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Maintenance Plan for the APE 1236 Hazardous Waste Incinerator

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Abstract: In order to address the final life-cycle stage of ammunition stockpiles in the United States, munitions must go through the demilitarization process. Incineration provides demilitarization capabilities that are regulated by the federal government. The purpose of this report is to address the maintenance challenges facing the APE 1236, which is the Program Executive Office of Ammunition's (PEO Ammo) ideal method for demilitarization. The System's Decision Process serves as a methodological approach to the analysis and development of solutions for PEO Ammo. The SDP is an iterative and value based approach to decision making that involves four phases: Problem Definition, Idea Generation, Solution Design, and Decision Making. Research determined that the incinerators currently operate on an inconsistent response maintenance program that does not effectively utilize preventative maintenance procedures. The solution is an Excel based framework that allows PEO Ammo to record maintenance data and facilitate data analysis for future operations.

Keywords: Demilitarization, Systems Decision Process, Value Focused Thinking, Modeling, Maintenance Plan, PEO Ammo

1. Introduction

Demilitarization is a complex and critical stage in the life-cycle of munitions. The U.S Army faces significant challenge in addressing its demilitarization needs as stockpiles grow across the nation and at U.S installations abroad. Demilitarization includes the complete range of processes that renders weapons, ammunitions, and explosives unfit for their originally intended purposes. Incineration provides a controlled environment for destroying and disposing of munitions while enabling operators to monitor pollutant emissions regulated by the federal government. The Joint Munitions Command (JMC) under PEO Ammo operates the APE 1236, which is one of JMC's primary pieces of incineration equipment. PEO Ammunitions must address the unique challenges that accompany the maintenance of low density equipment. JMC currently operates on an inconsistent response maintenance program which does not effectively address its maintenance needs. The goal is to provide PEO Ammo with a long-term, preventative maintenance program that incorporates data collection with uniformity across the various incineration locations while adhering to state-dependent environmental regulations. The methodology involved in solving this type of problem includes a collaborative, iterative, and value based decision process that addresses the wants, needs, and desires of the stakeholder. This process is called the Systems Decisions Process (SDP), which includes four phases: Problem Definition, Solution Design, Decision Making, and Solution Implementation. This report addresses the first three phases to the SDP as it pertains to the maintenance plan for the APE 1236 incinerator, and includes conclusions, findings, and an explanation of the final proposed solution.

2. Background

Ammunition is essential for the U.S warfighter and will remain essential for the foreseeable future. Like all things, ammunition has a life cycle that, if unused, must end with destruction and disposal. Disposing of and destroying unserviceable or unused munitions is complex and extremely technical due to the explosive and dangerous nature of unexploded ordnance. The current U.S stockpile is estimated at almost 480,000 short tons of conventional ammunition, not including missiles and missile components. As this stockpile continues to grow, demilitarization and munitions management will become increasingly more important for the U.S Army, the U.S government, and the environment. Over the last few decades, the U.S Army has moved away from more traditional demilitarization methods such as Open Burning and Open Detonation (OB/OD) and towards more environmentally conscious methods such as Closed Disposal Technology (CDT). In order to meet increasing stockpiles of the U.S Army and adhere to binding environmental laws and regulations, the U.S Military has turned to incineration which requires strict monitoring and system upgrades in order to ensure it is adhering federal regulation. The

U.S Army uses a series of Ammunition Peculiar Equipment (APE) to achieve these objectives. The APE 1236 is a rotary kiln deactivation furnace that demilitarizes and disposes of small munitions such as fuses, detonators, and small arms ammunition (Stratta, 1996). The APE 1236 is a tool that aims to alleviate ongoing environmental issues that threaten individual safety and improve the way the Armed Forces utilizes its resources. In order to realize the mission of PEO Ammo, the APE 1236 must operate on an efficient and well-monitored preventative maintenance plan.

3. Methodology

The SDP, illustrated in Figure 1, provides the basis for decision making. As systems become increasingly more complex, dynamic, and interconnected, it is important to approach systems decision making with value-focused thinking. The SDP is a collaborative, iterative, and value-based decision process that can be applied in any system life cycle stage.

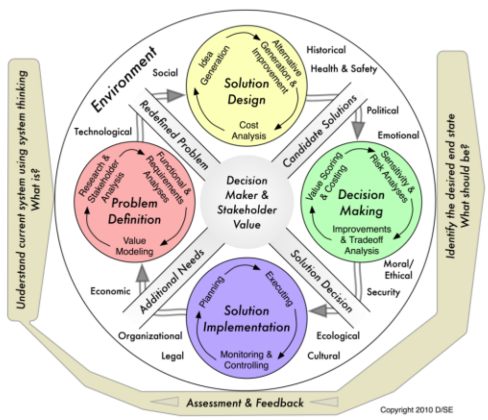

Figure 1. Systems Decision Process

The SDP begins with the problem definition phase, which focuses on understanding the current system and its foundations. The process involves taking an extensive look at the decision maker and stakeholder values, focusing on the important system functions, objectives, requirements, and constraints. The problem definition phase includes *research and stakeholder analysis*, *functional and requirements analysis*, and *value modeling*, which are used to create the Fundamental Objective (FO) and redefined problem statement. The fundamental objective is the absolute minimum that the system should accomplish, while the redefined problem statement clearly outlines what the issues are that the proposed solution must address. One tool used in the problem definition phase is the systemigram, which provides a holistic visual representation of the systems and subsystems. The systemigram describes each entity in the system and how they are connected to one another. The systemigram allows individuals to understand all the potential stakeholders that will be affected or will have influence over the candidate solution. From there, a functional flow block diagram (FFD) determines the interrelationships between the functions of the existing system, ultimately providing a deeper understanding of all the potential problems that must be addressed. All of the findings from research and stakeholder interviews are compiled into a findings-conclusions-recommendations matrix (FCR) which clearly outlines recommendations for the future system. The FCR matrix is simply a summarization of the research, the implications of the research, and the resulting recommendations to address the problems in the system. The systemigram, FFD, and FCR matrix all inform the functional hierarchy (FH). The functional hierarchy is a hierarchy of the major function, objectives, and value measures that will determine the candidate solution. The value measures are the values that describe the various benefits of the proposed candidate solutions. Finally, the stakeholder decides what weights to assign each value measure, and a weighted candidate solution can be determined that best fits the needs, wants and desires of the stakeholder.

4. Analysis

The purpose of this research is to develop a maintenance program for PEO Ammo and JMC to use for the APE 1236 Hazardous Waste Incinerator. The initial statement provides context to the situation by focusing on the needs, wants and desires of the stakeholders. The following is the initial problem statement for the maintenance program project:

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The APE 1236's current maintenance program is inefficient and causes long delays. Create a preventative maintenance program which effectively utilizes the workforce and addresses potential failures before they occur.

A stakeholder interview provides initial research data from the client that outlines their needs, wants, and desires. The stakeholders provide insight into the operations of the incinerator and the maintenance challenges across the five APE 1236 locations. A site visit at Tooele, Utah, allows for further research through observation of the incinerators and consolation with operators and subject matter experts who work with the equipment. The literature review allows for a well-rounded understanding of the machine, its history, and its importance. Information gathered from the literature and stakeholder interviews informed the systemigram, shown in Figure 2, which illustrates all the entities within the system and how they interact with one another.

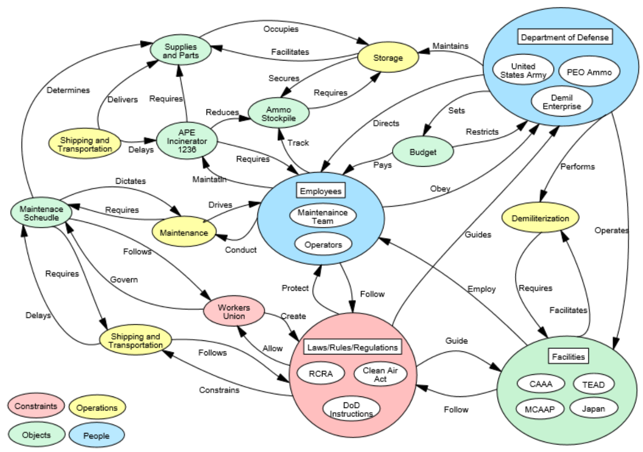

Figure 2. APE 1236 Maintenance Systemigram

The systemigram creates a visual representation of the complexity of the system and determines how each component relies on or impacts others. The U.S Army assigns PEO Ammo and Demil Enterprise with the mission of destructing hazardous waste and ammunitions from U.S stockpiles. PEO Ammo operates facilities in Tooele, McAllister, Crane, and Japan. All locations have varying environmental requirements and regulations which must be followed in order to continue operations. These regulations, the RCRA, Clean Air Act, and the military's DoD Instructions heavily monitor APE 1236 operations for compliance. The maintenance schedule is influenced by the ability of the employees and the allowances of worker's unions. Operation of the APE 1236 depends on the current stockpile of ammunitions and is constrained by the available storage of supplies and inventory. Visualizing the system through the systemigram allows for a better understanding of the constraints and confounding variables of the system.

The literature review, initial stakeholder interviews, and the systemigram all informed the FCR matrix. The research resulted in eighty findings, which generated sixteen conclusions and four recommendations: Demilitarization is a critical task for the U.S; incineration through the APE 1236 is the most environmentally conscious method for demilitarization; maintenance procedures for the APE 1236 are based on an ineffective response model, and that demilitarization needs must be maintained on a budget across all respective depots.

The recommendations generate the Fundamental Objective (FO), which is the foundation for the Functional Hierarchy (FH) and the Qualitative Value Model (QVM). The FO is stated below:

Develop a <u>reliable, efficient, and sustainable</u> preventative maintenance program in order to <u>support continuous operations</u> of the APE 1236 at all locations to support the mission of PEO Ammo and Demil.

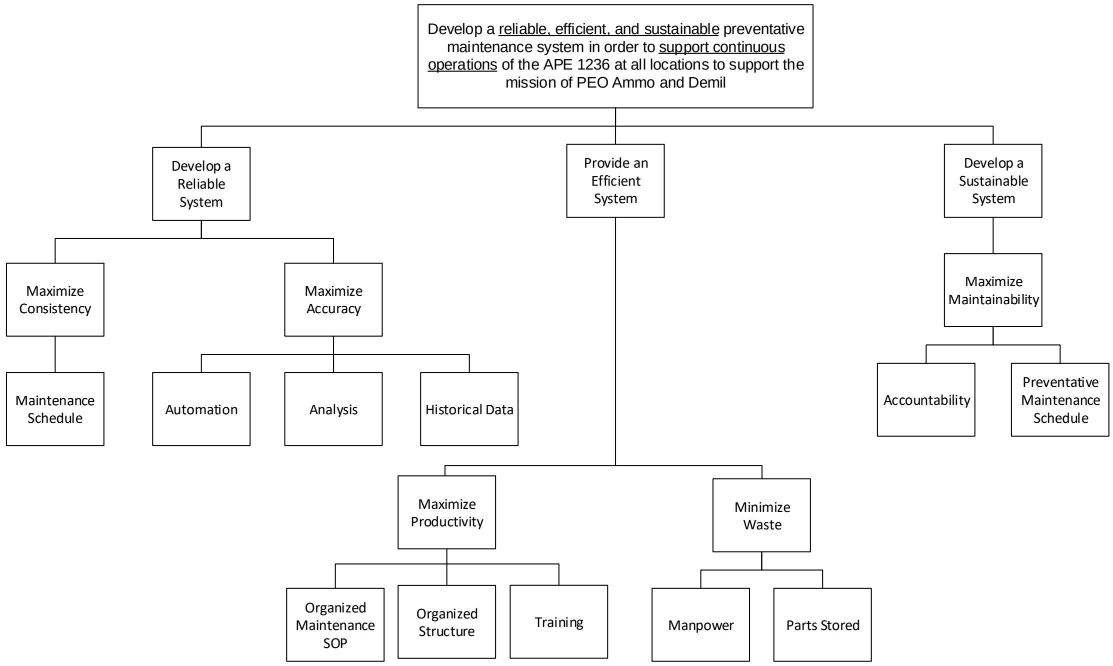

Figure 3. Maintenance Program Qualitative Value Model

The FH is created by using the FO to develop top level functions. The FO is broken down into the following functions: develop a reliable system, provide an efficient system and develop a sustainable system. Because the SDP is a value-based decision process, these functions were determined through stakeholder interviews. Each function is listed in the FO and therefore directly ties into what the project should accomplish. The FH is broken down into objectives and value measures. The resulting QVM shown in Figure 3 drives decision making by allowing the stakeholder to place values on the specific components of the project.

The QVM was completed with the stakeholder analysis of each value measure. From this information a redefined problem statement was developed which explains the problem in sufficient and accurate detail:

PEO Ammo's APE 1236 currently operates on an inconsistent response maintenance program which does not effectively utilize the workforce or address the best method for maintaining the incinerators. In order to address these challenges, the project maintenance program must incorporate reliable data analysis in order to provide sustainable, long-term support to the APE 1236 and facilitate more efficient operations in the future.

The redefined problem statement drives the solution design phase. Brainstorming and morphology lead to various candidate solutions. These candidate solutions included design characteristics to address each component value measures from the FH. The alternative solutions varied between creating an excel based model or an access based model. Other solutions, such as purchasing maintenance programs commercially, were not considered due to feasibility screenings and practical applications. The candidate solutions were then scored using the value measures from the QVM and the swing weights determined by the stakeholder. Ultimately, the highest scoring candidate solution was an excel based Incinerator Maintenance Program (IMP) model that has the ability to archive all maintenance activity, preventative maintenance checks and services (PMCS) schedules and procedures, and utilizes charts and graphs in order to track maintenance statuses. A sensitivity analysis was conducted on the weights of the value measures and resulted in no sensitivity to the selected solution.

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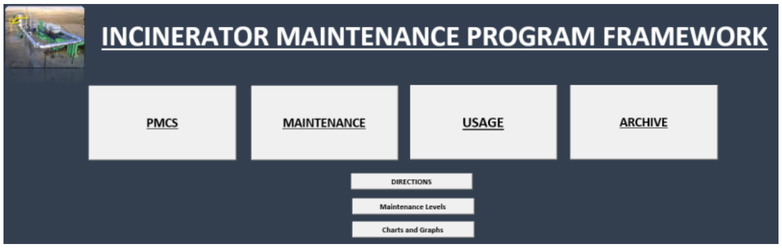
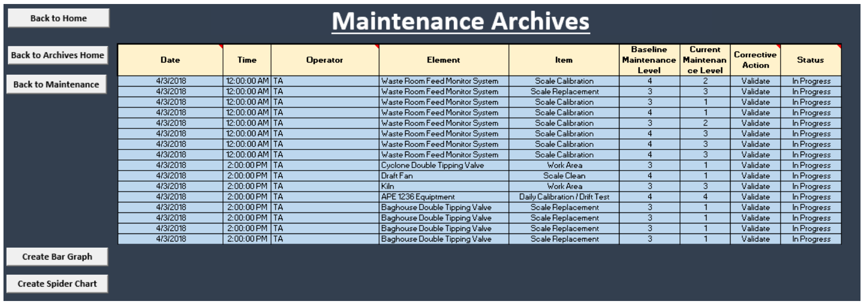


Figure 4. – IMP Model Framework

Although sensitivity analysis concluded that certain aspects of the solutions were sensitive (SOP, Analysis, Historical Data), the stakeholder placed the most significance on automation. Due to stakeholder feedback, an excel based framework was determined to be the most user-friendly option for the Depots and subsequently was determined to be the most optimal candidate solution. Figure 5 provides an example of the final candidate solution, which is a maintenance log that tracks and archives maintenance data through the IMP model.



Date	Time	Operator	Element	Item	Baseline Maintenance Level	Current Maintenance Level	Corrective Action	Status
4/3/2018	12:00:00 AM	TA	Waste Room Feed Monitor System	Scale Calibration	4	2	Validate	In Progress
4/3/2018	12:00:00 AM	TA	Waste Room Feed Monitor System	Scale Replacement	3	3	Validate	In Progress
4/3/2018	12:00:00 AM	TA	Waste Room Feed Monitor System	Scale Calibration	3	1	Validate	In Progress
4/3/2018	12:00:00 AM	TA	Waste Room Feed Monitor System	Scale Calibration	4	1	Validate	In Progress
4/3/2018	12:00:00 AM	TA	Waste Room Feed Monitor System	Scale Calibration	3	2	Validate	In Progress
4/3/2018	12:00:00 AM	TA	Waste Room Feed Monitor System	Scale Calibration	4	3	Validate	In Progress
4/3/2018	12:00:00 AM	TA	Waste Room Feed Monitor System	Scale Calibration	4	3	Validate	In Progress
4/3/2018	12:00:00 AM	TA	Waste Room Feed Monitor System	Scale Calibration	4	3	Validate	In Progress
4/3/2018	2:00:00 PM	TA	Cyclone Double Tipping Valve	Work Area	3	1	Validate	In Progress
4/3/2018	2:00:00 PM	TA	Draft Fan	Scale Clean	4	1	Validate	In Progress
4/3/2018	2:00:00 PM	TA	Kiln	Work Area	3	3	Validate	In Progress
4/3/2018	2:00:00 PM	TA	APE 1236 Equiptment	Daily Calibration / Drift Test	4	4	Validate	In Progress
4/3/2018	2:00:00 PM	TA	Baghouse Double Tipping Valve	Scale Replacement	3	1	Validate	In Progress
4/3/2018	2:00:00 PM	TA	Baghouse Double Tipping Valve	Scale Replacement	3	1	Validate	In Progress
4/3/2018	2:00:00 PM	TA	Baghouse Double Tipping Valve	Scale Replacement	3	1	Validate	In Progress
4/3/2018	2:00:00 PM	TA	Baghouse Double Tipping Valve	Scale Replacement	3	1	Validate	In Progress

Figure 5. Maintenance Log for IMP

This data, archived over time, will provide the basis for future analysis. Some useful tools from the IMP model include graphs and charts that visually describe the current status of the individual incinerator sections. Figure 5 provides an example of the generated spider chart, which depicts the ideal and current levels of maintenance for the incinerator. The goal is to have current maintenance levels (red line) meet the ideal maintenance levels (blue line) over time, indicating more efficient maintenance operations. The spider graph provides a great visual representation of systems that are not performing to standard.

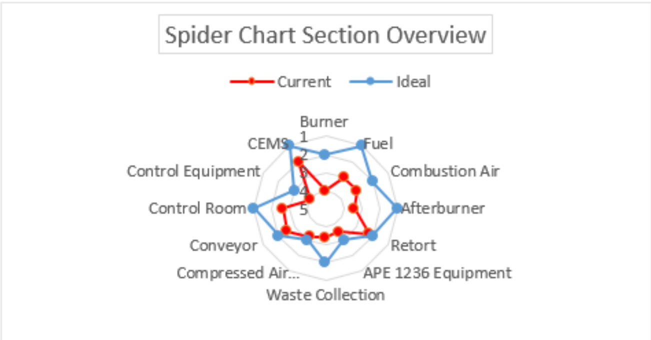


Figure 6. Example Spider Chart for an archived Maintenance Log.

The excel IMP model provides a user friendly interface that archives important maintenance and PMCS data for the APE 1236. This information will provide the basis for important follow-on analysis that can inform a more efficient maintenance and storage plan for the APE 1236.

5. Conclusion

The objective of this research was to evaluate the current status of demilitarization using the APE 1236 incinerator and create a maintenance program that helps reduce stockpiled munitions while ensuring consistent operations. The IMP model developed analyzes the plan for all incinerators over time. Major findings led to recommendations which drove the development of the fundamental objective. The fundamental objective was used to create a functional hierarchy, which resulted in value measures. Value measures lead the decision making process because they highlighted the needs, wants, and desires of the stakeholder and ensured that the project met his intent. The redefined problem statement informed the solution design phase, which ultimately lead to the creation of the IMP Model for data collection and analysis.

The IMP model that enables the collection of maintenance, usage, and failure rate data for PEO Ammo. This data will ultimately allow PEO Ammo to conduct data analysis on their maintenance procedures. This analysis will facilitate updates to their PMCS procedures, allow them to make informed decisions about storage allocation and parts management, and ultimately create a running archive of data for future analysis. The future maintenance data has the potential to be used for failure rate analysis of the APE 1236, the types of munitions being incinerated, and the number of hours the incinerator is running. The IMP model is user friendly and easily accessible making it the ideal solution for an organization with multiple individuals, who are spread throughout the US and Japan.

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