Documentation Process of Radioactive Materials

James Meadows

Office of Science, Science Undergraduate Laboratory Internship Program (SULI)

Stanford Linear Accelerator Center (SLAC)

Stanford, CA

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Participant (Me)

Research Advisor (Mentor)

Abstract

The Stanford Linear Accelerator Center (SLAC) handles a variety of complex projects many of which require significant documentation. SLAC must maintain a record of all radioactive materials under their management. The documentation process ensures safe handling and disposal of radioactive items at SLAC facilities. This research focuses on how documentation at SLAC can be improved using an automated web application. A specialized software solution reduces the dependency on manual data processing. Manually inputting data can result in errors in the dataset and a significant time burden on staff to manage these issues. Software applications can also generate useful information for employees and provide additional functionality that is not possible with current methods of documentation. During a ten-week internship, a website was developed to address the issues of manual documentation. Staff now input information into the website for items, containers, shipments, and burials. A database stores the user input and outputs useful information such as reports and calculated volume for a given item. This software application will help staff at SLAC better understand the types of materials under management and lead to better documentation standards for the safe handling of radioactive materials.

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I. INTRODUCTION

A. Project description

Over the course of a ten-week internship, I developed a website for the SLAC National Accelerator Laboratory. I used my time here to build a website that would rework the way that SLAC employees document radioactive materials in their facilities. Once complete, the website will streamline the process of managing item documentation. Manual documentation will be replaced with an all-in-one web application. This report details the research and development process of the software application.

B. People involved

The Science Undergraduate Laboratory Internship (SULI) program provided me the opportunity to work on a project under the mentoring of Ryan Ford. Ryan Ford is a radiation health and safety specialist at SLAC. His expertise guided the development of this project. Under his leadership, I developed the web application to meet the requirements needed by SLAC. My background involves computer science which will be the focus of this discussion. Information directly related to radioactive materials should be directed to Ryan Ford.

II. PROJECT OVERVIEW

A. Project scope

SLAC handles radioactive materials which must be documented appropriately. The general workflow for documentation can be summarized in the following steps. Register an item using the "Radioactive Material Declaration Form" as shown in (**FIG. 1)**. Next add the item to an appropriate container. Once the container reaches capacity, it may be assigned a shipment. Shipments have a final burial site where the radioactive item can be safely disposed. Items, containers, shipments, and burials each store information relating to their real-world representation. Notable fields of information presented in (**FIG. 1)** include the following: declaration number which identifies an item, container number which specifies the container that holds the item, and hazard level which warns employees of potentially dangerous items. This information must be tracked and stored in perpetuity to meet the safety standards for handling radioactive materials.

B. Problem presented

The process of documenting items can be quite involved to meet the standards for safe radioactive materials management. Employees currently use Excel spreadsheets and PDF files to track information pertaining to the radioactive items in the facility inventory. Important information for items must be filled in the given fields by hand. This means input data may be incorrectly added, difficult to read, or forgotten all together. Errors in data logging could result in items going missing. This could pose a safety hazard if the item remains unaccounted for. Given the large set of items under management and the timeframe that records must be stored, manual documentation can be a challenging task to overcome.

C. Solution to problem

This project aims to solve many of the issues created by manually documenting items at SLAC. Much of the manual work of documentation can be replaced with an automated web application. This holds true for most documentation and works particularly well for SLAC’s case. Instead of inputting information into PDF and Excel files, staff will utilize a specialized website that ensures they enter information correctly. The website serves web forms to the user to gather information about the types of materials managed by SLAC. A database then stores the information where it can be processed using detailed queries. A query allows information to be derived from the underlying information. These queries process data in ways that the manual documentation could not. For example, databases outshine traditional documentation methods because of how they build relations between sets of data. The main driver of this research will be finding the best relationship model for the required data.

Radioactive Material Declaration Form
Exhibit to the Radioactive Waste Manual (RWM)

RADIOACTIVE MATERIAL DECLARATION FORM

For RP use only	For RP use only
Container #: ______	Declaration Number: ______
Location: ______	Old Declaration Number: ______ [ ] N/A

Complete this form in full. RP cannot accept the waste/material if this form is not filled out completely and properly. Call x2823 if you have questions.

A. Item Description:

THREE METAL FLANGES WITH SOME BELLOWS ATTACHED
BALL OF ALUMINUM (<1 FT³) METAL SHAVINGS FROM
DRILL PRESS WORK, NITRILE GLOVES
4 lbs

Generation Process:
[ ] Special Project
[ ] Facility Upgrades/Changes
[ ] Remediation/Excavation
[X] Other (please describe): B25 DRILL PRESS WORK
[ ] Accelerator Equipment Upgrades/Replacement
[ ] Emergency or One-Time Cleanup Operations
[ ] Decommissioning & Decontamination

Generation location/system:
Account #:
Destination: [X] RAMSY [ ] Other:

B. Waste Properties, Characteristics, Constituents
Waste Volume: 1 (ft³, liters) circle one

Attach documentation: SDS, manufacturer specifications, analytical results, process knowledge collection documents which further describe the item's materials of construction and/or function.

Physical State:
[X] Solid
[ ] Solid w/freestanding or absorbed liquid
[ ] Liquid (If liquid, indicate if the liquid is:
[ ] Single Layer
[ ] Multi-layer
[ ] Gas

pH: [X] N/A [ ] ≤ 2 [ ] > 2 but < 12.5 [ ] ≥ 12.5

Flashpoint: [X] N/A [ ] < 140 °F [ ] > 140 °F but < 200 °F [ ] > 200 °F

Characteristics:
[ ] Corrosive
[ ] Ignitable
[ ] Reactive
[ ] Radioactive
[ ] Toxic

Asbestos Content:
[ ] Friable
[ ] Non-Friable
[X] None

PCB Content:
[ ] > 5 ppm
[ ] < 5 ppm
[X] None

Metal Content:
[ ] Aluminum [ ] Antimony [ ] Arsenic [ ] Barium [ ] Beryllium [ ] Brass/Bronze [ ] Cadmium
[ ] Chromium [ ] Cobalt [ ] Copper [ ] Iron [ ] Lead [ ] Mercury [ ] Molybdenum
[ ] Nickel [ ] Selenium [ ] Silver [X] Stainless Steel [ ] Thallium [ ] Vanadium [ ] Zinc
[ ] Other (List) ______
[ ] None
[X] Friable, powder, or finely divided metals and metal compounds (list):

Composition
[ ] Batteries [ ] Cardboard [ ] Circuit board
[ ] Cloth [ ] Concrete [ ] Glass
[ ] Paint [ ] Paper [X] Plastic
[X] Rubber [ ] Soil [ ] Solder
[ ] Wood [X] Other (describe): METALS

Constituent:	Volume % (range):	Constituent:	Volume % (range):
METAL	90		
PLASTIC	5		
RUBBER	5		

FIG. 1. Radioactive Material Declaration Form. Example of how items are documented before the implementation of the website.

III. DEVELOPMENT PROCESS

A. Software environment

A Software project requires choosing the right languages for the given requirements. Choosing languages that synergize well with the project ensures a smoother development process. The backbone of this website uses a C# Razor Pages implementation to process information. Think of it as the glue that ties the entire project together. C# opens connections to the database and sends queries that update and retrieve stored data. These database operations are written using MySQL, a database specializing in relational data. Once the necessary information loads, users receive web pages written in Hypertext Markup Language (HTML) and Cascading Style Sheets (CSS) which display the information in an elegant manner. The website uses JavaScript for calculating results in the user's browser. Lastly, collaboration on the project is done through a GitHub repository where the codebase can be shared between multiple computers and people.

B. Database overview

The most important research question of this project pertains to how the given dataset fits into a relational database structure such as MySQL. Answering that question involves finding a data structure that meets the following criteria: it is organized into separate tables, avoids duplicate data, and references data from other tables. The website we created incorporates these principles into its design. The diagram depicted in (**FIG. 2)** shows how items, containers, shipments, and burials follow the ideas of a relational data structure. Each table stores the minimum information needed. For example, instead of duplicating the information about a container, the database can store only a reference to it. Items store a reference id to a separate field in the container table as seen in (**FIG. 2)** To update an item's container information, only one field must change, the 'container id' field. These relational references allow the dataset to remain concise and easy to manage.

C. Query processing

MySQL provides powerful tools built into the language to process the data stored in the database. Some of these features include search functionality and relational join operations. The web application makes heavy use of the join operation. Joining tables together in queries allows the website to access the referenced fields from other tables. For instance, to retrieve the items in a container, the item and container tables must be joined together. This is done through a MySQL query as shown in (**FIG. 3).** Essentially that command links the two tables together by the given field. Once the tables are connected through that field, the referenced data can be accessed. This can be seen in the "Output Joined Table" in (**FIG. 3).** The output table can be interpreted as a list of items where each row is an item. The first two columns tell which container holds the item. Using join queries creates a reliable process for accessing the linked tables in the database.

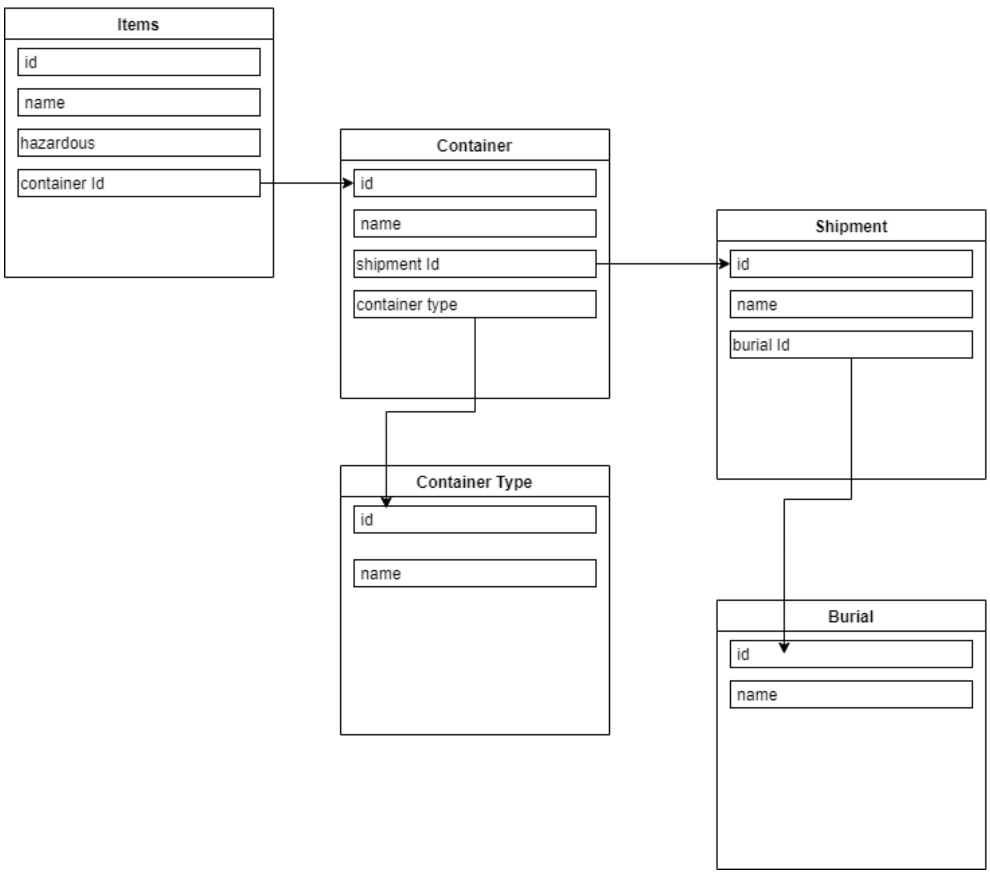

FIG. 2. Database relation diagram. An overview of how the tables of data relate to one another. Irrelevant fields and tables omitted.

MySQL Command:

SELECT * FROM container LEFT JOIN items ON container.id = items.container_id

Left Table: Containers

id	name
1	fuel container
2	trash bin

Right Table: Items

id	name	hazardous	container_id
1	spent fuel cell 1	Yes	1
2	spent fuel cell 2	Yes	1
3	trash 1	No	2

Output Joined Table:

id	name	id	name	hazardous	container_id
1	fuel container	1	spent fuel cell 1	Yes	1
1	fuel container	2	spent fuel cell 2	Yes	1
2	trash bin	3	trash 1	No	2

FIG. 3. Example left join query output. The output table after running a 'left join' on the container and items tables.

IV. FINAL PRODUCT

A. Website features

The website currently fulfills the requirements set forth by SLAC. Users can add items, containers, shipments, and burials to the database using their respective web views. Users may submit information about fields for items using the format depicted in (**FIG. 5)**. The website validates user input information to ensure the correct format for identification numbers and dates are used. The website will not accept incorrectly formatted data from users. Tool tips help users meet these specified requirements. The web page also calculates on the fly information about the item such as volume given in cubic feet.

After entering information into the website, users can generate reports (**FIG. 5)**. Reports display information such as a list of all items shipped between two dates. Users can see the list of items pertaining to that report and can click hyperlinks that bring them to that specific item's information page. The user can optionally export these reports to Excel for further documentation purposes.

Furthermore, items may be added to containers in the container view menu. The container view menu shows details about a container such as how much volume is occupied by items in cubic feet. Next, containers may be assigned to a shipment in the shipment view menu (**FIG. 6)**. The shipment view calculates the total volume occupied by the containers. Each shipment has a maximum volume capacity defined by the program.

Miscellaneous features include, searching records from tables by a specified field and adding attachments. Attachments may be added to items, containers, shipments, and burials where they are stored in the database. The website supports uploading and displaying image and PDF files with plans to expand to more file types.

B. Future expansions

While the website currently provides the basic functionality needed by SLAC, a roadmap of ideas in the planning phase will expand the scope of the project and add new useful features. A more detailed report generating system will be completed in the next phase of the project. The next iteration of report generating will include a menu that allows the user to specify conditions for any field in a table. For example, the user could generate a report of all hazardous items declared between two dates in a specific container. Another planned feature in the pipeline is a method for authenticating users. The website will authenticate with SLAC's user management system to provide access control for web pages. These features will further improve the documentation process for SLAC employees.

C. Final thoughts

Project development will continue after this internship reaches completion. The website will go into production mode and see real use here at SLAC. With that in mind, I dedicated time to ensure the project meets standards for expandability. The GitHub repository includes documentation for the next team of people to continue the project. I learned an incredible amount of information about database planning and website programming over the course of this internship. This was an excellent project to work on and I really hope my website makes an impact at SLAC.

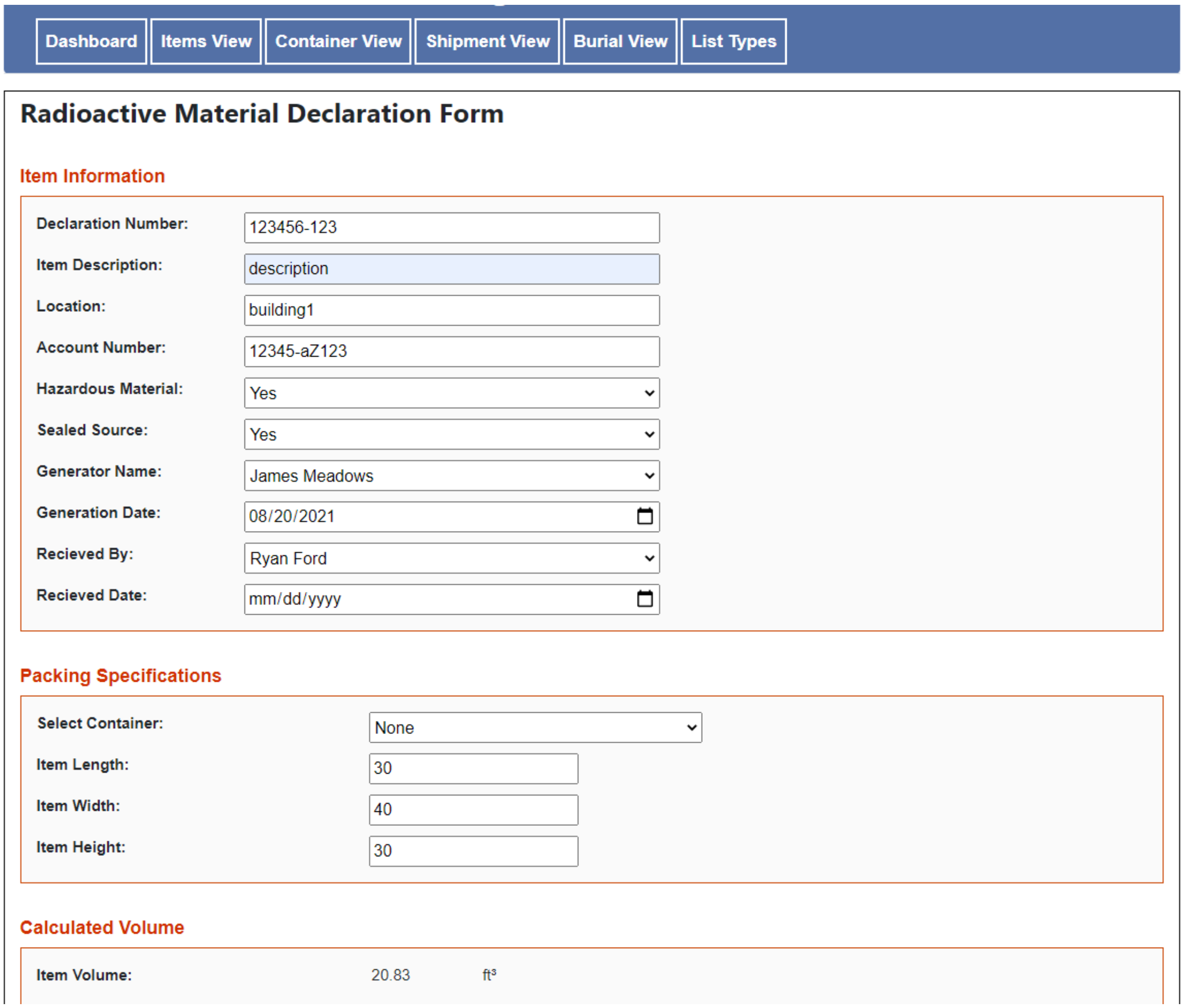

FIG. 4. Create item page. The web page where items are declared and added to the database.

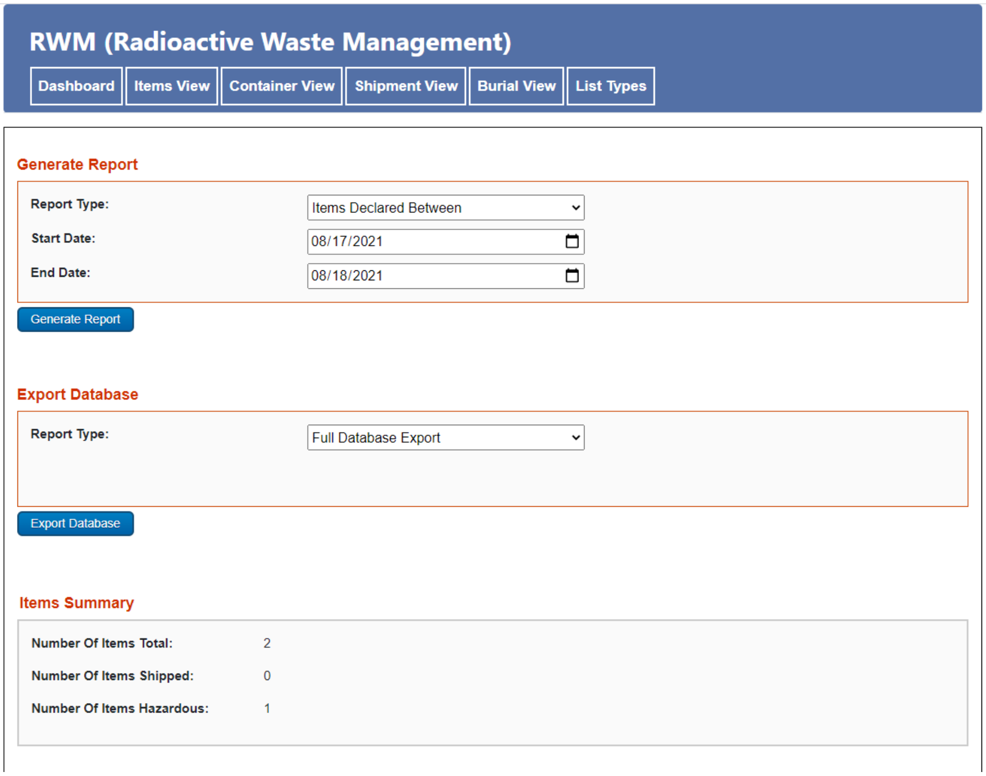

FIG. 5. Website dashboard. Generates reports about information in the database.

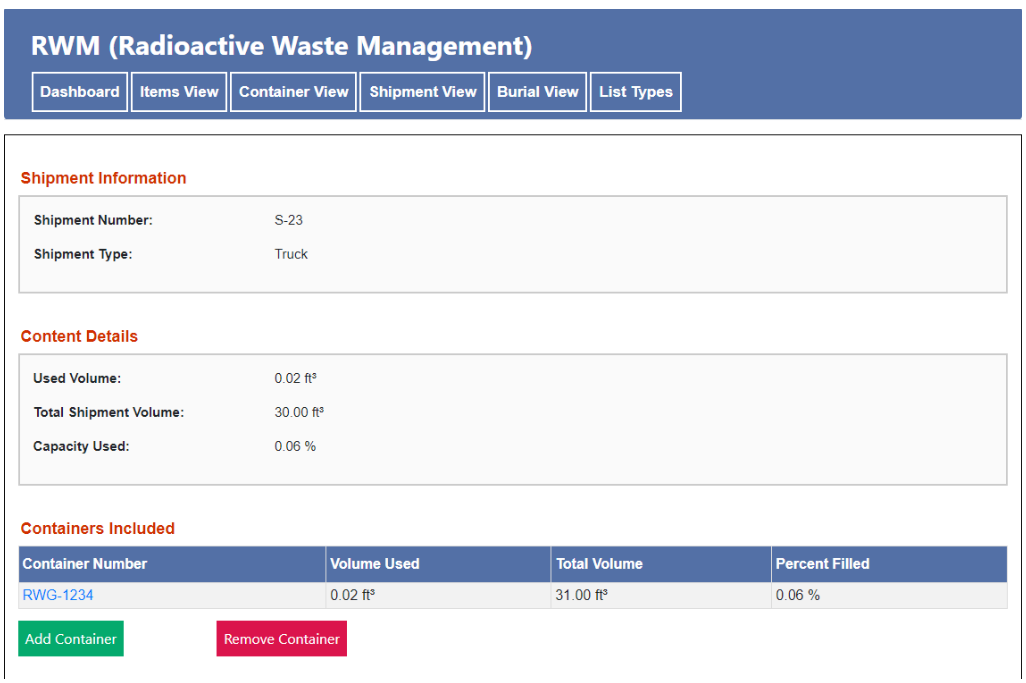

FIG. 6. Shipment view. View information about shipments. Add or remove containers here.

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