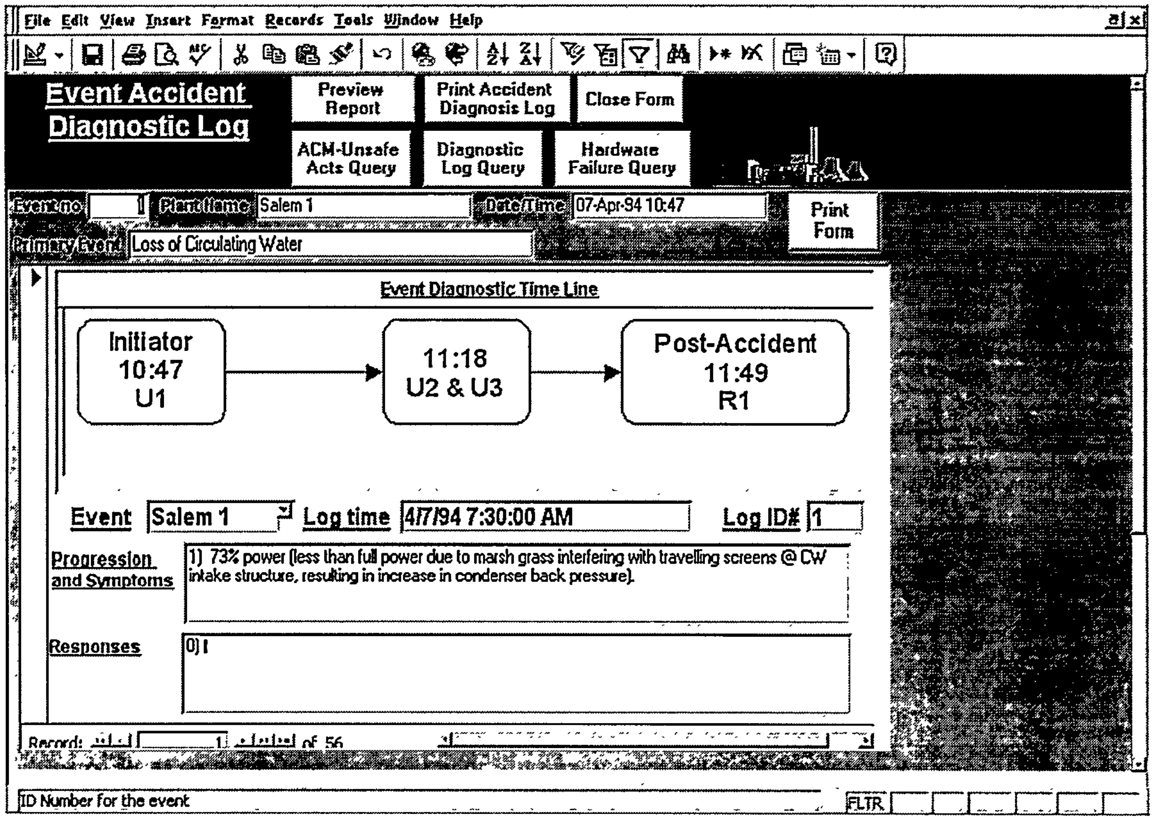

Figure 5.22: Accident Diagnostic Log Form

As can be seen in Figure 5.22, this form displays the same basic event header information, the diagnostic time line, and several data fields containing the Event (i.e., Salem 1), the Log Time and date (i.e., 4/7/94 7:30:00 AM) and the Log ID#, i.e., LOG ID=1. (NOTE: Look at the navigation buttons on the bottom left-hand corner of this screen. You will see that this Log ID#=1 refers to the fact that it is record #1 of 56 possible records for the Salem 1 event. You can click on the individual navigation buttons to see other diagnostic log and time line notations or you can use the "**Print Form**" button to print the entire diagnostic log for the selected event). Also displayed are individual progression-symptom data and responses that are linked to each individual logged entry. When these fields show either a "0" or "N/A", it indicates that data was not provided in the ATHEANA analysis.

As before, if a user wants to see all of the diagnostic log data from this form, he/she can click on the "**Preview Report**" button at the top of this form and then select and print only those pages of interest, like, for example, all of the diagnostic log entries for the Wolf Creek event. Actuating the "**Print Accident Diagnosis Log**" button will skip the preview and print all of the data from this form for ALL events in the db. "**Close Form**" closes this form and takes you back to HERA's main display.

5.7.3 Diagnostic Log

The final ATHEANA control button is labeled "**ATHEANA Summary**". By clicking the mouse, it opens a form (Figure 5.23 below) displaying a collection of summary material derived from the ATHEANA analysis of the selected event. As can be seen in this figure, the ATHEANA Summary Form contains seven data fields in a folder and tab format, providing summaries of interpretive data derived from the ATHEANA analysis of this event. Tab labels, associated data fields, and sources are listed in Table 5.2.

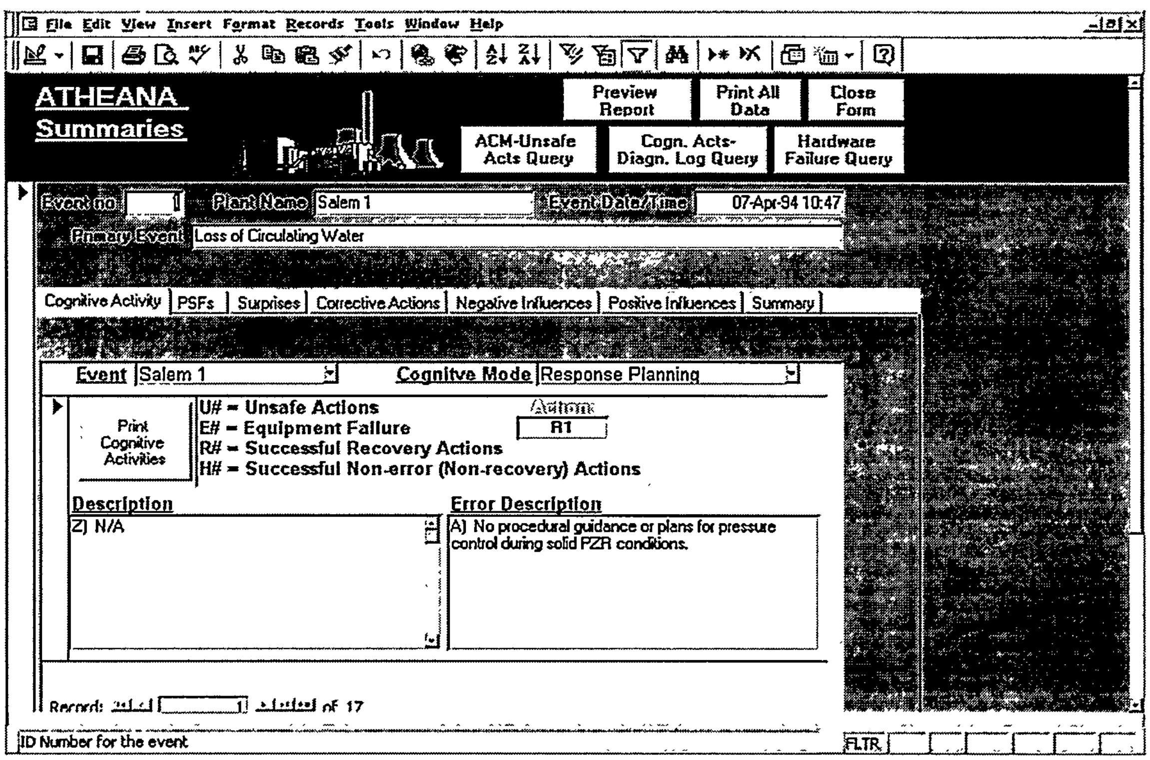

Figure 5.23: ATHEANA Summaries Form

Table 5.2: ATHEANA Summaries Form, Tab Label, Data Fields, and Data Sources		
Tab Name	**Data Fields in Tab**	**Source**
Cognitive Activity	1) Event	Table 4.1
	2) Cognitive Mode	Table 4.5
	3) Cognitive Action	Table 4.5
	4) Cognitive Description	Table 4.5
	5) Error Description	Table 4.5
PSFs	1) PSF Type	Table 4.6
	2) Cognitive Action	Table 4.6
	3) PSF ID Number	Table 4.6
	4) PSF Description	Table 4.6
Surprises	1) Event	Table 4.1
	2) Event Surprises	Table 4.13
Corrective Actions	1) Event	Table 4.1
	2) Licensee Corrective Actions	Table 4.13
Negative Influences	1) Event	Table 4.1
	2) Most Negative Influences	Table 4.13
Positive Influences	1) Event	Table 4.1
	2) Most Positive Influences	Table 4.13
Summary	1) Event	Table 4.1
	2) Event Significance	Table 4.13

5.8 Queries

At the simplest level, queries are formal requests to either retrieve data from a database 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. Unfortunately, by design, **querying capability was not included in the Access run-time development tools that were used to create HERA's run-time version.** If you want to create and use queries, then you must buy the full version of Access `97. Fortunately, for users of HERA that want 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. It should be noted however, that this QBE functionality is only available for those end users of HERA who have installed the FULL version of Microsoft Access `97. As a result, the bottom line is that if one wants to utilize the full querying power of a given data base like HERA, that user will have to take the time to learn how to use Access `97's querying capability. The upside to this is that Microsoft has provided some excellent querying "Wizards" and help functions as aids to bring neophytes up to experienced user levels. Some brief, further discussion and examples of QBE are include in Section 5.8.2 below.

5.8.1 Run-time Query by Form Capability

Apparently as Access data base developers began to distribute various run-time versions of their products, the lack of querying capability became a major drawback that limited product functionality. So, developers like Getz, Litwin, and Reddick (1994) used inherent filter by form functions in the full version of Access to create what is now called Query by Form[12] or QBF. QBF provides a filter by form substitute for queries in run time applications like HERA. Essentially, the use of QBF allows developers to create a form that runs queries which filter and display selected data according to parameters of interest.

Because HERA was created as an Access run-time product, with no direct querying capability, QBF has been used to provide three distinct QBF functions.

HERA's limited QBF functions can be accessed in three different ways. First, as seen in Figure 5.24, users can enter the querying functions by first selecting the "**Query**

[12]QBF in HERA was adapted from "Microsoft Access 2 Developer's Handbook", by Getz, Litwin, and Reddick (Sybex) Copyright 1994-1997.

by Form-NPP Data" control found on the second startup switchboard. Clicking on this button will bring up a third display, as seen in Figure 5.25 below. As you can see, this switchboard has three control buttons (labeled "**Action Characterization Matrix-Unsafe Action Query by Form**", "**Diagnostic Log/Unsafe Action Query by Form**", and "**Equipment Failure/Unsafe Action Query by Form**"), that will actuate the three, limited, query by form functions within HERA (each of these buttons will be individually discussed in the

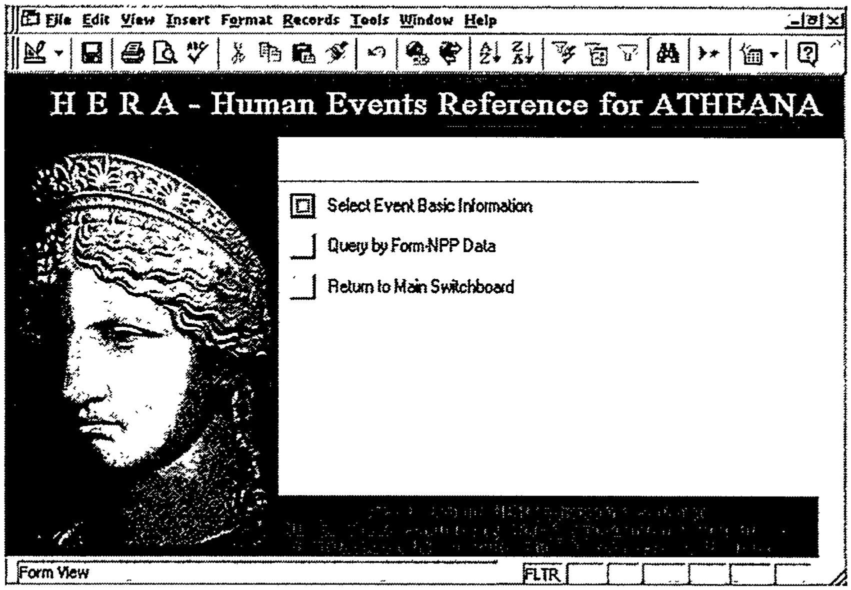

Figure 5.24: Selecting the Query by Form Control

following sub-sections). The fourth switchboard control,

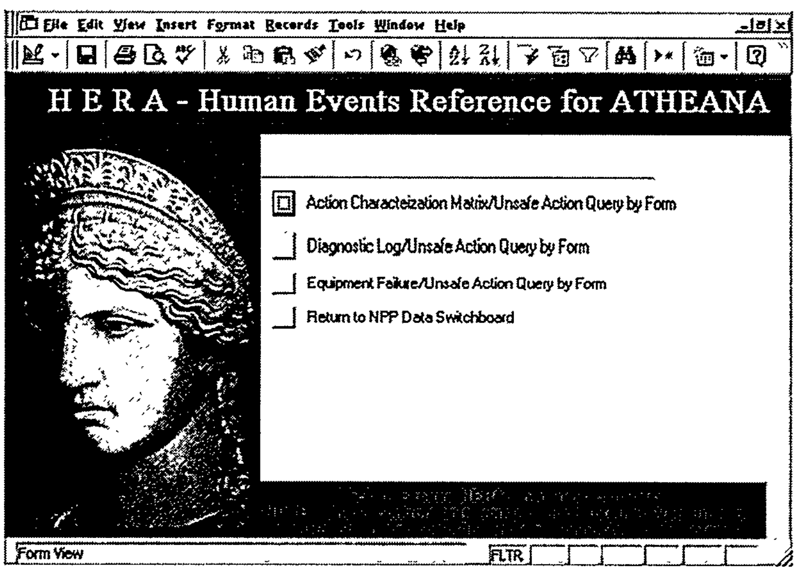

Figure 5.25: Query by Form Switchboard

labeled "**Return to NPP Data Switchboard**" will take you back to the preceding switchboard where you have the options discussed in Section 5.6.2 above.

A second way to initiate the limited queries involves clicking one of the three query control buttons on the "**Event Basic Information**" main form in HERA (discussed in Section 5.6.3 above). As you can see in the following figure, Figure 5.26, these control buttons are located to the right of the "**#2-View Event Data**" controls and are grouped next to the label "**#4-HERA Query by Form**".

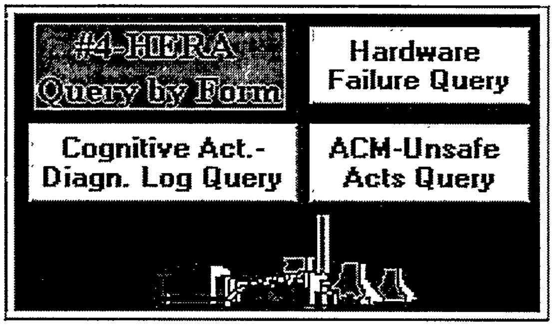

Figure 5.26: Query Controls

Individual query control buttons have bold blue lettering and are labeled "**Hardware Failure Query**", "**Cognitive Act.-Diagn. Log Query**", and "**ACM-Unsafe Acts Query**".

Finally, the third way to initiate HERA's limited querying capabilities is to actuate one of the three query buttons from inside one of the opened "**ATHEANA Analyses**" forms (discussed in Section 5.7 above). An example of the query controls in the "**Cognitive Action**" form is shown in Figure 5.27 below.

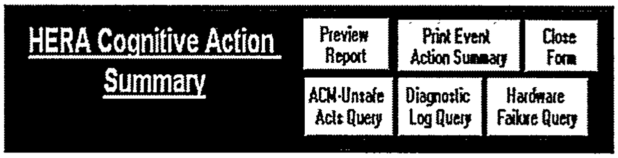

Figure 5.27: Accessing Queries in Other Forms

Individual query control buttons once again, have bold blue lettering and are labeled "**Hardware Failure Query**", "**Cognitive Act.-Diagn. Log Query**", and "**ACM-Unsafe Acts Query**".

5.8.1.1 Using the Hardware Failure Query by Form

Figure 5.28 below shows the form that opens after you click on the "**Hardware Failure Query**" control button. This QBF function was developed to run a query based on hardware/equipment failures, i.e., those failures in the db that have been specifically coded with an "E#" action number within HERA's tables. As you can see, this form is comprised of: 1) a set of instructions at the top (yes, do take the time to read the instructions); 2) five white boxes with drop-down menus; and, 3) a set of darkened gray boxes.

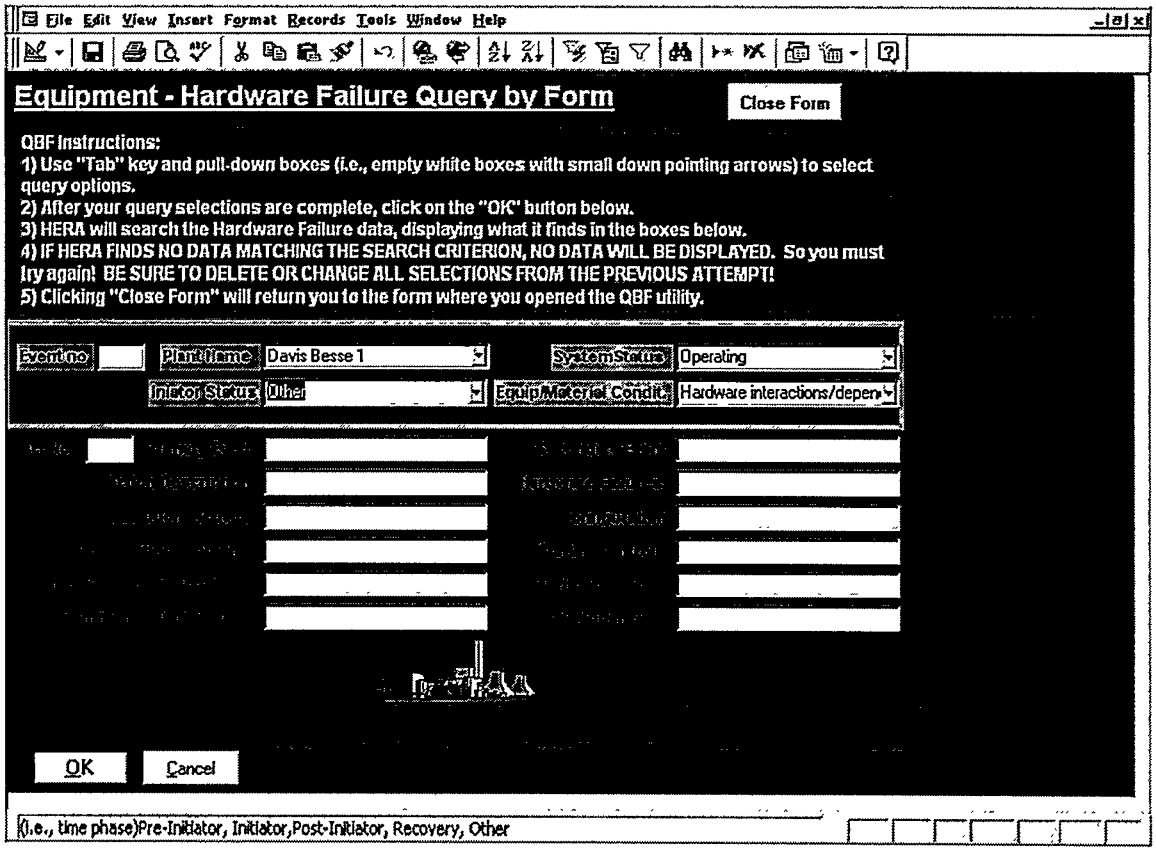

Figure 5.28: Hardware Failure Query by Form

To use this QBF form, either tab into the white spaces, or use the mouse/cursor to click inside one of the five white spaces. Make a selection using the drop down menu. Move to the next white box and make a selection, etc. When you are finished selecting items, click on the "OK" button in the bottom left hand corner. Now, depending on the complexity of your query, the size of the data base, and most importantly your CPU processor speed and type, you will have to wait for a few moments while HERA actually runs the select query[13].

For example, in Figure 5.28 above, the query that is about to run has selected a plant name of Davis Besse 1, a system status of Operating, an initiator status of Other, and an equipment - material condition of hardware interactions - dependencies. When "OK" was clicked, a form resembling Figure 5.29 below is displayed. This form displays the

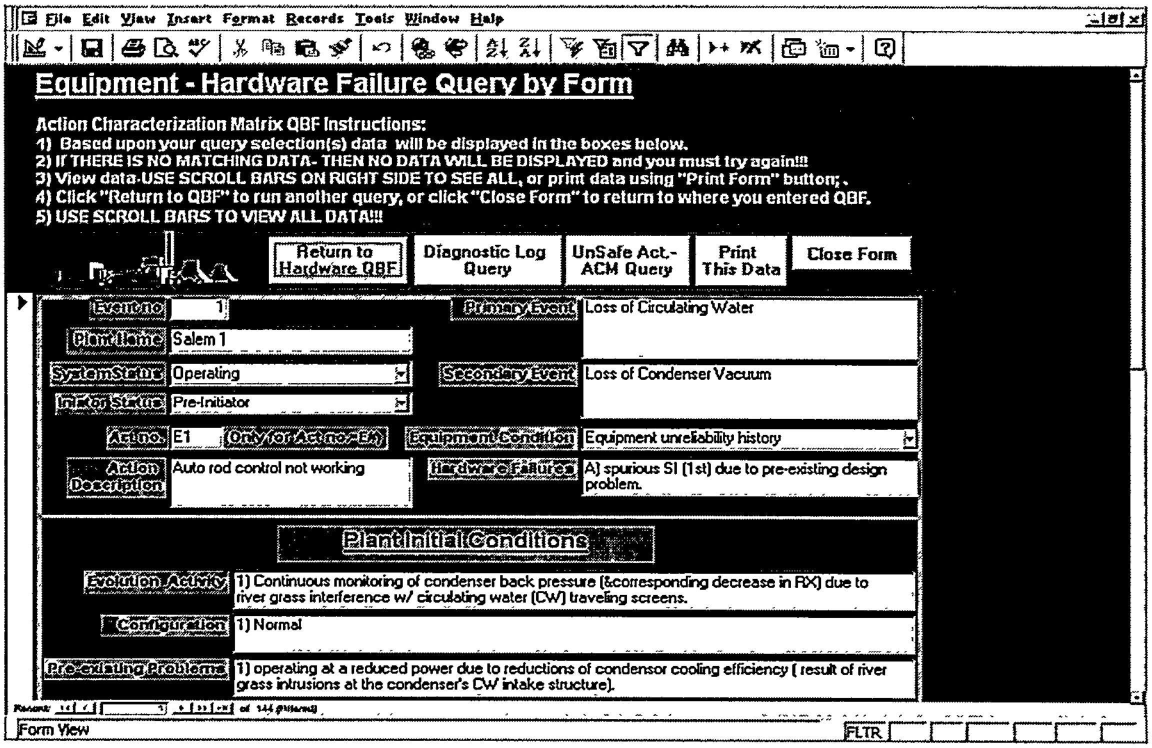

Figure 5.29: Hardware Failure QBF Results

results of this query, specifically showing the data (if any is found) associated with that particular equipment failure. Take a moment to run this QBF query. Results can be printed by clicking the "**Print this Data**" button. Also, from this form, you can either return to the Hardware QBF query form, or can actuate one of the two other pre-defined QBF queries.

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[13]Complex queries or queries with a large amount of output will require MINUTES of processing time on a Pentium CPU. If you are running HERA on a 486 machine, or a laptop that doesn't have a Pentium Processor, it could take MUCH LONGER! Be patient and remember, "If it ain't broke, don't fix it!"

Clicking "**Close Form**" will return you to where you originated this query.

Please note that if HERA runs your pre-defined query and then fails to locate appropriate data, as defined by you in your selections on the QBF form, HERA will display a BLANK SCREEN. Once again, this is normal. HERA is not broken, so do not try to fix it! The blank screen simply means that there is no data matching your selection criteria. Simply return to the Hardware QBF form and try another combination of selections.

5.8.1.2 Using the Cognitive Action-Diagnostic Log Query Form

Clicking on the "**Diagnostic Log Query**" button will display a form resembling Figure 5.30 below. The Diagnostic Log QBF

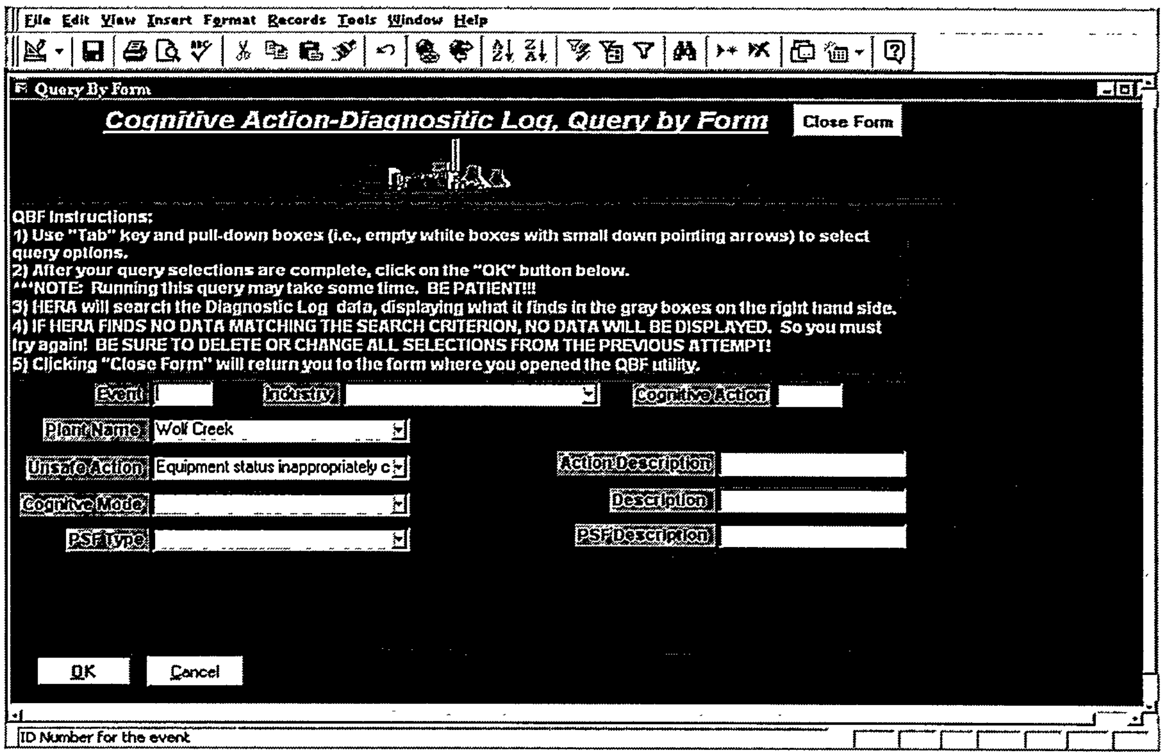

Figure 5.30: Cognitive Action-Diagnostic Log Query by Form

function searches the diagnostic log data for any cognitive action i.e., cognitive actions coded as E#, H#, R#, or U#) that has associated PSFs, unsafe actions, or cognitive mode data. This particular QBF query will allow you to select querying combinations based on the following parameters: 1) Industry; 2) Plant Name; 3) Unsafe Action; 4) Cognitive Mode; or 5) PSF Type.

In Figure 5.30, for example, the QBF query is selecting all unsafe actions = equipment status inappropriately changed for the Wolf Creek event only. Clicking "OK" runs the query

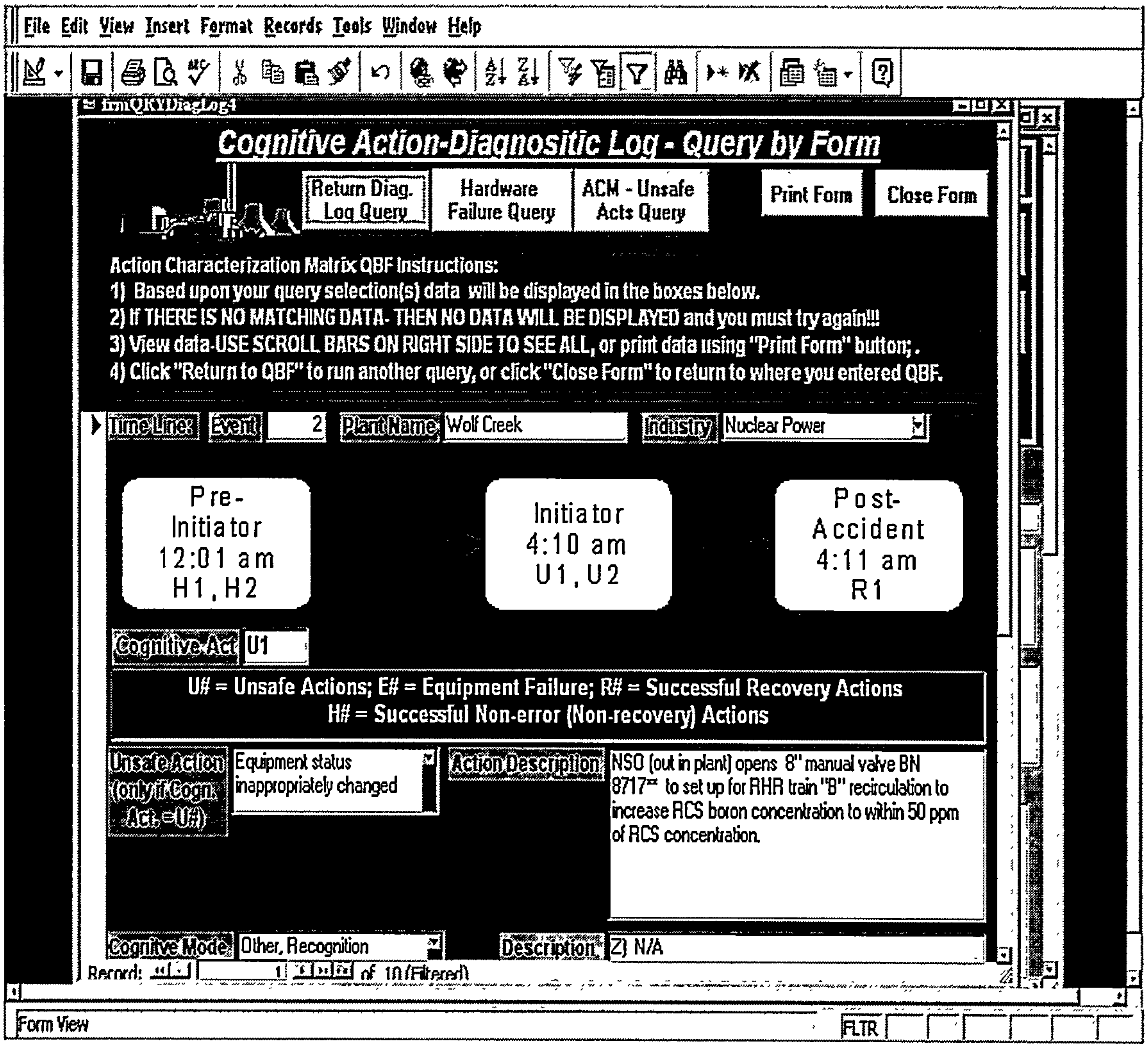

Figure 5.31: Cognitive Action-Diagnostic Log Query by Form Results

and displays a result form resembling Figure 5.31 above. This display will present the event's diagnostic time line and the relevant data selected according to the parameters chosen on the QBF form. Note that the field titled "**Unsafe Action (only if Cogn. Act. = U#)**" will only display data if a particular record in the QBF query's dynaset[14] has been coded as an unsafe act (i.e., a U#).

As in the preceding QBF form, results can be printed by clicking the "**Print this Data**" button. Also, from this form, you can either return to the "**Diagnostic Log Query**" QBF form, or can actuate the two other pre-defined QBF queries. Clicking "**Close Form**" will return you to where you originated this query. Also, note that blank screens after clicking "OK" mean that there is no data matching your selection criteria.

5.8.1.3 Using the Cognitive Action-Unsafe Actions QBF Form

Figure 5.32 below shows the displayed form after clicking on

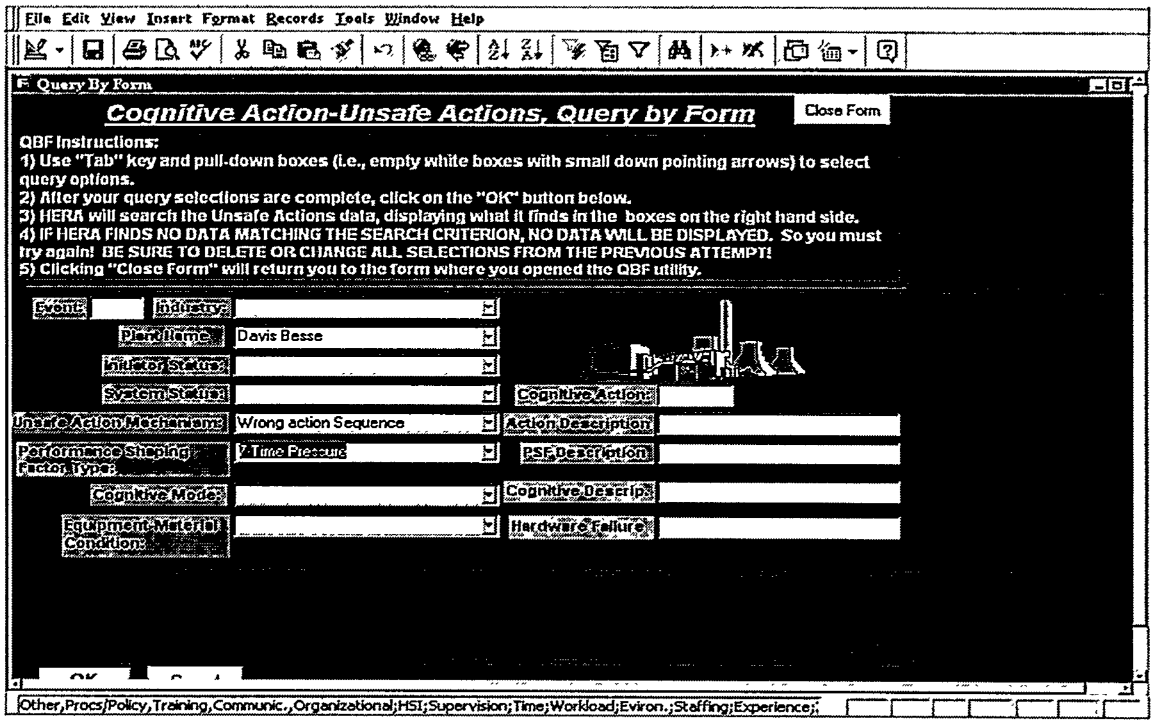

Figure 5.32: Cognitive Action-Unsafe Actions QBF Form

the final pre-defined QB query, labeled "**ACM-Unsafe Acts Query**". This particular QBF query filters the resulting

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[14]A dynaset is simply the collection of rows and columns in a computer's RAM memory. It represents the values in specific tables, a filtered table, or the results of a query.

dynaset on the basis of the "Cognitive Action". Specifically, the query selects records where the cognitive action has been defined as an "Unsafe Action" (i.e., where the cognitive action has been coded as U#). Given this caveat, the **"ACM-Unsafe Acts Query"** permits the selection of querying parameters based on industry, plant name, and the ACM dimensions of initiator status, system status, unsafe action mechanism, performance shaping factor type, cognitive mode, and/or equipment-material condition. User can select one or more of the querying parameters to select and combine data from HERA's related tables. Results of the query will be displayed in a format resembling Figure 5.33 below.

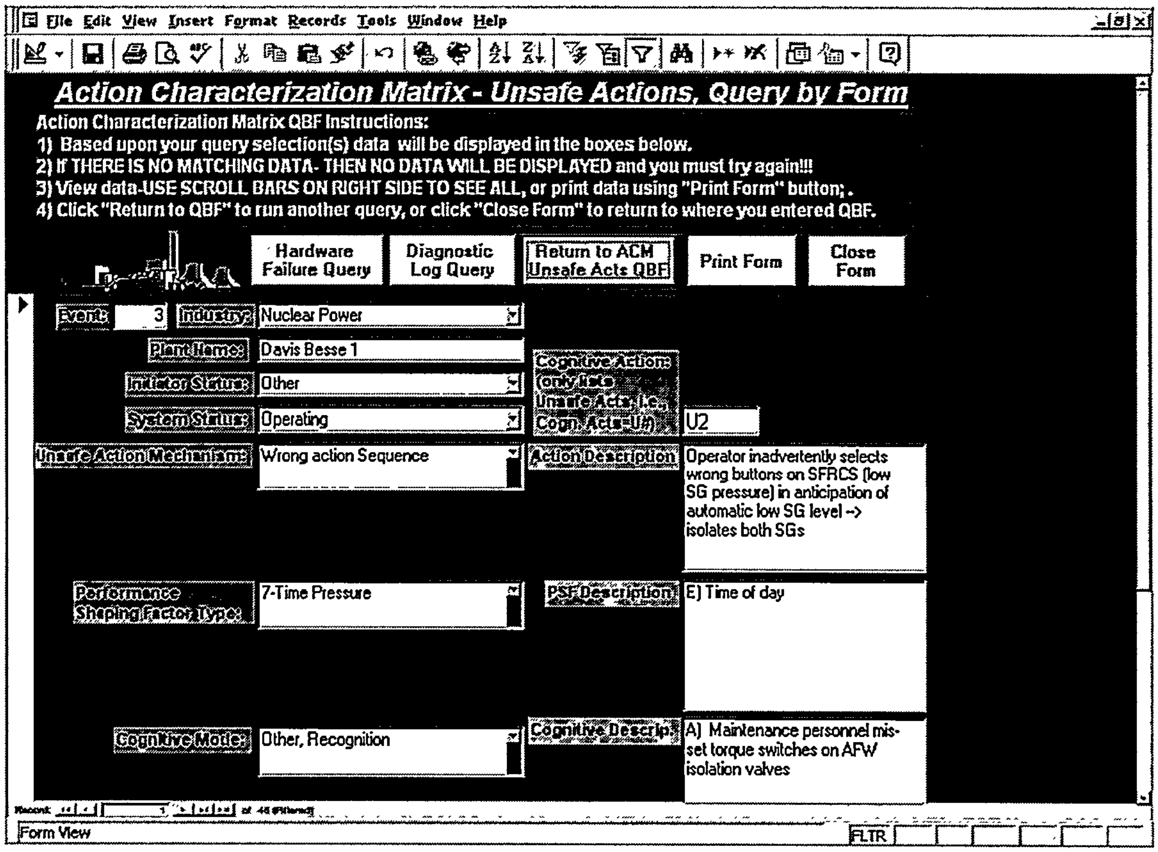


Figure 5.33: ACM-Unsafe Action QBF Results Form

This query will generate ACM data in accordance with the selected parameters for specific unsafe actions (U#) that match the criterion. For example, the query displayed in Figure 5.32, shows selecting parameters for plant name= Davis Besse, unsafe action mechanism= wrong action sequence, and PSF type= 7-time pressure. Clicking "OK" generated the results seen in Figure 5.33 including related data for each of the six ACM dimensions.

As in the preceding QBF form, results can be printed by clicking the "**Print this Data**" button. Also, from this form, you can either return to the "**Diagnostic Log Query**" QBF form, or can actuate the two other pre-defined QBF queries. Clicking "**Close Form**" will return you to where you originated this query. Also, note that blank screens after clicking "OK" mean that there is no data matching your selection criteria.

It should be noted that each of the pre-defined QBF queries are limited and work on the basis of "AND" in a Boolean algebra sense. This means that the query is selecting parameter 1 AND parameter 2 AND... However, the functional equivalent of "OR" queries can be generated by running two sequential "AND" queries while changing one parameter. For example, using the query in Figure 5.32 above, first select parameters for plant name= Davis Besse, unsafe action mechanism= wrong action sequence, and PSF type= 7-time pressure 9(results show 49 records). Run the query and print it out. Now, return to the original query and select parameters for plant name= Davis Besse, unsafe action mechanism= wrong action sequence, but change PSF type to 2-training/knowledge. Rerun the query and print the results. You now have over 70 different records that when compared to the previous results, provide a functional Sequence 1 vs.("OR") Sequence 2. More efficient and complex queries can only be generated through the use of the Access `97 full version. The next segment, Section 5.8.2, presents a basic, simple example of how to use queries with HERA in the Access `97 full version.

Section 5.8.2 Generating Queries - A basic Example

At the outset, to follow the example below, you MUST be using HERA within the FULL Access `97 version. This example will not work with HERA in the limited run-time version. As mentioned earlier Microsoft did not provide querying capability for Access run-time data bases distributed through the use of their Office Development Tools package.

To begin this example, you must be running HERA from within the full Access `97 version. Assuming that this is so, we need to get to the main HERA data base window, as seen in Figure 5.34 below.

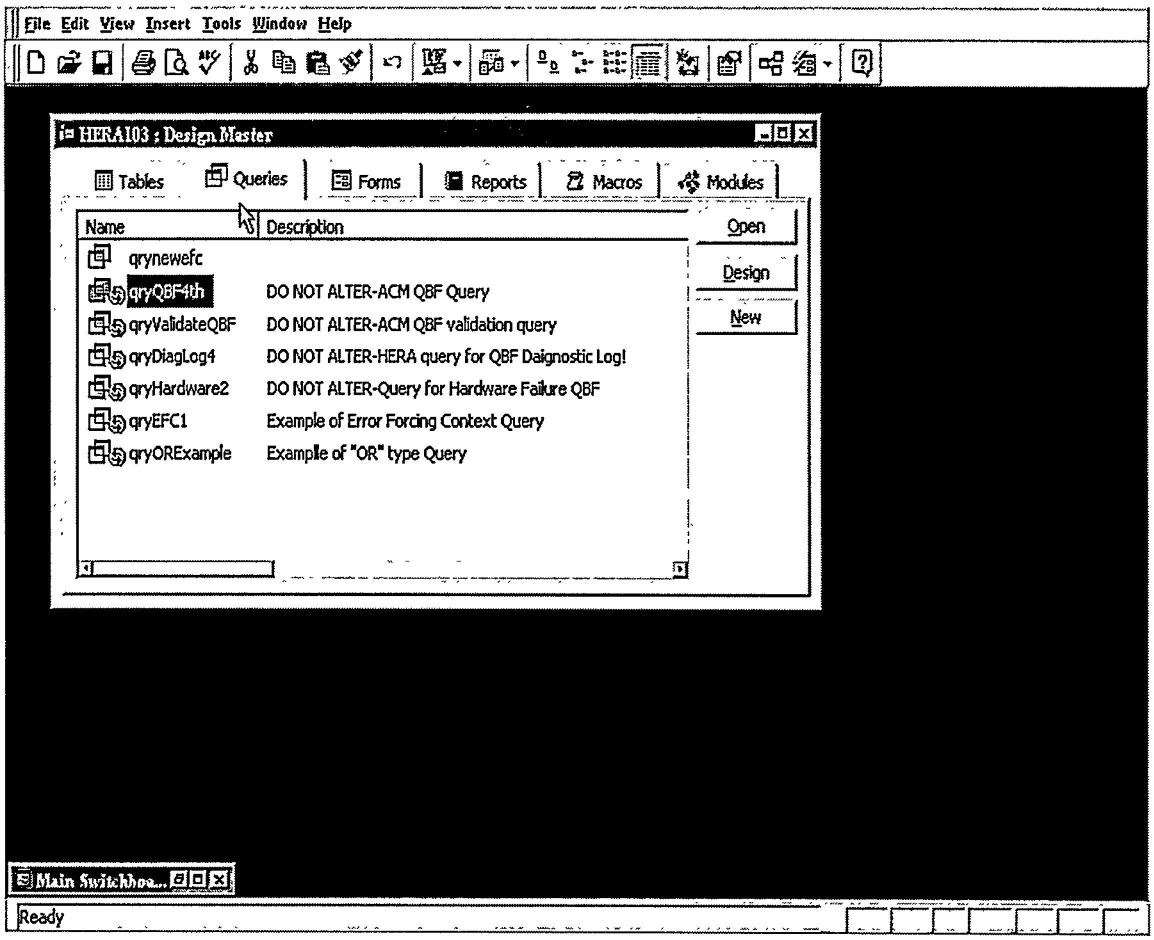


Figure 5.34: Main Database Window

To find the data base window, simply close (or minimize) HERA's initial switchboard and/or any other forms that may be open. Next, move the cursor and click on the "Queries" Tab. Now, move to the right and click on the "New" control button. This will present a semblance of Figure 5.35 below.

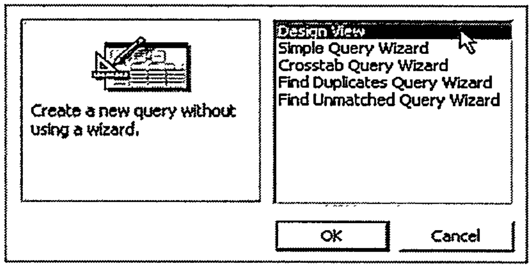


Figure 5.35: Creating a New Query

Move your cursor down and select the "**Simple Query Wizard**". Clicking "OK" then displays Figure 5.36 below. At this

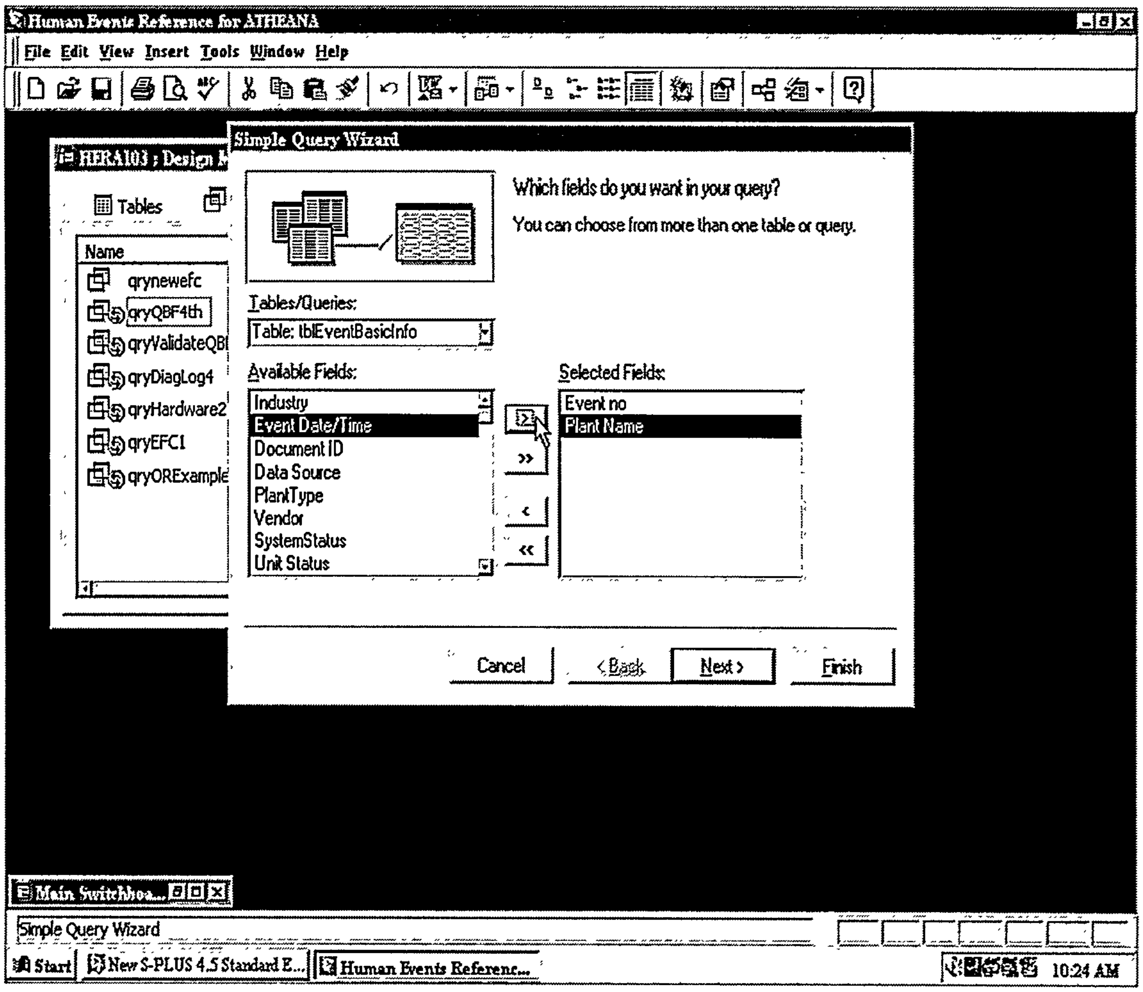


Figure 5.36: Query Wizard-Table and Field Selection

point, move your cursor to the "**Tables/Queries**" drop down menu box and click on the small downward pointing arrow (to display the menu options). Scroll within this menu until you find and select the "**Table: tblEventBasicInfo**". When this is done, the "**Available Fields**" box will be filled with all of the data fields from **tblEventBasicInfo**. Next, move the cursor into the "**Available Fields**" box and select-highlight "**Event no**". We want to move this field into the "Selected Fields" box on the right. We do this by: 1) highlighting the field to be selected and then clicking on the control with the single right pointing arrow; or, 2) highlighting the selection and double clicking on it. At this point your query wizard should look just like Figure 5.36 above.

From here, we want to repeat this process using fields from **tblActionPSFs**. So, click on the "**Tables/Queries**" drop down menu and select "**Table: tblActionPSFs**" as seen in the following figure, Figure 5.37. Now, move the "**Event no**",

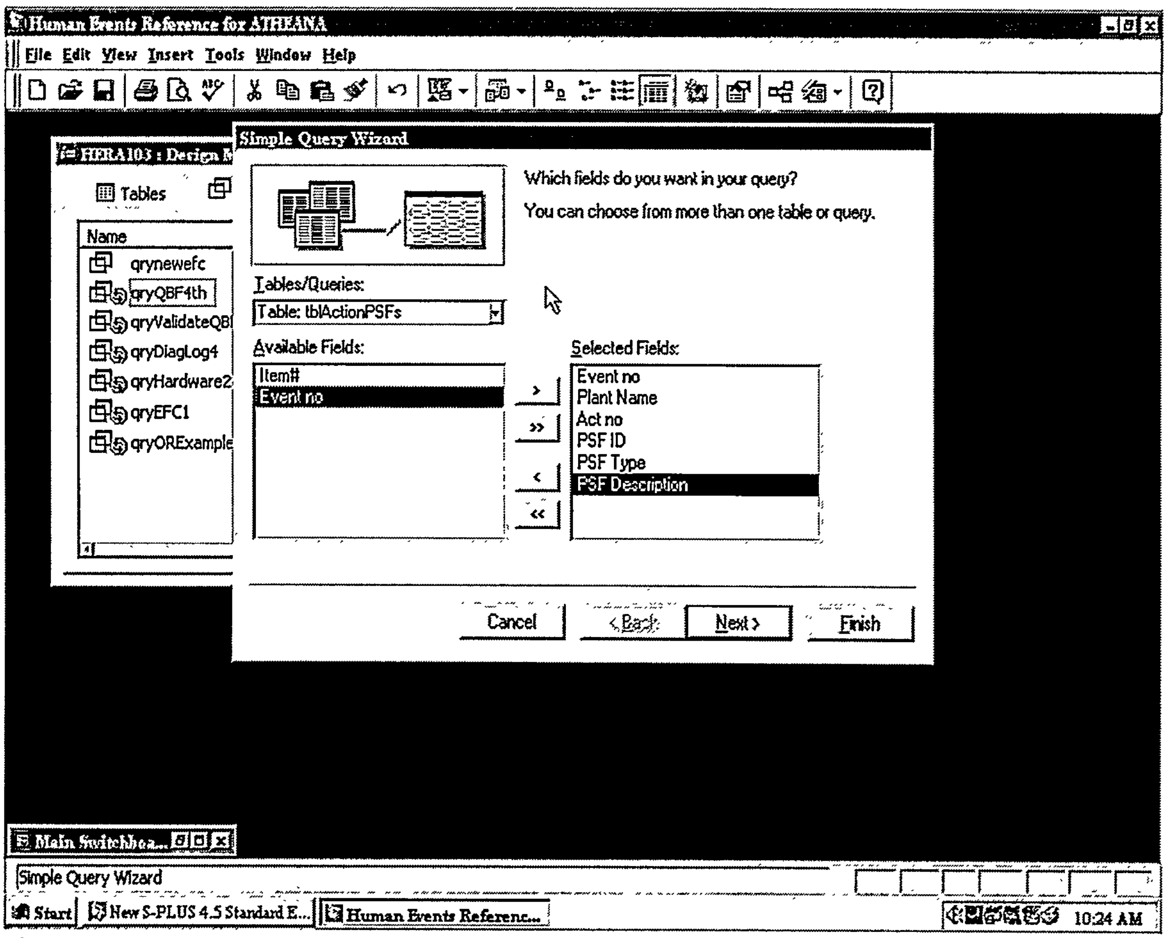


Figure 5.37: Adding Fields from a Second Table

"**Plant Name**", "**Act no**", "**PSF ID**"; "**PSF Type**", and "**PSF Description**" fields from the available box to the selected box. Your screen should look just like the preceding figure. If it does, click the "**Next**" control button on the bottom of this display. (If it does not resemble Figure 5.37 above, just click "**Cancel**" and start over). Clicking "**Next**" will take you to Figure 5.38 below.

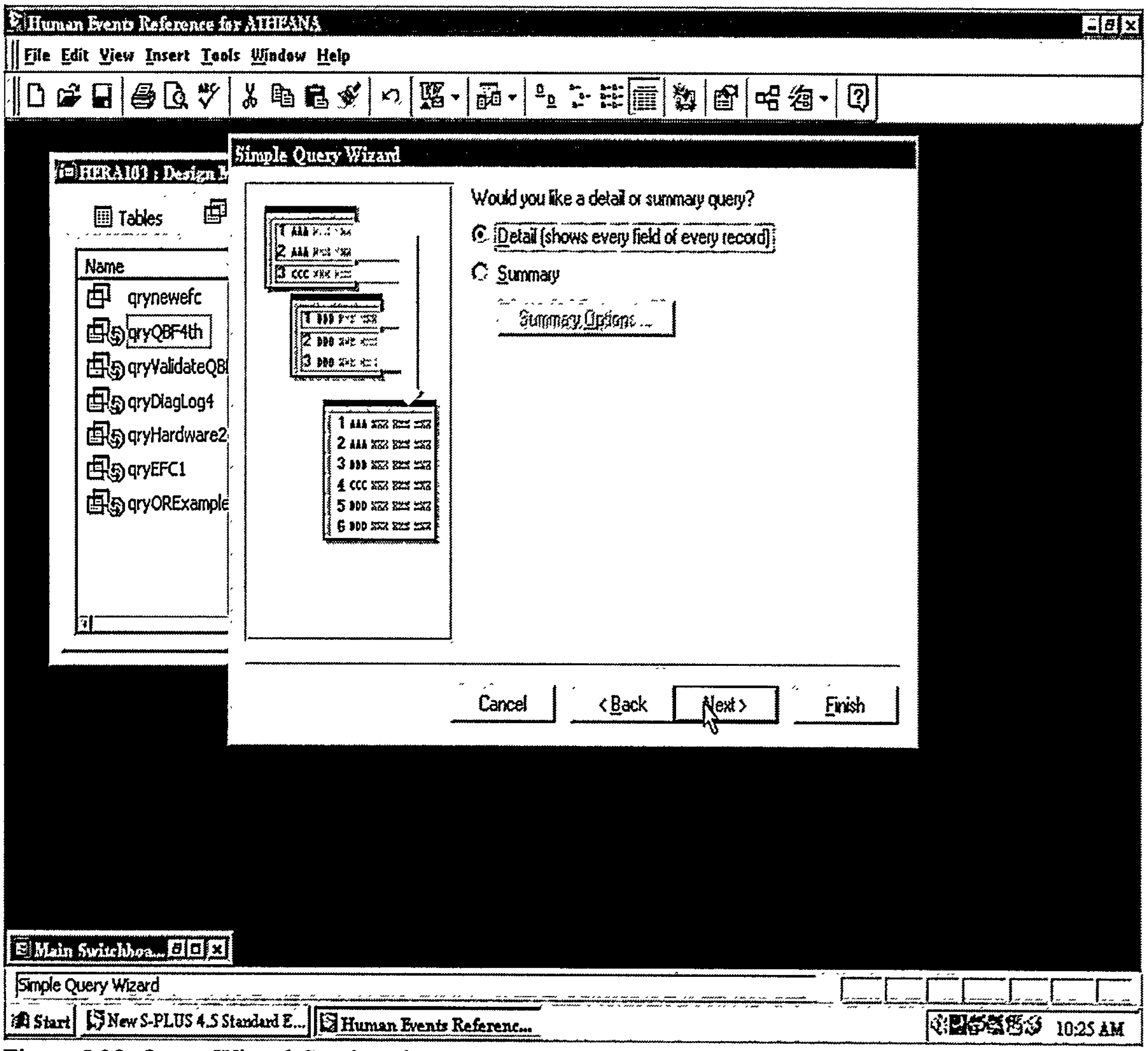


Figure 5.38: Query Wizard Continued

We want a "Detail Query". So do not change anything on this form within the query wizard.

Accept the default as shown in the preceding figure and click "Next". The Access query wizard will then present a form where you have three options: 1) change the suggested name; 2) "Open the query to view information"; or "Modify the query design. This form is shown in Figure 5.39.

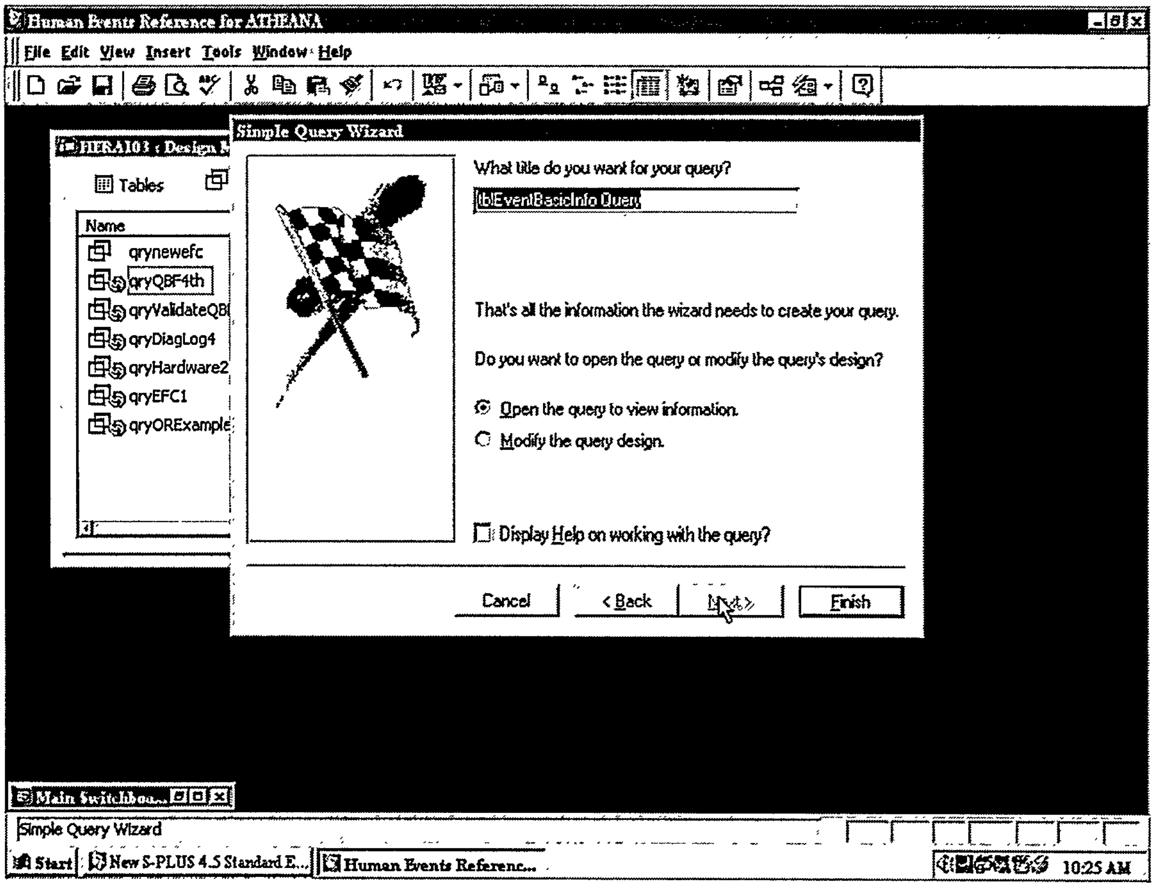
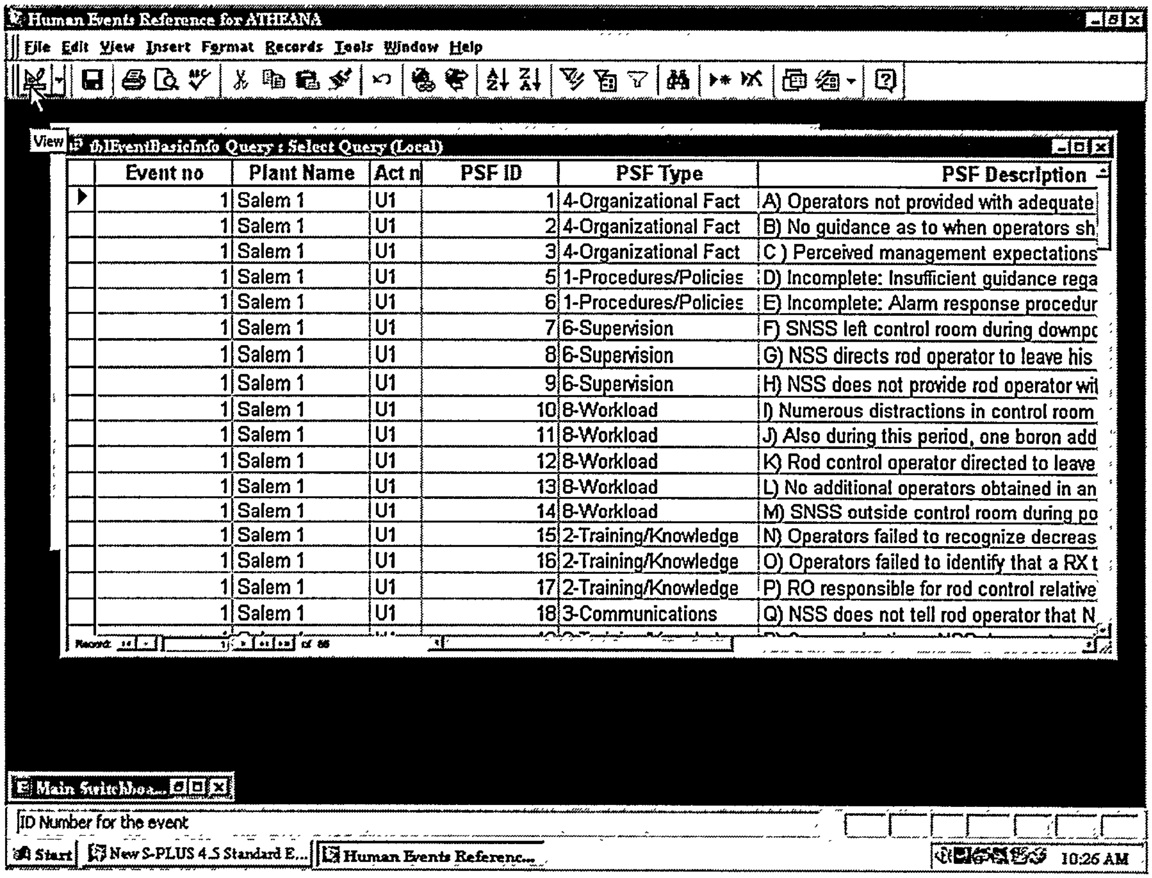


Figure 5.39: Query Options

As before, we want to use the wizard's default here, so do not change anything. Click "**Finish**" to see the results of your simple query. NOTE the very bottom of this form where there is an option to check "**Display Help on working with this query?**" If you are curious or you want help, check this option and click "**Finish**".

Even though you cannot see what is happening at this point, the Access query wizard is using your specified parameters to generate a real query using SQL, i.e. sequential query language. The wizard then runs your query and displays the results in a dynaset, or data sheet view. This displayed dynaset only temporarily exists in RAM (random access memory). So, when running queries, you will have to save them, print them, or make a db table out of the resulting dynaset. If you close the dynaset without at least saving the query (as you did by giving it a name in the query wizard), the query and its results will be lost. Figure

5.40 below depicts the results after running our simple query. Here you can see the fields (displayed horizontally across the top) and resulting records that have been created from your query. Use the scroll bars to view all the data. Note that the fields are generated in the same order that you specified them within the initial forms of the query wizard.



Event no	Plant Name	Act n	PSF ID	PSF Type	PSF Description
1	Salem 1	U1	1	4-Organizational Fact	A) Operators not provided with adequate
1	Salem 1	U1	2	4-Organizational Fact	B) No guidance as to when operators sh
1	Salem 1	U1	3	4-Organizational Fact	C) Perceived management expectations
1	Salem 1	U1	5	1-Procedures/Policies	D) Incomplete: Insufficient guidance rega
1	Salem 1	U1	6	1-Procedures/Policies	E) Incomplete: Alarm response procedur
1	Salem 1	U1	7	6-Supervision	F) SNSS left control room during downpc
1	Salem 1	U1	8	6-Supervision	G) NSS directs rod operator to leave his
1	Salem 1	U1	9	6-Supervision	H) NSS does not provide rod operator wi
1	Salem 1	U1	10	8-Workload	I) Numerous distractions in control room
1	Salem 1	U1	11	8-Workload	J) Also during this period, one boron add
1	Salem 1	U1	12	8-Workload	K) Rod control operator directed to leave
1	Salem 1	U1	13	8-Workload	L) No additional operators obtained in an
1	Salem 1	U1	14	8-Workload	M) SNSS outside control room during po
1	Salem 1	U1	15	2-Training/Knowledge	N) Operators failed to recognize decreas
1	Salem 1	U1	16	2-Training/Knowledge	O) Operators failed to identify that a RX t
1	Salem 1	U1	17	2-Training/Knowledge	P) RO responsible for rod control relative
1	Salem 1	U1	18	3-Communications	Q) NSS does not tell rod operator that N

Figure 5.40: Query's Dynaset

Now let us suppose that this query was not exactly what we had in mind, i.e., we actually want to include some information on PSFs. To do this we have to use Access's Query by Example functions. Move your cursor to the top left part of the dynaset where you can see a small icon which looks like a ruler, triangle, and pencil. This control actually allows users to toggle between the design view and the resulting dynaset after running the revised query.

Click on this icon to enter "Design View". You should see something like Figure 5.41 below.

Figure 5.41 is actually showing you what your query looks like if you would have used the design view option instead

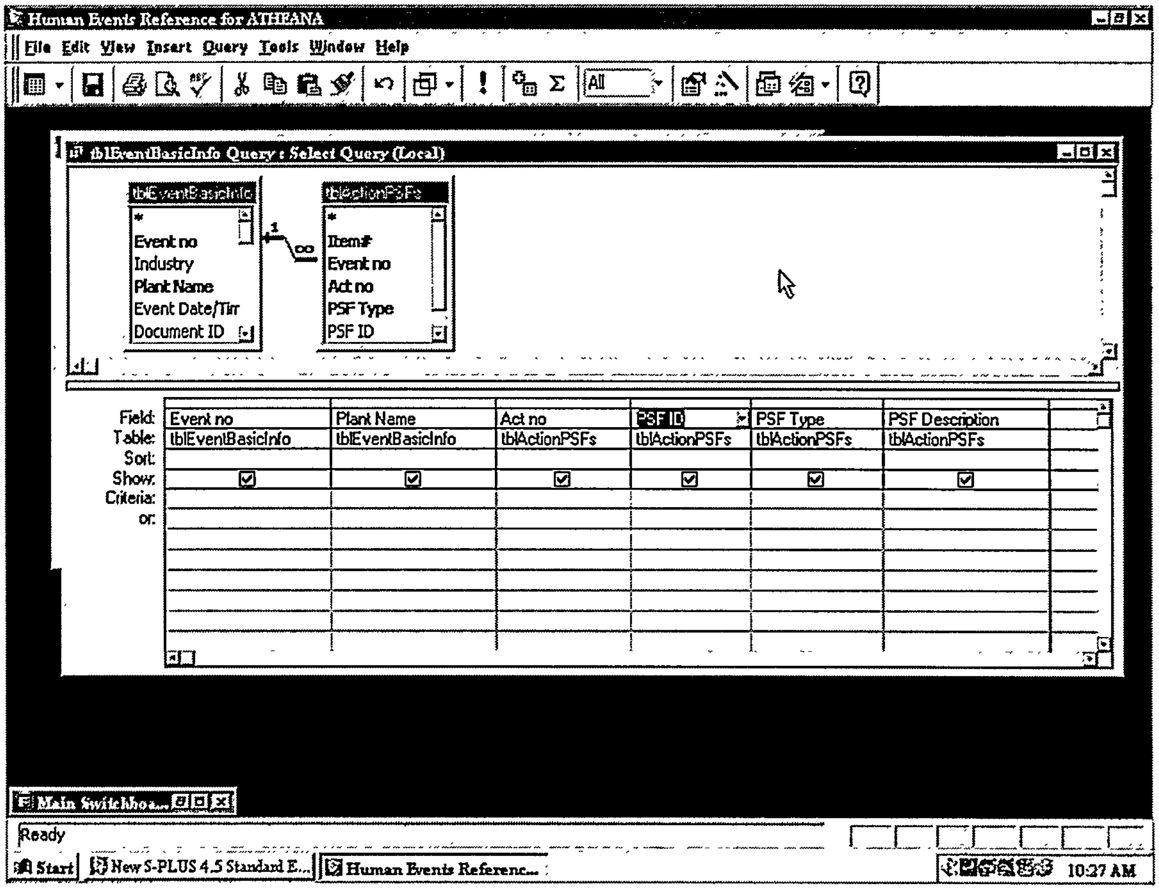


Figure 5.41: Query by Example Design Grid

of the simple query wizard. This form has two main parts, the top portion where you see to tables and the bottom, grid-like portion that contains the fields we selected using the query wizard. Notice that the two tables in the top portion are expandable (click on an edge and drag) so that you can see all of the individual fields listed for that table. Also notice a dark line with an infinity symbol on the right and an arrow and "!" on the left. This is showing you that tblActionPSFs is linked by the "Event no" field, in a many to one relationship with tblEventBasicInfo. Recall that tblEventBasicInfo is HERA's main data table (see section 4. Above) and that all other tables are linked to the event number. This form says that for every unique event number in tblEventBasicInfo, there are many corresponding entries (based on event number) in tblActionPSFs. (Press F1 to start Help for more detailed information on joins).

Next we want to add several data fields from tblAccdntCondits. Move your cursor to the top of the form where you will see another small icon with a yellow "+" and small data sheet (just to the right of the bang "!" icon). Click the "+, data sheet" icon (named the "Show Table" icon and you should see Figure 5.42 below.

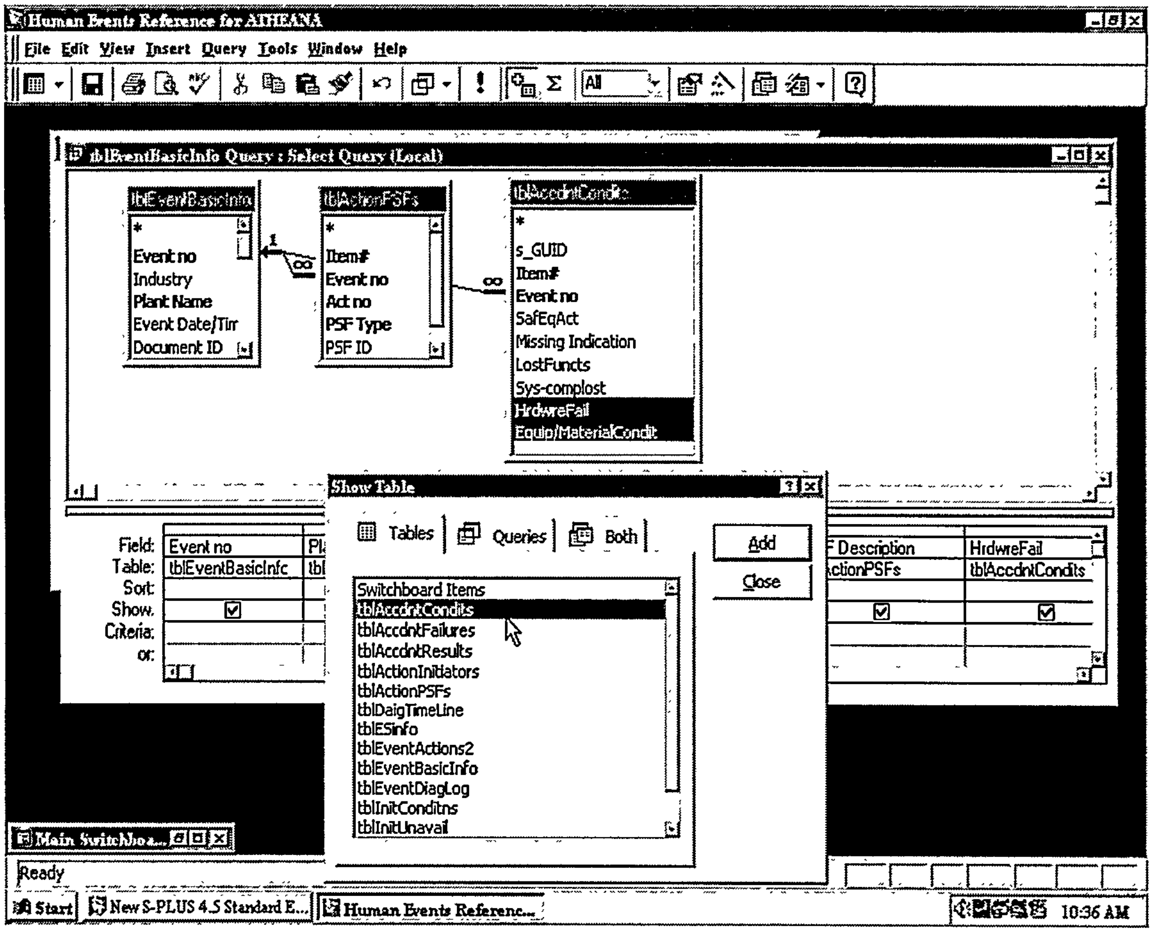


Figure 5.42: Show Table Form - Adding Another Table to the Query

You now see that Access has provided the "**Show Table**" sub-form where we can select additional tables and/or queries to add to our example. Click on the "**Tables**" tab. Click on **tblAccdntCondits** to select it, and then click on "**Add**". You can also just double click on tblAccdntCondits to add this table to the top portion of our QBE form.

At this point, if successful, you will see an addition to your QBE example, shown in Figure 5.43 below.

As you can see "**tblAccdntCondits**" has been added to the top

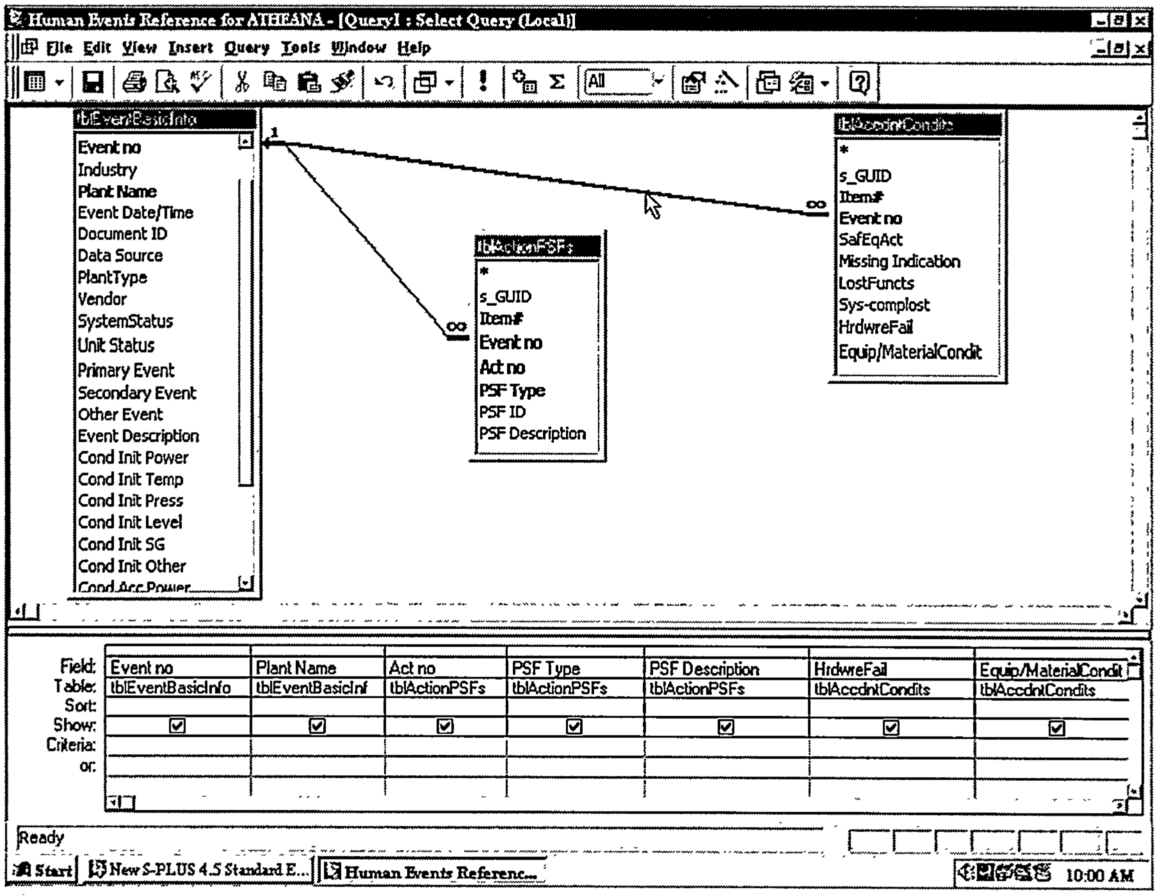


Figure 5.43: Adding a New Table

portion of the QBE form. It also has a many to one relationship, by default, with "**tblEventBasicInfo**". However, we now must change this relationship because if we run the query like this, it will not work. (Go ahead and try to run the query - Click on the icon with the "!" bang symbol. You will get a cryptic error message that can be deciphered using Help-F1). Move your cursor so that it is touching the line showing the join between tblAccdntCondits and tblEventBasicInfo. Click on the line once. It should become a little thicker and darker when you select it (i.e., when it receives the focus). No delete the line by pushing the delete key ("Del" or "Delete")on your keyboard.

Next, we must redefine the relationships so this query will work. Move your cursor to the "**tblActionPSFs**" form and click/select "**Event no**". While keeping your mouse button depressed, carefully drag "Event no" to the right until it is sitting over "**Event no**" within the "**tblAccdntCondits**" table; release the mouse key. You should see that Access has now added a new join line between the "Event no" fields on both tables (See Figure 5.44 below). For more information, you can move the cursor and double click on the new line, then press F1 for more detailed help.

To complete the revised query, we now must add to new fields

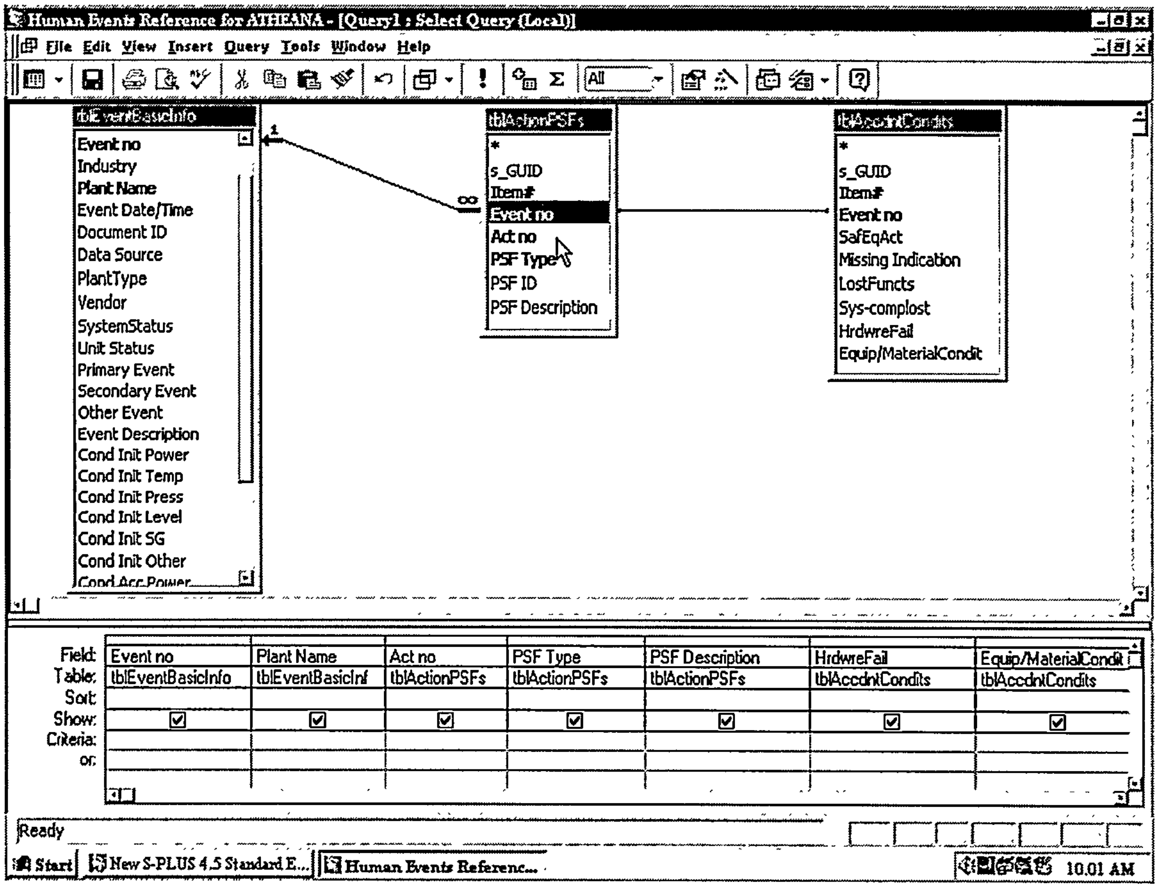
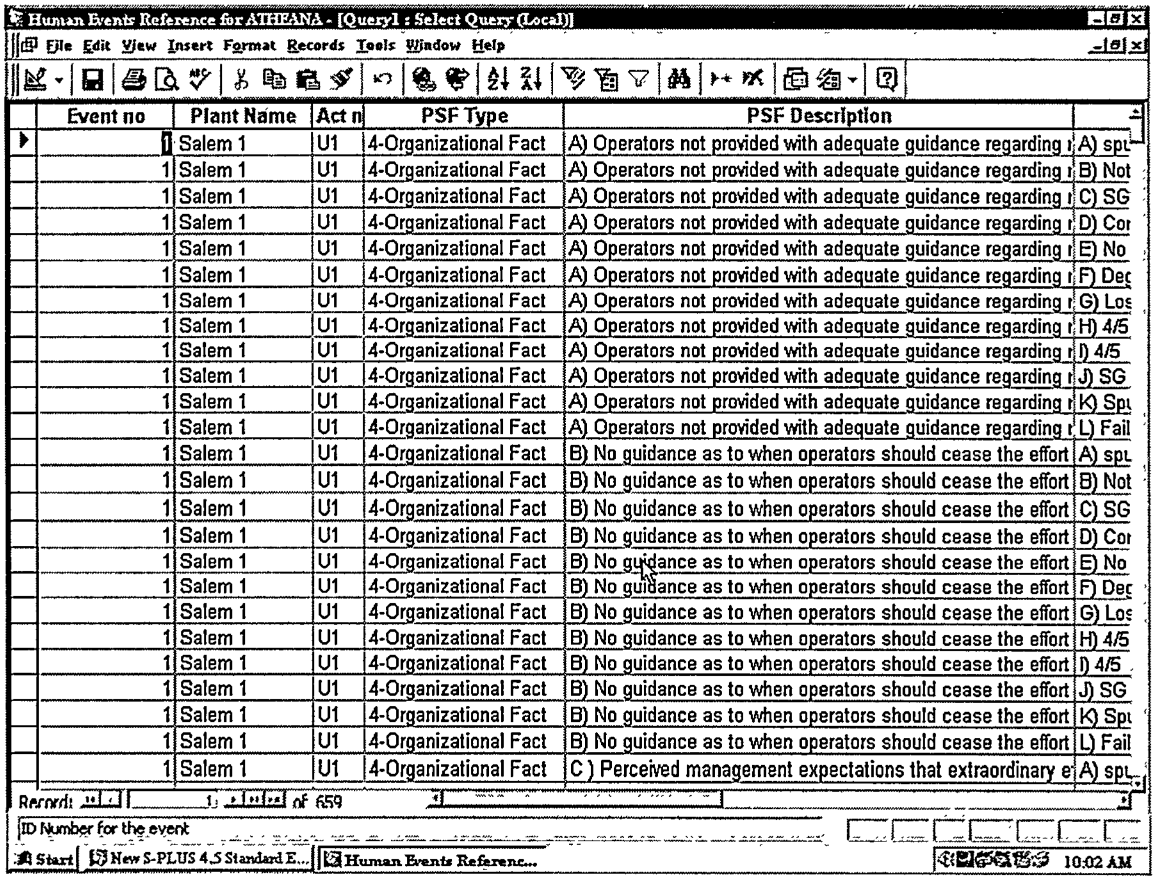


Figure 5.44: Creating a New Join Line

to the QBE grid at the bottom of this form. Move your cursor to "**tblAccdntCondits**" and select the "**HrdwreFail**" field (click on it). Now, keep you mouse key depressed and drag this field onto the empty grid, just to the right of where you see the "**PSF Description**" field in the QBE grid. Release the mouse key and the "**HrdwreFail**" field will be added to the grid. You can also double click on the "**HrdwreFail**" field and it will automatically be added to the first blank column in the QBE grid. Finally, use the same procedure to add the "Equip/MaterialCondit" field from "tblAccdntCondits". When complete, your revised query should look exactly like Figure 5.44 above.

Click on the "!" bang icon at the top of this form to run the query. After some time, Access will display a new dynaset (see Figure 5.45 below), based on your query, with 659 records. As you scroll through the dynaset, you will see how Access combined your parameters of interest to create this new dynaset. If you examine all of the records, you should also see that the "Act no" field contains unsafe acts (U#) as well as other entries like equipment failures (E#).
However, we just realized that we really did not want to



Event no	Plant Name	Act n	PSF Type	PSF Description	
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	A) spu
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	B) Not
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	C) SG
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	D) Cor
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	E) No
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	F) Deg
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	G) Los
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	H) 4/5
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	I) 4/5
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	J) SG
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	K) Spu
1	Salem 1	U1	4-Organizational Fact	A) Operators not provided with adequate guidance regarding r	L) Fail
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	A) spu
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	B) Not
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	C) SG
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	D) Cor
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	E) No
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	F) Deg
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	G) Los
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	H) 4/5
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	I) 4/5
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	J) SG
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	K) Spu
1	Salem 1	U1	4-Organizational Fact	B) No guidance as to when operators should cease the effort	L) Fail
1	Salem 1	U1	4-Organizational Fact	C) Perceived management expectations that extraordinary e	A) spu

Figure 5.45: New Dynaset

have any data on equipment failures. We are only interested how PSFs are related to the noted equipment failures within HERA. Now, save this query (i.e., File, Save, or click on the save icon) and then click the "Design View" icon in the upper left corner (i.e., the ruler, square, and pencil) to return to the QBE form. We need to now do several things to modify our query. Use the following figure, Figure 5.46 as an example with the next modification steps.

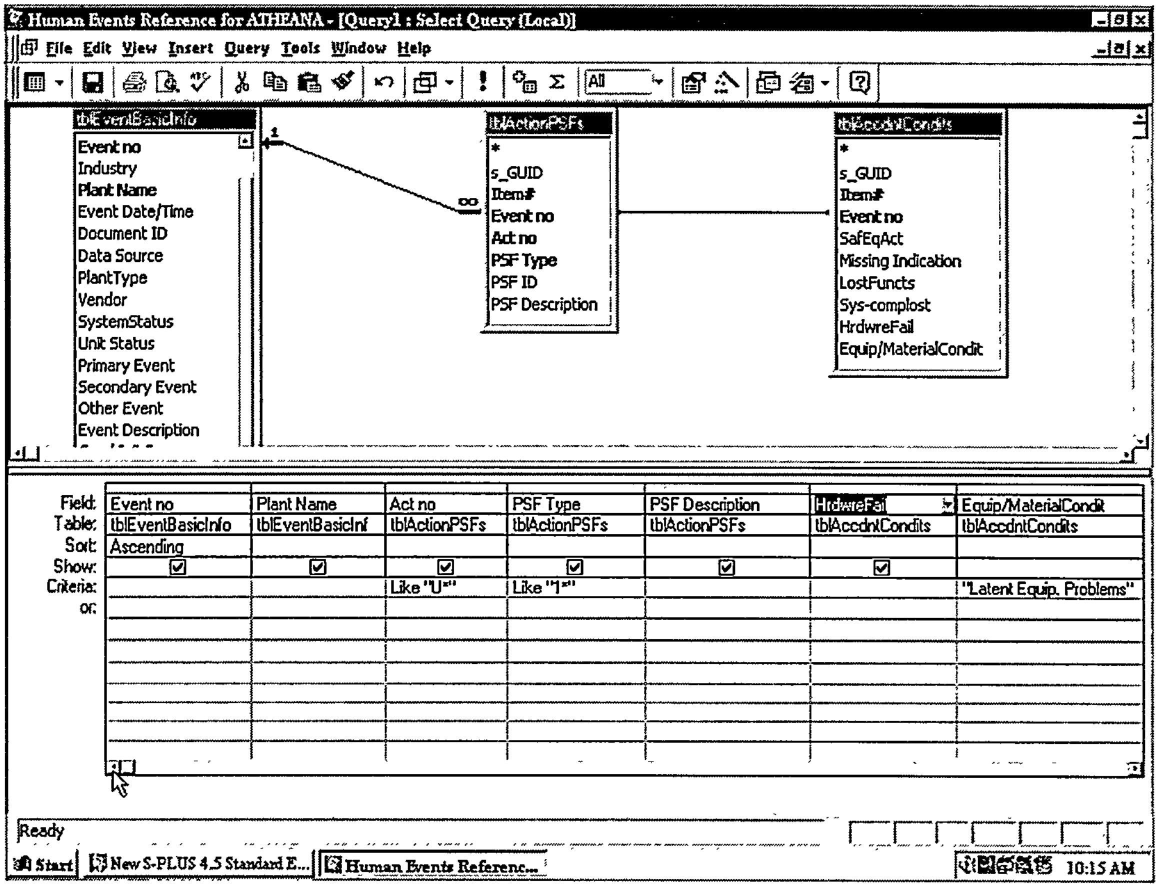


Figure 5.46: Configuring QBE Selection Criteria

First, find the "Event no" column on the far left of the QBE grid. You should see **Field: Event no, Table: tblEventBasicInfo, Sort: (blank), Show: box with check mark, Criteria: (blank)**, and **or: (blank)**. Move your cursor into the blank "Sort" box and click, selecting "Ascending". As you can guess, this is setting up a default to do an ascending sort on "Event no", i.e., 1,2,3, etc. (Run the query to see for yourself).

Next, because we are only interested in unsafe actions, i.e., those actions coded as a U#, we need to make another addition. Find the "**Criteria**" row and move your cursor into the "**Criteria**" box in the third, i.e., the **Act no** column. Click in this blank box and then type Like"U*". This is telling Access to run the query while only selecting those records from tblActionPSFs that are equivalent to a "U" (i.e., any unsafe act) followed by whatever other text or numbers after the "U". Now use your "Tab" key and tab once to the right, moving the cursor into the blank "Criteria" field in the "PSF Type" column. This time just type 1* and tab to the right one more time. Access will smartly and automatically change your typing to the correct SQL format. So you should now see Like"1*" in that field (see Figure 5.46 above). We have just now modified our query so that we are asking for all unsafe action data (Like"U*) AND all PSF Type data that is equivalent to 1-Procedures/Policies from tblActionPSFs. In this example we used the first character for the first PSF type, followed by the universal text "*"; i.e., "1*". Note that you can and probably should type in the whole phrase, exactly as it is found in tblActionPSFs (i.e., in this case it would be Like "1-Procedures/Policies", the first PSF type in that table).

Third, move your cursor into the "**Criteria**" field under the last column, "**Equip/MaterialCondit**". Type: "Latent Equip. Problems" and tab out of this box. Access will provide the correct SQL formatting for your criteria where we have now said that we only want to find an equipment/material condition that is equivalent to "Latent Equip. Problems". Our query now states the following: find those records from the database where there is an event number (sort it ascending) **AND** plant name **AND** action number (like U*-unsafe actions) **AND** PSF type (Like 1-Procedures/policies) **AND** PSF description for that action **AND** associated hardware failure, **AND** the equipment/material condition (Like Latent equip. Problems). "**AND**" is being used in a true Boolean Algebra sense, within the unseen SQL language generated by Access. You can see the SQL equivalent of this graphical QBE, simply by clicking on **View, SQL View**, in the menu at the top of this form. If you do this, be sure to click **View, Design View** to return you to this version.

At this point we need to make one final change to the QBE defaults for our specific query. We must tell Access to generate a dynaset based on our query, that only has unique values. Without doing this, Access runs queries based on the SQL and Boolean parameters. As a result, it can and will generate a dynaset that has some amount of redundant data in the records. In some cases this may be permissible. However, in our example we only want unique values for the records that our query finds.

So, move your cursor into the gray area at the top of the form and double click on any blank area. (You can also select **View, Properties** from the menu at the top of this form). You should see Figure 5.47 below, displayed on your monitor.

Every data base object within Access, whether it is a table, form, control, or query, etc., has a listing of default

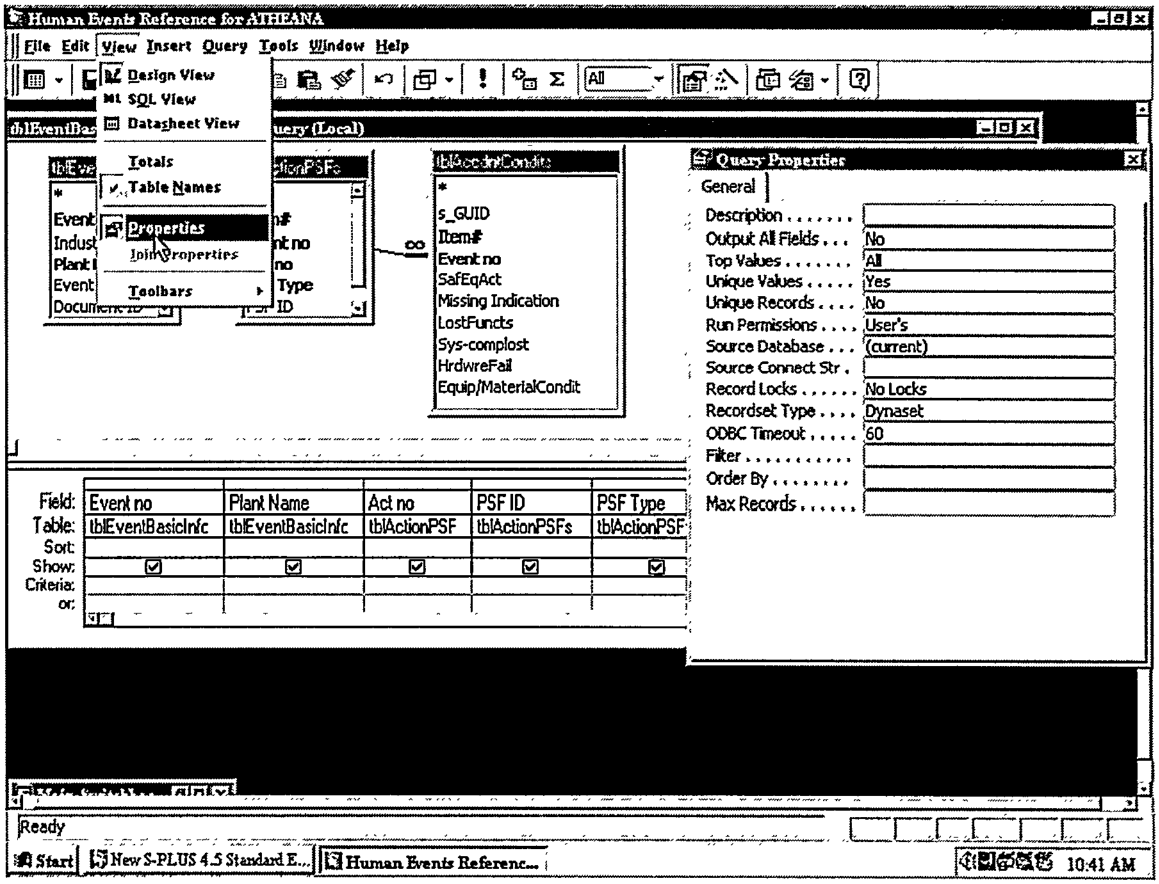
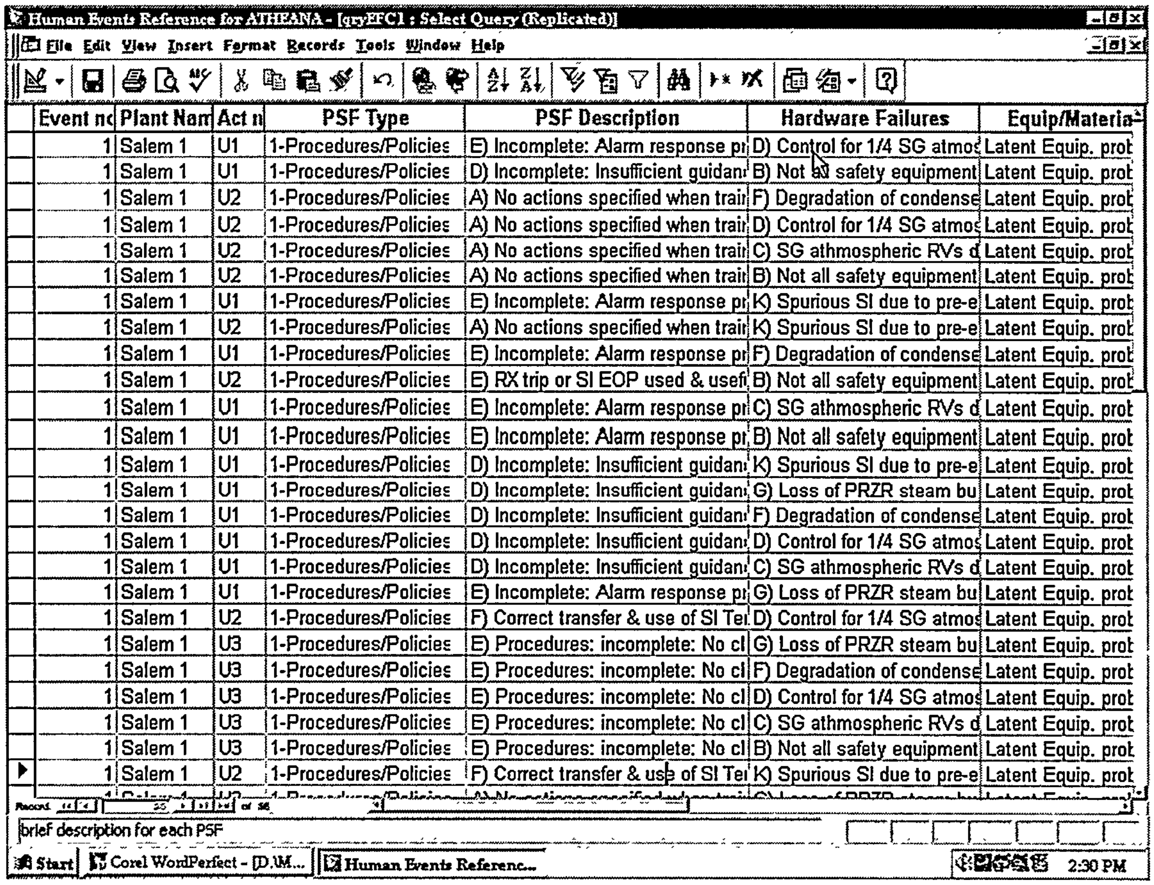


Figure 5.47: Query Properties

properties that can be modified to change how that object functions. Figure 5.47 is showing you the general "Query Properties" sub-form. We want unique values for our records, so click on the "Unique Values" box and change the default (i.e., "No") to "Yes". If you need help, click on the "Unique Values" box and then press F1. Access will display context specific help for you. Do not change anything else, just close this form by clicking the little boxed X in the upper right hand corner. This will take you back to our QBE form where you can now run the query - click on the red "!".

Access will run the query and display the dynaset shown in Figure 5.48 below. You should quickly see that this dynaset now has only 36 records compared to almost 700 before.

Use your scroll bars to examine the data. Note how the query is sorted (ascending) in the "Event no" column. Also note that this dynaset only contains records that are unsafe



Event nc	Plant Nam	Act n	PSF Type	PSF Description	Hardware Failures	Equip/Materia
1	Salem 1	U1	1-Procedures/Policies	E) Incomplete: Alarm response pr	D) Control for 1/4 SG atmos	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	D) Incomplete: Insufficient guidan	B) Not all safety equipment	Latent Equip. prob
1	Salem 1	U2	1-Procedures/Policies	A) No actions specified when trai	F) Degradation of condense	Latent Equip. prob
1	Salem 1	U2	1-Procedures/Policies	A) No actions specified when trai	D) Control for 1/4 SG atmos	Latent Equip. prob
1	Salem 1	U2	1-Procedures/Policies	A) No actions specified when trai	C) SG athmospheric RVs d	Latent Equip. prob
1	Salem 1	U2	1-Procedures/Policies	A) No actions specified when trai	B) Not all safety equipment	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	E) Incomplete: Alarm response pr	K) Spurious SI due to pre-e	Latent Equip. prob
1	Salem 1	U2	1-Procedures/Policies	A) No actions specified when trai	K) Spurious SI due to pre-e	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	E) Incomplete: Alarm response pr	F) Degradation of condense	Latent Equip. prob
1	Salem 1	U2	1-Procedures/Policies	E) RX trip or SI EOP used & usef	B) Not all safety equipment	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	E) Incomplete: Alarm response pr	C) SG athmospheric RVs d	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	E) Incomplete: Alarm response pr	B) Not all safety equipment	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	D) Incomplete: Insufficient guidan	K) Spurious SI due to pre-e	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	D) Incomplete: Insufficient guidan	G) Loss of PRZR steam bu	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	D) Incomplete: Insufficient guidan	F) Degradation of condense	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	D) Incomplete: Insufficient guidan	D) Control for 1/4 SG atmos	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	D) Incomplete: Insufficient guidan	C) SG athmospheric RVs d	Latent Equip. prob
1	Salem 1	U1	1-Procedures/Policies	E) Incomplete: Alarm response pr	G) Loss of PRZR steam bu	Latent Equip. prob
1	Salem 1	U2	1-Procedures/Policies	F) Correct transfer & use of SI Te	D) Control for 1/4 SG atmos	Latent Equip. prob
1	Salem 1	U3	1-Procedures/Policies	E) Procedures: incomplete: No cl	G) Loss of PRZR steam bu	Latent Equip. prob
1	Salem 1	U3	1-Procedures/Policies	E) Procedures: incomplete: No cl	F) Degradation of condense	Latent Equip. prob
1	Salem 1	U3	1-Procedures/Policies	E) Procedures: incomplete: No cl	D) Control for 1/4 SG atmos	Latent Equip. prob
1	Salem 1	U3	1-Procedures/Policies	E) Procedures: incomplete: No cl	C) SG athmospheric RVs d	Latent Equip. prob
1	Salem 1	U3	1-Procedures/Policies	E) Procedures: incomplete: No cl	B) Not all safety equipment	Latent Equip. prob
1	Salem 1	U2	1-Procedures/Policies	F) Correct transfer & use of SI Te	K) Spurious SI due to pre-e	Latent Equip. prob

Figure 5.48: Revised Dynaset

actions (U#) **AND** are "1-Procedure/Policy" PSF Type **AND** are an equipment/material condition type of "Latent Equip. Problems". You have now just created and run a rather sophisticated Access query. If you do not believe this, return to the QBE Design View and take another look at the SQL version. You created this using the easy to use graphical user interface while Access automatically translated your input into SQL. You could have also learned SQL and created the same query using SQL[15].

As a final part of this example, suppose you want to modify this query so that we want the following: [action numbers like U# (unsafe acts) OR like R# (recovery actions)] AND [cognitive mode like 1* OR 3-communications] AND [PSF Type like 8-* OR like 4-* OR like 2-*]. You do not have to go through the individuals changes because this query is provided as an example on the HERA "Queries" tab of the main data base window. It is called "**qryORExample**". Just click on it once and then click on the "Design" control to open the QBE form. You will see the form resembling Figure 5.49 below.
From this form note that Access reads the Boolean **AND** by

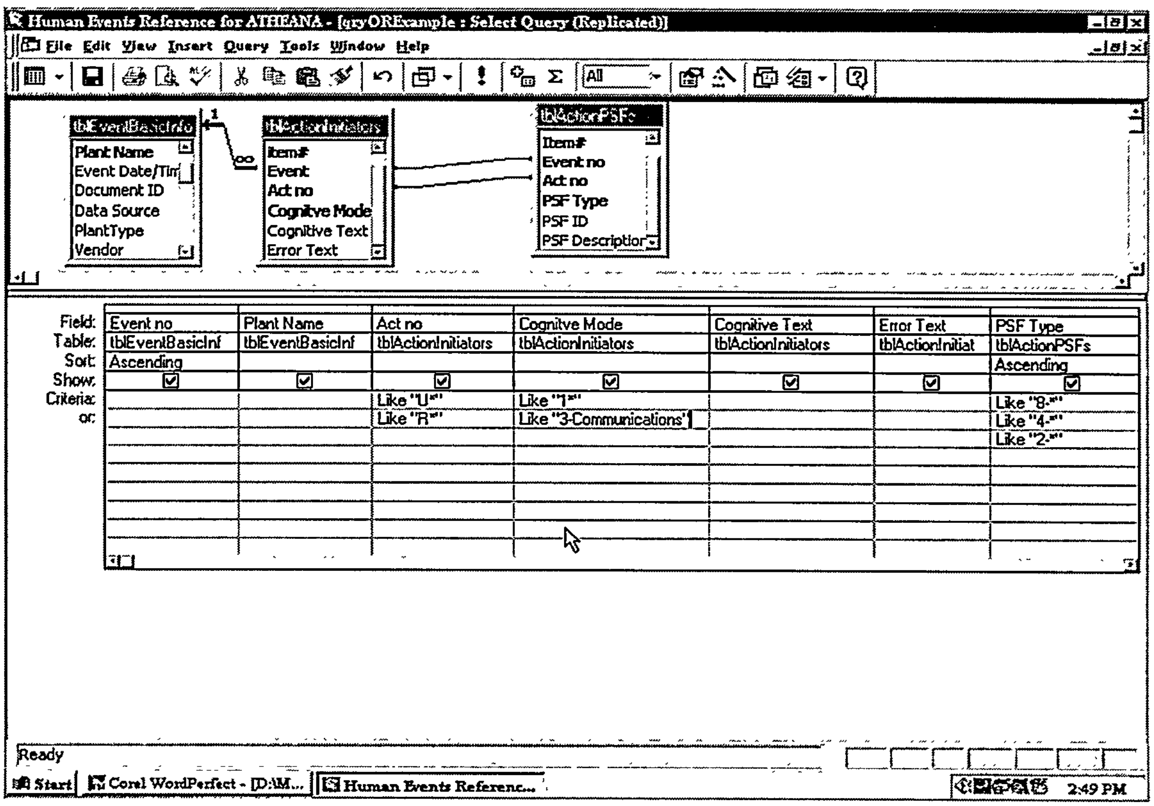


Figure 5.49: Example of "OR" Type Query

[15]If you still are having problems with this example, this very same query is included on the "**Queries**" tab of HERA's main data base window. It is called "**qryEFC1, ...Example of Error Forcing context Query**". Click on it once and then click on the "**Design**" button to open the QBE form.

going horizontally across the QBE grid, noting entries within the "**Criteria**" field. Access also identifies the Boolean "**OR**" operator by reading vertical entries within the "**Or:**" column. For example, look at the "**Act no**" column where you see **Like "U*"** entered in the "**Criteria**" field and **Like "R#"** entered in the "**or:**" field. If these were the only entries in this query, Access would run the query looking for records (as described in the earlier example)that are equivalent (Like) U# (unsafe actions) OR equivalent to R# (recovery actions). Running this query would result in a dynaset where the Act no. column had listings containing a U# OR a R#.

Our example query is much more complex. We are looking for records in HERA that are equivalent [(like) action numbers coded U# OR R#] AND [like cognitive modes coded 1-procedures/policies OR 3-communications] AND [like PSF Types coded like 8-* OR like 4-* OR like 2-*]. Run the query and scroll through the results. To see how this works.

This ends the basic tutorial/example section. Confused or need help? Microsoft has provided all sorts of HELP functions to get you up to speed. For example, return to the design view for this query by clicking the ruler/triangle/pencil icon in the upper left corner. Now, click on any field in the QBE grid and press the F1 key on your keyboard. Access will display helpful information that is context specific, i.e., related to the same box/field that you just clicked. If that is not sufficient, go to the Help item on your menu bar at the top of any form. Selecting Help, Contents and Index will start an Access wizard of sorts where you can ask a question or look for related items from a detailed index. You can also select Help, What's this and then move your cursor to the place where you need help. Clicking on the item will open context specific help trying to explain what this is.

Finally, you can also acquire a good reference on the use of Microsoft Access. This document's reference section contains at least four decent but explicit references with coded examples that will soon take you from a neophyte generator of queries to an expert.

6 Planned Future Database Features

Several of the identified deficiencies of HSECS could not be fully addressed in this version of HERA. Specifically, there is not yet a framework for entering the facts and data (versus the analysis of those facts and data) associated with non-NPP events into the database.

The effort to provide for entry of facts and data from at least one non-NPP industry (probably chemical processing) is expected to be pursued in FY99. At that time, it is hoped that all events from both the NPP environment and the selected industry(ies) that are referenced in the ATHEANA documentation will be analyzed in the database.

Further, as originally conceived, the database was only seen as a mechanism for providing examples of the application of the ATHEANA methodology based on well-documented existing events -- that is, for retrospective analysis. Now that the first full-blown ATHEANA demonstrations are nearing completion, there is a recognition that the ability to review other analysts' thinking in their application of ATHEANA in its predictive mode is equally (if not more) instructive. Therefore, the database will be modified to accept predictive analyses, including the quantification of error forcing contexts. Similarly, because future analysts of existing events may be interested in incorporating estimated probabilities into their analyses, the retrospective portion of the database will be modified to accept such data. This work is expected to be completed in FY99.

Finally, concepts reflected in new work being performed by the Idaho National Engineering and Environmental Laboratory on management/organization factors will need to be incorporated into the database to the extent that that work influences the ATHEANA methodology. This task, too, is expected to be begun in FY99.

Of course, improvements to the HERA interface will continue to be pursued as they suggest themselves during development of the features outlined above. In particular, the intent to have ATHEANA analysts archive their data in HERA makes it important to (a) improve the user interface for data entry and (b) develop protocols for data exchange and validation to allow non-LANL users to update the database with new records.

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