STUDENT SUMMER INTERNSHIP TECHNICAL REPORT

Development of an Authorized Release Limit Database

DOE-FIU SCIENCE & TECHNOLOGY
WORKFORCE DEVELOPMENT PROGRAM

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EXECUTIVE SUMMARY

This research work has been supported by the DOE-FIU Science & Technology Workforce Development Initiative, an innovative program developed by the U.S. Department of Energy's Office of Environmental Management (DOE-EM) and Florida International University's Applied Research Center (FIU-ARC). During the summer of 2020, a DOE Fellow intern, Brendon Cintas, spent 10 weeks doing a remote summer internship from Miami, FL with DOE-EM's Office of Safety, Security, and Quality Assurance under the supervision and guidance of Amanda Anderson from Field Operations Oversight (CNS) and Larry Perkins from the Office of Safety Management. The intern's project was initiated on June 1, 2021, and continued through August 6, 2021 with the objective of developing a comprehensive, easy-to-use database that can be accessed through internal connection on the DOE network to hold a system of records that can be created, modified, monitored, and recalled, and potentially modify the Authorized Limit of any DOE complex in accordance with DOE O 458.1.

U.S. Department of Energy (DOE) complexes must abide by DOE Order (O) 458.1 Chg 4, which sets requirements to protect the public and the environment against radiation due to activities conducted by the DOE pursuant to the Atomic Energy Act of 1954. One of the requirements within DOE O 458.1 Chg 4 is known as an "Authorized Limit", which restricts the "concentration or quantity of residual radioactive material on the surfaces or within property that has been derived consistent with DOE directives including the ALARA (As Low as Reasonably Achievable) process requirements".

During a remote ten-week internship from Miami, FL, Florida International University (FIU) and the DOE Office of Environmental Management (EM) were in collaboration to develop a comprehensive, easy-to-use database that can be accessed through internal connection on the DOE network to hold a system of records that can be created, modified, monitored, and recalled, and potentially modify the Authorized Limit of any DOE complex in accordance with DOE O 458.1. This database was required to comply with all Quality Assurance (QA) standards in accordance with DOE O 414.1D Chg2, which establishes acceptable methods for implementing the safety software quality assurance requirements of DOE O 414.1C. It was also required to comply with all cybersecurity requirements of DOE O 205.1C, which establishes a set of minimum requirements for cybersecurity and software-related risk management.

This document outlines the efforts towards creation of the authorized release limit database, current features and technical issues of the database, and future implementations that were unable to be finalized before the end of the internship.

1. INTRODUCTION

The U.S. Department of Energy (DOE) complex must abide by DOE Order (O) 458.1 Chg 4, which establishes requirements to protect the public and the environment against radiation due to activities conducted by the DOE pursuant to the Atomic Energy Act of 1954. The five requirements are to: (1) conduct DOE radiological activities so that exposure to members of the public is maintained within the dose limits established in this Order; (2) control the radiological clearance of DOE real and personal property; (3) ensure that potential radiation exposures to members of the public are as low as is reasonably achievable; (4) ensure that DOE sites have the capabilities, consistent with the types of radiological activities conducted, to monitor routine and non-routine radiological releases and to assess the radiation dose to members of the public; and (5) provide protection of the environment from the effects of radiation and radioactive material. [1]

To meet the requirements of this order, there is an established limitation on the quantity or concentration of residual radioactive material on services or within property that has been derived consistent with DOE directives, including ALARA. This limitation is what is referred to as an authorized limit (AL). The development of ALs "involves an evaluation process where land structures, discrete items, or personal property may be cleared even though they contain minute, residual amounts of radioactivity from DOE activities", and by developing and applying Authorized Limits, residual radioactive contaminants and some generated waste during Decontamination and Decommissioning (D&D) may be sent to a public or DOE landfill instead of a Low-Level Waste facility without compromise to health and safety". ALs are authorized to every site across the DOE-EM complex and must be monitored closely to ensure that each site is abiding by O 458.1 Chg 4.

With consistent changes to ALs being present across various sites as clean-up efforts are adjusted to meet the needs of the sites, DOE-EM noted a need for development of a database that allows for monitoring, recalling, and entering data that is comprehensive, easy-to-use, and accessible within the DOE intranet for all sites within the DOE-EM cleanup effort. The objective of the database was to hold a system of records that can be created, modified, monitored, and recalled, and potentially modify the Authorized Limit of any DOE complex in accordance with DOE O 458.1. This database was required to comply with all Quality Assurance (QA) standards in accordance with DOE O 414.1D Chg2, which establishes acceptable methods for implementing the safety software quality assurance requirements of DOE O 414.1C [2]. It was also required to comply with all cybersecurity requirements of DOE O 205.1C, which establishes a set of minimum requirements for cybersecurity and software-related risk management [3].

2. RESEARCH DESCRIPTION

A database is a systematically organized collection of data that is stored electronically within a computer system and can be accessed electronically to manage and update data within the collection. Communication with the database involves the use of a programming language known as *Structured Query Language* (SQL). SQL is a type of programming language that manages relational databases and performs various operations on the raw data. Some operations include defining the data in the form of creating, altering, or deleting tables, views and objects; manipulating the data records within tables; controlling the data's access; and database indexing.

There exists a variety of different tools that can be used. Deciding on the foundation of the database is dependent on the understanding of the different approaches to creating the database, understanding the data that is to be entered into the database, and the organization's goals of the database. A literature study was conducted on various tools that could have been used for the database from both open-source and proprietary software solutions to determine which would be the optimal choice for managing the AL, achieving DOE-EM's objectives of comprehensibility, ease-of-use and accessibility.

Open-source is a term that refers to software in which the source code is publicly accessible, meaning anyone can view the code, modify, and redistribute as needed; whereas proprietary (closed source) describes software with source code that is only accessible to the person, team, or organization that created the software and maintains exclusive control over it. Each type of software carries their own legitimate reasons for their applications. During the literature survey, three candidates from open-source systems such as MySQL, PostgreSQL, and MariaDB were identified, as they are the most popular open-source database solutions. They are supported by nearly every content management system (CMS) or CMS framework; however, where the difficulty lies is in their feasibility. Because one of the goals of the database was for it to be hosted within the DOE intranet, when using open-source utilities that are hosted on the web, receiving clearance from SQA and cybersecurity would have been far more challenging, and was not reasonable for the task, which forfeited the possibility of using any of the considered open-source tools.

Similarly, proprietary/non-open-source management tools were also identified but did not meet two of the objectives – some systems such as Oracle and IBM Db2 were cloud-based solutions that would need to be held outside of the DOE intranet, while others utilized their own propriety language that would be difficult to learn, and in the case of seeking assistance, can only be sought out by the developers of that proprietary system. There was one solution, however, that met all the objectives: Microsoft Access.

Microsoft Access is a database management system that combines a powerful Jet Database engine with a graphical user interface (GUI) and software development tools that are intuitive and available as part of the Microsoft 365 suite of applications. It was selected as the tool to be used to create and maintain the database for the following reasons:

- Microsoft Access is an excellent tool for creating custom systems that have a database at its foundation. It includes various wizards to increase efficiency towards the process of creating a database application and a vast array of readily available functionality.

- Using Visual Basic for Applications (VBA), user-friendly applications can be made to interact directly with the database tables and automate processes, such as opening forms to input data to being able to search for data by keyword.

- Implementing changes to the database structure or adding functionality to the database is simple.

- Access and its VBA programming language are known by many developers, programmers, and software companies.

- With each new version of Microsoft Access, new capabilities have evolved. With improvements made to SharePoint Lists and their integration with Access, an organization can now link their fully-functioning desktop Access application to your data in the Cloud.

- An Access database is scalable and can be integrated into large systems and expansion.

3. RESULTS AND ANALYSIS

The Microsoft Access database was developed with the following objectives considered:

1. Create, obtain, and modify AL records for each site.

2. Display current and archived ALs.

3. Search for a record by a multi-select keyword search.

4. Obtain the full AL package from any record.

5. Analysis from SQA and cybersecurity.

6. Consult with EITS to upload database link to EM SharePoint.

Of the six objectives, four were completed during the ten-week program, which are discussed in further detail below.

1. Create, obtain, and modify AL records for each site.

In the Access database, users can create, retrieve, and modify ALs for each site. To control the data, a set of five tables was created: a master table that holds all the AL information in records, and four reference tables for EM sites, approval offices, intended end uses, and radioactive isotopes. Upon opening the database, the user is greeted with a main menu where the user can choose a mode of operating the database as shown in Figure 1.
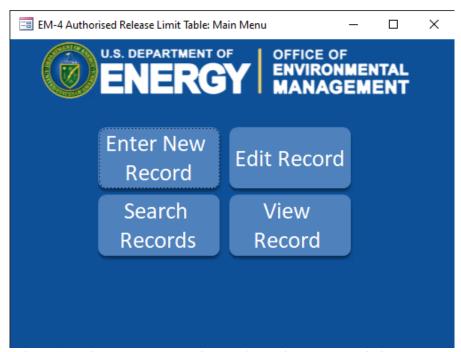

Figure 1. Main menu when opening the Authorized Release Limit Database.

A user must select from four options: create a new record, edit an existing record, search for a record, or view a record in read-only mode.

i.   *Entering New Records:* Upon selecting the option to create a new record, the user is greeted with another interface as shown in Figure 2. The user is then able to populate the empty fields for: Site, approval office, approval date, contaminant, end use, dose constraint in mrem/year, model dose constraint in mrem/year, comments, and any attachments for the AL record. When the user populates any of the fields, a new entry ID is tabulated in the Authorized Limit table (green highlight) and is saved to the table every time the user presses the enter key or manually presses the "save record" button (red highlight). Navigation bars allow the user to navigate through records that they have created in that instance, but do not allow the user to navigate to any of the other records in the table. This prevents a user from inadvertently modifying a record that was not meant to be changed. Upon closing the New Record form, all the generated records are saved to the table, and any future changes to them must be done through another form: the "edit record" form.
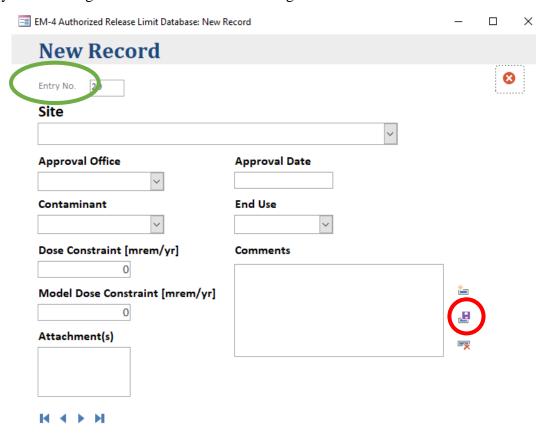

Figure 2. New Record Interface for creating new Authorized Limit Records.

ii.   *Modifying an Existing Record:* To modify an existing AL record, the user selects "Edit Record", which will open the form that allows a user to edit a record upon providing the record's entry ID, which was generated when initially creating the record as shown in Figure 3. By default, the form will open to the first entry in the table. A user can also navigate through existing records in the table using the navigation buttons at the bottom of

the form, but cannot create new records within the table. In this form, a user can change any of the currently populated fields within the record and can save the information to update the record. If a user wishes to edit and they are unsure of the entry ID, a search form can be used to search from a series of filters (Figure 4.)
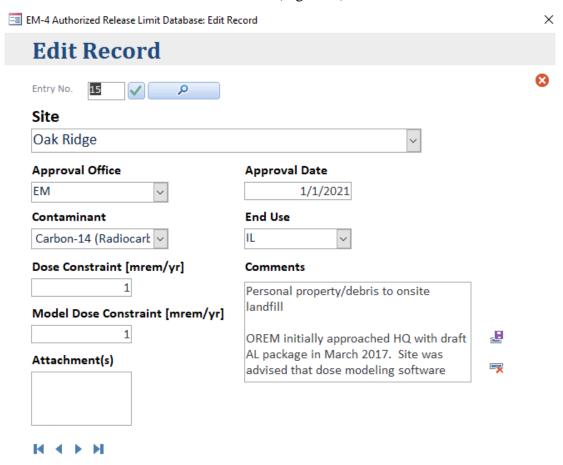

Figure 3. Edit Record interface for modifying existing records.

iii.   *Browse Record:* If a user wants to browse records without modifying any of its contents, the user can press "View Record", which will open an interface similar to "Edit Record" in read-only mode. The user can still interact with the fields, but the fields will not populate with any new information, and the drop-down selections for Site, end use, and radionuclide will be greyed out, preventing the user from making any selections (Figure 5).
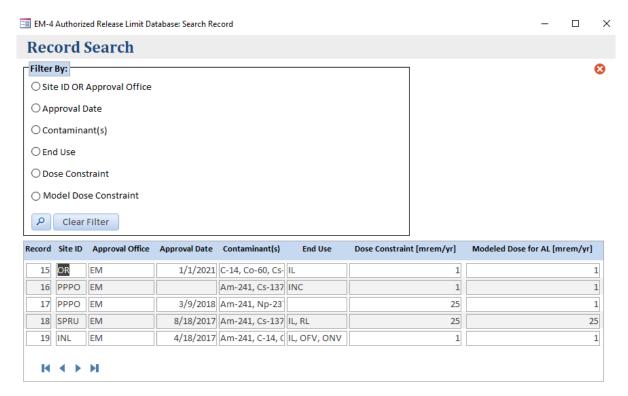
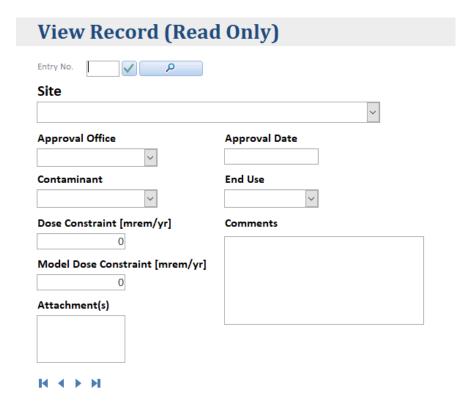**Figure 4. Record Search form for searching records.**

Figure 5. Read Only form for browsing records.

2. Display current and archived ALs.

When browsing the authorized limits within the search form, it is imperative that the correct authorized limit is referenced. To do this, each record contains an audit log which contains three fields that indicate: (i) when an AL has been approved, (ii) when an AL has been entered into the system, and (iii) when an AL record has been modified. When an AL is approved, the attachment that describes the conditions of the approval is dated, which is the indication of when the AL has been approved. For the record entry or entry modification within the table, however, a timestamped text box saves the time and date in which a record was created and/or modified and is used to show when an entry is current or archived when searching for a record, with the latest approved limit always showing at the top of the search form, as shown in Figure 6.
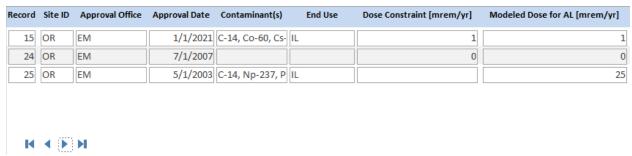
Record	Site ID	Approval Office	Approval Date	Contaminant(s)	End Use	Dose Constraint [mrem/yr]	Modeled Dose for AL [mrem/yr]
15	OR	EM	1/1/2021	C-14, Co-60, Cs-	IL	1	1
24	OR	EM	7/1/2007			0	0
25	OR	EM	5/1/2003	C-14, Np-237, P	IL		25

Figure 6. Latest approved limit shows at the top of the search result for Oak Ridge.

For future implementations, it is recommended that a Boolean expression for each record is added so that when browsing individual records, a banner will highlight whether the record is current by being highlighted green, or archived/outdated by being highlighted in red.

3. Search for a record by a multi-select keyword search.

A user can search for records by selecting the option to "Search Records" from the main menu but may also access the search form by clicking the search button while navigating the "Edit Record" or "View Record" forms. When accessed, the user will view the form as seen in Figure 4. This form allows the user to search for a record from a series of filters that will populate the search results subform with filtered results. The 'Filter by' feature allows the user to search for categories from the authorized limit records:
- o Site ID
- o Approval Office
- o Radionuclide
- o End Use
- o Dose Constraint
- o Modelled Dose Constraint

For the Site ID, Approval Office, Dose Constraint, and Modelled Dose Constraint, the user can populate the text box with either a full keyword or partial keyword, and the form will interpret what the user wishes to enter through a series of wildcards (Figure 7). This means that the user can enter an incomplete Site ID or Approval Office, and the result will still show what was being searched for. As for Radionuclide and End Use, the user can select multiple items from a drop-

down box, and the search form should populate the results subform with the records that contain some or all the selections. Future implementations for this objective are to allow the user to select multiple filters and multiple selection of radionuclides and end-uses, as opposed to selecting one radionuclide or one end-use at a time.
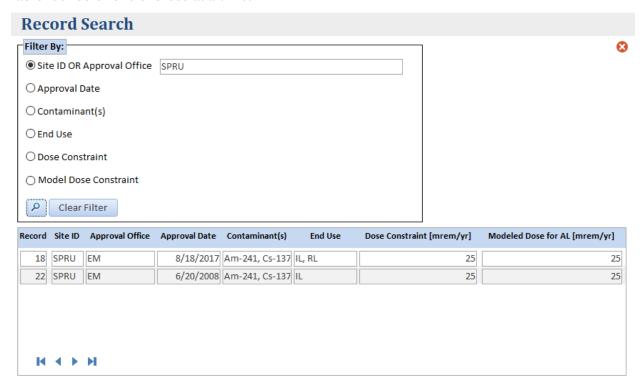

Figure 7. Filtered search results for the approved limits at SPRU.

4. Obtain the full AL package from any record.

The user possesses the ability to attach as many files as needed for each record, and can be viewed, downloaded, and printed all from within the database's new record, edit record, and view record forms. The only limitation to this feature is the maximum size of the database, which is 2 GB. Future implementations for this feature are a live document preview in the view record form, where a user can read the authorized limit package without needing to download the file first, and to generate a full report package for the AL record and all attachments.

4. CONCLUSION AND INTERN REFLECTION

During the ten-week internship experience, lessons were learned from the development of the Access database from the difficulties during the development. These three lessons were:

1. *The most convenient solution may not be the ideal solution.*
   When creating the database, the intern was learning different parts of Access and its features. During the development, the developer found two features that while at first seemed useful, created many difficulties that needed to be reverted, i.e., the use of multi-selection combo-boxes in the user forms, and multi-selection look-up tables within the radionuclide and end-use fields in the authorized limit table; however, as the timeline for development was approaching the final date, I opted to leave the system as is. A major implementation to consider in future is to roll-back this change and redevelop it with a more efficient relational structure.

2. *Trust what is known, but do not be afraid to ask questions.*
   Though the developer is familiar with programming in C++ and MATLAB, VBA comes with its own set of limitations that the intern needed to work with in order to achieve the objectives. Some of these limitations included adapting to the unfamiliar syntax of the language, adapting to using Microsoft Access as an Integrated Development Environment (IDE) as opposed to the developer's preferred IDE, and it was necessary to occasionally visit StackOverflow and reference learning tutorials on how to achieve a desired result.

3. *Junk in equals junk out.*
   Junk in equating to junk out is a mindset of being efficient. In one of the search form features, an inefficient method of searching and filtering data was utilized in the results subform, where the subform would requery every time the search form fields were populated with keywords or drop-down selections. The result of this was a slow search form that became unusable when the database contains many records. Upon researching further, the developer learned of a much more efficient method that applies a filter to the data as opposed to requerying the recordset every search, which reduced the requisite code and computation time by about half, which shall prove effective for when the database contains a large amount of records.

In conclusion, efforts were presented regarding development of a Microsoft Access database for referencing Authorized Limits that is lightweight, easy to use, and comprehensive. This database was developed in compliance with all Quality Assurance (QA) standards in accordance with DOE O 414.1D Chg2 and all cybersecurity requirements of DOE O 205.1C in consideration. Clearance from Quality Assurance and Energy Information Technology Systems (EITS) is pending for release to use the database within the DOE Intranet.

5. REFERENCES

[1] D. Favret, DOE O 458.1 Chg 4 (LtdChg), Radiation Protection of the Public and the Environment, Washington, DC: U.S. Department of Energy, 2011.

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[3] B. Wright, DOE O 205.1C, Department of Energy Cybersecurity Program, Washington, D.C.: U.S. Department of Energy, 2019.