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Development and Application of a Methodology for Evaluating Type II Expired Shelf Life Hazardous Material Generation in the United States Air Force

Thesis

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Thesis

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The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U. S. Government.

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Abstract

The Pollution Prevention Act of 1990, Air Force Directive 19-4, and the Air Force Pollution Prevention Plan require installations to reduce the amounts of hazardous waste generated. To meet the requirements set forth in these documents, each waste stream containing a hazardous waste needs to be identified and characterized for changes in policies or procedures that would reduce the hazardous waste generated. This research develops a methodology to determine the amount of materials with a type II shelf life that is disposed of as hazardous waste because the shelf life expired while the material was in base supply storage. This methodology is then applied to determine the portion of the total waste stream accounted for by these materials.

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I. Introduction

General Issue

Every year an estimated 400,000 tons of hazardous waste is generated by the Department of Defense. Of this amount, an estimated 96,000 tons are attributable to the Air Force (12:8). Disposal of this amount of waste is a costly endeavor. The bill for the disposal of hazardous waste for the Department of Defense came to over $92 million in 1990 (14:15). Because of these costs, and recent pollution prevention legislation, the Department of Defense and the Air Force are working to prevent hazardous waste generation at the source.

The Pollution Prevention Act of 1990 mandates the use of pollution prevention techniques by all generators of hazardous waste. This act establishes a hierarchy of preferred pollution prevention methods. In order of preference these methods are:

1) Source Reduction
2) Recycling/Reuse
3) Treatment
4) Disposal

Although the Pollution Prevention Act has not been codified and entered into the Code of Federal Regulations by

the United States Environmental Protection Agency (EPA), to began EPA has started planning how it plans to implement pollution prevention regulations. When possible, the EPA wants to regulate pollution prevention using market-based incentives by contining to enforce environmental regulations creating an incentive for companies to adapt pollution prevention because of increasing costs (1:18). By strictly regulating waste treatment and management, the EPA plans to create an incentive to practice pollution prevention methods rather than use costly and less reliable compliance methods (1:27-28).

The Air Force developed a pollution prevention program for hazardous waste when, in 1992, the Secretary of the Air Force issued a directive that specifically stated that to the extent possible, the Air Force will prevent waste generation at the source (4:1). This directive was followed by a Pollution Prevention Program Action Plan in which the third objective is to reduce waste generation at installations. This plan sets goals of identifying processes and systems which generate hazardous waste by the end of 1993, and reducing the amount of hazardous waste disposed of by 25 percent by 1996 and by 50 percent by 1999 (5:3-5).

The goals of the Pollution Prevention Program Action Plan include all hazardous waste streams located all bases. One waste stream that occurs on bases includes items that

must be disposed of because their shelf life has expired. Items such as paints, paint thinners, solvents, oils, batteries, and cleaning supplies have expiration dates stamped on the containers. These expiration dates are based on the expected time until the container or material begins to degrade. For most materials, this date is two to five years from the date of manufacture. Once the expiration date has passed, if the shelf life cannot be extended, and the material meets the hazardous waste criteria, the material must be transferred to the Defense Reutilization and Marketing Office (DRMO) for disposal (17:11-1).

In 1985, the DOD contracted to Ch2m-Hill for a study of modifications that would improve industrial processes in Army, Air Force, and Navy facilities. One of the areas addressed by T. E. Higgins, the author of the resulting report, was the purchase and use specifications of materials with a shelf life designation. These specifications include the length of shelf life assigned to materials at purchase, stock control and maintenance procedures, and shelf life extension procedures. In his work, Mr. Higgins presented the opinion "that expired shelf-life items constitute a significant percentage of the hazardous wastes produced by the military" (17:11-2). The U. S. Navy estimated that 13 percent of all hazardous waste turned into the Defense Property Disposal Office (DPDO), predecessor to the DRMO, by the Naval Ship Yard and Naval Air Rework Facility in Norfolk

Virginia was material with an expired shelf life. The estimated cost of purchasing material and properly disposing of it as hazardous waste at Norfolk Naval Base was over one million dollars. These observations characterized only Norfolk DPDO, but they describe the percent of hazardous waste generation that could potentially be due to expired shelf life materials (17:11-4).

Expired shelf life material is one part of the waste stream that is important because as a source of hazardous waste, expired shelf life items meet the criteria for the highest ranked hazardous waste reduction technique, source reduction. The PPA specifically states that "source reduction is fundamentally different and more desirable than waste management and pollution control" (26:3).

A management technique routinely used by the Air Force is the designation of materials with a shelf life as type I or type II materials. Type I items are items which have an nonextendable shelf life. Type II items include items that have an assigned shelf life that can be extended once it has expired. To extend the shelf life of type II items, the integrity of the material and its container are tested (6:14-42). Designating shelf life materials as type I or type II allows for the extension of the shelf life of materials that might otherwise require disposal. This decreases both the need to purchase more of the item, and the amount of waste generated by the disposal of shelf life items.

However, this is only one method of source reduction that could be implemented to reduce disposal amounts. Other ways to decrease this amount include assigning a longer shelf life initially, and implementing stricter inventory control programs (12:41).

Definition of terms

Hazardous Materials: materials that are potentially dangerous enough to require that special control measures be taken so that no harm is done to life or property (6:10-159 through 10-161).

Hazardous Waste: "solid waste that exhibits the characteristics of ignitability, corrosivity, extraction procedure toxicity, and reactivity, or appears on any of EPA's lists of hazardous waste" (12:40).

Shelf life: time a material can be unused and in storage before being tested or condemned (6:1-50). The designated shelf life period begins on the date that the item is manufactured, cured or assembled, or on the date on which the integrity of the item was last tested or inspected (6:10-125).

Shelf life items: all items assigned a shelf life code according to Air Force Manual 67-1 (6:14-42).

Type I shelf life materials: "item of supply which is determined through an evaluation of technical test data and/or natural experience to be an item with a definite nonextendable period of shelf life" (6:10-133).

Type II shelf life materials: "item of supply having an assigned storage time period that may be extended after completion of inspection, test, or restorative action" (6:10-133).

Research Objective

The Pollution Prevention Act of 1990, Air Force Directive 19-4, and the Air Force Pollution Prevention Plan require installations to reduce the amount of hazardous waste generated. To meet the requirements set forth in these documents, each waste stream containing a hazardous waste needs to be identified and characterized for changes in policies or procedures that would reduce the hazardous waste generated. This research will develop a methodology to determine the amount of materials with a type II shelf life that is disposed of as hazardous waste because the shelf life expired while the material was in base supply storage. Type II materials were selected for this study because these materials comprise the largest portion of the shelf life materials managed by the supply system. This

information will then be used to determine what portion of the total waste stream is accounted for by these materials.

Specific Research Question

This research will develop a methodology that can be used within the Air Force to quantify the amount of waste generated when the shelf life of type II materials expires, and compare this amount to the total amount turned in to the DRMO.

Research Questions

To complete this study, the following questions will be addressed.

1. How can the volume of type II material, turned in to the DRMO after being rejected from serviceable stock by the base supply system's shelf life inspection program, be quantified?

2. What volume of type II material is turned in to the DRMO after being rejected from stock by the Base Supply System's Shelf Life Program?

3. How can the volume of type II material turned in to the DRMO be quantified?

4. What volume of type II material is turned in to the DRMO?

5. What percent of type II material turned in to the DRMO for disposal originates in Base Supply?

Scope/Limitation of the Research

This study will be limited to inspections of type II materials that occurred during a six month period extending from January 1993 through June 1993 at Wright-Patterson AFB. These materials include items such as sealing compounds, cleaning solutions, photochemicals, and lubricants.

In addition, this search will be limited to materials that are identifiable in the records kept by Base Supply. The identifiable materials include materials that enter the Base Supply System, and are then turned in to the DRMO. Unidentifiable materials would include items that are purchased locally using discretionary funds, or items that might be taken off of the Installation by a contract that is not administered by DRMO.

Summary

Each year the Air Force generates about 96,000 tons of hazardous waste. The Pollution Prevention Act of 1990 and the Air Force's Pollution Prevention Plan are designed to drive down the amount of hazardous waste generated through the use of waste reduction techniques. Source reduction is the preferred method for reducing hazardous waste, and includes the reduction of wastes generated due to shelf life expiration. This research encompasses type II shelf life materials that are identifiable in the base level supply system. The goal of the research is to develop a methodology that can be used to quantify expired shelf life waste.

As part of this research, the amount of material waste generated by the shelf life program will be determined. In addition, the amount of these materials transferred to DRMO will also be quantified. These two amounts will then be compared to determine the percentage of the total material turned in to DRMO that is generated by the shelf life program. These steps will validate the methodology.

The following chapters will describe the effort undertaken to complete this research. Chapter II will discuss the reasons for doing this research, the Pollution Prevention Act of 1990, describe the base supply and disposal system, discuss recent developments in hazardous material management, and summarize the Base Supply shelf life program. Chapter III will describe the methodology developed and used. Chapter IV will report the findings from this research. Chapter V will include an analysis of the findings and recommendations.

II. Literature Review

This chapter summarizes the Pollution Prevention Act as the legislation that is driving the reduction of hazardous waste using methods such as source reduction in the United States. In addition, previous studies on the generation of waste from material management will be summarized. This chapter will also describe the Standard Base Supply System (SBSS). The section on the SBSS summarizes how materials are issued to using organizations when the material is available, and how materials are purchased and then issued to using organizations when the material is unavailable. Then the base shelf life and health hazard programs will be described, followed by a description of the process of disposing of the material through the DRMO. Finally, this chapter will discuss alternative methods of managing a stock of hazardous materials that are being evaluated.

Legislation

Environmental issues have commanded increasing public concern since the Rivers and Harbors Act was passed in 1898 to eliminate pollution in navigable waters (27:20). Since then, legislation has been passed to control hazardous wastes entering the water, air, and lands of the United States. The prominent pieces of legislation leading to the Pollution Prevention Act deal with hazardous waste management and disposal. These acts include the Clean Air Act,

the Clean Water Act, the Resource Conservation and Recovery Act (RCRA).

The Clean Air Act. In 1970, the Clean Air Act was passed to control pollutants being released into the air. Amendments in 1977 and 1990 increased the scope of the legislation. Today the Clean Air Act provides a basis for regulation of mobile pollution sources, stationary pollution sources, chemicals contributing to acid precipitation, and ozone threatening chemicals. Under this act, the EPA established ambient air quality standards for pollutants listed by the EPA, and performance standards for sources emitting hazardous substances into the air (10:524).

The Clean Water Act. Passed in 1972 as the Federal Water Pollution Control Act, amended and renamed in 1977, the Clean Water Act was established to allow regulatory control of toxic substances entering the waters of the United States. This act allows the EPA to limit pollutants in effluent flows, set water quality standards, establish a permit system, develop provisions for oil spills and releases of toxic substances, and grant money for the building of publicly owned treatment facilities (10:68).

Resource Conservation Recovery Act. The Resource Conservation and Recovery Act (RCRA) was passed in 1976 to guide the management of hazardous waste in the United States. As amended by the Hazardous and Solid Waste Amendments of 1984, this legislation establishes the criteria

that a waste must meet to be considered a hazardous waste, and requirements for companies, individuals, and government agencies involved in the generating, transporting, and disposing of hazardous waste (10:406). RCRA establishes the criteria wastes must meet to be considered hazardous wastes, and the classifications under which hazardous wastes fall: listed, or characteristic.

Listed Waste. Listed wastes include unused chemicals appearing on either of two list of hazardous wastes. These lists were developed by the EPA for the purpose of identifying hazardous wastes. "P" listed wastes are unused chemicals that have been declared acutely hazardous by the EPA. "U" listed wastes include unused chemicals that have been designated as hazardous by the EPA (10:412-413). Items appearing on either of these lists require disposal as a hazardous waste.

Characteristic Wastes. Characteristic wastes include wastes that meet the requirements of ignitability, corrosivity, toxicity, or reactivity. Materials meeting any of these requirements would require disposal as hazardous wastes.

Ignitable wastes include wastes that could cause or intensify a fire. To be considered ignitable, a waste must meet one of the following four criteria:

1. Be an aqueous solution that is less than 24 percent alcohol with a flash point below 140 degrees Fahrenheit (60°C),

2. Be a solid or gas that, when subjected to stresses such as friction, moisture or chemical changes, could initiate combustion or burn vigorously once combustion has started, or

3. Be defined as an ignitable compressed gas under Department of Transportation regulations,

4. Be defined as an oxidizer under Department of Transportation regulations (10:414).

Corrosivity was included in RCRA because the EPA determined that a waste that could corrode metal could also degrade its container and containers of other wastes. The EPA also believed that waste that is either very acidic or basic could harm human tissue and react dangerously with other wastes. To meet the requirements of corrosivity, a waste must either have a pH of less than or equal to 2.0, or greater than or equal to 12.5, or corrode steel faster than 6.35 millimeters annually (10:414).

Reactivity is a characteristic that describes a waste's potential to react violently during management operations such as storage, transportation, and disposal. The EPA was unable to develop test protocols for this characteristic so it issued a narrative definition of reactivity that is used

to determine that a waste should be considered reactive (10:414-415).

The characteristic of toxicity was included in RCRA to identify wastes that could result in contamination of groundwater if mismanaged. To determine if wastes meet the toxicity characteristic, the Toxicity Characterization Leaching Procedure (TCLP) is used. This procedure tests for 25 organic compounds, eight inorganic compounds, and six insecticides/herbicides that could leach into the groundwater (10:415).

Wastes meeting the requirements identified by RCRA as listed or characteristic wastes are subjected to strict cradle-to-grave control measures. These control measures require the generator of waste to track the waste through the transportation and disposal process, as well as requiring the generating facility, the transporting party and the disposal facility to be permitted. Under RCRA authority, the EPA also established controls and restrictions on the land disposal of hazardous waste (19:186).

The Pollution Prevention Act. Enacted in 1990 to establish pollution prevention policy for the United States, the Pollution Prevention Act (PPA) directly addresses waste reduction. The PPA gives the EPA the authority to develop a program to attack waste before it is generated, and designates source reduction as the preferred method of reducing

pollution. A hierarchy of methods for applying pollution prevention is stated in the policy statement.

> The Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner. (26:3-4)

Figure 1 presents each of the methods of pollution prevention mentioned in the Pollution Prevention Act and how each is applied to reduce waste.

Source Reduction. Source reduction is defined as "the reduction or elimination of waste generation at the source, usually within a process" (4:40). As seen in Figure 1, source reduction includes changing products by using a less hazardous product, using less of the product, substituting less hazardous components into the product, and source control. Source control is achieved by changing the material going into the product by starting with a pure or less hazardous material, improving the technology used in a process, or changing the operating practices. Technology changes include altering the processes used so that a smaller quantity of hazardous waste is generated, or so that the waste generated is less hazardous. An example of this is the Air Force's recent change from stripping solvents to

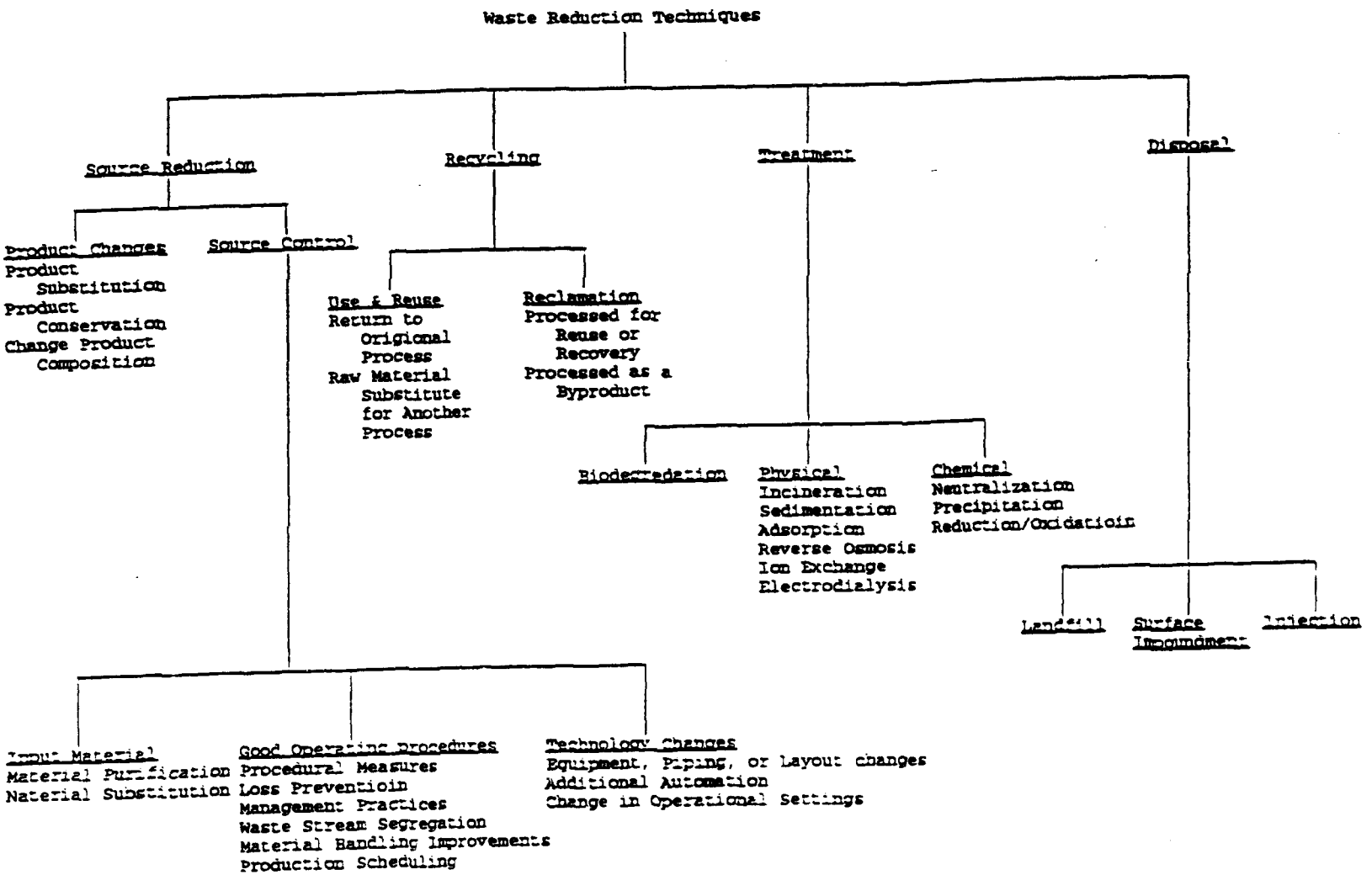

Figure 1. Waste Reduction Techniques (23:24, 19:260)

bead blasting in paint removal operations. Other technology changes include updating equipment and changing operational settings. Operating practices include procedural measures, loss prevention methods, management practices, waste stream segregation, material handling techniques, and production scheduling. Examples of management practices are methods for determining and assigning the shelf life to an item and material issuance procedures (25:24).

Recycling. The two types of recycling presented in Figure 1 are use and reuse, and reclamation. These pollution reduction techniques both involve finding a use for a waste after it has been produced. In use and reuse, the waste is used directly in the process that produces it or as a substitute for a raw material in another process. In both of these instances, the waste is not treated prior to being used. When a waste is reclaimed it is processed for reuse. Selling expired shelf life materials and using recovery systems that collect wastes such as antifreeze and process them to remove or concentrate the contaminants are examples of reclamation techniques (25:24).

Treatment. Treatment procedures include biological, physical, and chemical procedures. Each of these treatment techniques renders the waste less hazardous or reduces the volume of hazardous waste. Aqueous biological systems involve pumping the contaminant into a treatment facility for consumption by microorganisms. This

includes pumping wastes into a publicly owned treatment facility or a base-operated waste treatment plant that uses microorganisms to break down the hazardous constituents (11; 19:260).

Physical processes include incineration, sedimentation, adsorption, reverse osmosis, ion exchange, and electrodialysis. These processes either concentrate the contaminants or transfer them to another medium. For example, sedimentation concentrates the waste by allowing it to settle to the bottom of the treatment facility or attach to bubbles that are introduced in the treatment process. Adsorption involves the transfer of the waste from one medium, such as water, to another, such as activated carbon. In this process the waste stream is introduced to granular activated carbon to which the contaminant adsorbs (11).

The applicability of chemical processes depends on the type of waste being generated. Neutralization can only be applied to wastes that meet RCRA's criteria for hazardous wastes. Similarly, precipitation works best to remove heavy metals from solutions. Oxidation/reduction reactions have been used successfully on many wastes such as benzene, phenols, other organic compounds, chromium VI, mercury, lead and chlorinated organics (19:258).

Disposal. Disposal is the least preferred method of pollution prevention because it does not change the waste to reduce the hazards associated with it. Landfilling and

injection both involve placing the waste into the surface of the earth. Surface impoundment is the above ground storage of hazardous waste. Release includes allowing the waste to dissipate into the environment (19:265).

Disposal and treatment are the least preferred method of managing hazardous waste. They are also the methods that have become more costly as more environmental legislation is passed and the facilities available for disposal become less available. In the last decade, the cost of hazardous waste treatment and disposal has increased as much as 300 percent (1:5). Pollution prevention, on the other hand, "has the potential to save raw material (including energy), reduce present and future waste management costs, minimize liability, and earn public goodwill" (1:17).

Source Reduction Procedures in Inventory Management. Source reduction as a pollution prevention technique includes inventory management, the combination of inventory and material control. Wastes resulting from inventory management include "out-of-date, off-spec, contaminated or unnecessary raw materials" (22:41). By changing inventory control programs, companies in the private sector have successfully reduced their wastes resulting from inventory management (22:41). Some of the changes implemented include changing the shelf life program, replacing materials entering a process with a less hazardous substitute, educating purchasing personnel in the special needs of items

such as shelf life and potentially hazardous items, and reviewing the assigned shelf life of hazardous materials.

Shelf Life Program Studies

Two studies that relate to shelf life materials have been completed. The first of these studies resulted from a contract between the U.S. Army Corps of Engineers, the DOD Environmental Leadership Project Office, and Ch2m-Hill. The purpose of the study was to identify three industrial processes provided the greatest potential for application of hazardous waste reduction techniques. To accomplish this, Ch2m-Hill evaluated 40 industrial processes used by the Army, Navy, and Air Force (17:1-1). This evaluation was based on "costs, energy consumption, technical practicality, management, incentives, and program monitoring and auditing" (17:1-2). Eighteen processes were chosen for further study. Of these 18, three were chosen for waste reduction technique implementation. One of the processes identified in the initial 40 processes was the purchase and use specifications of shelf life items.

For evaluation of the purchase and use specifications of shelf life items, wastes generated at the Naval Ship Yard and Naval Air Rework Facility at Norfolk, Virginia was evaluated. The wastes from both of these facilities are accepted by the Norfolk Public Works Center (NPWC) for collection, packaging, and labeling prior to transfer to the

DRMO. The NPWC is able to track and monitor the wastes generated. In 1983, 477,000 gallons of hazardous waste were processed through the NPWC. The NPWC estimated that half of this was "virgin material with an expired shelf-life" (17:11-3). In 1991, a similar estimate was generated based on waste transferred to the Norfolk Hazardous Waste Disposal Facility. For the month of April, 13 percent (3,500 gallons) of the waste stream was attributed to items with an expired shelf life (17:11-4). The study did not include any recommendations for reducing the amount of shelf life material transferred to the disposal facility because its shelf life had expired. Additionally, since the waste generated by this industrial process was not easily quantified, the process was not selected for further study.

Following the study completed by Ch2m-Hill, the Navy contracted with Arthur D. Little, Incorporated to evaluate the shelf life of 55 commodities disposed of by the Navy. This study was undertaken after the Naval Supply Systems Command estimated "eighty percent (80%) of the hazardous material turned in for disposal by the Navy is unused and in its original packaging" (9:2-1). To complete the study, first, the items to be studied were chosen based on the value of the material before disposal. Those items which had a total material value of $1000 or more prior to disposal were identified for further study. This list of 600 materials was then limited to items that had a shelf

life term. This second elimination resulted in a list of 215 materials.

To choose the 55 items disposed of in the largest quantities, the quantity disposed for each item was determined from records obtained from the Defense Reutilization Marketing Service (DRMS). For this study, Arthur D. Little assumed that all materials received by the DRMS were attributable shelf life expiration. This assumption is not critical to the study because the ranking of the material by quantity will not change whether the total amount of material compared or a percentage of the material is compared. The shelf life term of the 55 materials with the largest quantities was then evaluated (9:2-2).

To evaluate the shelf life term and shelf life extension procedures of the materials selected, the literature, Arthur D. Little experts, and the material's manufacturer were consulted. Based on technical information for the item, commercial shelf life terms for the item, and degradation data, a decision to concur with or challenge the assigned shelf life was made for each material (9:3-2). This study recommended changing the assigned shelf life code for 31 of the 55 commodities selected for review. For 36 of the commodities, the consultants suggested altering the shelf life extension procedures used (9:1-3 through 1-5). Furthermore, the 55 items identified in this study all fell into the following ten Federal Stock Classes (FSCs): 6135

(Batteries), 6750 (Photographic Supplies), 6810 (Chemicals), 6840 (Pest Control and Disinfectants), 6850 (Miscellaneous Chemical Specialties), 7930 (Cleaning/Polishing Compounds), 8010 (Paints and Related Products), 8030 (Sealing Compounds), 8040 (Adhesives), and 9150 (Oils, Greases, Lubricants) (9:4-1). These FSCs include items that could be environmental or health hazards.

Two studies relating to shelf life materials have been completed. Both of these studies involved some analysis of the shelf life material used by the Navy. The first of these studies, completed by Ch2m-Hill, estimated that 13 percent of the materials transferred to the DRMS during the month of April 1991 was due to expired shelf life material. This study was limited to one Navy facility and one month. The second study was also based on the Navy. In this study, the assigned shelf life was evaluated for the 55 commodities disposed of in the largest quantity by the Navy. In determining the 55 commodities to be studied, the assumption that all material transferred to the DRMS was due to expired shelf life was made. In the Air Force, material is transferred to the DRMO for reasons other than shelf life expiration in the base supply system.

The Standard Base Supply System

Base supply is defined as the "activity responsible for requisitioning, receiving, storing and issuing, including

maintenance of accountable records of supplies/equipment supporting the assigned mission of the base wing" (6:1-16). This section overviews the organization of the SBSS and the procedures used to control expendable supplies. Expendable supplies include materials that are "consumed in use or those that lose their identity when attached to another assembly" (7:18). This section will also describe the process through which customers request and receive nonequipment items.

As seen in Figure 2, the SBSS can include up to six branches. The Explosive Ordnance Disposal Branch and Fuels Management Branch are specialized and can be created by the Major Command if a need for the branch is identified. In addition, the Operations Support and Material Management Branches can be consolidated at small bases. The actual number of branches is determined by the base's Major Command (7:5).

SBSS customers have four points of contact: Customer Service, Retail Sales, Equipment Management, and Demand Processing. Customer Service provides answers to questions concerning Supply. Retail Sales supports the Base Service Store, Tool Issue Center, and Individual Equipment Unit. These stores are where base personnel can "shop for needed housekeeping and administrative supplies, handtools, and individual equipment" (7:5). Equipment Management monitors equipment used on the base. Demand Processing handles

Supply Organizational Chart

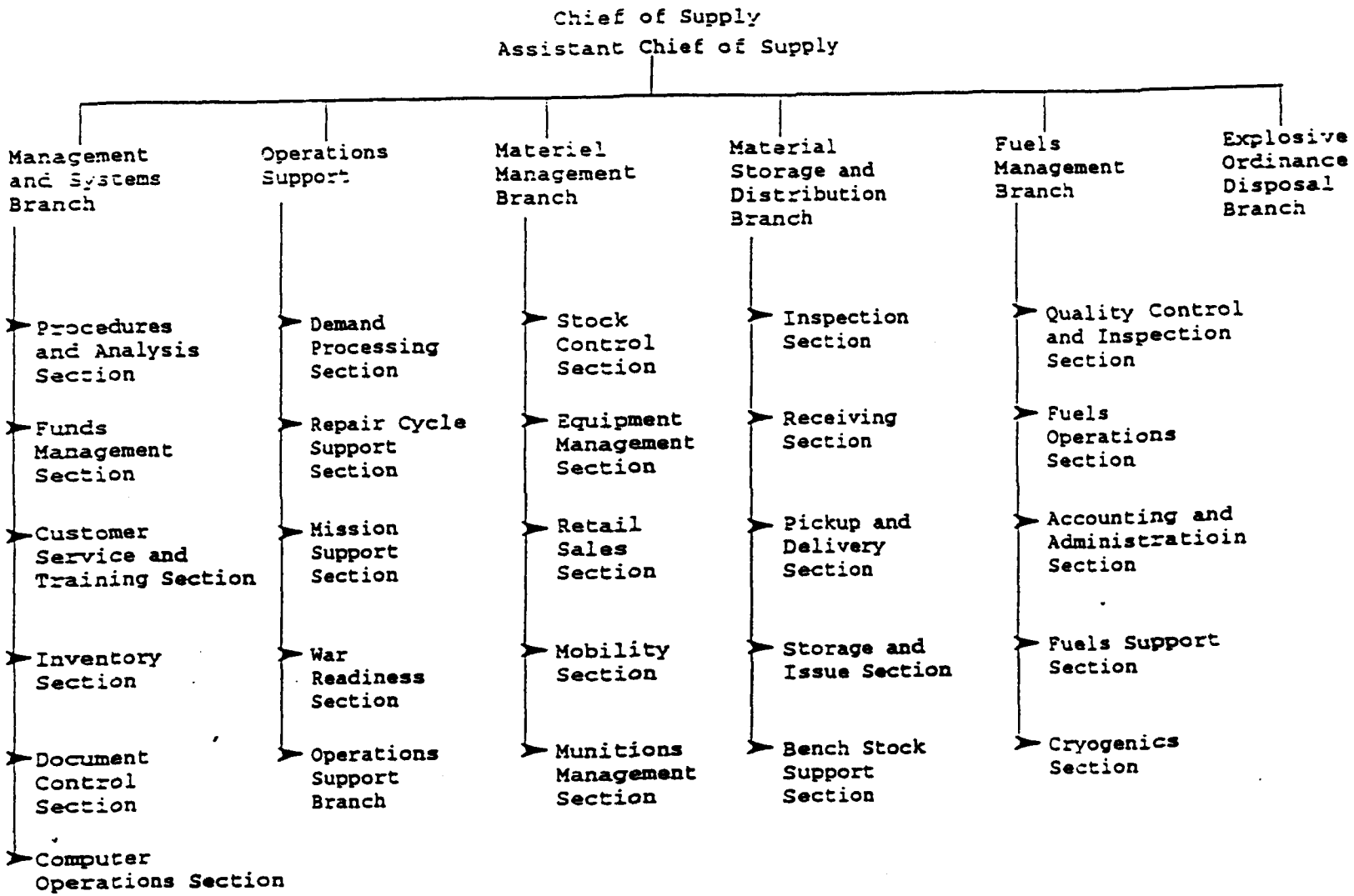

Figure 2. Supply Organizational Chart (7:5)

requests for expendable items that are not managed by Retail Sales. These items are primarily items that could not be found in a local office supply or hardware store (7:5).

When customers need non-equipment items that cannot be purchased from the Retail Sales Section, they have to request the item through Demand Processing. To request items, users first determine how much they will need of the item. Once their requirement has been determined, the user fills out a AF Form 2005, Issue/Turn-in Request. To complete this document, the user must include the name and telephone number of the individual requesting the supplies, the delivery destination, and the National Stock Number (NSN) of the item. If the NSN is not already part of the SBSS computer database, the user fills out a DD Form 1348-6, DOD Single Line Item Requisition System Document Manual-Long Form. When properly filled out, this document describes the item (7:22).

The Issue/Turn-in Request is processed by the Demand Processing Section. Demand processing will determine if the item is in stock and if there is any reason, such as an issue exception (IEX) code, for which the user should not be issued the item. IEX codes are alpha-numeric codes entered into the SBSS database to identify items which are subject to nonroutine issuing procedures (6:14-53). For example, an IEX of "9" is assigned to materials that present a health hazard to users. If the item has been assigned an IEX code

of "9" and the user requesting the item has not been previously approved to receive the item by the Bioenvironmental Environmental Engineer (BEE), Demand Processing will not process the order. When this happens, the requesting organization will be referred to the BEE. Based on the users' need and facilities, the BEE will decide to approve the user to receive the item, on either a one-time or recurring basis, or disapprove issuance of the item to the user.

If the item is in stock, and there are no reasons the material cannot be released to the requesting party, then Demand Processing enters the request into the SBSS computer system and an issue results. The computer then reduces the amount in stock by the requested amount and processes an DD Form 1348-1, DOD Single Line-Item Release/Receipt Document. This document authorizes Storage and Issue to release the item to Pick-Up and Delivery for transport to the customer (23).

If the requesting organization and Demand Processing are unable to identify a NSN for the required item, or the NSN has not been loaded into the Supply computer system, then the customer must fill out a DD Form 1348-6, DOD Single Line Item Requisition System Document Manual-Long Form. This form is forwarded with the AF Form 2005 to the Research Section of Base Supply where the item is characterized so that it can be purchased from a supplier such as the Defense

Logistics Agency, or a local vender. Research maintains basic information on all stock numbers entered in the Federal Catalog System. Research loads information about stock numbers new to the local SBSS into the appropriate database fields. This information includes the shelf life of the item if applicable, and health hazard information (23).

Once the information such as the shelf life and IEX codes have been entered into the computer and the item has been ordered, the item that was requested is placed on back-order status. This means that the item has been ordered, and when it is received on base it will be issued to the customer. When the item is received on the base, a 1348-1, DOD Single Line-Item Release/Receipt Document, is printed. This document directs the ordered amount to Pick-Up and Delivery for delivery to the customer (23).

Shelf Life Items. This section will describe the classes of shelf life items, and how they are identified. It will also identify how the management of these items differs from the management of items that do not require shelf life monitoring.

Identification. There are three classifications of items in terms of shelf life. There are items which do not require shelf life monitoring because the item is non-deteriorative and does not require shelf life monitoring, type I shelf life items, and type II shelf life items (6:10-

133). Type I shelf life items differ from type II shelf life items in the management practices used to maintain them. Type I shelf life items are automatically transferred to DRMO once the shelf life has expired. Type II shelf life items are items for which the shelf life can be extended once the item passes the necessary inspection or test. (6:14-43)

Codes. In the Air Force, the three types of shelf life items are differentiated by the shelf life code assigned to the item. Items that do not require monitoring under the shelf life program have a code of "0" assigned to them. Type I shelf life items are assigned an alpha-numeric code that corresponds to the designated shelf life. Type II shelf life items are assigned a numeric code. The shelf life of each code is shown in Table 1.

A shelf life code is assigned to an item after its stability and deteriorative characteristics are evaluated. Shelf life can also be based on advice from technical representatives (6:10-125). Official shelf life codes for specific NSNs are maintained as part of the USAF Management Data List which is also called the stock list (6:10-125). Many items are managed by other federal agencies such as the DLA, and General Services Administration (GSA). These items maintain the shelf life code that is assigned by the managing agency (6:10-125).

Table 1. Shelf Life Codes in the Standard Base Supply System

Assigned Shelf life	Type I	Type II
1 month	A	
2 months	B	
3 Months	C	1
4 Months	D	
5 Months	E	
6 Months	F	2
9 Months	G	3
12 Months	H	4
15 Months	J	
18 Months	K	5
21 Months	L	
24 Months	M	6
27 Months	N	
30 Months	P	
36 Months	Q	7
48 Months	R	8
60 Months	S	9

(6:10-133)

Storage and Issue. Air Force regulations establish additional requirements for storing and issuing shelf life items. The regulations specify that, when possible, shelf life item stocks are to be maintained separate from non-shelf life items. However, this separation may only be a difference in warehouse locations, or a designated bin row (6:10-126). Issuing shelf life items is based on the assigned shelf life and the remaining stock. The materials are to be issued on a first-in, first-out inventory control technique. There are a few exceptions to this policy. Examples are

1) if the older item is physically located in a place where the cost and time to retrieve it cannot be justified as a good management practice,

2) an item with a shorter remaining shelf life is received,

3) the item has been earmarked for an assembly, or

4) the item is being shipped overseas and the shelf life remaining on the older items would expire prior to their being received (6:10-126).

Inspection and Testing. Both type I and type II shelf life items are monitored by the Inspection Section of Supply. Type II items are divided into two groups for inspection purposes: those on the Chemical List, and those on the Shelf Life List. Items in Federal Stock Classes 6810 (Chemicals), 6820 (Dyes), 6840 (Pest Control Agents and Disinfectants), 6850 (Miscellaneous Chemical Specialties), 9150 (Oils and Greases: Cutting, Lubricating, and Hydraulic), and 9160 (Miscellaneous Waxes, Oils and Fats) require laboratory testing when their shelf life expires. These items are listed on a Chemical List that is received by the inspector. All other type II items appear on a Shelf Life List, or 401 Report. The items appearing on the Shelf Life List can be visually inspected, or tested locally. When items with a shelf life are placed in stock, the Material Examiner and Identifier, or Inspector, will note the month for the next inspection on the appropriate Shelf

Life or Chemical List. These lists are produced quarterly, or as requested by Inspection (6:14-43). These reports list the stock number, the unit of issue, the shelf life code, the warehouse location, the amount in the warehouse, and the nomenclature by warehouse location. Examples of these lists are included in Appendix A. Each month, the Inspector will check these lists for items that require an inspection. If a material appears in the month's inspection schedule, the Inspector will check to see if there is any of the item in stock. If the item is in stock, it must be either tested or inspected for shelf life extension (3).

Inspection or testing of type II shelf life items occurs 15 to 45 days prior to the expiration of the shelf life (6:14-43). However, testing is only done if it is cost effective. Two instances of when the material should not be tested are when only a small quantity of the material remains in stock and the cost of testing the outdated material exceeds the total dollar value of the outdated material, or when the entire amount of material remaining is required for the testing procedure (6:14-44).

All items appearing on the Chemical List must undergo testing before their shelf life can be extended. If material from the same contract or lot has not been previously tested, a sample of the item in stock will be sent to a lab for testing to determine if the shelf life can be extended. When these items require testing, the Inspector will first

check the Quality Shelf Life Listing, a microfiche catalog of the results of testing on items appearing on the Chemical List. This catalog is maintained by SA-ALC/SFTT at Kelly AFB. If the item is not in the Quality Shelf Life Listing, the inspector calls SA-ALC/SFTT to check the current testing records for the item. If the item is not listed in the Quality Shelf Life Listing and testing has not been requested for the item by another base, the Inspector will arrange to send a sample to the laboratory specified by SA-ALC/SIFT for serviceability testing. If the results of an item test are not received prior to the expiration of the previously assigned shelf life, or any other delay in processing occurs, the remaining stock is changed from condition code "A" serviceable to "J" unserviceable. This prevents the item from being issued before the testing is complete (6:14-43).

When the Inspection Section receives the test results, if the item does not meet the requirements for shelf life extension, the condition code is changed to "H", condemned for transfer to DRMO. If the item does meet the requirements, then the condition code is returned to "A", and the revised shelf life data is entered onto the container.

Barring any technical orders restricting the extension of the shelf life of a particular item, the shelf life of an item can be extended for the length of time of the original shelf life (6:14-42). When a large number of items are

packaged together in a larger container, the revised shelf life date is marked only on the outer container. In addition, the outer container is marked with a notice stating that when the larger container or packaging is opened, each of the items inside the container will be marked with the revised shelf life information (8:1-3).

All remaining stock classes are visually inspected at the storage location or tested by the inspector. During this inspection, the Inspector looks for "discoloration, changes in composition, and broken or leaking packages" (6:14-45). The inspector also can send a sample of the item to a maintenance shop for a test of the material's service-ability. If the inspector chooses to have a shop test the material, a sample is forwarded to the shop with a request that the shop test the material's integrity. Once the shop has tested the material, the memo is returned to the inspection section with a notation of the conclusions of the test. If the materials and containers appear to be suitable for additional storage, then the revised shelf life is noted on the container as described in the previous paragraph.

If items do not meet the requirements for their shelf life to be extended, then the Inspector initiates the process to transfer the expired shelf life item to DRMO. To start this process, the inspector changes the condition code of the item from either "A" or "J" to "H". Once the condition code is changed to "H", the item is transferred to

DRMO. At this time, the material is considered a waste by the supply system (6:14-44).

Health Hazard. Inspection is also responsible for watching for items that could potentially be hazardous materials. Federal Standard 313 and AFR 69-9 list the federal supply classes shown in Table 2 as items that require review by the BEE to determine what health hazards, if any, are associated with the item (6:14-53).

Table 2. FSCs Requiring Identification of All Items

FSC	Title
6810	Chemicals
6820	Dyes
6830	Gases: Compressed and Liquefied
6840	Pest Control Agents and Disinfectants
6850	Miscellaneous Chemical Specialties
7930	Cleaning and Polishing Compounds and Preparations
8010	Paints, Dopes, Varnishes, and Related Products
8030	Preservative and Sealing Compounds
8040	Adhesives
Group 91	Packaged Products
9110	Fuels, Solid
9130	Liquids Propellants and Fuels, Petroleum Base
9135	Liquid Propellant Fuels and Oxidizers, Chemical Base
9140	Fuel Oils
9150	Oils and Greases: Cutting, Lubricating, and Hydraulic
9160	Miscellaneous Waxes, Oils and Fats

(6:10-163)

In addition, the inspection section must be alert for materials in other Federal Stock Classes that could be hazardous because the items have toxic ingredients or

hazardous characteristics. These stock classes, their titles, and the items in the class that require identification are listed in Table 3. Many of these items would be classified under one of the FSCs in Table 2 but are not because of their intended use or because they are part of a kit (6:10-159 through 10-161). The items listed in Tables 2 and 3 are not issued to any users until the Bioenvironmental Engineering Section has either determined that the material is not a health hazard, or given the user authority to use the material.

DRMO and Disposal. In an effort to reduce the waste stream from installations, DOD policy is to reutilize, transfer, donate, or sell as much of the waste generated at installations as possible. To accomplish this, the DOD directed the DLA to provide hazardous waste disposal to the Air Force (6:10-1). To accomplish this, a Defense Reutilization and Marketing Office (DRMO), as a branch of the Defense Reutilization and Marketing Service, was established at major installations. Materials and equipment declared unserviceable or surplus are transferred to the DRMO by the using organization.

To turn-in unserviceable or surplus materials to the DRMO, the material must be properly identified. Prior to turn-in, the organization turning in the material must supply the following information. For items with a valid NSN, the NSN, the nomenclature, the chemical names of

Table 3. FSCs Requiring Identification of Hazardous Items

FSC	Title	Items Requiring Identification
1370	Pyrotechnics	Warning fuses, fire starters
1375	Demolition Mat	Explosive devices
2640	Tire Rebuilding, Tire and Tube Repair Materials	Items containing flammable or toxic compounds
3439	Welding and Brazing Supplies	Cleaner acids, flux and supplies that contain or produce hazardous fumes
3610	Printing, Duplicating and Book-binding Equip	Flammable or toxic lithographic solutions
5610	Mineral Construction Materials	cutback asphalt, deck and floor covering, deck and surface underlay compound sealing compound, flight deck compounds
5640	Wallboard, Building Paper, Insulation Materials	Asbestos cloth which has loose fibers or filings that may become airborne.
6135	Primary Batteries	Lead-acid, mercury, and alkaline (with electrolyte) batteries
6505	Drugs, Biologicals, Official Reagents	Hazardous items
6750	Photographic Supplies	Items containing hazardous chemicals, solvents, thinners and cements
6780	Photographic Sets, Kits and Outfits	Items containing hazardous chemicals, solvents, thinners and cements
7510	Office Supplies	solvents, thinners, cleaning fluids, flammable inks and varnishes.
8510	Perfumes, Toilet Preparations, and Powders	Shipping containers, and pressurized containers with flammable propellants
8520	Toilet Soap, Shaving Preparations	Shipping containers, and pressurized containers with flammable propellants
8720	Fertilizers	Items containing weed and pest control or other harmful ingredients
9920	Smoker's Articles	Lighter fuel and matches

(6:10-163)

hazardous constituents and a noun name of nonhazardous constituents, and the amount of both hazardous and nonhazardous constituents must be supplied with the material. If the material can only be identified by a locally assigned stock number, then the chemical names and amounts of the hazardous constituents and the noun names and amounts of the nonhazardous constituents are documented for DRMO (6:10-3).

Once this information has been gathered, the material can be transferred to DRMO. For the transfer of accountability of both materials and waste, a DD Form 1348-1, DOD Single Line-Item Release/Receipt Document is completed by the organization turning in the waste. This document transfers accountability for the materials from the organization to the DRMO. DRMO personnel input the information from the DD Form 1348-1 into the DRMS accountability tracking system, Defense Information Acquisition System (DAISY). If possible, physical custody is also transferred to DRMO. However, in some instances when hazardous materials or wastes are transferred, custody of the items remains with the using organization because DRMO does not have facilities with the appropriate storage requirements (13).

To comply with the policy set by the DOD to reutilize, transfer, donate, or sell waste materials, the DRMO will attempt to locate an installation that can use the

materials. However, most of the materials turned in to DRMO are either sold on a contract or reclassified as waste and included in the waste leaving the base (12). The DRMO has contracts known as Term Contracts under which a contractor purchases unused materials in various stock classes from DRMO. Under this contract, the contractor is notified once a predetermined amount of unused materials from the Federal Stock Classes (FSCs) covered by the contract is accumulated at DRMO. The FSCs typically negotiated in this type of contract include 8010 (Paints), 8040 (Adhesives), 6850 (Miscellaneous Chemical Specialties), and 6810 (Chemicals). For these FSCs, unused materials are turned in to the DRMO by the user. The DRMO stores the materials until the negotiated amount of the materials have accumulated. Once the base amount of the materials has been met, the DRMO contacts the contractor who comes to the DRMO to pick up the lot. Items not included in a contract of this type will be sold if it is cost efficient to do so, or reclassified as hazardous waste if there is only a small quantity. If the material cannot be sold or given away, it will be reclassified as hazardous waste, and disposed of according to environmental legislation (13).

Alternative Methods of Hazardous Material Control.

Two inventory management techniques are being applied to reduce the amount of hazardous waste generated. The

first of these techniques, called the Hazardous Material Cell, involves close monitoring of all hazardous materials and the organizations that use them. The second technique involves the implementation of a depository for hazardous materials.

The Hazardous Material Cell. Two years ago Hill AFB, Utah implemented a set of innovative hazardous materials management procedures commonly known as the Hazardous Material Cell. This cell was developed to better serve customers requiring hazardous materials. To accomplish this, personnel from Bioenvironmental Engineering, Environmental Management, Operational Contracting and Base Supply are pulled together to form the cell (15). As a result of the changes that were implemented, base personnel estimated a cost avoidance of ten million dollars in the first year. This cost avoidance comes from materials that were not purchased as well as reduced disposal of unnecessary materials (21).

The Hazardous Material Cell was conceived as a way to move the management of hazardous materials from the supply function to a smaller specialized function that is concerned only with the receipt and distribution of hazardous materials. In the cell concept, an area within Supply is dedicated to managing hazardous materials. All requests for chemicals and other potentially hazardous items are routed through this department. If the Environmental Management or

Bioenvironmental Engineering personnel decide that the material is a health hazard, an environmental hazard, or both, then the cell maintains control of the item. Regular supply recordkeeping methods are not used once the item is designated as a hazardous material. The cell uses the Hazard Material Management System (HMMS). The HMMS was designed to monitor which organizations are using hazardous materials, how much of any given material each organization uses, and at what location the material is being used. In addition, using organizations are only issued the material as needed, and only in the quantity needed. Inventory control is also monitored very closely. All requirements for materials are reviewed by supply personnel prior to requisitioning. Materials are not purchased unless there is a defined need for them, and when hazardous materials are purchased, the purchase amount is minimized (21).

In addition to providing strict inventory control, the Hazardous Material Cell allows the personnel working with the hazardous materials to become familiar with their special needs. By only working with hazardous materials Supply and Operational Contracting personnel become aware of unique requirements such as the need for a Material Safety Data Sheet (MSDS) for all hazardous materials, and other unique contract and storage requirements. Having all hazardous materials tracked through one office also allows the Environmental Manager and Bioenvironmental Engineer to

ensure that environmental, health and safety requirements are met for the material (15).

Oak Ridge National Lab. A dispensary type of system implemented at Oak Ridge National Laboratory has also been successful in reducing the amount of waste resulting from the inventory system. In this system, materials are labeled as hazardous or nonhazardous when they enter a central storeroom. If the material is hazardous, the hazard information is entered into a computer and the item is given a bar code. When organizations receive the materials, information contained in the bar code for the item and on the organization's identification card are read into the computer along with the amount of the hazardous material being taken. This information is used to track the materials and estimate future uses. This system works well for a small laboratory setting, but it is seen as infeasible for an organization as large as a military base because the number of transactions required (20:11).

Summary

This chapter described the legislation that led to an interest in source reduction as well as other pollution prevention techniques. It also covered the Base Supply System, the shelf life program, the DRMO procedures for dealing with waste, and the other methods of hazardous

material control implemented to reduce the amount of hazardous waste generated by inventory control programs.

Currently, the legislation driving pollution reduction is the Pollution Prevention Act of 1990. This act emphasizes source reduction as the most important method of pollution prevention. Included in source reduction is management techniques applied to shelf life and hazardous materials. In the Air Force, the SBSS manages materials used on individual bases. Hazardous and shelf life materials are given unique codes and are subject to additional controls. Hazardous materials are given an Issue Exception (IEX) code of "8" or "9". Shelf life items are assigned a numeric code if they are type II and a letter code if they are type I. Type II items can have their shelf life extended if they meet the extension criteria. Type I items are immediately transferred to the DRMO when their shelf life expires. The DRMO is a DRMS office that is responsible for receiving wastes and unused materials for disposal. This office attempts to reutilize, transfer, donate or sell all items that it receives. If this is not possible the DRMO will dispose of the waste in a legal manner.

There are two management systems designed to meet the needs of hazardous materials used in government settings. At the Hazardous Material Cell at Hill AFB in Utah, all requests for items are considered for management by cell

personnel. Hazardous items are strictly controlled. At Oak Ridge Laboratory hazardous materials are controlled by tracking the removal of the items from the storage area. In the following chapter, the development and implementation of the methodology used to answer the research questions presented in Chapter I will be described.

III. Methodology

Introduction

This chapter will describe the three waste streams quantified in this research, and discuss the data sources used to answer the questions presented in chapter I. This chapter will also describe the process used to quantify the amount of type II material removed from Base Supply Stock and transferred to the DRMO, as well as the amount of the material received by the DRMO. Once developed, this method of determining quantities of materials will be applied to a representative sample of bases that is used to characterize the Air Force. The amount of material resulting from this determination will be compared to the total amount received by the DRMS to determine what percentage of the material is attributable to the shelf life program. Lastly, this chapter will discuss the assumptions made in the development of the methodology and the limitations of the applications of the research that are inherent to these assumptions.

Waste Streams

There are three material streams quantified in this study, the type II material with an expired shelf life transferred to the DRMO, the total amount of material transferred to the DRMO through the SBSS, and the total amount of material transferred to the DRMO through the SBSS and directly from

other base organizations. Figures 3 and 4 illustrate these streams.

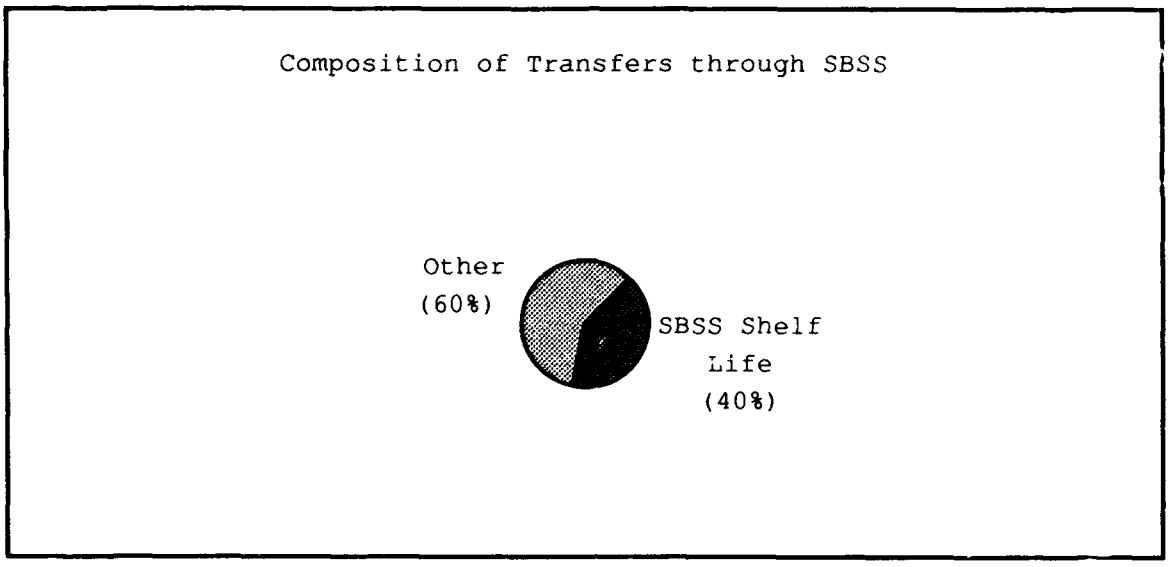

Figure 3. Composition of Transfers through the SBSS

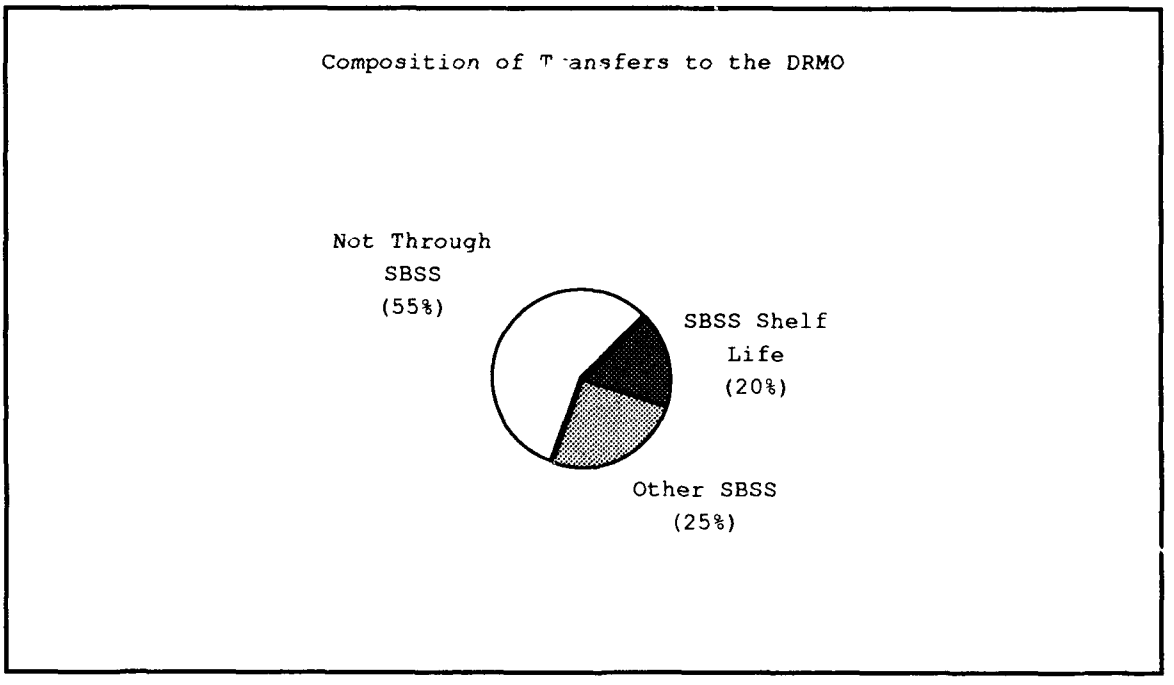

Figure 4. Composition of transfers to the DRMO

Figure 3 illustrates the two type of transfers that are found in SBSS records. These include those transfers occurring because the material's shelf life has expired and cannot be extended and all other transfers that could occur. Figure 4 includes the transfers through the SBSS as well as transfers from other organizations. The transfers through the SBSS include both SBSS shelf life and other transfers. This research will quantify each of these groups of transfers. Research question 2 quantifies the pieces shown in Figure 3. Research question 4 quantifies the entire chart in Figure 4.

Data Sources

There are two primary organizations that maintain records that can be used for data in this research, Supply and DRMO. Development of the methodology to apply to the Air Force, will use the records at Wright-Patterson AFB (WPAFB). The records at WPAFB include a file of the paper copy of the documents recording condition code changes completed by an inspector from Base Supply when an item is removed from stock because its shelf life cannot be extended. A condition code change transaction (FCC) is used to change the condition code of an item in the SBSS computer. The document used in this code change includes the notation "Expired Shelf Life Item" or "Expired Shelf Life" in the bottom left corner of the form when the

condition code is being changed because the shelf life has expired. These documents are maintained by the Chief of the Inspection Section of Base Supply in monthly files which are periodically purged.

As with all supply functions Air-Force wide, Wright-Patterson AFB maintains the Standard Base Supply System database. Included in this database are records of all transactions that occur in the SBSS computer. The transaction records include information such as the shelf life code and issue exception codes for NSNs. This database is also used in the first phase of the research when it is searched for the transaction identification code (TRIC) that is assigned to the transaction when an item is prepared for transfer to the DRMO. The TRIC identifies the type of transaction that has occurred to the material. This input TRIC is TRM for transactions transferring material to the DRMO. The TRIC FCC designates a condition change for the material.

The Defense Reutilization and Marketing Service (DRMS) maintains a database of materials that it receives. At each DRMO, the information included on the documentation accompanying the material being turned in is entered into the Defense Acquisition Information SYstem (DAISY). This information includes the turn-in document number, the date, the DRMO receiving the item, the item's NSN, the quantity being transferred, and the unit of issue.

To apply the methodology developed at WPAFB, transaction records kept by the Air Force Logistics Management Agency (AFLMA) at Maxwell-Gunter AFB, Alabama, will be used. The records kept by AFLMA include transaction histories for select Air Force bases which have been determined to be a representative sample of all AF supply accounts. This database includes SBSS records, similar to those for WPAFB, for the selected bases. The primary purpose for maintaining these records is for research purposes (18).

Process Development

This section describes the first part of the research, development of a process to quantify the amount of type II material turned in to DRMO after being rejected from stock by the base supply system's shelf life inspection program, and the total amount of material turned in to DRMO. This part answers questions 1 and 3 from the first chapter. For this portion of the study, information describing Wright-Patterson AFB will be u ed. Analysis of records from the supply account at WPAFB will form the basis for assumptions made when the procedures are applied to other bases.

To develop the process by which the amount of type II material, turned in to DRMO by Supply because the shelf life cannot be extended, can be quantified, information in the Wright-Patterson base supply records will be used. These

sources include condition change documents with a TRIC of FCC created by Inspection personnel when the shelf life of an item cannot be extended, and the SBSS database. To identify the NSN of all items transferred to DRMO due to expired shelf life, the FCC documents will be searched for those containing the notation that the condition of the material is being changed to "H", condemned, and cannot be extended. When this notation occurs, the NSN, unit of issue, the number of units, and the date of the transaction will be noted on a data sheet.

Once all items being transferred to DRMO because of an expired shelf life have been identified, those items which represent a health hazard will be identified. To accomplish this, the list of expired shelf life NSNs will be compared to a list of items which represent a health hazard. To identify items which present a health hazard, all items which are type II and a health hazard will be retrieved from the SBSS database by searching for all items with a numeric shelf life code and an Issue Exception code (IEX) of "8" or "9". Those NSNs appearing on both lists will encompass all items at Wright-Patterson AFB which are being considered in this research effort.

This comprehensive list of items being considered will then be used to determine what portion of the total amount of those materials being transferred to DRMO comes through the SPSS' shelf life program. To do this, the total amount

of the material transferred and number of transfers will be compared to the amount of material appearing on the FCC documents.

The total amount of material transferred, the number of transfers, and the cost of the unused material will be obtained from the SBSS by searching for TRM documents processed for the comprehensive list of NSNs during the timeframe, January through June 1993. The results of this search will be included on a SBSS Consolidated Transaction History (CTH) Report. From this report, the total amount of the material transferred to the DRMO will be obtained by summing the quantity appearing for each transaction. The total number of transactions will be determined by counting the number of transactions for all NSNs. The cost of the material transferred will be calculated by summing the cost of the material.

To determine the quantity of material involved in each transaction, information from the CTH report will be used. This report includes the NSN, the unit of issue, and the number of items transferred. Multiplying the unit of issue and number of items transferred results in the quantity transferred for each transaction. The total quantity of material transferred to DRMO for a NSN will be determined by summing the quantities transferred for each individual transactions for the NSN.

Once the total amount of material transferred and number of transactions has been determined, the amount of material transferred and number of transactions due to shelf life will be determined. This will be accomplished by comparing the date of transaction, amount of the transaction, and NSN for each transaction appearing on the CTH to the date and amount of the FCC documents to determine if the transaction occurred because of expired shelf life. Once the transactions that occur because of expired shelf life have been identified, the quantity of material transferred and number of transactions occurring due to shelf life expiration will be determined by summing the quantities and number of transactions.

After the quantities of each NSN have been determined, they will be changed to a volume-based scale. Each NSN has a unit of issue that is characteristic of the item. Examples of these units of issue include gallon, pint, box, each, pound, and can. Because these units are not consistent for all items, items with different NSNs cannot be summed. For this research, a consolidation of all items transferred to DRMO is one of the objectives. For this consolidation, the units of the items will be changed to a volume-based scale. Item records containing the volume of the container will be converted to gallons. For the few items which the item records include the weight of the item, the weight will be converted to a volume using the specific

gravity of the item that appears on the Material Safety Data Sheet (MSDS). An MSDS is kept at the Bioenvironmental Engineering Office for all materials with an IEX code of "8" or "9".

Once the quantity of type II material transferred because of expired shelf life and the total quantity of material transferred to DRMO have been determined and converted to a volume, the percentage of the total amount of material transferred to DRMO attributable to the shelf life program will be calculated. To accomplish this, the amount of shelf life material will be divided by the total quantity of the material transferred. The resulting percentage describes the portion of the total quantity of materials turned in to the DRMO that results from the base shelf life program.

The next step will be to answer question three, determining a method that can be used to quantify the amount of type II material turned in to the DRMO. To accomplish this, records in the DAISY database will be searched. For each of the NSNs found in the FCC documents, a transaction history will be obtained for the same time period from the DRMS in Battlecreek, Michigan. This transaction history will include all transactions accepted by the DRMO at Wright-Patterson AFB for the given NSN. For Wright-Patterson AFB, the Department of Defense Activity Address Code (DoDAAC) or Stock Record Account Number (SRAN) of FB2300 will be used as

the search criterion. Each document received by the Wright-Patterson DRMO has a document identifier. The first six characters of this identifier are FB2300. Materials that are transferred to the DRMO without being processed through the SBSS will not be identified unless the DoDAAC FB2300 was used. This will be addressed in the sections on Limitations.

This list of transfers to the DRMO will be compared to the transfers to the DRMO that were processed by Supply. As was done for materials appearing in the supply system, the amounts for each NSN will be summed and converted to a volume using the same conversion factor that was used previously for the materials. The result of this process will be a quantification of the amount of material received by DRMO at Wright-Patterson AFB.

This section described the methodology that will be applied in the following section. This process makes it possible to determine the amount of expired shelf life type II material generated by a base supply account and the total amount of that material received by the servicing DRMO. This methodology also allows the determination of the total quantity transferred from a base supply account to the servicing DRMO. In this methodology, a summation is made of the total amount of material being transferred with a TRIC, TRM, the amount attributable to shelf life expiration of type II materials (using FCCs), and the total amount

received at the servicing DRMO for those same NSNs. This is done using a volume-based conversion.

Process Application

The methodology developed in the first section of this chapter will be applied to a database of supply information that is maintained by the Air Force Logistics Management Agency (AFLMA) at Maxwell-Gunter AFB, Alabama. Applying the methodology will address research questions 2 and 4, quantifying the amount of type II material transferred to the DRMO due to expired shelf life and quantifying the amount of material received by the DRMO.

To quantify the amount of expired shelf life material transferred to the DRMO, first documents with a TRIC of TRM for items which are type II, with an IEX "8" or "9", will be pulled from the AFLMA database for a group of six bases that is used by AFLMA to characterize the Air Force. A CTH for each of these NSNs will be used to determine the quantities of each material transferred. The units of the materials will be converted to volumes, and the percentage of materials transferred due to shelf life expiration, determined at Wright-Patterson AFB, will be used to estimate how much material is transferred because of an expired shelf life at the sampled bases. The percentage determined for WPAFB will be used because a distinction cannot be made between transfers because a material is rejected by the SBSS

because of an unextendable shelf life, and transfers that are made for other reasons. Once this amount has been determined, the data will be extrapolated to determine the amount generated by the Air Force.

To extrapolate to the Air Force, the transaction records for the six bases used by AFLMA to characterize the Air Force will be searched for transactions with the TRIC TRM. Those transactions that are also a health hazard and type II material will be sorted and summed to determine the total volume of material transferred. The data from these databases will be extrapolated from the six bases to 125 Air Force bases by multiplying by 125 and dividing by six to estimate the total amount of material transferred by the Air Force. This amount will then be multiplied by the percentage representing the part of the transfers due to shelf life materials that was determined for Wright-Patterson AFB. Once this amount has been determined, it will be compared to the total amount of material transferred to the DRMO by supply and other base organizations. The limitations this extrapolation places on this research are addressed in the following section.

To quantify the amount of material received by DRMO, the process developed in the previous section will be applied. Once all NSNs have been identified, a transaction history will be obtained from the DAISY system, and the total amount of each item will be determined. These amounts

will then be converted into volumes, and the individual amounts will be summed. The results of this summation will be the total quantity received by DRMO.

The fifth question, determination of the percentage of type II material turned in to the DRMS for disposal that originates in base supply will be determined by dividing the amount obtained from the AFLMA database by the amount determined in the previous procedure. This percentage will represent the portion of the material received by the DRMS that is due to expired shelf life items.

Limitations

This research is limited by several assumptions made. The limitations are primarily related to the data used. The percentages applied to the information gained from the AFLMA supply data are characteristic of Wright-Patterson AFB, which may not be a representative base. Because of its unique mission including laboratory facilities and minor flying operations, Wright-Patterson AFB, may not be representative of the typical Air Force installation. This percentage will be conservative because these operations do not require the large amount of materials that would be used on a base with a flying or maintenance mission.

A second limitation of the application of this research is the use of IEX codes to define the hazardous properties of the items in the supply system. IEX codes are used to

sort out the type II items that are hazardous. However, in the SBSS, the IEX code that is given to a NSN is used to identify an immediate health hazard to humans. The code is not used for environmental monitoring purposes. For this research, it is assumed that an IEX-coded item will also be an item that needs to meet environmental disposal requirements. Because IEX codes do not encompass all materials that could be an environmental hazard, the number of NSNs considered in this study will be less than the number NSNs that present an environmental concern. This discrepancy will result in the calculated total quantity of materials transferred to the DRMO being lower than the actual quantity.

Another limitation occurs because all items transferred to the DRMO do not go through the SBSS. Documents accompanying these transfers may not have the DoDAAC assigned to the generating base. When this happens, the transfer will not be attributable to the generating base.

Summary

This chapter presented the methodology that will be used to answer the investigative questions presented in the first chapter. The data to answer these questions will be acquired from the WPAFB supply system and its supporting DRMO, the AFLMA, and the DRMS. The information used will be from both paper records and reports generated from databases

maintained by each of these organizations. First, the methodology to be applied to AFLMA records will be developed based on the SBSS at WPAFB. To accomplish this, a list of NSNs that have been transferred from the WPAFB SBSS to the servicing DRMO because their shelf life has expired will be composed. For the NSNs on the list, the volume of material transferred, number of transactions, and cost of unused materials will be determined for the shelf life transactions as well as the total transfers to the supporting DRMO. The percentage of total amount transferred that is attributable to the shelf life program will be determined so that it can be applied to transaction records from the AFLMA.

The amount of material received by the DRMO will be gathered from records in the DRMS database. The two amounts will be compared to determine what percentage of the material transferred to the DRMO was due to the WPAFB shelf life program for type II material.

Once this has been completed, the methodology will be applied to the Air Force. This will be accomplished by searching a sample of bases in the AFLMA database for documents with the TRIC, TRM. The percentage of materials calculated for WPAFB will then be applied to this amount to estimate the amount of transferred material that is attributable to the Air Force's shelf life program. This amount will then be compared to the total amount of these materials received by the DRMS to determine the percentage

of material received by the DRMS that is due to the shelf life program. These quantities and percentages will be described in the following chapter, Data Analysis.

IV. Data Analysis

This chapter will report the data analysis and findings from the methodology presented in Chapter III. To complete this, the data collected will be described and analyzed. Then an extrapolation of the data will be performed to describe the volume of waste generated by the Air Force by the shelf life program. In addition, the data collection and analysis for the determination of the amount of material transferred to the Defense Reutilization Marketing Office will be described. This will be accomplished for Wright-Patterson AFB, and the Air Force as a whole.

Process Development

To develop the methodology to evaluate the percentage of type II material turned in to the DRMO by Supply due to expired shelf life, the documents recording condition code changes kept in the Inspection Section of the SBSS were searched for the notation that the material being transferred to DRMO was expired shelf life material. This search resulted in a list of 107 National Stock Numbers (NSNs) for which material had been transferred to DRMO at Wright-Patterson AFB. As these stock numbers were collected, the amount and date of the condition change were also noted.

Next, a list of NSNs that have an extendable shelf life and present a health hazard was developed by searching the

SBSS database for items that were assigned a shelf life code of "1" to "9", and also had an Issue Exception (IEX) code of "8" or "9". The list of 776 items resulting from this search represents the type II materials that are considered a health hazard at Wright-Patterson, AFB.

To create a comprehensive list of items for further consideration, the NSNs which were both transferred to the DRMO because their shelf life could not be extended further and which had an IEX code of "8" or "9" were included on a third list. This was accomplished by comparing the two lists and including all NSNs that were common to both on the third list. A list of 33 items was the result.

For items on this third list, a Consolidated Transaction History (CTH) Report was generated from SBSS records for TRM transactions. This report was used to determine the volume or weight of the material involved in the transaction, the number of transactions that occurred for each NSN, and the cost of the material being transferred. The volume of the material involved in the transaction was determined from the quantity of the transaction and the unit of issue.

Fifteen of the items included in the list of 33 NSNs did not include a volume measure as the unit of issue or in the nomenclature. However, the weight of these items was available. For these items, either the specific gravity of the item was found using the Hazardous Materials Information

System maintained by the Bioenvironmental Engineer or the density of the material was found from The Handbook of Chemistry and Physics. This information was used to change the units to volumes. The specific gravity multiplied by the density of water, 1.04 pounds per pint, equals the density of the material. The density was then used to find the volume associated with a weight of material. The volume is equal to the weight of the material divided by the density of the material. For example, eight 8-ounce cans of sealant were transferred to the DRMO. The CTH does not include any information regarding the volume of the can containing the sealant, but the MSDS contains the specific gravity of sealant, 1.5. The amount of the sealant transferred (4 pounds) divided by the product of the material's specific gravity and the density of water (1.575 pounds per pint) yields an equivalent volume of 2.5 pints.

Table 4 shows the 38 TRM found in the SBSS database that transferred the 33 selected NSNs to the DRMO. Also included in this table are the volume of the material transferred and purchase cost for the amounts transferred. When summed, the total amount of type II material transferred to the DRMO in 38 transactions for the given NSNs was 2,840 pints (355 gallons) or an average of 75 pints per transaction. Of this amount 1,154 pints (144 gallons), representing 34 transactions, or 41 percent are attributable to the shelf life program. The 34 items that are not

Table 4. TRM Transactions at Wright-Patterson AFB

NSN	Nomenclature	Amount	Equiv Vol (Pints)	Cost of Mat
8010000637884	PAINT OIL	8 GL	64	50.78
8010001663152	LACQUER WHITE	6 QT	12	24.66
8010002575378	LACQUER TT-L-32	2 QT	4	7.12
8010005151596	ENAMEL TT-E-489	4 QT	8	21.36
8010005973636	VARNISH OIL	6 GL	48	100.44
8010006647468	PAINT HEAT RESIST	4 QT	8	29.60
8010007219752	LACQUER ACRYLIC	7 PT	7	8.75
8010009262133	FILLER DENT	1 QT	2	6.41
8010009269174	POLYURETHANE	30 GL	240	446.22
8010009357174	POLYURETHANE	12 GL	96	178.49
8010009901542	PAINT TRAFFIC	25 GL	200	277.30
8030000628449	CORROSION PREVENT	4.5 GL	36	107.58
8030000812339	SEALING COMPOUND	5 BX	0.1	32.50
8030000878630	ANTISEIZE COMPOUND	3 LB	2.9	149.91
8030001450383	COMPOUND SEALING	8 CN	2.6	134.40
8030002523391	COMPOUND SEALING	3 TU	4	4.68
8030002627358	CORROSION PREVENT	5 GL	40	72.94
8030006708553	COMPOUND MOLD	3 KT	6	7.00
8030009355841	SEALING COMPOUND	7 EA	0.3	33.39
8040001092481	ADHESIVE	2 TU	0.6	8.08
8040001429193	ADHESIVE IS-04E	15 BX	8.2	101.85
8040001429193	**ADHESIVE IS-04E**	**1 BX**	**0.6**	**6.79**
8040001449774	ADHESIVE	2 CA	1.4	72.82
8040001449774	**ADHESIVE**	**9 CA**	**6.2**	**327.69**
8040002254548	ADHESIVE	3 KT	2	9.06
8040002981946	ADHESIVE LIQUID	5 CN	2.7	11.20
8040004334065	ADHESIVE EC776	1 QT	2	13.61
8040006644318	ADHESIVE	1 PT	1	3.55
8040007542483	ADHESIVE	3 BT	1.3	2.13
8040007769605	ADHESIVE	5 KT	0.3	46.00
8040008658991	ADHESIVE BLACK	1 KT	0.8	122.67
8040009006296	ADHESIVE	2 GL	16	17.96
8040009419984	ADHESIVE	2 KT	0.4	61.33
9150002234134	HYDRAULIC FLUID	2 GL	16	13.84
9150002234134	HYDRAULIC FLUID	37 GL	296	256.04
9150002234134	**HYDRAULIC FLUID**	**1 GL**	**8**	**6.92**
9150002234134	**HYDRAULIC FLUID**	**209 GL**	**1672**	**1446.2**
9150004580075	LUBRICATING OIL	24 CN	24	81.84
Total of all items transferred through the SBSS:			2840.4	4303.1
Total of all shelf life items transferred through the SBSS:			1153.6	2515.5

highlighted are transactions that were determined to be transfers that were due to expired shelf life.

In Table 4, the transaction of hydraulic fluid which was 209 gallons is much larger than any other transfers that occurred at WPAFB. Because this amount is nearly seven times larger than the next largest transfer of material, the total volume transferred through the SBSS was also calculated excluding this volume. The resulting amount was 1,168 pints (146 gallons) or an average 31 pints per transaction. Using this lesser volume, the percentage of total transfers made from the SBSS that are due to shelf life expiration is 99 percent. For this analysis, the calculations will be made for both percentages. At the end of this section, there is a discussion of the results of the two calculations.

This table also presents a total purchase cost of $2515.51 for type II materials purchased at Wright-Patterson AFB and then transferred to the DRMO because the shelf life was not extended. The total cost is the sum of the individual amounts found on the CTH.

Because expendable items do not have to be returned to the SBSS prior to transfer to the DRMO, records maintained by the DRMO must be used to determine the total amount of material transferred. The organization using the item can complete a 1348-1, and transfer the material directly to the

DRMO. When this occurs, the SBSS has no record of the transfer.

Defense Reutilization Marketing Service (DRMS) transaction histories for the NSNs listed in Table 4 were used to determine the total amount of these materials transferred to the DRMO at WPAFB. This database contains all transactions recorded by the DRMO as they are input. The database was searched for all transactions involving the 33 selected NSNs. The transactions were sorted by Routing Identifier (RID) code for the DRMO at Wright-Patterson receiving the material. For the DRMO located on Wright-Patterson AFB the RID code is SVX. Initially, those transactions occurring for the RID SVX were consolidated. The DRMO at Wright-Patterson AFB receives materials from other local installations such as an Ohio National Guard Unit located in Springfield Ohio, Newark AFB, and Selfridge Air National Guard Base. To distinguish between the installations using the Wright-Patterson DRMO, the Department of Defense Activity Address Code (DoDAAC) that appears as the first six characters in the document the material is transferred under was used. For those documents received from Wright-Patterson AFB, the DoDAAC is FB2300. Of the 38 transfers reported by the SBSS, only seven transfers appeared on the DRMS records. The seven transfers were all transactions from the SBSS because of an expired shelf life.

Records kept by the local DRMO did not include the information needed to determine the total volume of material received by the DRMO for the NSNs targeted. The paper archives kept for audit trails did not contain data that could be used to determine the amount of material received by the DRMO. Because these records are paper copies of the records found in the DRMS database, the information contained in these records would only include the transactions found in the DRMS database. These two information sources lacked the information needed because the paper copies of the documents transferring the material remain with the material until the DRMO personnel retrieve both the documents and the material. Only after the documents have been retrieved can the information contained on them be inputted into the DRMS database, and the paper files be updated. Retrieval of the documents could happen as infrequently as only a few times each year (13). If the system was updated as items were transferred to the individual DRMOs, the data needed to quantify the total amount of material transferred would be available. To change the system, the reason that the items are not in the system would have to be determined.

The local database system was also inadequate for determining the amount of material received by the DRMO for the NSNs being considered. This system is used primarily to track items which the DRMO cannot reutilize, sell, or

transfer. For this reason only records for items which are not sold, reutilized, or transferred within 90 days of arrival remain in the system. All other materials are deleted as they are sold reutilized or transferred (22).

Methodology Application

To apply the methodology developed in the first part of this discussion, the supply records of six bases at the Air Force Logistics Management Agency were searched for all items with a IEX code of "8" or "9", a shelf life code of "1" through "9". These bases, Bitburg, Langley, Minot, Dover, Little Rock, and Kadena, are the six bases recognized by the Air Force as reflecting supply trends. The bases searched represent the sources used for most if not all supply studies completed by the AFLMA for the past six years (18).

Transactions coded TRM for all NSNs with an IEX code of "8" or "9" and a numeric shelf life code were considered. This search resulted in a list of 19 transactions from the six bases. These transactions are summarized in Table 5. Only one of the NSNs appearing in the WPAFB inspection records also appeared in the report from AFLMA. This was hydraulic fluid.

As was completed for Wright-Patterson AFB, the transactions were converted to a volume scale using the specific gravity or density. The total amount of material

transferred for these six bases was 13,350 pints (1,670) gallons, or an average of 700 pints per transaction. Taking 41 percent of this results in an estimated quantity of material transferred to the servicing DRMO due to and expired shelf life to be 5,470 pints or (684 gallons). Applying the higher percentage found at WPAFB, 99 percent, results in a total volume of material transferred of 13,200 pints (1,650 gallons).

Table 5. TRM Transactions found in AFLMA database

NSN	Nomenclature	Quan	Equiv Vol (Pints)
6830001690786	CHLORONEX TECHNICAL	662 LB	408
6850010457931	CLEANING COMPOUND	8 DR	3520
8010001903360	LACQUER	41 CN	1640
8010006160017	ENAMEL GRAY	137 GL	1096
8010007540348	ENAMEL FULL RED	35 PT	35
8010007540348	ENAMEL FULL RED	70 PT	70
8010008961980	EPOXY CLEAR	1 KT	16
8010010486538	EPOXY COATING	3 GL	24
8030004741419	SEALING COMPOUND	1 QT	2
8030011840329	SEALING COMPOUND	3 CA	9.6
9150001806381	GREASE GENERAL	93 CN	166.7
9150001806381	GREASE GENERAL	186 CN	333.3
9150002234129	OIL LUBE INSTRUM	16 CN	16
9150002234134	HYDRAULIC FLUID	721 GL	5768
9150002526383	HYDFLD MIL-H-5606	72 QT	144
9150005068497	LUBRICANT	107 TU	61.3
9150009857246	GREASE AIRCRAFT	3 CN	5.4
9150010536688	CLEANER LUBT	2 GL	16
9150010869466	SILICONE OIL	20 LB	18.2
Total volume transferred through the SBSS:			13,349.5

To apply this estimate to Air Force wide application, this value was extrapolated from six bases to 125 bases by dividing 13,350 pints by six to get the average number of pints transferred per base (2,225 pints per base), and multiplying this amount by 125 bases. This extrapolation resulted in an estimate of 278,100 pints (34,800 gallons) of material transferred to the DRMS through the Air Force SBSS for a one year period.

To estimate the volume of type II material transferred to the DRMS Air Force wide because its shelf life cannot be extended, the percentages determined for WPAFB are applied to the total amount of material extrapolated from the AFLMA database. When 41 percent is applied to the total volume (278,000 pints), 114,000 pints (14,200 gallons) is the result. Application of the 99 percent figure results in an estimate of 275,000 pints (34,400 gallons) of materials being transferred to the DRMS because the shelf life of the material has expired and cannot be extended.

The total amount of material received by the DRMS was determined by searching the DRMS database for all transfers into the DRMS system for the NSNs found in the AFLMA database. The resulting report included all transfers to the DRMS system by Air Force installations. Transfers from the Air Force had a document number that began with the letter "F". The volume of materials found on these documents summed to equal 84,300 pints (10,500 gallons) of

material received by the DRMS. Only one of the transactions appearing on the records from the AFLMA also appeared on the records from the DRMS. This transaction involved 4.8 pints of aircraft grease.

To determine the percentage of material received by the DRMS from the SBSS because the material's shelf life had expired and not been extended, the total amount of material transferred must be determined. This is estimated by summing the total volume of material transferred by the Air Force through the SBSS (278,000 pints) and the total volume of material received by the DRMS (84,300 pints), and subtracting the transaction that appears in both record systems (4.8 pints). The total amount of the material received by the DRMS for the NSNs resulting from the search of the AFLMA database was 371,300 pints (46,400 gallons).

Dividing the volume material transferred by the Air Force because of an expired, unextended shelf life by the total quantity of material received by the DRMS (371,300 pints) results in the percentage of expired, unextended shelf life material transferred to the DRMS. This percentage is 31 percent when it is assumed that the percentage of expired shelf life material transferred through the SBSS is 41 percent. When 99 percent is used, the percentage of material transferred to the DRMS because of an expired, unextended shelf life is 74 percent.

Table 6 summarizes the information presented in this chapter for the two percentages found at WPAFB.

To address the transfer at WPAFB of 209 gallons of hydraulic fluid, the transfers from the AFLMA database were analyzed. First, when compared with the transactions from the AFLMA database, this transaction of 209 gallons is not large. The transaction for the same material found in the

Table 6. Summary of Values Calculated

	Applied Percentage	
	41	99
Total material transferred through WPAFB SBSS (gal)	355	146
Total SL material transferred through WPAFB SBSS (gal)	144	144
Average material per transfer (gal)	9	4
Total material in AFLMA database (gal)	1,670	1,670
Est. SL material found in AFLMA database (gal)	684	1,650
Average material per transfer (gal)	88	88
Est. material transferred through AF SBSS (gal)	34,800	34,800
Est. SL material transferred through AF SBSS (gal)	14,200	34,400
Est. amount of material transferred to the DRMS (gal)	46,400	46,400
% of total material transferred that is expired SL	41 %	74 %

AFLMA database was over three times larger than the transaction at WPAFB. In addition, of the 19 transfers from the AFLMA database, two are greater than 209 gallons, and a third is of comparable size. For this reason, this transaction was assumed to reflect a transfer that occurs at bases.

Summary

This chapter reports the data analysis and findings from the methodology presented previously. One hundred seven NSNs were transferred to the DRMO in the six month period studied; of these NSNs, 33 had an IEX code of "8" or "9". All documents with a TRIC, TRM for these NSNs were used to determine the percentage of material processed through the SBSS that was transferred to the DRMO because of the shelf life program at Wright-Patterson AFB, 41 percent.

A total of 355 gallons of materials were transferred for the NSNs found on the condition change documents at WPAFB; 144 gallons of this amount were attributable to the shelf life program. A determination of the total amount of the material transferred to the DRMO at WPAFB was not made because of incomplete records at the DRMO.

The 41 percentage determined for Wright-Patterson AFB was then applied to a group of documents with a TRIC TRM that was gathered from a database maintained by the Air Force Logistics Management Agency. Document records were

pulled for six bases that are used in studies of the Air Force supply system. When 41 percent of the total amount transferred, 1670 gallons, was assumed to be expired shelf life material the amount was 684 gallons. This amount was extrapolated to characterize the Air Force. The total volume of material transferred was estimated to be 14,200 gallons.

Records from the DRMS database as well as the amount transferred through the SBSS for the Air Force were used to determine the amount of material received by the DRMS for the NSNs found in the AFLMA database. This search resulted in a total of 45,300 gallons of material transferred. This value was used to calculate the percentage of the total amount of material transferred to the DRMS which is material transferred because the shelf life has expired and cannot be extended. The percentage of expired shelf life material from the SBSS was 31 percent. The following chapter provides the conclusions from this research as well as suggestions for further research.

V. Results and Conclusions

The purpose of this research was to develop and apply a methodology that can be used to quantify the amount of waste generated when the shelf life of type II materials expires on base supply shelves, and compare this amount to the total amount turned in to the DRMO for possible application of source reduction techniques. This chapter discusses the methodology developed and used, the results of the analysis, and the findings, conclusions and recommendations developed as a result of this research effort. This will be accomplished by addressing each research question, followed by a section covering the findings, conclusions and recommendations.

The Research Questions

1. How can the amount of type II material, turned in to the DRMO after being rejected from serviceable stock by the base supply system's shelf life inspection program, be quantified? The total amount of type II material turned in to the DRMO can be estimated by searching the records for the base for all documents with a TRIC of "TRM", an IEX of "8" or "9", and a numeric shelf life code. The amounts of material transferred due to shelf life expiration can be found by searching records of condition changes found in the Inspection Section of the SBSS. With these two numbers, a

percentage of material resulting from the shelf life program can be found. In this research effort, 41 percent was calculated.

2. What amount of type II material is turned in to the DRMO after being rejected from stock by the Base Supply System's Shelf Life Program? For the Air Force in calendar year 1992, an estimated 14,200 gallons of type II material was transferred to the DRMS after its shelf life had expired.

3. How can the amount of type II material turned in to the DRMO be quantified? The total amount of material transferred to the DRMO was determined by searching the DRMS database for all documents recording the transfer of materials to all DRMOs.

4. What amount of type II material is turned in to the DRMO? The total amount of material resulting from a summation of the amount of material from transactions appearing in the SBSS database as well as the DRMS database in calendar year 1992 was 46,400 gallons. This amount includes type II materials transferred from the SBSS and other organizations.

5. What percent of type II material turned in to the DRMO for disposal originates in Base Supply? Dividing the volume found in question 2 by the volume found in question 4 resulted in the percentage of the total amount of type II

material received by DRMO that was due to shelf life expiration in the SBSS. This percentage was 31 percent.

Findings, Conclusions and Recommendations

Findings. This study did not include type I materials. There were more transfers of type II materials to the DRMO at WPAFB than type I materials. There were 13 type I materials with a condition change documents on file in the Inspection Section of the SBSS at Wright-Patterson AFB. This represents 11 percent of the total condition changes that were found.

It was also observed that the list items assigned an IEX code of 8 and 9 does not include all of the materials which might be regulated under environmental legislation. There were 3,626 type II materials identified by the SBSS computer at Wright-Patterson AFB. Of these, 776 were identified as health hazard items. Further observation showed that an additional 607 items could possibly be regulated as environmental hazards. For example, there were many oils and paints that did not have an IEX code of 8 or 9. Because of this assumption, the number of transfers to the DRMO is a smaller number than the number of transfers that actually occurred. This reduces the accuracy of the percentage of shelf life material determined at WPAFB, and the total amount of material transferred. The estimated

amount of material transferred will be smaller than the amount actually transferred.

Another area which affects the accuracy of this study is the extrapolation of the percentage of material that is transferred to the DRMO because the shelf life has expired and cannot be extended. This percentage was estimated to be 41 percent based on calculations made for WPAFB. This assumes that WPAFB is characteristic of the Air Force. However, the transactions from WPAFB were made in larger numbers, but smaller quantities. The average material per transaction at WPAFB was nine gallons as compared to an average of 88 gallons per transaction for the transactions appearing in the AFLMA. This difference in average volume per transaction suggests that the percentage found for WPAFB is not typical. However, it does not suggest if the percentage is conservative or not.

In this study, there was an inconstancy between records available through the SBSS database, and the DRMS database. These systems should both include transfers that are made through the SBSS. There were only seven transactions in both of the systems for the NSNs found at WPAFB. One transaction appeared in the DRMS database for the NSNs found in the AFLMA database. The DRMS system should also include all other transfers of material to the DRMOs. Because the transactions from the DRMS do not include transactions from the SBSS, searching the DRMS database for all transactions

to the DRMO did not accurately describe the total amount of material transferred by both he SBSS and other organizations. For the total amount of material transferred to the DRMS, the amounts of the transactions appearing in both databases were summed. This number is low, causing the percentage calculated in question 5 to be high.

On 19 July 1993, WPAFB issued a memorandum establishing Indefinite Delivery/Indefinite Quantity and Just-in-Time Contracts for Hazardous Materials. This memorandum is part of a program establishing a Hazardous Material Cell similar to the one currently operating at Hill AFB. The objective of this cell is to "reduce excess and buy only the smallest quantities necessary to meet workloads, thereby reducing acquisition costs and Hazardous Waste generation" (16:1). Using Indefinite Delivery/Indefinite Quantity and Just-in-Time contracts, the base Supply, Contracting, and Environmental Management Functions will be able to control the amount of hazardous materials received by WPAFB. Using this system, the closer records for waste generation will be kept.

Conclusions. Based on the quantities determined in this study, source reduction targeting materials transferred to the DRMS because of an unextendable shelf life would not be a productive use of time and money. Fourteen thousand two hundred gallons of expired shelf life material for the Air Force is an average of 114 gallons or two drums per

base. When compared to 96,000 tons of waste, an average of 800 tons of waste per base, two drums is not a large amount.

In addition, the methodology that was developed did not answer the questions presented in Chapter I accurately. The first question, quantifying the amount of material transferred to the DRMO for the Air Force that was due to the SBSS shelf life program, was inaccurate because WPAFB data was not similar to the data found at other bases. At WPAFB, there were 38 transactions. For the six bases in the AFLMA database, there were only 19 transactions. In addition, the transactions at WPAFB were only an average of 9 gallons each. This is much smaller than the average 88 gallons found for the six bases in the AFLMA database.

The methodology could also not accurately describe the amount of material transferred to the DRMO. This occurred because of the disconnect that exists between the SBSS and DRMS databases. The number of transactions that occurred is incomplete. This occurs because neither the SBSS system nor the DRMS system includes all of the transactions that occur. Standard Base Supply System records do not include transfers that are made by the using organization to the DRMO. DRMS records did not include transactions recorded by the SBSS at WPAFB or any of the other bases for which transactions were recorded. This leads to the conclusion that at both the local and nationwide records are not adequate for determining the total amount of material transferred.

Recommendations. For a study involving the total amount of material transferred to the DRMO to be successful, there must be a agency or office responsible for keeping records of material transfers. In the Air Force, all transfers to DRMO are not required to be processed by the SBSS computer. For this reason, all transfers cannot be tracked using this database. One suggestion for tracking waste generation would be to enter all transfers to the DRMO database, the SBSS database, or a database designed to monitor hazardous materials used on base. This is being done as bases implement the Hazardous Material Cell concept.

Another suggestion would be for the DRMO to enter their receipt of material into a database immediately, and rather than having the computer delete records of materials when they are transferred, have the database key on items that are over 90 days old. Alternatively, these records can be transferred to an archive file once the item has been placed.

A final suggestion would be for the Environmental Management (EM) Function to be involved in the transfer of materials to the DRMO. Currently the EM function is only involved in the transfer of waste to the DRMO. Materials transferred to the DRMO are not considered a waste, therefore they are not monitored by the EM function. If this is to be accomplished, EM would have to receive the documentation transferring certain stock classes to the

DRMO. This would allow EM personnel to determine if the material would be considered an environmental hazard so that it could be monitored.

As awareness of the environment increases, changes are made to decrease the amount of waste that could be environmentally harmful. This is occurring to hazardous material management in the Air Force. Future studies in the area of hazardous material management in the Air Force could include the effect of implementation of management techniques such as The Hazardous Material Cell. Does changing the procedures reduce the amount of waste generated from shelf life; does it reduce the amount of waste generated by other management techniques such as purchasing procedures; by how much does it reduce the transfer of materials?

Another suggestion would be a shelf life term study similar to that done by the Department of the Navy for the materials most used by the Air Force.

A third suggestion would be to evaluate the sources of hazardous materials transferred to the DRMO that are not due to the shelf life program. This would involve an evaluation of the sixty percent of the materials that were not considered in this study.

Conclusion

This research was intended to determine the amount of expired shelf life material transferred to the DRMO due to an expired shelf life, and compare this amount of material to the total amount of material transferred to the DRMO. The methodology for doing this included determining the percentage of transfers to the DRMO through the SBSS, that were due to shelf life, and applying this percentage to the total amount of material transferred through the SBSS. The total amount estimated for the Air Force was 14,200 gallons or 260 drums of material. This amount was then compared to the total amount of materials which were received by the DRMS for the Air Force. Because of the way records are kept by the DRMS, it was not possible to determine the quantity of material transferred to the DRMS accurately.

Appendix A
Supply Reports

STOCK NUMBER	UI	SD	ER BAL	SL	ISG#	WAREHOUSE L	NOMENCLATURE
6852PMWNONE3412	GL	81	0	P			INSECTICIDE
[illegible]	EA	81	2	2			TONER CARTRIDGE
5812PMWUZP2568G	GL	81	8	2			ACETONE ACS
[illegible]	BX	81	2	2			MANCO GAURD 6OZ CN
9152PMWDRP3568B	GL	81	P	P			VANADIUM HYDRIDE
[illegible]	EA	81	8	8			TONER KIT
68529169151	EA	81	8	8			DEVELOPER PRINTER
[illegible]	EA	81	8	2			TONER KYOCERA
6852P-326P-2	EA	81	8	2			NEUTRASORB REFILL
[illegible]	BX	81	8	P			TONER DIRECT 2EA
581PMWPE82A2881	LB	81	8	8			PHOCAMINE CHLORIDE
[illegible]	BX	81	8	P			MICROBUSTER 12 CONS
685PPRUST	EA	81	8	2			INHIBITOR RUST
[illegible]	QT	81	8	8			CALIBRATE SOLUTION
5859P2663A12	CN	81	8	2			COMPOUND CUTTIN 4OZ
[illegible]	EA	81	8	8			POLY-O-CRZ-L-SERIGN
6812P25 812-5	EA	81	8	8			SULFURIC ACID 4KG
[illegible]	LB	81	8	8			TRICHLORO1
9152P8691-J65	TU	21	8	8			GREASE STOPCOCK152G
[illegible]	GL	21	P	P			ORTI-FLURO O CHEMIC
581PM0C0F92286	LB	81	8	2			MERCURY WASTE
[illegible]	EA	81	8	8			RIH AMINO ACID
6852P24/25A	KT	81	8	8			FOAM POLYURETH 2 QT
[illegible]	EA	81	8	P			FMOC-L-ALANINE 25GM
5812PM0C0814732	GL	21	8	8			PAINT THINNER ZZZZZ
[illegible]	DR	81	P	P			CLEANING CMPD A55GL
6852P2184215239P	EA	81	8	P			P/R64-C682-8808TONE
[illegible]	QT	81	8	P			P/SOLVENT/SOLVENT
5852P9978-744	BX	21	P	P			TONER 382GR 68X
[illegible]	CN	21	P	P		82A8P24816	P/SMC-ME/IC-7161302
5952875923293	DZ	81	4	2		82A2P2C226	CLEANING COMPOUND
[illegible]	BT	81	250	6		[illegible]	CLEANING COMPOUND
5842817653662	CN	81	69	P		82A6639C18	DISINFECTANT 19OZ
[illegible]	BT	81	8	8		[illegible]	RAINREPELLENT WING C
5852PPWC121	PT	81	84	7		82A2638232	SOLVENT SURF PREP
[illegible]	CN	81	P	P		[illegible]	GRAPHITE SPRAY
9152P2Z617899	PT	81	9	7		82A2638844	PENETRATING OIL
[illegible]	CN	81	4	2	4289	[illegible]	METHYL ETHYL KE 5GL
5812P2Z278412	GL	81	9	P		82J2218[illegible]	ALCOHOL ISOPROPYL
[illegible]	GL	21	8	8		[illegible]	ALCOHOL BOTTLES
5852P2Z811985	GL	21	188	7		82J2818227	SOLVENT CL
[illegible]	CN	81	16	7		[illegible]	ACETONE TECH 5GL
5812JJ2512763	DR	81	4	2	4289	82JC[illegible]212	METHYL ETHYL KE55GL
[illegible]	BT	81	48	7		[illegible]	ACETONE REAGENT
5812PMX2L82-1	BT	21	8	P		82J2278823	HEPTANE BP98-99 2KG
[illegible]	DR	81	2	7		[illegible]	ACETONE TECHNICAL S
5812212752C1	DR	81	12	2		82J2278BP7	CYCLOHEXYLAMINE8BLB
[illegible]	CN	81	2	7		[illegible]	ALCOHOL DNTRC 5GL
5812822812795	GL	21	56	2	4289	82J2898271	METHYL ETHYL KETONE
[illegible]	GL	81	17	7		[illegible]	NAPTHA ALIPHATIC
5A82P25E	DR	21	6	8		82J2894225	PRAPITOL L10 55GAL

13 MAY 93 WRIGHT-PATTERSON/S 2338 01 SHELF LIFE LIST (4001) 0V481/921B52 93133 9:

(WAREHOUSE LOCATION SEQUENCE) (R/L TYPE SHAN)

STOCK NUMBER	SD	UI	S L	ERRC CODE	WAREHOUSE LOCATION	SERV BALANCE	ISS NBR		NOMENCLATURE	93	94	95
8C12212186856	C1	KT	4	X83	B28BB78F11	9		✓	EPOXY PRIMER COAT			
8E1888647468	01	QT	4	X83	B28BC78B13	3		✓	PAINT HEAT RESISTIN			
8H43327938686C	B1	CN	4	X83	B28BB78B14	8			ADHESIVE SPRAY 1PT			
8L1CP817A	C1	GL	6	X83	B28BB78C17	11			POLYURETHANE ENAMEL		Dec	
8M488027UA156	C1	TU	5	X83	B28C87AB18	38			ADHESIVE 1-3/4FL OZ		Jun	
8N4388e226438	B1	QT	6	X83	B28AB7AB28	11	4898	✓	ADHFSIVF LIQUID			
8P4811943457	C1	CN	4	X83	C2B8E78B21	6		✓	ADHESIVE 24 OZ			
8R13811346526	C1	KT	6	X83	B25BB7CCH1	28			POLYURETHANE CU 2EA		Mar	
8T1228e6647877	01	CN	6	X83	B28B87C883	18			FILLER WOOD PLAS4OZ		Jun	
8V 53BG9369946	C1	CN	5	X83	B28BC7C8B5	36		✓	SEALING COMPOUND 8O			
8W 38C2981946	B1	CN	4	X83	B28B87C8A6	8			ADHESIVE LIQUID 8OZ			
8X 32JC8288495	B1	KT	2	X83	B28BC7C838	8	9984		SEALING COMPOUN 1EA			
8Y 38b6e44318	B1	PT	2	X83	B28B87CE1C	8			ADHFSIVE 1PT TYPE2			
8Z 3JP77/69A	C1	GL	4	X83	B28B87CB13	3		✓	RESIN POLYESTER CMP			
9A 38d1u265562	81	CN	4	X83	B28B87CB14	2			SEALING COMPOUND8OZ	Lac		
9B 33Q84741419	B1	CA	2	X83	B28BE7CB15	83		✓	CMPD SEALING 6 OZ	Sec		
9C 3408339563	B1	KT	4	X83	B28B87CB16	68		✓	ADHFSIVE WHT 5 OZ			
9D 38BB1429128	C1	KT	2	X83	B28B87CB17	8			CMPD SEALING 1PT			
9E 12B8e453478	C1	GL	6	X83	B28B86A881	684	5364		PAINT RUBBER TTP29		Dec	
9F 1CP438C	C1	GL	6	X83	B28B88A883	8			PAINT TINT BASE			
9G 1B8B2812876	11	GL	7	X83	B28B88A884	5			STAIN TTS711			Jun
9H 13B12CC2637	C1	GL	7	X83	B2B0F8A8C8	17			THINNER EPOXY			Nov
9J 13P4178	C1	GL	6	X83	B28C88AB1B	7			POLYURETHANE ENAMEL	Nov		
9K 12B82P03495	C1	GL	6	X83	C2B0B88BB1	9			ENAMEL BLACK JET 16		Apr Nov	
9L 32BC2566155	C1	LB	6	X83	C2BBB8B0C2	8			BELT DRESSING LEATH		Oct	
9M 1A8C2B67836	C1	LL	6	X83	B2B0B8B0B3	48			ENAMEL PAINT WHITE			Mar

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13. ABSTRACT (Maximum 200 words)

The Pollution Prevention Act of 1990, Air Force Directive 19-4, and the Air Force Pollution Prevention Plan require installations to reduce the amounts of hazardous waste generated. To meet the requirements set forth in these documents, each waste stream containing a hazardous waste needs to be identified and characterized for changes in policies or procedures that would reduce the hazardous waste generated. This research develops a methodology to determine the amount of materials with a type II shelf life that is disposed of as hazardous waste because the shelf life expired while the material was in base supply storage. This methodology is then applied to determine the portion of the total waste stream accounted for by these materials.

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