The Design and Implementation of
the Web-Based e-Plan Database System

Graduate Project Report

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1. Abstract

This project is to enhance the design and implementation of a web-based database system called "e-Plan". The system provides an interface for generic database manipulations via the Internet, and functions as a tool for different authorized users to generate NRT One Plan Reports and EPA-SPCCP Plan Reports, and as a reference for fire departments in the event of the release of a hazardous material. Information in the database includes general information, building information, chemical inventory, processes, vulnerability analysis, emergency plans, employee training, people information, NRT One Plan, and EPA-SPCC Plan.
2. Background and Rationale

2.1 What is “e-Plan”?
"E-Plan" (previously named as "Integrated Contingency Plan") is being developed by Texas A&M University–Corpus Christi and the Environment Protection Agency Region VI to combine planning criteria into one effective system that is readily accepted by the regulatory authorities. E-Plan helps industry to consolidate information on chemical hazards, response procedures and resources.

2.2 What has been done in the past?
In the summer of 1999, the U. S. Environmental Protection Agency (EPA), as the chair of the NRT, started the beta testing of a new software planning tool named Basic On-Line Disaster Emergency Response (BOLDER) [1]. This Microsoft Access-based software was originally developed for the Chandler Ariz. Fire Department. By entering data into BOLDER, a facility completed at one time the many separate contingency plans that may be required by various state and federal governmental agencies, reducing the duplication of effort, redundancy and paper work into one concise document. Some problems were found during the beta testing of the software. The major ones included the inconvenience of distributing and transferring the data between different computers and the incomplete field design required by different types of reports.

The web-based e-Plan system project was started in the fall of 1999 by Jeff Zhu as his graduate project [8]. As part of his research, a web server has been set up and is ready for this system, and the main structure of the database has been defined. My graduate project was to continue the design and implementation of this system, especially on report generation and the interface design.

2.3 Why is this project necessary?
With requirements from numerous governmental agencies becoming redundant, confusing and difficult to access and interpret, let alone use in an emergency situation, the project shows its
importance in the following ways:

1. It helps the chemical facilities to be able to enter data and submit reports in an efficient and cost saving manner.

2. It helps responders to react to an emergency more quickly and effectively by providing rapid access to facility planning information.

3. It helps government agencies to monitor emergencies and coordinate with industry more effectively.

Ultimately, I believe this system will become a tool for everybody in the chemical industry.
3. Narrative

This section describes the features of the enhanced e-Plan database system as they appear to the users after completion of this project. This project has greatly improved the user interface design, as well as adding improved search capability (section 3.4.3.1), data entry capability (sections 3.4.3.2 and 3.4.3.3), report capability (section 3.4.3.4), and new online help capability (section 3.4.3.5).

3.1 Overview

The following diagram represents an overview of e-Plan system data flow:

Figure 1: Overview of e-Plan System Data Flow

1. Raw data of the facility information is entered into the computer and transformed into electronic format.
2. The electronic data is stored in the e-Plan database.
3. Reports can be generated for the users to view or print.
4. Information can be retrieved for the emergency responders.

3.2 Users of e-Plan system

Due to the security issues, the e-Plan system has several types of users based on the level of privilege. In descending order, they are database administrator, fire department, chemical
facility, government agencies, and general public.

Different types of users are offered different exposures to the database. For example, the fire department can access almost all the information on every facility. This is important because they can get the information as quickly as possible in the event of emergencies. By contrast, government agencies have less access, and the general public has the least access to the database.

3.3 Functions of e-Plan system

Specifically, the e-Plan system allows the authorized users to:
- add new information of a chemical facility to the database,
- update and delete records,
- search the database for specific information, e.g., information about a certain chemical facility,
- print reports of search results, and
- generate different reports required by different agencies.

3.4 User Interface

The user interface is composed of menu-like pages that guide the user through the necessary steps to perform the above tasks. There are four major pages: the Welcome Page, the Login Page, the Main Menu Page and the Logout Page.

3.4.1 Welcome Page

The Welcome Page (see Figure 2) starts with a greeting as “Welcome to the e-Plan System” and a picture of a very peaceful sunset image. Five links do the following:
- The Objective link describes the objective of this project.
- The Project Team link introduces the members involved in the project.
- Login Here link leads users to the Login Page.
- **FAQ** link lists and answers some of the frequently asked questions about the e-Plan system.
- **Related Downloads** link provides the free download of different versions of BOLDER software.

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**Welcome to e-Plan System**

![Welcome to e-Plan System](image)

**Figure 2: Welcome Page**

### 3.4.2 Login Page

The Login Page (see Figure 3) contains a prompt for the user name and password. There is also a message regarding the user name and password for general public access. Once the user enters a valid user name and password, he is lead to the next page, which is the Main Menu Page. If the user name or password is invalid, the new Login Page is loaded again for the user to enter his user name and password.

**Please login to e-Plan Project:**

Name:  
Password:  
Submit

Currently you are able to login as 'guest'. Just type "guest" in the login textfield and 'password' in the password field.

---

**Figure 3: Login Page**
3.4.3 Main Menu Page

The Main Menu Page (see Figure 4) presents seven different procedures, divided under six categories which are:

1. Search Database,
2. Update Database,
   Add a New Entry
   Modify an Existing Entry
3. Delete an Entry,
4. Generate Reports,
5. Online Help,

As in any typical web-page environment, the user selects the desired option using the mouse, and this leads to the next related page. Each page also has “Back to Main Menu”, “Online Help” and “System Logout” links available for the users to return to the main menu, ask for help, or exit from the current database.

Main Menu

Add a New Entry
Modify an Existing Entry
Delete an Entry
Search Database
Generate Reports
Online Help
Logout

Figure 4: Main Menu Page
3.4.3.1 Search Database

This page (see Figure 5) offers the users four options to search the database. They are:

- **Search by Facility**, which provides the facility information that the user requested by the facility name. All of the facility names available in the database are listed in a scrolling list. The user goes through the list and selects the facility name he wants to search. There is also a scrolling list, containing all the section names, that gives the user an option to search the facility entirely or partially.

- **Search by People**, which enables the user to search the database by a person’s name. The user must type in the person’s name that he wants to search for. There is a checkbox available for an “exact match” option. If the user knows the facility and section the desired person is related to, he can select the optional Facility Name and Section Name from the scrolling lists to improve the search speed.

- **Search by Building**, which enables the user to search the database by the building name. The user must type in the name of the building for which he is searching. There is also a checkbox available for “exact match” option. If the user knows which facility this building is related to, he should select the optional Facility Name from the scrolling list to improve the search speed.

- **Search by Chemical**, which enables the user to search the database by the chemical name. The interface is almost identical to “Search by Building”, except instead of typing in the building’s name, the user enters the chemical name.

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**Web-base e-Plan System**

Back to Main Menu  Online Help  System Logout

![Search Page](image)

Figure 5: Search Page
3.4.3.2 Update the Database

There are two options for updating the database system: Add a New Entry and Modify an Existing Entry. The first option asks the user to type in the name of the new facility. The second option lets the user choose one of the facilities available in the system. Both options lead to a page which has an interface similar to the BOLDER software (see Figure 6). There are ten sections available to be entered or modified. Each section has the following parts:

- The top frame has three links (Back to Main Menu, Online Help, System Logout) which provides the user the options to go back to main menu, ask for help, or logout from the system.
- The left frame lists all the links to the ten sections, which allows users to jump from one section to another without going back to the Main Menu page.
- The center frame contains a form related to the section the user selected. If the “Modify an Entry” option is selected, the form input fields display the related existing information for the selected facility, otherwise they are left blank. Every form includes the “Submit” and “Reset” buttons, which allow the user to submit his new data in the database or abort the submission.

![Image of Update System Page]

Figure 6: Update System Page

Each section is introduced briefly below:

(1) The **General Information** section includes general facility information such as facility
address, parent company’s address, and facility site plans.

(2) The **Building Information** section describes the uses, storage, and building layout for each facility. The type of data that can be entered ranges from electrical layouts to skylights to chemical storage locations.

(3) The **Chemical Inventory** section includes the storage information of chemicals, such as the chemical type, exposure routes, transportation methods, and Material Safety Data Sheets (MSDS) information.

(4) The **Process** section includes the chemical manufacturing information including the quantities of the chemicals produced, description of the processes, hazard classes.

(5) The **Vulnerability Analysis** section describes each of the types of hazards and the population, critical facilities, and environmental impact that may be affected.

(6) The **Emergency Planning** section describes all considerations covered by a specific standard operating procedure. This section also documents the “chain of command”, who is the qualified individual in a given scenario, where to contact specific individuals, and regulatory authorities. It addresses worker health assessment and personal protective equipment needed in or around the facility.

(7) The **Employee Training** section contains description of the different areas in which employees are trained in different procedures and practices. Users enter information in this form disclosing which employees are involved and to whom they report. In case of emergencies, personnel information may be retrieved.

(8) The **People Information** section is divided into eight subsections: Facility Owner, Property Owner, Technical Contact, Public Contact, Emergency Contact, Site Clean-up Contractor, NRT One Plan Key Contact, and SPCCP Authorized Representative. Each subsection represents the different type of people related to the facility. For examples, Site Clean-up Contractors are the people who the facility can call for hazardous waste and site clean-up; NRT One Plan Key
Contact and SPCCP Authorized Representative are the people who take charge of the corresponding plans. Each subsection contains the contact information, such as address, telephone number, or email address of that particular type of people in the facility.

(9) The **NRT One Plan** section includes extra necessary information which is not covered in the previous eight sections but required by the NRT-One Plan, such as the information on Plan Elements for Plan Development and Maintenance and Incident Documentation.

(10) The **EPA-SPCC Plan** section includes the extra information necessary for generating a EPA-SPCC Plan report. It is divided into four subsections: Major Elements, Facility Storage, Spill History and Potential Spill Predictions.

### 3.4.3.3 Delete an Entry

This page (see Figure 7) offers the user seven options to delete an entry from the database. They are:

- **Facility Delete**, which enables the user to delete the facility information from the database. All of the facility names available in the database are listed in a scrolling list. There is also a scrolling list which contains all the section names. The user has the option of deleting the facility information entirely or partially.

- **People Delete**, which enables the user to delete the particular people information of the facility from the database. Again, all of the facility names available in the database are listed in a scrolling list, and the names of the categories are also listed for the user to choose. If there are multiple entries under one particular type, such as Emergency Contact, the user has the option of deleting single or multiple entries.

- **Building Delete**, which allows the user to delete the particular building information of a facility from the database. First the user should select the facility name from the scrolling list. If there are multiple buildings in that facility, all the building names are shown in the scrolling list. The user can delete either single building or multiple ones as desired.

- **Chemical Delete**, which allows the user to delete the particular chemical information of a facility from the database. The interface is almost identical to “Building Delete”, except if
there are multiple chemicals, all the chemical names are shown in a scrolling list instead of the building names.

- **Process Delete**, which allows the user to delete the particular process information of a facility from the database. The interface is similar to “Building Delete”, except if there are multiple processes, all the process names are shown in a scrolling list instead of the building names. And if there are multiple chemicals involved in a particular process, all the chemical names are displayed in a scrolling list for the user to select. The user may delete all the processes and chemicals involved in the processes or a single process. The user also has the choice of deleting multiple or single chemicals involved in a particular process.

- **Vulnerability Delete**, which allows the user to delete the particular vulnerability information of a facility from the database. The interface is almost identical to “Building Delete”, except if there are multiple vulnerability analysis cases, all the chemical names in the vulnerability analysis are shown in the scrolling list instead of the building names. The user can delete single or multiple vulnerability analysis cases.

- **EPA – SPCC Plan Delete**, which provides the ability for the user to delete the different sections of the SPCC plan elements. The interface is similar to the “People Delete”. If there are multiple entries in some section such as Spill History and Facility Storage, all the names of the entries are listed for the user to select. The user has the choice of deleting single or multiple entries.

![Web-base e-Plan System](image)

**Figure 7: Delete Page**
3.4.3.4 Generate Reports

This page (see Figure 8) allows users to generate different types of reports required by different regulatory agencies. Currently available reports are *Spill Prevention Control and Countermeasure Plan for the Environmental Protection Agency (EPA-SPCC Plan)* and *the National Response Team One Plan (NRT-One Plan)*. Users must pick the report type first and choose the facility they want.

The generated report can be viewed or printed. Both reports are in the format accepted by the regulatory agencies. Example reports are available in Appendix A and Appendix B.

**Web-base e-Plan System**

Back to Main Menu  Online Help  System Logout

![Report Generation Section](image)

Figure 8: Report Page

3.4.3.5 Online Help

This page (see Figure 9) acts as the help menu for the user. The page is divided into two frames. In the left frame, six help topics are listed. And if the user clicks one of the topics, the detailed
instructions on that topic are displayed in the right frame.

**Welcome to e-Plan System**

**Introduction:**

e-Plan system is a web-based electronic integrated contingency planning system, which is intended to make it easier for facilities to file and maintain regulatory requirement documents and to provide rapid access to facility information to emergency responders in the event of an emergency.

e-Plan is being developed using commonly available Internet tools and protocols. The use of Internet standards for building e-Plan allow easy distribution and communication of information and eliminates many of the difficulties inherent in proprietary packages and systems.

One of the key components of the e-Plan system is the use of the Lightweight Directory Access Protocol (LDAP) as the repository for facility information.

Figure 9: Online Help Page

3.4.3.6 Logout

The Logout option leads the user to the Logout Page, exiting from the current database.

3.4.4 Logout Page

The Logout Page (see Figure 10) displays to the user a thank you message, and two links which allow users to go back to either the Login Page or the Welcome Page.

*Thanks for visiting e-Plan system!*

Back to e-Plan Login  Back to e-Plan Home

Figure 10: Logout Page
4. Project Environment

4.1 Minimum Hardware Required
The computer used for the server should be 386 or higher PC with minimum of 16 MB of random access memory and 500 MB hard disk. A web browser such as Netscape or Internet Explorer is used for the client to view and retrieve the information from the system.

4.2 Minimum Software Required to Implement e-Plan System
The database system is implemented by using Lightweight Directory Access Protocol (LDAP) under RedHat Linux 6.1 on a PC. Apache is used as the Web Server software. OpenLDAP is used as the LDAP server. The Perl module Net::LDAP and PHP’s LDAP API are used to interface with the database. The interface system can be displayed through any web browser such as Netscape, Internet Explorer. The Hypertext Markup Language (HTML) is used to generate the forms and reports. The Common Gateway Interface (CGI) and PHP are used to access the LDAP database and to generate those HTML forms and reports dynamically.
5. Procedure

The enhancements to the e-Plan system described in section 3 of this report have been implemented according to the following steps:

1. Met with Jeff Zhu and learn what he has done so far on the system.
3. Interviewed the clients and discussed the requirements for the report.
4. Modified the existing design of the system as well as the interface.
5. Implemented the CGI/Perl and PHP programs to generate forms and reports.
6. Added several sample data sets into the database.
7. Showed the clients the sample forms and reports for feedback.
8. Optimized the graphical user interface in the system.
9. Wrote online help topics for the users.
10. Tested the web-based e-Plan system.

5.1 Existing System Review

5.1.1 Clients’ Requirements

Since the beginning of last June, the e-Plan project team has been meeting with the clients including the EPA contractor, environmental consultant companies, emergency responders and industry representatives to discuss their needs for the system. Because the e-Plan system is designed to assist multiple tasks such as regulatory review, emergency response, report submission and public access, this system had to be secure, reliable, easy to use, capable of multi-processing and offer quick research of the database.

5.1.2 Requirements Analysis

Several choices have been made for this system based on the clients’ requirements. The RedHat Linux 6.1 version operating system was used for the e-Plan system. Apache HTTP Server was chosen as the Web server. LDAP (Lightweight Directory Access Protocol) directory and database server was chosen as the database. Perl modules are used to provide two services. One is Net::LDAP, which allows connections to the directory server and makes
queries including add, delete, update and search. The other is to write CGI applications for
the web, creating HTML forms and reports and parsing their contents. The reasons for those
choices can be found in Jeff Zhu’s graduate report [8].

In addition, PHP was used in creating HTML forms and reports in this project. PHP was
chosen because its power and ease of use. Since PHP has been built for the web, and for data
access, it makes form data manipulation, database access, cookies, file functions easier to
understand and implement. And its open-source property has made PHP an important web
technology [4].

Figure 11 is a simplification of the major components of the current e-Plan system and how
they interact with each other.

![Diagram of Major Components of the e-Plan System]

**Figure 11: Major Components of the e-Plan System**

Communication between the user’s browser and Apache is performed using HTTP and
HTML. Apache executes Perl scripts using CGI, and the Perl scripts communicate with the
OpenLDAP server by using LDAP. Apache interprets PHP codes, interacting with the
OpenLDAP server directly by using PHP LDAP API.
5.2 Project Implementation

The system implementation for this project consisted of four parts:

- Modify the existing LDAP directory information tree by reorganizing and adding more attributes to the tree to satisfy the requirements for generating the regulatory reports such as NRT-One Plan and EPA-SPCC Plan.
- Improve the existing user interface to allow easier entry and modification of e-Plan data. This included conversion of some pages to use PHP and general improvement of the user interfaces.
- Use PHP scripts to create NRT-One Plan and EPA-SPCC Plan reports from e-Plan data.
- Improve the search capability of e-Plan to be more suitable for use by emergency responders.

5.2.1 Development of LDAP Directory Information Tree (DIT)

In LDAP, directory entries are organized in a hierarchical tree-like structure. The following figure shows an example of LDAP directory information tree. (Figure 12)

![LDAP DIT Diagram]

**Figure 4: An Example of LDAP DIT**