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JUST-IN-TIME TECHNIQUES AS APPLIED TO HAZARDOUS MATERIALS MANAGEMENT

by
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Just-in-Time (JIT) production and purchasing techniques represent highly effective methods to procure and move material through a manufacturing or service process in a continuous flow. Successful use of these techniques means that material never sits idle, eliminating the need for inventory systems and costs associated with them. Another characteristic of JIT is its focus on the elimination of waste by using resources to their full potential. This focus on smooth flow of materials and elimination of waste is especially appealing in the area of hazardous materials (HAZMAT) management. This is because there are high inventory and disposal costs associated with this material and because HAZMAT typically has a limited shelf life. For this reason HAZMAT management programs seek to reduce and consolidate inventories, reduce material entering the waste stream, ensure materials are used only where appropriate, and guarantee appropriate vigilance. There are several features of JIT that mirror the goals of Navy HAZMAT management programs. This study investigates the feasibility of integrating JIT techniques in the context of hazardous materials management. This study provides a description of JIT, a description of environmental compliance issues and the outgrowth of related HAZMAT policies, and a broad perspective on strategies for applying JIT to HAZMAT management.

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JUST-IN-TIME TECHNIQUES AS APPLIED TO HAZARDOUS MATERIALS MANAGEMENT

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ABSTRACT

Just-in-Time (JIT) production and purchasing techniques represent highly effective methods to procure and move material through a manufacturing or service process in a continuous flow. Successful use of these techniques means that material never sits idle, eliminating the need for inventory systems and costs associated with them. Another characteristic of JIT is its focus on the elimination of waste by using resources to their full potential. This focus on smooth flow of materials and elimination of waste is especially appealing in the area of hazardous materials (HAZMAT) management. This is because there are high inventory and disposal costs associated with this material and because HAZMAT typically has a limited shelf life. For this reason HAZMAT management programs seek to reduce and consolidate inventories, reduce material entering the waste stream, ensure materials are used only where appropriate, and guarantee appropriate vigilance. There are several features of JIT that mirror the goals of Navy HAZMAT management programs. This study investigates the feasibility of integrating JIT techniques in the context of hazardous materials management. This study provides a description of JIT, a description of environmental compliance issues and the outgrowth of related HAZMAT policies, and a broad perspective on strategies for applying JIT to HAZMAT management.

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I. INTRODUCTION

A. BACKGROUND

In the past several years, there has been an explosion of requirements and regulations concerning the safe handling and disposal of hazardous material (HAZMAT). As a result, the administrative structure necessary to implement and monitor a hazardous material inventory program has increased. While few would argue against safeguarding the environment and protecting public health and safety, the resulting regulatory structure generates significant resource outlays. Not only is there an administrative burden, there is the cost of inventory management, manpower requirements, and the exposure to potential liabilities if this material is mishandled.

To lessen these costs, while maintaining the integrity of the HAZMAT program, the Navy is looking at various alternatives to organically managing HAZMAT inventory stocks. One of these potential alternatives focuses on vendors directly delivering hazardous materials using Just-in-Time (JIT) concepts, and outsourcing other areas of HAZMAT management. Ideally, the Department of Defense (DOD) -- in this case specifically the Navy -- would have a supplier deliver HAZMAT as needed, eliminating the need for inventories. In addition, it may be possible to have the vendor shoulder the burden of removing hazardous materials and disposing what material remains after its industrial application. Conceivably, such an arrangement could also include compiling and submitting required environmental reports.

B. OBJECTIVE

As a means of examining this broad area of concern, this thesis focuses on JIT techniques as they might be applied to hazardous material management. Data were collected, analyzed, and applied to the general field of HAZMAT management. This study identifies the potential cost reductions available under a streamlined JIT procurement process. Additionally, it describes the potential for expanding JIT concepts within the Navy and DOD.

Specifically, this study identifies a JIT approach that satisfies the Navy's requirements for HAZMAT management. It explores efficient and economical applications of JIT delivery, eliminating the costs and potential liabilities associated with maintaining organic inventories.

C. THE RESEARCH QUESTION

The primary research question is: "How should the Department of the Navy structure a hazardous material management and delivery system that uses the full capabilities of Just-in-Time (JIT) concepts and what are the benefits of applying Just-in-Time techniques to the comprehensive management of hazardous materials inventories at Navy activities?" The subsidiary research questions are:

- Under the existing system, what are the resource requirements necessary to acquire, maintain, monitor, and deliver HAZMAT?
- What are the specific goals and objectives for HAZMAT management as they exist today?
- What is the concept of JIT procurement and how is it currently utilized by DOD activities?
- What are current practices within the private sector regarding JIT and HAZMAT management?
- Given current regulations, which HAZMAT management requirements represent explicit Governmental functions and which functions could be outsourced to commercial industry?
- To what extent could private industry satisfy the Government's HAZMAT management needs using JIT concepts?
- What benefits accrue under JIT management of HAZMAT inventories?

D. SCOPE, LIMITATIONS AND ASSUMPTIONS

As a means of examining this broad area of concern, this thesis will focus on JIT techniques as they might be applied to overall HAZMAT management. As such, this thesis provides a strategic overview of the potential for JIT within the Navy's hazardous material management structure. In this context, this thesis does not represent a specific implementation plan.

This study is limited to the environmental policies and regulations of the United States. International environmental policy was not researched. Therefore, HAZMAT management practices at overseas bases and installations are not addressed.

The key assumption in this study is that the reader is familiar with basic contracting fundamentals to include general business and Government relationships.

E. LITERATURE REVIEW AND METHODOLOGY

The literature used in this study included a primary text: Just-in-Time Purchasing by A. Ansari and B. Modarress and two secondary texts: Just-in-Time Manufacturing -- an Introduction by T.C.E. Cheng and S. Podolsky, and Just-In-Time Manufacturing in Perspective by Allan Harrison. In addition, several related texts, articles, journals, and General Accounting Office (GAO) Reports were examined. Various theses pertaining to JIT were also reviewed, including: "Just-In-Time Contracting in the Department of Defense" by Brian Joseph Calahan -- December 1991, "Adopting the Prime Vendor Program to Manage Marine Corps Authorized Medical/Dental Allowance Lists" by Kevin L. White -- December 1994, and "JIT Purchasing: A Guide for Successful Implementation within the DOD" by Michael B. McPeak -- December 1995.

The methodology for this study consisted of data collection conducted at four primary research sites: Norfolk, VA; San Diego, CA; Bremerton, WA; and Pearl Harbor, HI. This research focused on Navy HAZMAT management, particularly those activities responsible for or servicing commands heavily involved in the acquisition, use, or disposal of HAZMAT. As a means of comparison, private industries involved in the use and disposal of HAZMAT were studied to determine the extent to which the private sector has utilized JIT concepts for HAZMAT and to what degree these techniques are applicable to the Navy and DOD.

The data collected included a series of interviews that focused on the following types of questions:

- How do related private industries (e.g., commercial aviation, shipbuilding) manage hazardous materials?
- What are the industry trends as well as the advantages and disadvantages?
- How many companies can provide JIT delivery and HAZMAT management?
- What regions can they cover and what materials and services can they provide?

For selected Navy activities, interview questionnaires addressed these additional questions:

- Who currently manages the HAZMAT program?
- What regulations govern the operation of the program?
- How is the program set up?
- How does it operate?
- How effective is the overall program in the eyes of HAZMAT managers?
- How effective is the program in the eyes of the activity's customers?
- What are the potential concerns and considerations for outsourcing HAZMAT management?

Naval Supply Systems Command (SUP 04) sponsored this research and provided information regarding DON HAZMAT policies and regulations.

F. ORGANIZATION OF THE THESIS

This thesis addresses concepts and strategies for applying JIT techniques to hazardous materials management. Chapters were organized to provide the reader with:

- An understanding of JIT
- An overview of environmental law, regulation and compliance issues
- An understanding of how, within this regulatory environment, the Navy manages HAZMAT, both in theory and in practice; and
- Concepts for applying JIT techniques to this HAZMAT management structure

To this end, Chapter II introduces the reader to JIT manufacturing techniques by describing the overall concept, its appeal to DOD and its potential applications within the military logistical structure. This chapter concludes by identifying the elements necessary to implement JIT systems.

Chapter III discusses the history and general philosophy of environmental regulations as they concern hazardous materials. Specifically, this chapter provides background on initiatives to protect the environment and their resulting codification in law and regulation. Additionally, it describes the impact of environmental regulation on DOD officials and the resulting steps DOD and the Navy have taken to address environmental compliance. Finally, Chapter III reviews the procedures the Navy has set in place to manage hazardous materials.

Chapter IV continues this discussion by presenting data collected in the course of research. This chapter describes the actual hazardous material management activities, including the challenges faced by managers. This provides an accurate description of how HAZMAT management initiatives work in practice. Secondly, this chapter describes the current market of JIT HAZMAT providers to determine what services are available to the Navy and private industry. Finally, Chapter IV provides an overview of the trends in private industry with regard to JIT and hazardous materials management.

Chapter V analyzes different issues and strategies for merging HAZMAT management with JIT techniques. In Chapter V, a model is developed to describe the hazardous material management system. Several features of this model are examined, and these features are compared to JIT concepts. Following this is a discussion of methods for linking buyers and suppliers in an integrated JIT system.

Finally, Chapter VI summarizes the information presented and draws conclusions and recommendations developed from this research. Areas for further research are suggested.

II. CONCEPTUAL STRUCTURE AND METHODOLOGY OF JUST-IN-TIME INVENTORY MANAGEMENT

A. INTRODUCTION

This Chapter examines Just-in-Time (JIT) manufacturing techniques by first defining the overall principles and basic concepts of JIT and exploring of the history of JIT from its genesis early this century until today. This discussion reviews both the techniques and mechanisms necessary to implement a JIT manufacturing and delivery system and how JIT functions once implemented. In order to view the advantages of JIT in an appropriate context, the costs of traditional warehousing inventory systems will be examined, especially as they apply to the Department of Defense (DOD). The chapter then ends by contrasting the structure of a JIT procurement system to traditional DOD procurement concepts.

B. THE OVERALL CONCEPT AND GOALS OF JUST-IN-TIME

Just-In-Time (JIT) Purchasing is a subset of basic management principles that evolved in Japan as an extension of the Total Quality Management (TQM) system developed by W. Edwards Deming and others [Ref. 1:p. 13]. As part of a broader system of total quality, JIT must be viewed and applied in the context of those principles. JIT is not a hand-to-mouth purchasing or inventory system, nor is it an inventory reduction system. JIT is a concept that views the development of products from raw materials to finished goods as a continuous, uninterrupted process. In this system, Manufacturer A doesn't simply provide processed materials to Manufacturer B. Instead, Manufacturer A is the first step in an overall system that provides quality finished goods to the end user.

This represents a different way of thinking for all entities involved with JIT. For example, under a JIT concept, US Steel is not in the business of producing steel; US Steel is in the business of producing quality automobiles, ships, buildings, or anything else that uses steel. Companies using JIT concepts are integrated as teams to produce finished goods. The only way for a team to be successful is if the members work cooperatively. The emphasis is on cooperation, not competition. Under JIT, individual companies

in the production chain work to optimize the product and not their individual positions. A simple and effective illustration of this concept is a bucket brigade. This represents a simple supply chain designed to move water from one location to another. The brigade's goal is to extinguish a fire. To this end, full buckets are moved down the line and empty buckets moved back in a continuous integrated process.

Like the bucket brigade, JIT dictates that individual processes be linked together in a continuous chain. Items should move efficiently from one step in the process to the next. The ideal is that material should never stand still and should enter and leave the manufacturing process by the shortest route possible [Ref. 1:p. 11]. Under JIT, warehousing represents waste and inefficiency.

1. The Manufacturing Chain

JIT emphasizes efficiency and ease of production [Ref. 2:p. 10]. To this end, JIT techniques integrate all aspects of the manufacturing chain in a continuous process. This requires careful coordination among individual processes and overall focus on the customer and the end product. For this system to work, each entity in the manufacturing and supply chain must coordinate their efforts to provide material as it is needed. This applies not only to quantity and schedule but also to other aspects such as packaging, quality, design and so on. Material must be designed to fit into the next stage of production. Referring back to the example of US Steel, it is somewhat inefficient to cast steel in sixteen foot bars to be delivered to Chrysler, only to be melted down again to be cast into an auto body frame. A much more efficient system is to have the steel manufacturer pour steel into the proper mold and then send it on to Chrysler for further assembly.

Similarly, it is inefficient to have the entire year's stock of auto body frames delivered en masse. This requires Chrysler to commit resources to receive and store these frames and then pull them back out of storage when needed. From the perspective of US Steel, it is inefficient to gear up for a massive production run and then shut down again for the remainder of the year. Matching Chrysler's steady, predictable demand for auto body frames with a steady production run eliminates a great deal of waste.

2. Elimination of Waste

Eliminating waste is a central tenant of JIT [Ref. 1:p. 32]. Waste is defined as any activity that does not add value [Ref. 1:p. 33]. This applies to holding inventories and to a far broader range of considerations. Toyota identified seven wastes, which are found to apply in many different types of operations -- both service and production [Ref. 1:p. 34]. They are described below.

a. Process and Design

As stated earlier, efficiencies are gained by viewing the manufacturing chain as a continuous process and coordinating activities accordingly. Management should carefully examine these processes and how they are linked to streamline the overall system and to eliminate non-value added activities. A manufacturing or service system should try to attain the same efficient integration of effort as is represented by the bucket brigade.

This is one aspect of process. Another key aspect is design. Studies in automotive and aerospace companies have shown that design determines 70-80% of production cost.[Ref. 3:p. 83] Design should emphasize efficient use of materials and better processing techniques requiring fewer components and subassemblies [Ref. 1:p. 53]. To this end, value analysis studies product designs in order to identify inefficiencies related to function and cost [Ref. 4:p. 561].

Value analysis is a creative, systematic thought process that can be applied to problem solving in a wide variety of areas [Ref. 4:p. 574]. This includes traditional supply processes as well as manufacturing design. For example, a receiving area may be reconfigured to allow for more efficient flow of material or a purchasing operation might be placed in a location close to potential customers. In all types of applications, the focus is on function. Specifically, how can the function be performed at the lowest cost for a specified quality level [Ref. 4:p. 575].

Another key aspect of eliminating process inefficiencies is to ensure equipment and facilities are well maintained. This is done to reduce costly unscheduled disruptions. Planned

maintenance can be integrated into the production schedule. Corrective maintenance can not. The role of maintenance is essential in providing a reliable facility. Breakdowns cause disruptions in the production process that are often avoidable. This, in turn, causes bottlenecks leading to sporadic, vice continuous, flow of materials and services.

b. Transportation

Unnecessary transportation of material does not add value to any process. Therefore, at the macro level, transportation paths should be established to optimize the efficiency and economy of moving material along a given network. To this end, there are several linear programming techniques that may be applied to identify optimal solutions to routing material along a given network (e.g., minimum possible cost) [Ref. 5:p. 225].

At the micro level, steps should be taken to avoid repetitive material handling. Double and triple material handling represents waste and inefficiency. Facility layout becomes a critical factor in setting up optimal transportation paths. For example, a system whereby material is delivered by truckload, off-loaded by forklift, placed in a storage location by hand, only to be removed by hand, palletized, moved by forklift and trucked to the end user inefficiently uses several resources -- namely: fuel, manpower, space and, most valuable of all, time. This is one of the primary reasons direct delivery systems are preferred to tiered inventory systems.

c. Time

As mentioned above, time is a critical resource. Once it is gone, it can not be re-acquired. Because of this, a central tenant of JIT is to minimize waiting time by emphasizing machine efficiency, labor efficiency, and transportation efficiency [Ref. 1:p. 35]. As wait times increase, customers in the production chain tend to compensate with inefficient behaviors, such as stockpiling needed materials. Because of this, JIT lives and dies by response time.

d. Overproduction/Over-purchase

Toyota has identified overproduction as the single greatest source of waste [Ref. 1:p. 34]. While producing or purchasing more than is required provides a comfortable buffer, it also leads to

scheduling problems, lead time delays, extra space requirements, extra work in progress (WIP), and a lack of responsibility for quality [Ref. 1:p. 34]. In several examples to follow later in this chapter, the impact of overproduction (more specifically over-purchase) within DOD is readily demonstrated.

e. Defective Goods

One of the basic reasons JIT considers inventories to be undesirable is that inventories hide quality problems. Unacceptable items can be replaced with goods from inventory while defective materials are reworked or thrown away. Because of this, quality problems are not given the attention they deserve [Ref. 4:p. 433]. This is inefficient. If these items are placed in inventory, defects may not be identified until material is pulled for use. By this time, the defect may cover the entire production run. Under a JIT production concept, these non-conforming materials are identified immediately. This allows the supplier to take equally immediate action to correct the problem.

To identify quality problems before they infect an entire production run, another inefficiency is often introduced. Quality assurance inspectors are hired to ensure incoming material meets specifications before it is stored. This still requires batches of material to be returned for rework or disposed of. A more effective application of resources is to identify quality problems as they may occur and correct them immediately, before further resources are squandered.

f. Motion

JIT emphasizes economy of motion not only in the transportation of items but also in production and service delivery. These functions are often rife with non value-added activities, unnecessary checks, internal paperwork, improper physical layout, and illogical task assignments all lead to waste and inefficiency. Tasks under JIT should be simple, streamlined, and straight forward. Materials should be ready for application in the next stage of any process with little need for further handling or preparation. This is one of the key reasons JIT emphasizes delivering materials instantaneously, in the condition in which they are needed, to complete the next step in any process.

g. Inventory

The previous discussion leads to the central tenant of JIT: inventory represents waste and inefficiency. Inventories hide quality problems, require repetitive handling of material, waste resources, and are the epitome of a non-value added activity. JIT was not developed as a way to reduce inventories. Instead, eliminating inventories is a logical extension of the JIT focus on efficiency and eliminating waste.

3. Total Quality

Total Quality (TQ) defines a set of principles designed to promote excellence. Quality in this system is defined by the customer. It entails developing an obsession for delighting customers -- not being satisfied with merely getting rid of what annoys them but understanding their current and future needs and surprising them with products and services they didn't even know were possible [Ref. 6:p. 11]. While JIT is a tool for attaining efficiency, TQ is a guiding principle. Because of this, the two concepts complement each other and are often expressed together [Ref. 1:p. 40].

There are six fundamental techniques for attaining Total Quality. They are summarized below. [Ref. 1:p. 40]

a. Management Leadership

Management must provide focus and consistency of purpose. Without a shared aim, the elements of an organization have no guidepost by which to navigate. They operate as separate fiefdoms, each pulling in its own direction [Ref. 6:p. 31]. Organizations tend to become parochial and compete internally for resources and recognition. Leadership is required to align elements of an organization together and instill a singularity of purpose.

b. Integration of Effort

Processes within an organization are integrated together by viewing each as a customer-supplier relationship [Ref. 1:p. 41]. In this way, each process owner seeks to satisfy the exact needs of the next process owner in a continuous chain that ends with the final customer. This focuses all process steps

on the end user. In the context of DOD, the chain might work something like this. The supply function seeks to satisfy the maintenance function. The maintenance function, in turn, seeks to satisfy the war-fighter. The war-fighter seeks to satisfy the policy maker and the policy maker seeks to satisfy the needs of the nation. Infighting along this chain creates waste and inefficiency.

c. Prevention

Preventing defects is a basic premise of quality control. It is far better to find defects during a process than in the products of that process [Ref. 1:p. 41]. With this in mind, TQ organizations establish processes that produce goods within the tolerances that meet customer requirements. This not only applies to manufacturing products, but also to providing services. If the customer defines quality as being able to receive materials within an hour following his or her request, a total quality organization should set up a timely delivery system and monitor its operation in order to ensure this delivery time is met.

d. Detection

To prevent defects from impacting quality, it is critical to establish efficient detection systems. This entails such techniques as Statistical Process Control (SPC), charts, and checklists [Ref. 1:p. 41]. This allows process owners to identify defects early on and make the necessary corrections immediately. There is, however, one additional consideration that must be taken into account when setting up any detection and monitoring system. Systems should be set up such that it can provide the necessary oversight at a minimum cost to the organization. This focus on efficiency and eliminating waste is one of the common tenants that link JIT and TQ.

e. Ownership

Responsibility rests with the process owner [Ref. 1: p. 41]. This means that the process owner is responsible for any defect, and that he or she should be empowered to ensure that the function they oversee meets the customer's needs. Without empowerment and accountability, process owners are limited with regard to the quality of goods or services they may provide.

f. Continuous Improvement

Management should never be satisfied that they have established an efficient process that needs no further improvements. Business environments are constantly changing and the only way for organizations to be effective is to adapt with the environment. What works today may not work tomorrow. A clear example of this was Ford's adherence to production of the Model T in the face of the changing automobile market. Because of this, Ford lost its place in the automobile industry to innovative firms such as General Motors (GM); ironically GM similarly saw its dominance in the automobile industry eroded by the Japanese auto industry's ability to meet changing customer demands.

C. A HISTORY OF JUST-IN-TIME

As stated earlier, the push for efficient production processes was successfully applied by the Japanese. Much of what we now know as JIT was developed by Taiichi Ohno of Toyota. His application of these techniques allowed Toyota to rise out the first oil shock of 1972-73 and continue to grow. Based on this success, other Japanese manufacturers embraced the Toyota Production System (as JIT is more widely known in Japan). [Ref. 1:p. 13]

Throughout the 1970s, Japanese companies vigorously applied these concepts and integrated them along the entire range of production. The resulting manufacturing efficiencies were manifest in low cost, high quality products and an increasing market share -- especially in the automobile industry. [Ref. 1:p. 13]

Alarmed by the loss of market share, American automobile producers led the way in the west by adopting the principles of JIT and TQM in the early 1980s. The successful Japanese example and early American applications of JIT led to a rapid adoption by a wide array of U.S. Industries. Like their Japanese counterparts, American firms applying these techniques are producing high quality goods at lower costs. This in part has led to the recent resurgence of American industry. [Ref. 1:p. 13]

D. DEPARTMENT OF DEFENSE INTEREST IN JUST-IN-TIME

In much the same way that American industry adapted to a changing environment using JIT, DOD looks to these principles as a means of adapting to reduced budgets and increased costs. JIT is especially appealing to DOD because it emphasizes efficient material movement by effectively using limited resources [Ref. 2:p. 3]. One need only examine the vast DOD supply system to see glaring examples of inefficient material movement and resource use.

1. Purchases in Excess of Requirements

Through the Defense Logistics Agency (DLA) and the individual Services, DOD has historically maintained vast multi-tiered inventories to re-supply operating forces on demand. Throughout the post World War II period, this entailed stockpiling large inventories at the consumer, regional, Service, and defense system levels. This inventory strategy peaked in the early to mid 1980s when DOD supplies and spare parts inventories increased by $60 billion. [Ref. 7:p. 2]

By 1992, DOD had accumulated a $100 billion inventory of spare and repair parts, clothing, medical supplies, and other support (secondary) items, of which $40 billion was considered excess [Ref. 8:p. 6]. Put another way, over 40% of DOD's 1992 inventory, by cost, was in excess of operational requirements. The Government Accounting Office (GAO) cited the following as examples of excessive supplies purchased and warehoused by DLA:

- The Defense Distribution Depot, Columbus, Ohio, has stocks of wool cold weather shirts several decades old. The large size (NSN 8415-00-188-3799) has stock that was packed in the 1950s, 1980s, and 1990s. Based on average demand during 1992, this item had over nine and a half years of stock on hand. DLA is in the process of disposing of most of these wool shirts as they have been preserved with dichloro-diphenyl-trichloroethane (more commonly known as DDT) and are potentially unsafe to wear. [Ref. 9:p. 21]
- DLA, in fiscal year 1993, had 18,289 switch boxes in storage valued at $1,755,744. The agency last bought these boxes 7 years ago. In the past 5 years, DLA has issued only 152 of

them to the military Services and expects to issue only 4 more in the next 12 months. Some stock of this item has been in storage for 25 years. [Ref. 10:p. 17]

- In fiscal year 1993, DLA disposed of 22,470 capacitors valued at $82,914 because the Services had requested only one capacitor in the past 2 years. These capacitors, which are used on communications equipment on various Navy ships, were last purchased in 1974 and have been stored in DOD warehouses since that time. DLA plans to retain only 254 to meet future demand. [Ref. 10:p. 18]
- At the Fleet and Industrial Supply Center (FISC) Norfolk, Virginia, three pump rotors for a ship water pump (costing about $22,000 each) have remained in storage since 1970. Recently, these items were transferred to DLA for management under the Consumable Item Transfer Program. Under this program, DLA assumes management responsibility for selected consumable items used by more than one Service. Under DLA's disposal policy, they will not be considered for disposal at for least two years. [Ref. 11:p. 8]

2. Cost of Inventory

While the preceding examples are perhaps among the more extreme cases, they provide graphic evidence of some of the waste associated with DOD's procurement and inventory policy. While this chapter has already examined the inefficiencies of overproduction and over-purchase, it is useful to examine some of the actual costs associated with these policies. These costs primarily reflect obsolescence, deterioration, storage, and loss. Each will be briefly examined and contrasted with the savings associated with JIT systems.

a. Obsolescence

First, holding inventory introduces the potential cost of materials becoming obsolete before they are ever required. Warehousing seeks to provide a ready pool of materials today in order to meet tomorrow's requirements. This model leaves little room for changing technologies. JIT, on the other hand, stresses process flexibility and adaptation. Inputs can be adapted as they are processed to

meet changing customer needs. Take the simple example of an engineering change. In a JIT system, the parts that arrive today arrive with the change already incorporated. In a warehousing system, all the parts in storage must be returned to the manufacturer for re-work, adding cost and inefficiency. In the worst case, material being warehoused can become obsolete and must be disposed of. Such situations represent a total waste of resources.

b. Deterioration

Material in storage tends to deteriorate over time. GAO cited several examples, including a $48,500 hoisting antenna stored outside for so long it was covered with grass and rust [Ref. 11:p. 13]. Less dramatic but far more costly examples can be found in shelf life material. These are items that have a limited amount of time they may be stored before they must be used. Once the shelf life has expired, DOD has not only incurred the cost of purchasing, receipt, and storage. Now, DOD must also pay the cost of pulling this material and disposing of it. In many cases, the costs of disposal exceed the original purchase cost (this is especially true of items with a hazardous material content). Buying something, storing it, and then throwing it away at a cost represents inefficiency and waste in the extreme.

c. Storage

Another obvious cost associated with a warehousing system is building and maintaining large storage facilities. Under JIT, material stays in the pipeline, greatly reducing storage costs and space requirements. Freeing up space allows it to be used for other more productive applications. The example of the grocery store is often cited. In most grocery stores there is very little back room area. Most of the floor space is dedicated to customer displays. Re-stocking is generally done at night using JIT deliveries. In this case, the reduction in storage volume results in an increase in sales volume.

While DOD is not concerned with sales volume and profit, it is concerned with storage costs and savings. DOD stocks about 2.2 million different items equating to a volume of 130.4 million cubic feet. A typical DOD warehouse is 595 feet long and 180 feet deep. DLA estimates are that a minimum of 205 such warehouses are required to store this volume of material. Additionally, DLA estimates that holding costs for 130.4 million cubic feet of material is $94 million per year. [Ref. 11:p. 4]

d. Loss

One final contrast of warehousing , as opposed to a JIT system, is loss. Under JIT, material is pulled in as required. This requires material to arrive on schedule. If it doesn't, it is missed immediately and corrective actions are taken (i.e., material has management attention at all times). Under warehousing, assets do not have the same degree of visibility. This often results in loss. This loss takes place at every level where inventory is amassed. For example, a typical aircraft carrier has an inventory of approximately 80,000 line items valued at $260 million. Inventory adjustments representing material losses are typically in excess of $1million per ship per year [Ref. 12].

3. The Need for Change

Clearly an extensive warehousing system represents inefficiencies and related costs that are increasingly difficult to justify in a limited resources environment. In an effort to streamline, DOD has turned to concepts such as JIT to cut cost and promote efficiency.

As stated earlier, JIT is not an inventory reduction model. It is part of a larger concept that must be understood as it relates to the whole system. To understand the changes that must be adopted to implement a JIT system, it is also necessary to understand the factors that have historically contributed to large DOD inventories. While these factors are many, there are two major contributing factors.

a. Asset Visibility

The DOD logistics system holds sufficient material stocks to meet future needs. This leads to excessive stock. This is because DLA and the individual Services have historically lacked total system wide asset viability and an integrated control mechanism for material issue. Excess retail and customer level inventories are often invisible to the wholesale system. As a result, there is a significant degree of redundant stock. More importantly, needless purchases are often made to satisfy requirements for which DOD holds material. Such purchases are often in excess of requirement quantities contributing to inventory build up.

b. Approach to Contracting

The traditional contract cycle emphasizes large production runs under short term contracts. The objective is to get the best price per unit. Frequently, DOD has to provide the supplier with enough incentive to gear up a production line that might have laid dormant since the last Government contract was delivered. Both of these contributing factors illustrate the importance and potential applications of JIT in DOD acquisition practices.

E. THE STRUCTURE OF A JUST-IN-TIME PROCUREMENT SYSTEM

JIT Procurement practices differ from traditional industry and Government practices, primarily in terms of the relationship between supplier and buyer. As stated earlier, JIT abandons the concept that each manufacturer optimizes their own position at the expense of the overall production system (from raw materials to finished goods). JIT favors a cooperative, integrated team concept. As such, suppliers and buyers work hand in hand to provide finished goods to the customer.

This essential to the JIT concept. Traditional purchasing philosophy holds that the buying firm alone is the customer[1]. This is only partly true. JIT assumes the buying firm is part of a process to provide a continuous chain of finished goods or services to the customer. As such, both the buyer and the seller should cooperatively focus on the final user of the good or service. As stated earlier, this is done by the entire production process as a system of buyer-seller relationships, regardless of organizational boundaries. In order to provide quality goods, DOD -- like any other activity -- must adapt to the notion that the next activity to receive the good or service is the customer.

Like the business world, traditional DOD procurement philosophy held that DOD alone was the customer (specifically the DOD Supply System). Under JIT, this is not the case. JIT emphasizes having the right item, of the right quality and quantity, in the right place at the right time [Ref. 2:p. 1]. In terms of repair parts, this entails having the right repair part available when the maintenance technician needs

[1] The term "traditional" is used in this discussion to provide a point of reference and contrast. Traditional in this sense is used to define one end of a continuum and JIT the other. The Federal Government and most firms are somewhere between the two extremes. Progress toward a JIT system entails moving away from traditional methodologies and towards JIT principles.

it. It doesn't matter to the maintenance technician that the part may have come from private industry or a DLA warehouse. What matters is that the part is available when needed.

In terms of subsistence, this would equate to providing a the customer a quality meal, served on time. This involves providing stores to the galley as needed, which entails receiving produce from the vendor on schedule, all in a continuous pipeline. All activities involve the business of providing nourishing meals. This requires a cooperative system where efficiencies are gained by providing materials in a continuous flow. Receiving and storing activities are de-emphasized in favor of meal preparation activities. Vendors might suggest improvements, such as pre-preparation and packaging modifications, to facilitate meal preparation. The important point is that both the galley and the vendor are focused on the meal and the customer.

As simple as this sounds, it represents a radical departure from the paradigm under which DOD acquisition policy was conceived. Traditional procurement systems have looked to the source that can provide the product at the lowest price, as determined by competition. Such a system tends to foster an adversarial relationship. Additionally, DOD contracting has relied on short term contracts for a wide variety of parts and services. This tends to increase competition and the volume of paperwork associated with awarding and administering short term contracts. From the supplier's point of view, this means unstable, short term relationships with Government buyers. This has a negative impact on price determination and the supplier's degree of cooperation.

With regards to quantity, this system emphasizes large buys designed to fill shelf space as a hedge against future requirements. The supplier, faced with the uncertainty of further business, can only be compelled to quote a low price if the quantity purchased is sufficient to reduce average product cost. Infrequent and unpredictable buys often involve starting and stopping production runs -- even though there may be a constant, predictable level of demand.

JIT, on the other hand, emphasizes a partnership with suppliers. As opposed to traditional purchasing, JIT emphasizes single sources of supply, performing under long term cooperative agreements. This includes tapping into contractor expertise on design, packaging, transportation, and any other issue

which will improve the system's ability to satisfy the end user. In other words, the JIT contractor becomes an extension of a material development and delivery system. Table 2.1 provides an overview of the fundamental contrasts between JIT and traditional purchasing practices.

Comparison of Traditional and JIT Purchasing Systems		
Activity	JIT Purchasing	Traditional Purchasing
Purchase Size	small lots	large batches
	frequent deliveries	infrequent bulk deliveries
Supplier Selection	long term	short term
	single sources of supply	multiple sources of supply
Supplier Evaluation	focus on value	focus on price
	no rejects acceptable	2% rejects acceptable
Inspection	initial reduction	reliance on counting and inspecting
	eventually eliminated	entrenched philosophy
Negotiations	emphasize long term relationship	obtain lowest price
	emphasize quality	
	reasonable price	
Transportation	pull system	push system
	emphasizes on-time delivery	seeks to lower costs
	buyer has schedule responsibility	supplier has schedule responsibility
Product Specs.	performance specifications	reliance on design specifications
	supplier innovation	
Paperwork	less paperwork	large volume of paperwork
	greater flexibility	inflexible terms and conditions
Packaging	small, standardized containers	regular packaging
	exact quantities	not tailored to need

Table 2.1. Source: After [Ref. 2:p. 102]

For the supplier, this equates to long term production schedules, reduced administrative paperwork, and, most importantly, a chance to positively affect and influence the way material is provided to the end user.

For the Government, this relationship equates to consistent product quality, resource preservation, reduced costs, a supplier concerned about improving systematic performance, and a cooperative relationship -- a win-win situation.

As stated previously, JIT views the buyer/supplier relationship as a partnership. This partnership should work toward the following goals: [Ref. 2:p. 103]

- Shrinking the supplier base
- Establishing long-term relationships
- Relying on a single source and eliminating secondary sources as a buffer
- Reducing the frequency of order scheduling
- Improving pricing
- Eliminating counting, unpacking, and inspecting incoming materials
- Streamlining receiving and payable systems
- Eliminating bulk breaking
- Reducing inventory levels
- Eliminating material spoilage and loss, and
- Increasing customer and supplier involvement in design and product development

Quite obviously, DOD has a long way to go to implement a JIT system. However, with recent inroads in acquisition reform, there is movement along the spectrum. Programs such as Prime Vendor are demonstrating that JIT is workable within DOD. There is every reason to believe, given the wholesale inventory problems outlined earlier, JIT principles will gain support among key DOD decision makers.

F. SUMMARY

This chapter presented the basic features of JIT systems as well as an overview of related Total Quality concepts. Attention was then focused on the applicability and appeal of these systems to DOD by

examining the costs associated with traditional tiered inventory systems. Following this was a discussion of the necessary elements needed to implement JIT systems.

Given that JIT is a tool for improvement, the next chapter will focus on the potential context for application of that tool. Specifically. the next chapter discusses the background and formulation of DOD environmental policies, with emphasis on what effect those policies have had on the management of hazardous materials.

III. GOALS AND OBJECTIVES OF HAZARDOUS MATERIALS MANAGEMENT

A. INTRODUCTION

This Chapter examines the history and general philosophy of environmental regulations as they concern hazardous materials (HAZMAT) as well as the extension of these guiding philosophies into legislation, regulation, and policy. Specific attention is given to the steps the Department of the Navy (DON) has taken to self-regulate, current strategies underway to minimize operational stocks of HAZMAT, and steps taken to control the amount of material going into the waste stream. This chapter describes the factors driving the need for HAZMAT management, the approach the Navy has taken to address these factors, and the structure the Navy has put in place to execute policies dictated by higher authority.

B. BACKGROUND

In the 1960s, environmental protection became a salient political issue in the industrialized world. Environmental issues were instilled in the American consciousness by works such as Rachel Carson's book "Silent Spring," which warned that environmental contamination posed dangers to humankind as grave as nuclear war, and events such as the 1967 Torey Canyon Oil Spill [Ref. 13:p. 1]. This shift in attitudes toward the environment is documented by several Gallup surveys conducted during the late 60s. According to these surveys, the percentage of Americans who identified air and water pollution among the three problems they most wanted government to treat during the next two years increased by 300 percent between 1965 and 1970 [Ref. 13:p. 3].

Concern about the environment continued to gain momentum, accompanied by the growth of scholarly and popular literature. Non-governmental organizations (NGOs) that had traditionally been concerned with the environment gained prominence and influence as the environmental movement swelled (e.g., The Audobon Society, The Sierra Club, and The League of Conservation Voters). Eventually, the environmental movement became intertwined in the two other predominate movements of

the 1960s: the civil rights movement and the anti-war movement. All three movements reflected idealism and a longing for simplicity. Unlike the other two movements however, the environmental movement enjoyed a broad base of support that stretched across economic, cultural, and racial boundaries. Because of this overall consensus, legislative and regulatory action proceeded at a rapid pace. [Ref. 13:p. 3]

1. Environmental Regulation

Environmental regulation was nothing new to the Federal Government. For example the first Federal efforts to control water pollution can be traced back to the Refuse Act of 1899 [Ref. 13:p. 3]. However, prior to the environmental consciousness of the 1960s, environmental protection was largely left to local and state governments [Ref. 13:p. 3]. Because of increasing public concern, the Federal Government's role expand significantly beginning in 1963.

The Clean Air Act of 1963 was the first in a long stream of Federal environmental legislation that established strict standards, making protection of the environment a Federal responsibility [Ref. 13:p. 3]. As amended, the Clean Air Act established national ambient air quality standards (NAAQS) for common air pollutants ("criteria pollutants") and required States to establish air quality control regions to achieve the NAAQS. Additionally, this act required the Federal Government to establish necessary air quality controls where States failed to do so, and to monitor 138 identified pollutants. The Clean Air Act was then followed by the Water Quality Act of 1965 and the Air Quality Act of 1967. [Ref. 14:p. A-1]

The two most important steps in establishing Federal control over environmental policy came in 1969 and 1970: first, with the passage of the National Environmental Policy Act (NEPA) of 1969; second, through President Nixon's 1970 Reorganization Plan Number 3, which formed the Environmental Protection Agency (EPA). These actions centralized environmental policy authority within one Federal agency, significantly increasing the Federal Government's ability to oversee and enforce environmental laws and regulations. [Ref. 13:p. 4]

From these beginnings, the Federal Government continued to produce environmental statutes and regulations. Appendix A of the Navy's Environmental and Natural Resources Program Manual lists 38

separate laws, 94 Federal regulations, 14 executive orders, 12 DOD directives, and one Office of Management and Budget (OMB) circular, all of which pertain to environmental compliance [Ref. 14: p.A-1]. This explosion of environmental requirements has required a rapid evolution in environmental management practices across the entire spectrum of public and private sector organizations.

2. Enforcement

Environmental compliance requirements embody mechanisms to control negative externalities associated with pollution. There are four broad categories of public-sector remedies for these externalities [Ref. 15:p. 220]. The Government can:

- Impose regulations
- Impose fines
- Subsidize expenditures to reduce negative externalities, or
- Define, through the legal system, property rights that can discourage negative externalities

Because the environment represents a public good in the truest sense (i.e., there is no cost for an additional individual to enjoy the environment and, realistically, it is impossible to exclude an individual from access to the environment), property rights have not been extensively used as a mechanism to control pollution in an aggregate context. Additionally, pollution abatement subsidies, in principle, provide an effective incentive for private firms to limit pollution, but they do not have the same impact on public entities. This is because there are limited budgetary mechanisms in place to provide these subsidies and public firms aren't driven by profit motives [Ref. 15:p. 225]. That leaves the Government two primary enforcement mechanisms to control public agencies: regulations and fines.

a. Regulation

On the face of it, the concept of dictating regulations and standards from one public agency to another would seem an effective means to ensure public agencies comply with environmental policy. Logic dictates this would apply especially to DOD -- an organization that operates on a command system. This, however, has not been the case. There exists a myriad of regulations concerning

environmental protection at DOD installations, none of which were historically adhered to. DOD activities, in the face of increasingly stringent regulations, continued to operate much as they had prior to the environmental movement of the 1960s. This was in large part because of the equal cabinet level status DOD enjoyed with EPA and because of the perception that DOD, because of national security reasons, operated somewhat outside of the requirement to adhere to strict environmental standards. [Ref. 14: p. 1]

b. Fines

The basic principle involved with the imposition of fines is simple: whenever there is an externality (in this case pollution) a properly calculated fine imposes a cost on the firm which equals the difference between the private cost and the social cost of the externality [Ref. 15:p. 221]. In an effort to ensure compliance with environmental policy, the Federal Government has taken this concept one step further. It levies fines both on the activity responsible for the regulatory infraction and on the accountable official in charge of that activity. Focusing liability on the accountable individual, vice the organization, spurred sweeping changes to the structure of HAZMAT management beginning in the 1990s.

C. CONCEPT OF PERSONAL LIABILITY

The concept of personal liability drastically altered the degree of DOD management attention placed on environmental compliance. By exposing individual employees to fines and penalties, the Government gave these people a stake in environmental protection. This potential exposure applies to both civil and criminal liability. An examination of both aspects of personal liability is provided below.

1. Civil Liability

Generally, the Government and agents of the Government have enjoyed the protection of sovereign immunity. Sovereign immunity is a concept derived from English Common Law which holds that, without the sovereign's consent, no legal action can be taken against the Government. This meant that the Government was immune from suit unless, through an act of Congress, it consented to be sued. The Federal Tort Claims Act (FTCA) in 1978 provided that consent in a number of cases, including environmental compliance [Ref. 16:p. 2]. Via this Act, Congress waived sovereign immunity for the

actions or inactions of its employees and agents. With certain limitations, FTCA allows plaintiffs to bring tort actions for negligent and wrongful acts or omissions of Federal employees acting within the scope of their employment [Ref. 16:p. 2].

It is important at this juncture to define negligence as it applies to environmental compliance. Negligence occurs when a defendant fails to exercise the degree of care, skill or diligence a reasonable person would exercise under similar circumstances. Negligent conduct can arise from either an act or a failure to act [Ref. 16:p. 1]. The FTCA waived the immunity accountable officials had previously enjoyed in the exercise of their duties and exposed them to civil suits. Although later court interpretations defined limits on civil liabilities [Ref. 17], there is a risk of tort liability for environmental noncompliance, especially in cases involving intentional acts.

2. Criminal Liability

Criminal liability attaches when one commits a crime. Punishment can include punitive fines and/or imprisonment. Most environmental statutes contain criminal provisions from which Federal employees are not immune from prosecution [Ref. 16:p. 6]. Increasingly, these penalties have been meted out against DOD employees via other state and Federal agencies.

Not only has the responsible officer or supervisor with direct knowledge of the violation been the focus of these fines and penalties, in addition Commanding Officers (COs) have increasingly been the focus of penalties under the doctrine of the Responsible Corporate Officer (RCO) [Ref. 18]. This doctrine holds that officers of corporations operating within industries regulated by public welfare statutes have a duty to know about violations occurring within their area of domination and control. Consequently, lack of knowledge of a particular violation is not a defense [Ref. 16:p. 9].

a. Public Welfare Statutes

A public welfare statute is any statute that regulates the handling of dangerous articles or substances that threaten the community's health and safety. Most environmental statutes have been held to be public welfare statutes. [Ref. 16:p. 9]

b. Presumption of Knowledge

The defendant who operates within a community regulated by a public welfare statute is presumed to know that articles or substances capable of threatening the public's health and safety must be handled with a greater degree of care. Accordingly, the prosecution need not prove that the defendant intended to violate the statute [Ref. 16:p. 9]. Indeed, the court has held that: "Where...dangerous or deleterious devices or products or obnoxious waste materials are involved, the probability of regulation is so great that anyone who is aware that he is in possession of them or dealing with them must be presumed to be aware of the regulation." [Ref. 19]

c. Applicability to Federal Employees

Although originally developed in the context of criminal prosecutions of corporate officers, the RCO Doctrine has been used in prosecuting Federal employees [Ref. 16:p. 9]. Beginning in the late 1980s, the increased use of fines and the specter of criminal liability focused DOD's attention on establishing positive managerial controls over the use and disposal of hazardous materials (HAZMAT). The following is a short list of prosecutions of Federal employees: [Ref. 16:p. 10]

- U.S. v. Carr, 880 F.2nd 1550 (2d Cir. 1989). On December 16, 1988, Mr. Carr, a maintenance foreman at the Fort Drum Firing range in Watertown, NY, was convicted of two counts of failing to report the spill of hazardous substances into the environment. Mr. Carr was sentenced to two one year terms of probation to run concurrently and a $300.00 fine.
- U.S. v. Dee, Lentz & Gepp, 912 F.2nd 741 (4th Cir. 1990) cert. denied 111 S.Ct. 1307. On May 11, 1989, three senior civilian managers (SES-4, GS-15, GS-14) at the Army's Aberdeen Proving Ground in Maryland were each sentenced to three years probation and

1,000 hours of community service following their convictions on various counts of illegally storing, treating, and disposing of hazardous wastes.

- U.S. v. Ferrin, Case no. 91-0946-GT, (SD, CA). On March 24, 1992, Mr. Ferrin, a civilian supervisor at the hazardous waste storage facility at Naval Station San Diego, CA (32nd Street) pled guilty to one count of directing subordinates to mix methyl isocyanate, a hazardous waste, with absorbent and dispose of the mixture in an ordinary trash dumpster behind the facility. Mr. Ferrin was sentenced to three years of supervised probation (including three months of home detention) and a $50.00 penalty.
- U.S. v. Curtis. On May 26, 1992, Mr. Curtis, a GS-12 Fuel Division Officer at NAS Adak, AK, was sentenced to ten months confinement following his conviction on three counts of violating the Clean Water Act by allowing 500,000 gallons of JP5 fuel to spill into U.S. waters.

The cases cited above reflect the court's view that responsible officials will be punished for environmental violations. This view is also shared by regulatory agencies which increasingly have administered fines based on more stringent oversight. This necessitated the development of strategies to aggressively monitor and control HAZMAT.

D. DEPARTMENT OF THE NAVY STRATEGIES TO ADDRESS ENVIRONMENTAL REGULATIONS

Faced with increasing pressures from regulatory organizations, NGOs, and the courts, the Navy established overarching policy regarding hazardous material control and management (HMC&M) with promulgation of the Office of the Chief of Naval Operations Instruction (OPNAV INSTRUCTION) 4110.2. This Instruction applies to all Navy organizations and shore activities involved in planning, procurement, acquisition, storage, distribution, requisition, use, or other disposition of HAZMAT, including disposal of resultant hazardous wastes (HAZWASTE) [Ref. 20:p. 1]. The Department of the Navy, through this Instruction, recognized that HMC&M was a life cycle requirement involving all

elements of the Navy. Further, it required HMC&M concepts to be addressed for all new or modified Navy systems, through all stages of acquisition, from concept exploration to final disposition [Ref. 20:p. 2].

With regard to management of HAZMAT inventories, OPNAV INSTRUCTION 4110.2 requires vigorous Navy action to plan, control, and manage HAZMAT inventories. It also recognizes that: "HMC&M also provides a means to increase operational readiness by reducing hazards to life, property, and the environment [and] accrued savings in manpower, facilities, and supplies to the primary Navy mission also result." [Ref. 20:p. 2] While not providing further justification for this conclusion, this document appears to recognize the burdens and exposure to liability represented by past HAZMAT management practices.

1. Department of the Navy Guiding Policy

It is important to note that, with the promulgation of OPNAV INSTRUCTION 4110.2, DON established specific policy that the Navy would comply with all Federal, State and DOD standards, directives, instructions, and regulations related to HAZMAT and HAZWASTE [Ref. 20:p. 2]. It is also important to note some of the definitive policies that flow from recognizing that DON must comply with environmental laws and regulations dictated by higher authority. These policies represent DON self-governance and strategies for adhering to the policies of higher authority. The reader should bear in mind the lines of debarkation where one enters into the internal policies and regulations of the Navy. Through this HMC&M standard, five additional policy statements are delineated.

a. Integrated Logistics Planning

The Navy and its system acquisition contractors shall identify HAZMAT needed to meet mission requirements and, where feasible, substitute less hazardous material. Secondly, the Navy shall incorporate into its system research and development programs environmental protection, health hazard and risk assessments. Assessments shall be geared to control and reduce HAZMAT requirements and minimize costs associated with HAZMAT generation and disposal [Ref. 20:p. 3]. This is, for the most

part, a direct reflection of Federal acquisition policies contained in the Federal Acquisition Regulation (FAR) Part 23.

b. Economic Analysis

The Navy directed that decisions to use HAZMAT or substitute less hazardous materials shall be supported by an economic analysis, appropriate to the magnitude of the decision being made. This analysis includes cost factors and intangibles such as savings from reduction in training and other related impacts. [Ref. 20:p. 3]

c. Material Safety Data Sheets (MSDS)

Navy policy is that unlabeled, incompletely labeled, or improperly labeled HAZMAT received from manufacturers, vendors, or distributors shall not be accepted. Proper labeling and an accompanying MSDS shall be provided in accordance with Federal Code [Ref. 20:p. 3]. This ensures all hazardous material inventories can be readily identified by content in order to protect public safety and facilitate emergency response where necessary.

d. Up-Front Hazardous Material Control

This instruction also required measures to reduce the amount of HAZMAT used and HAZWASTE generated by means of up-front control in acquisition, procurement, supply, and utilization by developing: [Ref. 20:p. 3]

- Acceptable local mechanisms at shore activities to identify materials in the system that are hazardous and to limit quantities of HAZMAT acquired and stored.
- Creation of authorized HAZMAT use lists (AULs) and controls over HAZMAT quantities to reduce the generation of HAZWASTE.
- A plan to review Navy specifications that direct use of HAZMAT or generate HAZWASTE to determine if any changes are needed to further minimize the use of HAZMAT and the generation of HAZWASTE.
- Mechanisms for substituting less hazardous material where technically feasible.

- An overall HMC&M program encompassing hazard communications (HAZCOM) to promote and protect the health and safety of Navy workers, systems, system components and the environment.
- New maintenance plans and manuals that clearly identify known HAZMAT and include general HAZWASTE minimization (HAZMIN), safety, health, and disposal guidance.
- Changes/modifications to HAZMAT units of issue to be sure minimum HAZWASTE results from not using or excessing HAZMAT.

e. Regional Consolidation

Lastly, OPNAV INSTRUCTION 4110.2 encouraged the consolidation of several commands and shore activities into a single local or area program when mutually agreeable to the involved activities and oversight from area and local area coordinators is available. [Ref. 20:p. 3]

2. Department of the Navy Strategies for the Management of Hazardous Materials

The last three enumerated policies are of significance to this discussion. They provide concrete ground rules for individual Navy activities to follow regarding the control and minimization of hazardous material inventories. Left with this general policy and the liability issues discussed earlier, activities pursued individualized strategies to effectively control HAZMAT. This widespread experimentation developed several different hazardous material minimization (HAZMIN) programs. One of the most successful and innovative programs was initiated by Naval Air Weapons Station (NAWS) Point Mugu, California [Ref. 21:p. 1-1]. Eventually, the Navy incorporated features from Point Mugu's program, as well as features of several other successful HAZMIN programs, into a standard guide [Ref. 21:p. forward].

E. THE CONSOLIDATED HAZARDOUS MATERIAL RE-UTILIZATION AND INVENTORY MANAGEMENT PROGRAM

The Consolidated Hazardous Material Re-utilization and Inventory Management Program (CHRIMP) is a concept developed by the Naval Supply Systems Command and promulgated by the Office of the Chief of Naval Operations. It provides guidance for managing hazardous materials, both afloat and

ashore [Ref. 22:p. 1]. As originally developed, CHRIMP included the Hazardous Material Inventory Control System (HICS), a stand-alone software package for hazardous material inventory management.

CHRIMP recognized that increasing outside pressures have "virtually ensured that Navy activities will be brought into compliance with applicable Federal, state, and local environmental pollution controls." [Ref. 21:p. 1-1] This program represents a methodology to achieve life-cycle control and management of HAZMAT and HAZWASTE at the command and activity level [Ref. 21:p. 1-1].

1. Focus on Inventory

CHRIMP specifically addressed the problems posed by HAZMAT inventories. Historically, these inventories had been managed like other non-hazardous consumable material. Users submitted requisitions based on inventory requirements and immediate needs. Unused portions were then stored at the activity until required -- often without regard for proper and safe storage or environmental impact. In the meantime, the material shelf life may have expired or the container may have become damaged, requiring the item to be turned in for disposal. This scenario occurred simultaneously across many work centers, commands, and activities within close proximity to one another. [Ref. 21:p. 3-1]

By centralizing and consolidating inventories, CHRIMP minimizes these wastes while still providing immediate material availability. This is done through a hazardous material minimization center (HAZMINCEN), where all HAZMAT is centrally controlled and managed. All work centers within the command or activity and tenant commands who participate in the program are required to turn in currently held HAZMAT and to use the HAZMINCEN for all future HAZMAT needs [Ref. 21:p. 3-2]. Customers then draw HAZMAT as needed and return unused portions for reuse. In this way, redundant inventories across activities within a set region are minimized, along with the material entering the waste stream (i.e., requiring disposal). Figure 3.1 graphically demonstrates this concept of operations.

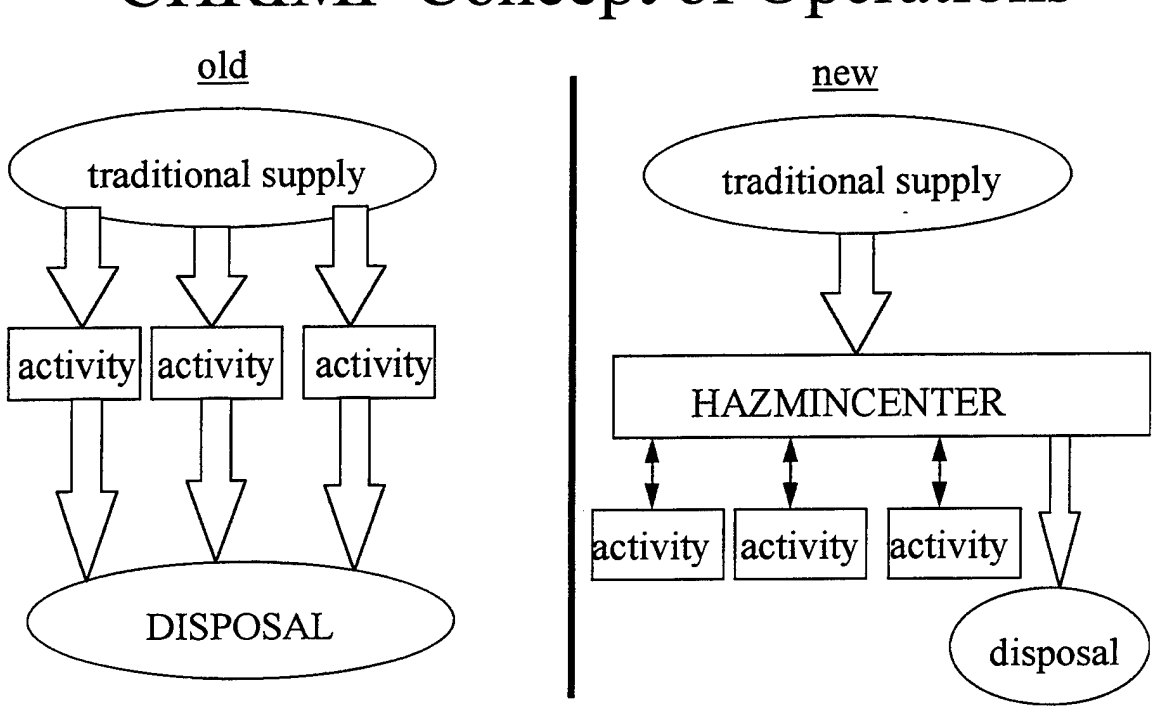


Figure 3.1. Source: developed by researcher

By adding a new centralized inventory structure, the Navy consolidated inventory over a range of activities and maintained visibility over this material.

2. Implementation

The implementation plan, as spelled out in the CHRIMP manual, identified the local Fleet and Industrial Supply Center (FISC) as the coordinating point for this effort. Specifically, FISC was to perform the following functions: [Ref. 21:p. 3-4]

- Accept excess HAZMAT from all participating activities and ships in the region.
- Tightly control HAZMAT utilizing HICS software to monitor all issues and ensure return of unused portions.
- Establish a "Consumer Level" stock of HAZMAT sufficient to satisfy local demand with a sufficiently high fill rate to eliminate the need for caches of HAZMAT at customer activities.

- Provide HAZMAT in the smallest unit of issue to satisfy immediate requirements and eliminate excess material that results when only large units of issue are available from the supply system.
- Establish operating procedures for issuing and returning material that require a minimum of paperwork by the customer.

The local FISC was designated the contact point in each region for all issues regarding HAZMAT management, to include training [Ref. 21:p. 3-5]. In this way the Naval Supply Systems Command (NAVSUP) not only exercised control over the CHRIMP concept but also provided a mechanism with which to enact these policies. NAVSUP exercises overall programmatic control of the Navy's hazardous material management system.

3. Potential Benefits of this Approach

As envisioned, this centralized management structure allows the Navy to exploit economies of scale associated with consolidating inventories and eliminating redundant efforts. Additionally, the local FISC can maintain visibility over regional stocks of HAZMAT and track this material, via HICS, from acquisition to its final application. Lastly, by putting HAZMAT management under one umbrella, this program allowed regional activities to focus necessary expertise on this material.

The CHRIMP manual cited the following specific benefits, realized at the Point Mugu prototype from March 1991 to October 1993: [Ref. 21:p. 3-8]

- $44,000 reduction in line items
- $21,000 cost avoidance in 55 gallon drums
- $40,000 cost avoidance/rebate reclaimed oil
- $254,000 requisition processing cost avoidance
- $130,000 reduction in material entering the waste stream
- $26,000 cost savings attributed to re-utilization vice disposal
- $53,000 revenue from the sale of recycled material

4. Required Elements for Successful Implementation

To be successful, the developers of CHRIMP recognized that the program would have to be both efficient and effective. To this end, HAZMINCENs would have to minimize material, personnel, and facility costs while maintaining the ability to provide near immediate delivery and rapidly adapt to customer needs [Ref. 21:p. 3-5]. The parallels with Total Quality (TQ) techniques are not by accident. The CHRIMP Manual expressly declares that: "This instruction defines uniform policy, guidance and requirements for the life cycle control and total quality management (TQM) of hazardous material." [Ref. 21:p. 1-1]

This is a particularly salient issue. The CHRIMP concept goes beyond a focus on results. It represents the beginnings of a systems approach to the responsible management of hazardous materials [Ref. 6:p. 9]. It recognizes the interdependencies of several interrelated processes and expands management focus. As a means to address environmental compliance issues, as well as accountability and stewardship, the CHRIMP concept goes beyond fixing outputs or individual processes. This concept, instead, addresses the system as it exists within the loop of Navy management [Ref. 6:p. 35].

F. SUMMARY

Chapter II discussed the basic structure of a JIT delivery system. This chapter has described the environmental movement and context in which the Navy must operate. Based on the proliferation of environmental laws and regulations and the drive for compliance, the Navy developed compliance policies and programs that recognized and addressed the importance of operational readiness. This required an innovative approach to hazardous material management. The culmination was a systems approach manifested in CHRIMP. The next chapter will detail how CHRIMP has worked in actual practice and define the program as it exists today. This lays the groundwork for discussing how JIT concepts can be applied to HAZMAT management.

IV. DATA PRESENTATION

A. INTRODUCTION

This chapter presents data collected over the course of research. Data were gathered via interview questionnaires and on-site observation conducted in three primary locations: San Diego, CA; Bremerton, WA; and Norfolk, VA. In addition, data were gathered remotely from Pearl Harbor, HI and Fort Huachuca, AZ.

This information will describe the dynamics of DON HAZMAT management and the challenges faced in implementing established policy. Of particular concern is the Navy's execution of its HAZMAT management system. While CHRIMP represents a philosophy for managing HAZMAT, it does not dictate an exact structure. For this reason, the program is highly adaptive.

Secondly, this chapter examines the current JIT HAZMAT providers to determine what services are available to the Navy and private industry. Data in this section were gathered from interview questionnaires administered to eight firms as well as information available in current publications and professional journals.

Finally, this chapter reviews current trends in private industry regarding JIT, hazardous material management, and supplier-buyer concepts currently in use. Of primary concern throughout this chapter are the following three points:

- What is the structure of today's Navy HAZMAT management system and what drives this structure?;
- What HAZMAT service and supply capabilities are available in the commercial sector?; and
- What strategies are being employed by private industry to manage hazardous materials?

Examination of these data lays the groundwork for analyzing the potential for applying JIT concepts to hazardous material management within the Department of the Navy.

B. QUESTIONNAIRE RESULTS FROM HAZARDOUS MATERIAL MINIMIZATION CENTERS

Questionnaires were administered to personnel involved in managing and administering hazardous material minimization activities within the San Diego, Puget Sound, and Norfolk regions. At these primary research sites, both FISC personnel as well as personnel from non-FISC activities independently involved in hazardous material management were questioned. Additionally personnel at FISC Pearl Harbor and Fort Huachuca, AZ were interviewed by telephone. The results of these questionnaires are summarized below.

1. Organizational Structure

Organizational structure is somewhat dictated by CHRIMP. However, in practice, CHRIMP actually represents more of a philosophy than a standard organizational manual. The CHRIMP manual cites the set-up at Point Mugu as an example and requires that all base activities be aligned with the HAZMIN Center [Ref. 21:p. 1-1]. While this worked at Point Mugu, it was primarily because it had the full support of the base commander who, threatened by personal fines, dictated that the plan be followed [Ref. 24]. When applied elsewhere, CHRIMP has not enjoyed the same definitive direction of higher authority. When the program is exported to areas like San Diego, FISC must address the concerns of many diverse activities, all under different commanding officers, and all answering to higher authority along different chains of command. FISC has no direct authority over any of these regional activities. In fact, the relationship FISC sets up with area activities represents a buyer-seller relationship with the local FISC offering various services, tailored to the needs of present and potential customers.

For this and other reasons, organizational structure varied significantly across the primary research sites. As mentioned in the previous chapter, the local FISC was designated the contact point in each region for all issues regarding HAZMAT management [Ref. 21:p. 3-5]. In practice, this policy carries little weight. In order for the local FISC to interface with individual activities, that activity must agree to enter into a partnership arrangement. This "partnering" arrangement is done on a strictly

voluntary basis. Without the consent of these activities, FISC does not play a role [Ref. 25]. The result is that activities like the Naval Aviation Depot (NADEP), North Island, Puget Sound Naval Shipyard (PSNS), and Oceana Naval Air Station operate their own HAZMIN programs independent from the regional FISC. While PSNS Supply has recently been incorporated into FISC Puget Sound and, along with it, HAZMAT management, the other activities maintain independent programs, as of this writing.

FISC San Diego, Puget Sound, Norfolk, and Pearl Harbor are actively selling the partnering concept to regional activities. This is done by developing a Business Case Analysis (BCA) which demonstrates the impact of a partnering arrangement to the potential partner [Ref. 25]. While many partnering agreements have been motivated by savings demonstrated by the BCAs, many activities do not choose to partner with the FISC. The reason most often cited is the desire to maintain organizational autonomy [Ref. 24].

Organizational autonomy applies not only to the FISC customer base, but also to the individual FISCs themselves. Because each FISC operates relatively independently, there is significant diversity in how individual HAZMIN programs are structured. Examples of this diversity include areas such as manpower, financial management, day-to-day operations, data processing and networking arrangements.

a. Manpower

FISC San Diego, Bremerton, and Norfolk rely primarily on Government personnel (military and civilian). This is augmented by some limited contractor support. FISC Pearl Harbor, in comparison, relies heavily on contractor personnel [Ref. 26]. At the far extreme, the Army at Fort Huachuca has recently contracted out their HAZMIN operations. This is significant because Fort Huachuca's HAZMIN Center was patterned after the Navy HAZMIN Center in San Diego [Ref. 27].

NAVSUP is also considering contracting out FISC HAZMIN functions. A study is underway to determine which HAZMIN management functions are inherently governmental and which may be outsourced. The consulting firm Coopers & Lybrand is assisting Navy personnel in this effort. Based on the outcome of this study, as well as similar outsourcing efforts, many HAZMIN management

functions could potentially be outsourced. Initially, this may take the form of Office of Management and Budget (OMB) Circular A-76 type solicitations at selected sites. [Ref. 28]

b. Financial Mechanisms

Each primary research site addressed cost of operations differently. In their partnering arrangements, FISC San Diego estimated the average volume of new "A" condition material that each activity required, assigned a cost and associated charge, and processed an operational funds transfer from the comptroller of the partnered activity to FISC [Ref. 29]. In contrast, FISC Puget assigns no charge for services associated with the use of the HAZMIN center, while FISC Norfolk applies a 15% value added charge (VAC) to the issue of all "A" condition material [Ref. 27]. It should be noted that the charges applied in San Diego and Norfolk are all in addition to the Defense Business Operations Fund (DBOF) surcharge already applied to "A" condition material.

The generic concept is that activities partnered with FISC pay a premium for new material but reap greater savings because they do not invest in inventory or administer disposal actions. Additionally, partnered activities receive -- free -- cost avoidance (CA) material. This material represents excess hazardous material turned into the local HAZMIN center rather than turned in to Public Works for disposal. This policy applies to all FISCs surveyed.

c. Daily Operations

While the basic concept of operations remained constant for all sites surveyed, there were differences in their administration practices. Naval Station San Diego, for example, employs a program called "One Call Hauls All" whereby the Public Works Center (PWC) will pick up any excess/unwanted material and ensure its proper disposition. With regard to HAZMAT, PWC will deliver it directly to the HAZMIN center, where a determination is made whether to absorb it in inventory or have PWC initiate disposal action [Ref. 30]. Puget Sound and Norfolk have no like program.

This represents one of many idiosyncrasies across the operations surveyed. Others include transportation policy, delivery policy, and redistribution policy. The important point is that individual HAZMAT managers exercise a great deal of autonomy in executing their programs. This

allows programs to be tailored to individual customers. It also means that there is no uniform method of operation across FISCs.

d. Automatic Data Processing (ADP)

This lack of uniformity also applies to ADP support. As stated in Chapter III, a software package called HICS allows HAZMIN centers to manage hazardous material inventories in an automated format. While this software is an appropriate tool for inventory management, it is not adequate for other aspects of HAZMAT management, namely compiling and generating environmental reports. Because of this, the Defense Information Systems Agency (DISA) has developed a separate software package called Hazardous Substance Management System (HSMS) and a sister software package called Regional Hazardous Management System (RHMMS). [Ref. 31]

As envisioned, HSMS will replace HICS ashore at all HAZMIN centers to provide environmental reporting capabilities, and RHMMS would be used to link all HAZMIN centers together to provide inventory control and asset visibility to the FISC and ultimately the Navy supply system [Ref. 23:p. 1]. Current strategy calls for RHMMS to eventually interface with the Uniform Automatic Data Processing System Phase II (UADPS/U2). UADPS/U2 is the Navy's primary ADP system for regional inventory management. This tie-in will provide regional inventory management capabilities for all "A" condition HAZMAT, including wholesale stock and consumer level inventories carried in HAZMIN centers. Conceptually, this would eliminate yet another tier of inventory, namely Special Account Class (SAC) 260 material currently carried in HAZMIN centers [Ref. 23:p. 1].

The U2 connection would allow direct billing for this material while consolidating all FISC owned HAZMAT within the HAZMIN network. This effectively eliminates one tier of inventory and offers the potential to bring DLA inventory under the same umbrella. This equates to a material flow from the commercial supplier to the HAZMIN Center to the customer. Figure 4.1 illustrates the potential streamlining of this process.

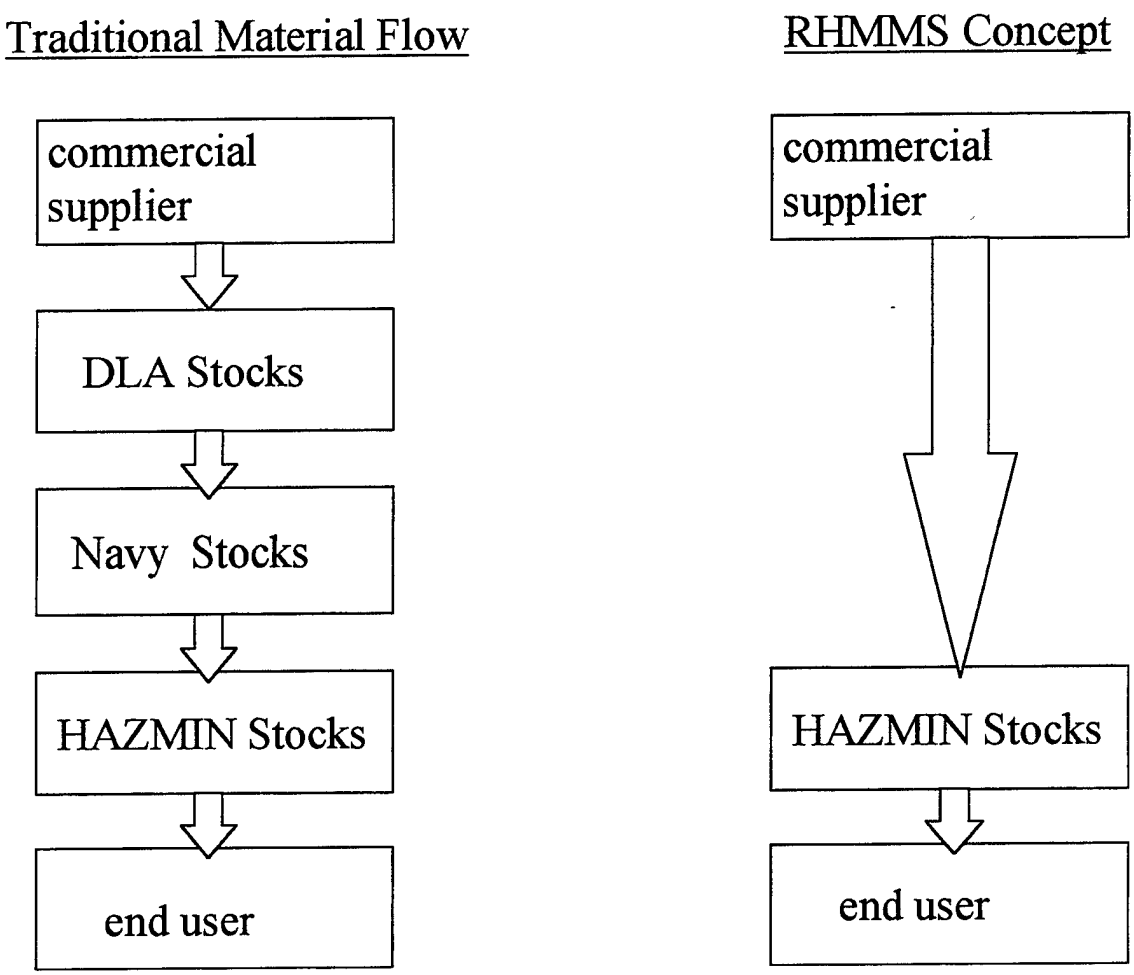


Figure 4.1. Streamlining of Inventory Flow. Source: developed by researcher

This clearly approaches a Just-in-Time (JIT) flow, eliminating redundant, tiered inventories, allowing for a more direct link between supplier and customer. Under this concept, HAZMIN Centers would still collect and consolidate expended HAZMAT stock and issue this material to its customers free of charge, in place of chargeable "A" condition material. These pre-expended stocks represent "A" condition material drawn by activities, not used, and collected by the HAZMIN Center. This material remains Ready For Issue (RFI) and represents a Pre-Expended Bin (PEB) of HAZMAT. It's labeled Cost Avoidance (CA) and provided in lieu of stock fund material at the customer's option. Using this mechanism, the HAZMIN Center and the supporting FISC can divert a large quantity of material from the waste stream while saving operational (OPTAR) dollars for end-users.

e. network

RHMMS has allowed NAVSUP to take the area HAZMIN center concept and integrate these centers both regionally and globally. Under this global visibility concept, NAVSUP is attempting to link all HAZMIN centers in a network as diagrammed in Figure 4.2.

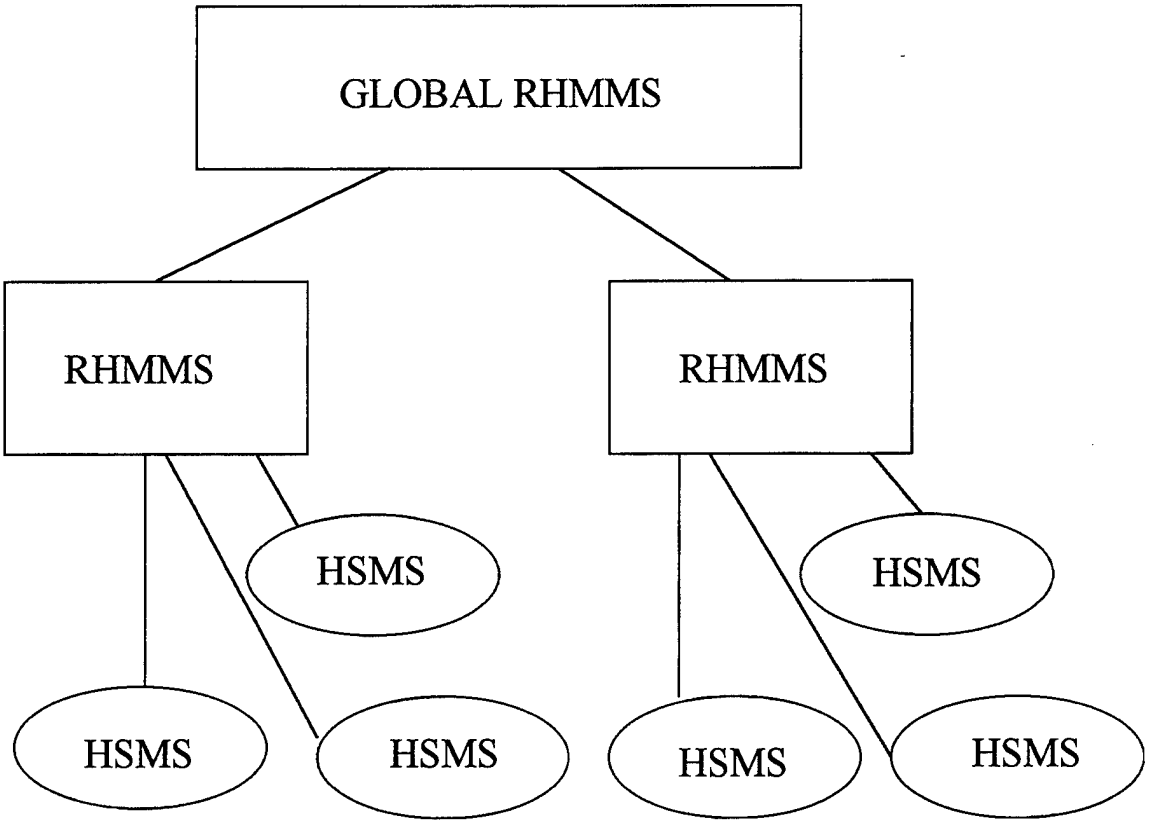


Figure 4.2. HAZMIN Network. Source: developed by researcher

This would link regions along the lines of current regional inventory concepts and eventually provide global asset visibility. It would create a direct financial link with Budget Project (BP) 28 and provide the ability to move material within both a regional and a global network [Ref. 23:p. 1]. The regional inventory tie-in also fits within the scheme of UADPS-/U2 regional inventory management. This is a significant step beyond the current Hazardous Inventory Control System (HICS), which is essentially a stand-alone system with limited networking capability.

Again, participation in this network is completely voluntary. While the Chief of Naval Operations (CNO) mandates that commands follow the philosophy of Consolidated Hazardous Material

Re-utilization and Inventory Management Program (CHRIMP), they are free to use the FISC system or develop a system of their own. Keyport is developing their own system in Puget Sound, as is the Naval Aviation Depot (NADEP) North Island in San Diego. This increases redundancies and reduces economies of scale that might be realized if all activities in the area join the network.

NADEP North Island is a particularly interesting example of a redundant effort. Here a major user of HAZMAT is not participating in the area HAZMIN network. Additionally, NADEP is not using HICS or HSMS. Instead, they are using a software package called Depot Maintenance Hazardous Material Management System (DHMMS), developed for DOD by NCI Information Systems Inc. [Ref. 32]. While providing many of the capabilities of HICS and HSMS/RHMMS, DHMMS is stand-alone and does not interface with other sites or UADPS/U2.

f. Separate Initiatives

The effort at NADEP North Island warrants additional examination. Efforts are currently underway to man and operate eight HAZMAT issue centers. These issue centers would contain a seven day working stock of HAZMAT. Material in these centers would be issued and tracked on a job-by-job basis to the artisan requesting the material. All issues would be tracked using a bar code reader to link the container to the individual. Individuals remain accountable until the container is returned and the exact quantity of material used is identified and recorded. This program is run on DHMMS software. [Ref. 32]

This arrangement is especially interesting because it easily lends itself to contractor operation. Currently, central HAZMAT stocks are managed by FISC and the issue centers are manned by NADEP. Conceivably a contractor could (organically) manage a central stock and provide JIT delivery or broker JIT delivery from other vendors, maintain the seven day working stock, track the material and prepare required reports. I proposed that scenario to the person responsible for this program: Mr. Mel Barrera. He had no objections and thought it was a feasible idea. Outsourcing this function at NADEP would eliminate manpower requirements for approximately 21 persons (For FISC: one supervisor and four

workers to manage the central stock of HAZMAT; for NADEP: sixteen people to run eight work stations). Currently NADEP is taking the workstation requirements out of hide [Ref. 32].

Additionally, NADEP North Island is pursuing some interesting strategies for contractor HAZMAT re-utilization (vice disposal). One particularly interesting initiative concerns recycling the silicon media used to sandblast aircraft. The media and the paint residue are both considered hazardous. However, a private contractor is taking this material, heating it and molding it into perfectly safe plastic countertops [Ref. 32]. Finding valuable applications (particularly "green" applications) for recycled HAZMAT would be a particularly useful incentive to attract contractors into closed loop HAZMAT management. It might also provide significant leverage to reduce the cost of a closed loop JIT contract.

2. Reporting Requirements

Because of the volume of statutes and regulations, all activities face a myriad of reporting requirements administered by state and Federal authorities, including the Environmental Protection Agency (EPA), the Occupational Health and Safety Administration (OSHA), the Department of Transportation (DOT) and others. Suffice to say that there are tight requirements concerning any aspect of HAZMAT, covering its manufacture, storage, use, transportation, and disposal. Of interest to this discussion are the requirements requiring the preponderance of management attention.

a. Emergency Planning and Community Right-to-Know Act (EPCRA)

The primary reporting requirement is the Emergency Planning and Community Right to Know Act (EPCRA). This Act encourages and supports emergency planning and provides timely and comprehensive information to the public about potential hazards associated with toxic chemical releases. Specific sections of EPCRA require immediate notification of release of extremely hazardous substances and hazardous substances defined under the Comprehensive Environmental Response, Compensation, and Liability act (CERCLA) to state and local emergency response planners. EPCRA requires state and local coordination in planning response actions to chemical emergencies. This Act also requires the submission of information on chemical inventories and releases. [Ref. 14:p. 4-3]

This reporting system establishes threshold quantities for release of HAZMAT into the environment and mandates a reporting system if these thresholds are exceeded [Ref. 14:p. 4-3]. Release may occur accidentally or through ordinary use. For example, as an aircraft is painted, a portion of that paint will adhere to the aircraft and a portion will be released into the environment [Ref. 31]. This information is compiled and provided to community authorities, whether or not threshold quantities are exceeded [Ref. 30]. Navy policy is to track all releases within base fencelines [Ref. 14:p. 4-4]. This means that the fenceline owner (a.k.a. the host command) is required to file one report for the entire facility. As stated above, HSMS provides an automated methodology for EPCRA reporting [Ref. 23:p. 1].

b. Transportation Regulations

Rules governing transportation of HAZMAT on the open road are strict and vary from state to state. This means that HAZMIN center personnel must be trained and certified as to a strict set of requirements. This involves OSHA training regarding the proper loading and manifesting of hazardous material [Ref. 33]. This is a critical concern to HAZMIN managers since fines associated with non-compliance are severe and are applied to accountable individuals (i.e., management) [Ref. 25]. Additionally, individuals who supervise HAZMAT loading and manifesting are traditionally warehousemen whose paygrade doesn't necessarily reflect the importance of their duties and responsibilities [Ref. 25].

3. Other Management Activities

There are, in addition, several other base activities/organizations responsible for the management of hazardous material. Of concern are activities within the Navy and DOD that must interface to effectively manage HAZMAT and HAZMIN programs. Of specific interest were the following program elements and functions:

- Ordering
- Storage
- Issue

- Use
- Disposal
- Monitoring
- Control
- Reporting

Historically, ordering, storage, and issue are base supply functions. Use and monitoring are controlled by the maintenance work center utilizing this material. Disposal falls under the guise of Public Works Centers, while control and reporting are the responsibility of base safety and environmental departments. Since CHRIMP's goal is to provide total program control and visibility, and NAVSUP holds overall responsibility for administering this program Navy wide, responsibility for HAZMAT programs has become a supply function [Ref. 21:p. 3-2]. This applies to both the organizational and policy levels.

Under the generic CHRIMP structure, the activity supply department is responsible for setting up a HAZMIN program to:

- Control the ordering of "A" condition material
- Monitor its issue
- Reclaim any unused portions
- Provide the Safety Department with usage information
- Transfer excess "A" condition stocks to the Defense Reutilization Management Office (DRMO) for redistribution; and
- Transfer excess "F" condition stocks to PWC for eventual disposal

Under this arrangement, activity supply departments are the focal point of policy implementation, while safety/environmental organizations and PWC perform sub-functions. This can be accomplished either through the FISC or internally. Figure 4.3 presents this generic structure.

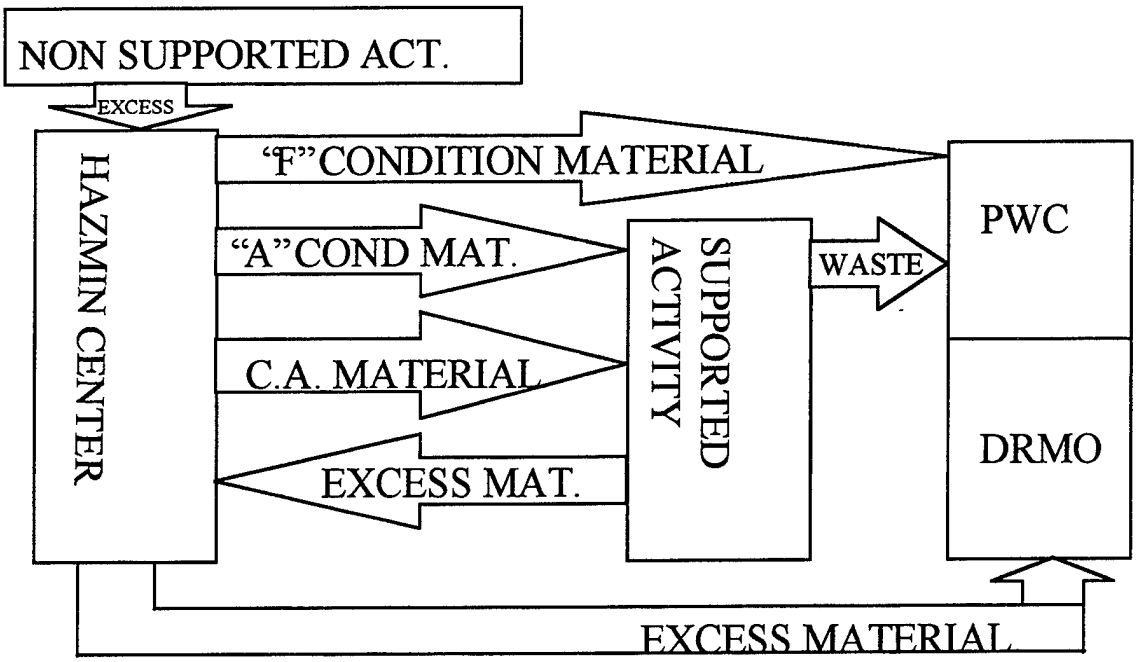


Figure 4.3. Structure of HAZMAT Flow. Source: developed by researcher

Under the partnering concept, Fleet and Industrial Supply Centers seek to exploit economies of scale by expanding HAZMIN coverage across numerous activities. Activities that partner with FISC retain only monitor, control and reporting functions. FISC is responsible for all aspects of inventory and coordinates reutilization and disposal. This lifts the burden of inventory from individual organizations, reduces redundant activities and emphasizes the benefits of centralization. These benefits include consolidating requirements, facilitating coordination and control, more effective planning and research, and technical specialization [Ref. 4:p. 103].

While decisions to centralize functions typically tradeoff efficiencies for effectiveness, this has not been the case with the partnering concept [Ref. 4:p. 103]. Unlike many centralization/decentralization decisions, which are dictated by top management, the decision to partner with FISC is made by the customer activity. For its part, FISC must guarantee rapid effective response and cost savings to sell the partnering concept to a potential customer activity. This general structure achieves both efficiency and effectiveness by focusing on the customer. By pursuing this business strategy, FISC has taken a generative vice bureaucratic approach toward fulfilling its mission [Ref. 34:p. 3]. The substance of this

focus can not be overemphasized. If the Navy had dictated that activities must partner with FISC to minimize HAZMAT stocks and flow into the waste stream, FISC would have no incentive to provide timely service.

HAZMIN Centers are keenly aware that the success of their programs hinges on rapid response to customer needs. At FISC Norfolk, LCDR Chris Valle captured this awareness with the following statement:

> When I was onboard ship, it might take five to seven days for FISC to deliver material. We can't provide service like that and expect our customers to turn their HAZMAT stocks over and partner with us. We have to be able to respond within hours to the requests of our customers. We live and die on our ability to respond. [Ref. 35]

This sentiment was reflected by all HAZMIN personnel interviewed.

4. Management Concerns

While activities pursuing their own HAZMIN programs independent from FISC offered few suggestions, all FISC HAZMIN activities interviewed expressed the same frustration: they can not control all elements necessary to make the program successful. Specifically, activities can not be compelled by logic or directive to become part of the HAZMIN network [Ref. 24]. Even if the benefits can be readily demonstrated, participation in the FISC network remains voluntary. The general sentiment that emerged during the interviews was a general frustration that, faced with a more economical, efficient way of doing business, area commands still choose not to partner with FISC.

While frustrated with this paradox, FISC HAZMIN operations continue to refine their programs and pitch their services to potential customers. Refinements include establishing transportation networks to provide more rapid service, [Ref. 30] providing customized services such as a paint mixing shop, [Ref. 24] and directly delivering materials to specific work sites [Ref. 36].

5. Streamlining

A primary concern voiced by all FISC personnel interviewed focused on the administrative burdens of partnering. Currently activities are required to produce a well researched business case

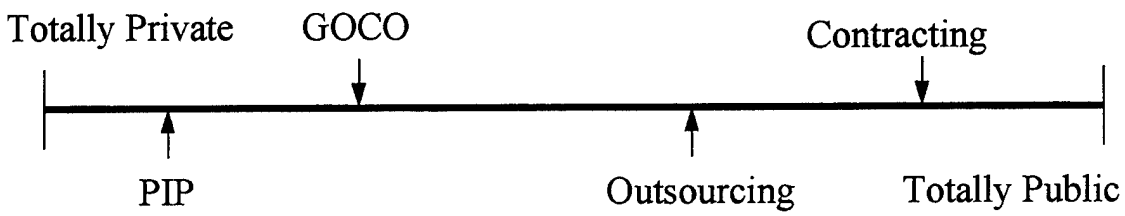
analysis to identify the costs and benefits of a partnering relationship [Ref. 25]. A BCA requires time and manpower to produce; there is some concern that the cost of producing this document is excessive, especially in light of the fact that proven benefits are common across activities.

Another concern for FISC personnel was that the Naval Sea Systems Command (NAVSEA) and the Naval Air Systems Command (NAVAIR) rely exclusively on military specifications (MILSPECS) when HAZMAT is used for maintenance actions. While some MILSPECS are clearly required because they are superior to commercial specifications and their application is critical (e.g., high performance military aircraft), others are probably extraneous and unnecessary because a commercial specification will suffice (e.g., marine outboard engine oil) [Ref. 30]. In many cases, reliance on MILSPECS mitigates further savings under the HAZMIN concept. A reduction in MILSPECS will correspond to a reduction in line items that DLA and HAZMIN Centers must carry [Ref. 37]. While this issue was addressed at the First Annual Joint Service Pollution Prevention Conference (San Antonio, TX, August 19-21, 1996), neither NAVSEA nor NAVAIR committed to any specific action to review these issues [Ref. 38].

6. Potential for Privatization

HAZMAT program managers were asked about the potential for privatizing certain HAZMIN functions. This term can describe anything from a low degree of contractor assistance in a Government activity to a completely commercial activity [Ref. 39:p. ii]. Figure 4.4 illustrates the privatization spectrum. Of specific interest is more closely aligning the Navy and private industry in a buyer-supplier relationship by potential movement along this spectrum.

All persons interviewed agreed that many HAZMIN functions could be satisfied by private industry and most activities are exploring varying degrees of privatization. All FISCs studied contract out some warehouse services in the form of Intra-fleet Supply Support Operations Program (ISSOP) services. Additionally, FISC Pearl Harbor is currently outsourcing several HAZMIN functions, including compiling EPCRA reports [Ref. 26]. Fort Huachuca has proceeded the furthest along this spectrum. Here the Army has established a Government-Owned Contractor-Operated (GOCO) HAZMIN Center [Ref. 27].



The Privitization Spectrum

Figure 4.4. The Privatization Spectrum. Source: From [Ref. 39:p. 1]

As previously stated, NAVSUP is currently studying the extent to which HAZMAT management can be privatized. While these studies will undoubtedly provide more definitive guidance, there is one area of HAZMAT management identified by all interviewed as inherently governmental: overseeing the transportation, control, use, and eventual disposal of hazardous materials. Once these materials enter the fenceline, the Government is required to maintain appropriate vigilance regardless of the extent to which functions are privatized [Ref. 40].

7. Volume of Business

All HAZMIN Centers contacted maintained extensive records outlining business volume by dollar amount and quantity. Selected business metrics from FISC Norfolk readily demonstrate the impact of the CHRIMP Concept when applied to an entire region.

In September 1993, FISC Norfolk established their HAZMIN program for the Tidewater Area. This came at a critical time because the Navy was decommissioning several ships and squadrons. These decommissionings required the divestiture of organizational level inventories held by these activities. Because the HAZMIN Center was available to handle this material, FISC captured HAZMAT before it was turned in for redistribution or disposal. This effort removed over 3.8 million pounds of HAZMAT

from the waste stream in its first three years of operation. This resulted in a disposal cost avoidance in excess of $7.49 million. [Ref. 41:p. 1]

Beyond this initial surge of business, FISC Norfolk has continued to save the Government money by diverting hazardous material away from the waste stream and providing it to activities that have a requirement. This reduced both disposal and acquisition costs. Table 4.1 details these savings by the sites with which FISC Norfolk is partnered.

HAZMAT Cost Avoidance at FISC Norfolk		
Site	Acquisition Cost Avoidance	Disposal Cost Avoidance
NAVSTA Norfolk	$2,780,833	$2,145,840
NAB Little Creek	35,710	41,410
Cheatham Annex	16,586	32,229
SIMA Norfolk	33,234	33,447
SIMA Portsmouth	58,690	53,505
FCTC Dam Neck	6,825	8,802
Total	$2,931,877	$2,315,233

Table 4.1. HAZMAT Cost Avoidance at FISC Norfolk. Source: After [Ref. 41:p. 8]

Clearly this strategy eliminates a substantial amount of waste compared to non-networked organizational inventories. Additionally, FISC Norfolk plans to maintain only a two month stock of "A" condition material and to ensure it turns at approximately the same rate (e.g., in a six month time frame, inventory would turn three times). Table 4.2 illustrates the success FISC Norfolk is having with these objectives for the six month period ending 31 August 1996.

HAZMAT Inventory Objectives at FISC Norfolk		
Site	Months Inventory On-hand (Six Month Average)	Stock Turns in Past Six Months
NAVSTA Norfolk	4.2	1.43
NAB Little Creek	3.4	1.78
Cheatham Annex	3.1	1.96
SIMA Norfolk	1.5	4.00
SIMA Portsmouth	2.9	2.10
FCTC Dam Neck	5.1	1.17
Total	3.7	1.63

Table 4.2. HAZMAT Inventory Objectives at FISC Norfolk. Source: After [Ref. 41: p. 8]

This push to minimize stock recognizes the relatively short shelf life of this material and provides more focused management attention on the importance of rapid material movement both in and out of area HAZMIN Centers [Ref. 24]. Additionally, material is moved around the network to satisfy a shortage in one center using excesses in others [Ref. 33]. This management technique is mirrored at FISC San Diego, Puget Sound, and Pearl Harbor.

C. QUESTIONNAIRE RESULTS FROM JUST-IN-TIME (JIT) CAPABLE COMPANIES

Names of companies providing hazardous material management services were solicited from FISC Contracting Center personnel at the three primary data collection sites (San Diego, Norfolk, and

Puget Sound). The initial strategy was to gather lists of individual vendors who provide hazardous material to the Navy. This was done by searching contract data bases for all types of hazardous material purchased during fiscal years 1995 and 1996. These lists proved voluminous. At Puget Sound alone, there were 1,338 contract awards during this period for hazardous materials of every description [Ref. 42]. Rather than identifying individual commodities and providers, focus shifted to companies that provide HAZMAT management services, including delivery of hazardous materials. These firms primarily act as third party logistics agents for their clients, brokering material from a wide variety of sources. They act in much the same way as the defense supply system, which collects material from a wide variety of commercial providers and delivers it to end users.

These companies were identified by questioning FISC personnel as well as organizations such as local Chambers of Commerce and the San Diego Contracting Opportunity Center. The 12 August 1996 RFP submitted by FT Huachuca for private operation of their HAZMIN Center also helped. This RFP identified 32 interested companies of which eight submitted proposals. At the end of this identification process, questionnaires were administered to representatives of the following companies:

- Technology Management Inc. (TMI)
- Ecology & Environmental Inc.
- QHI Inc.
- Environmental Scientific Products Inc.
- MANTECH Inc.
- High Technology Solutions Inc. (HTS)
- J.J. McMullen and Associates
- HM3

This is by no means the entire market, but it adequately represents the market for the purposes of this study.

1. Hazardous Materials Management and Just-in-Time

Companies were asked to what extent they utilize JIT techniques. HM3 specifically advertises JIT delivery in their company literature (the company advertises it will provide customers with "Just in Time (JIT) replenishment methods and establish Hazardous Materials Minimization Centers."). The other companies do not typically reference their methods as being JIT, although descriptions of the inventory delivery techniques they employ match JIT definitions and premises. "Seamless delivery" and "direct delivery" were generally the terms of choice [Ref. 43]. This was largely considered a matter of semantics since the descriptions match JIT techniques (e.g., pull scheduling, close alignment with users, elimination of waste, elimination of inventory other than small working stocks, etc.).

It should be noted that most of the companies that provide this type of service are in their infancy. Of the eight companies interviewed, only one (Ecology and Environmental Inc.) had been in this type of business for over five years. This matches the general trend for logistics companies. Roughly three quarters of firms have been in business for five to seven years. Others have only been in business for two to three years [Ref. 44:p. 121].

2. Service Capabilities

Each of these organizations stated that they could provide services ranging from consultation to complete hands-on management of hazardous material programs. Additionally, all employ HAZMAT minimization strategies similar to CHRIMP. HM3, for example, was started by the same individual who developed the original CHRIMP prototype at Pt. Mugu. The techniques employed by HM3 are a direct reflection of CHRIMP right down to the employment of HICS software [Ref. 43].

Other companies have worked closely with the Navy in the past and are familiar with existing HAZMIN operations. Ecology and Environment Inc. prepared waste management plans for all NADEPs nationwide and all Public Works Centers in the San Francisco Bay Area. Their non-DOD clients include: UNICAL, IBM, and Stanford University. The company has extensive experience in HAZMAT

management and indicated they could establish JIT HAZMAT deliveries and consolidate and coordinate disposal of this material. [Ref. 45]

MANTECH is another company that is rapidly branching out into hazardous waste disposal. Currently their main focus is working with the Department of Energy (DOE) to clean up the Hanford, Washington site [Ref. 46]. That, coupled with inventory management efforts, would indicate MANTECH has the necessary elements to compete for a JIT contract. This discussion indicates that traditional military/Government contractors (MANTECH, HTS, CACI, etc.) would likely be interested in contracts mirroring current Government functions. The list of companies submitting proposals on the Fort Huachuca RFP confirms this suspicion.

In addition to the companies interviewed, there are several companies that specialize in hazardous material management. Most recognize the headaches involved in managing this material and the expertise that must be brought to bear. This approach complements organizations that want to focus on producing goods and services while getting out of the HAZMAT management business [Ref. 47:p. 70]. This also follows the general pattern of outsourcing logistics functions. Typically 8.0%-11.5% of revenues are tied up in logistics functions. Companies that can perform these functions more economically are increasingly favored by industry [Ref. 48:p. 24].

3. Geographical Coverage

All companies contacted advertised complete U.S, coverage. Additionally, all companies stated they could easily work within the framework described by the FISC regionalization concept.

4. Certification Requirements

There are over 75 different disciplines within the overall category of HAZMAT management. Some require certifications. Most of these disciplines cover laboratory processes not applicable to inventory management [Ref. 45]. Major certifications required to provide JIT services are OSHA certifications for transporting and handling HAZMAT and EPA certifications for storage and disposal. All firms operating in the United States are bound by these certifications. There are additional state

certifications in states such as California. These certifications were recognized by all companies interviewed. Agencies such as EPA and OSHA enforce compliance.

5. Challenges Unique to the Department of Defense

The questionnaire asked JIT providers to comment on any challenges they considered unique to dealing with DOD. For companies who have experience with military environments, two issues were noteworthy: MILSPECs and program implementation.

a. Military Specifications

Mr. Carl Adams of QHI Inc. mentioned that three particular MILSPECS add significant cost on disposal contracts. In his opinion, they add cost and little value since Federal and State requirements are significantly stringent. These MILSPECS are: 02080 (disposal of lead contaminated products), 02081 (asbestos), and 02050 (demilitarization). [Ref. 49]

b. Implementation

Mr. Ritter, of Ecology and Environmental Inc., emphasized his company's frustration when dealing with the Navy and the Government. His company would draft comprehensive management plans, and gain the concurrence of the Government only to have the plan shelved as other events took precedence. He was adamant that, given a stated goal/philosophy for HAZMAT minimization and environmental compliance, his company can develop and effectively implement a plan to the Navy's satisfaction. [Ref. 45]

C. TRENDS IN COMMERCIAL INDUSTRY

Research was also conducted to ascertain the extent to which private industry is using JIT acquisition for hazardous materials and whether they are outsourcing HAZMAT management functions. As stated in the previous sections, JIT is a growing trend in commercial industry. Companies like Boeing are using JIT to minimize work-in-process and cut cycle times by as much as 65% [Ref. 51:p. 48]. Boeing is also applying these techniques to hazardous materials, cutting inventory costs and saving valuable floor space [Ref. 36]. Boeing's approach emphasizes involvement of the purchasing function in designing and

implementing JIT procedures [Ref. 51:p. 67]. Boeing is a particularly appropriate example since it performs industrial work similar to Navy industrial activities. Puget Sound Naval Shipyard relied heavily on the Boeing example when designing their HAZMIN operations concept [Ref. 36].

Other companies using these techniques can be found in just about every facet of industry. Sun Microsystems, for example, has teamed with USCO Distribution Services to handle all of it's warehousing and distribution functions, including HAZMAT [Ref. 52:p. 56]. This arrangement features a two hour response time and delivery of materials to exact work locations [Ref. 52:p. 60]. This allows Sun to focus on its core competencies and reap the savings the distribution company provides through its inventory network and associated economies of scale [Ref. 52:p. 57].

D. SUMMARY

This chapter has demonstrated how the CHRIMP HAZMIN concept actually operates. Each HAZMIN Center is tailored to the environment in which it must operate. There are, however certain generic features common to each operation. The next chapter will more closely examine this generic model to provide an overall assessment of how JIT can be applied Navy-wide.

This chapter also examined a specific aspect of the hazardous material market. Namely, what firms can meet the Navy's overall hazardous material requirements, not just the requirement for specific commodities? In addition to providing material, these firms can interface with the Navy to provide overall HAZMAT management. Given these capabilities, the next chapter will explore appropriate buyer-supplier models using a systems approach.

Finally, this chapter briefly explored the extent to which commercial industry is developing JIT buyer-supplier relationships. These examples will be expanded upon in the next chapter which explores potential strategies for merging JIT techniques with hazardous material management concepts.

V. INTEGRATION OF JUST-IN-TIME AND HAZARDOUS MATERIALS MANAGEMENT

A. INTRODUCTION

The previous chapters described JIT, environmental regulations and the structure the Navy has set into place to address environmental law and regulation. This chapter analyzes strategies to merge these concepts. Specifically, this chapter will analyze strategies for integrating HAZMAT management objectives and JIT techniques. In order to accomplish this, a generic model of the Navy's hazardous material management structure will be presented. This model represents the system the Navy has assembled to meet environmental objectives and illustrates how individual systems are linked together to form a logistics network. Once presented, this model will be compared and contrasted with JIT concepts. Following this analysis, there is a discussion of approaches for constructing buyer-supplier relationships and of the impact those relationships have on Navy functions and the potential for JIT purchasing and supply.

B. NAVY HAZARDOUS MATERIAL MINIMIZATION MODEL

The CHRIMP model for hazardous material management represents a structure with many unique features, that readily lend themselves to JIT techniques. The first part of this section will examine the structure of the HAZMIN model, focusing on how different activities and processes are integrated to execute the CHRIMP philosophy. Following this, the structure and function of the CHRIMP model will be compared with JIT and the larger context of the Total Quality (TQ) approach to providing goods and services.

Next, the model will be examined to identify how sites are linked together in a network arrangement. Such arrangements allow activities to distribute resources efficiently across a system of sites. This networking arrangement and its compatibility with JIT will, in turn, be analyzed.

1. The Basic Model

Figure 5.1 illustrates the general CHRIMP model for managing hazardous material and hazardous waste. This model depicts the integration of various organizations and the flow of material within that system. Note that, as complex as this model may first appear, there is only one physical input to the system, HAZMAT, and two physical outputs, excess HAZMAT and hazardous waste. Subject to policy generated by EPA, the Office of the Secretary of Defense (OSD), the Navy and others, this structure provides HAZMAT to end users and accomplishes four other basic functions:

- Minimizing the amount of HAZMAT that enters the system
- Ensuring HAZMAT that enters the system is utilized to its full potential, thereby minimizing the amount of material entering the waste stream
- Ensuring hazardous waste is disposed of appropriately; and
- Generating required environmental reports

These functions or processes are linked together to operate as a system. Within this system, there are inputs provided by suppliers, steps and processes by which work is accomplished, and customers who receive those outputs [Ref. 6:p. 25]. Customers include end-users, as well as the community, which is served by ensuring these materials are handled properly and that they are used properly in the smallest quantities possible. The general public is also a customer of this system in another sense. It relies on the Navy to develop efficient, cost effective ways to manage this material so that the public receives the best value for every tax dollar applied.

Viewing the HAZMIN Model as a system is essential for developing optimal strategies to promote efficiency and eliminate waste. As with the example of the bucket brigade cited in Chapter II, JIT techniques seek to integrate processes into systems and move material efficiently through that system. This entails breaking down barriers and developing cooperative relationships among all process owners [Ref. 1:p. 41].

The HAZMIN Model

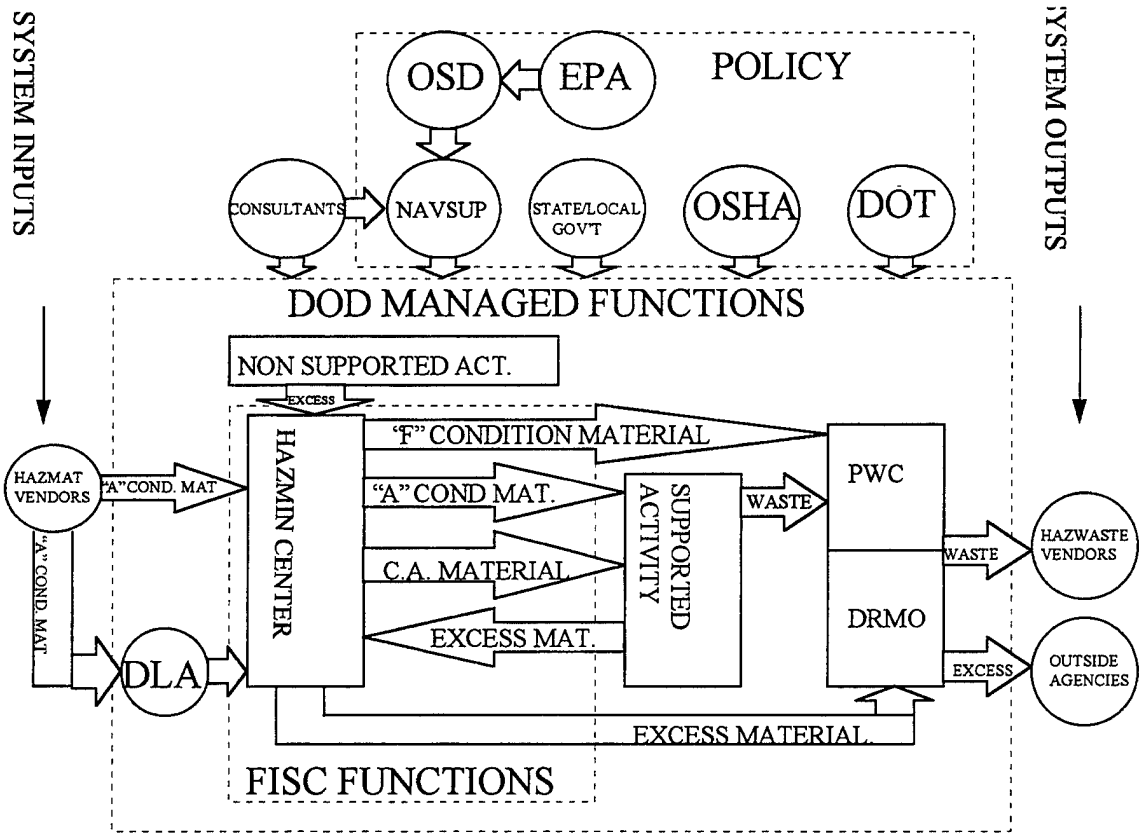


Figure 5.1. The HAZMIN Model. Source: developed by researcher

These cooperative relationships apply across all aspects of the system, particularly the logistical structure represented by this model. This includes integrating hazardous material suppliers and hazardous waste disposal firms. Specifically, JIT emphasizes long term cooperative relationships with material and service suppliers. JIT also emphasizes best value as opposed to lowest cost. This is manifested in the form of on-time delivery, product quality, reduced inventory levels, reduced storage requirements, reduced disposal costs, and reduced contract administration costs [Ref. 2:p. 99]. In other words, the buyer-seller relationship must be constructed to optimize the overall system and not individual elements [Ref. 6:p. 28]. DOD has traditionally embraced a strategy of obtaining the lowest price by buying commodities in bulk. In the area of HAZMAT, this approach has increased disposal costs,

redundant inventories, and non-value added storage costs, to name a few. To obtain best value, the focus must extend beyond item price alone.

Under JIT, suppliers are integrated into daily operations to attain JIT supply. Like current FISC strategies, this is typically done through partnering arrangements with commercial suppliers. Much like the FISC concept, the objective of these JIT partnering relationships is to reduce costs, improve efficiency, and increase profitability for both buyers and suppliers [Ref. 4:p. 437]. The similarities with JIT partnering and FISC partnering are striking.

2. The Model as a Network

In the context of this broader focus, there is an added dimension to the Navy's HAZMAT management system that must be understood. HAZMIN Centers are increasingly being networked together regionally and (potentially) globally. A network is an arrangement of paths connected at various points, through which one or more items move from one point to another [Ref. 5:p. 717]. In this context, each HAZMIN Center represents a node supplying a group of users. Sources of material at each node include vendors, DLA, FISC, and returned (re-use) material. Customers (referred to as "sinks" in network models) are represented by issue to end users, transfers to outside activities via DRMO, or disposal via PWC. Linking these nodes and modeling this system as a network provides a potentially powerful tool by which the Navy can increase efficiency.

This is done by assigning costs and capacities for moving material to the paths or branches linking the nodes of the network and then determining the optimal flow of material through the network using linear programming techniques [Ref. 5:p. 731]. Optimal flow in this scenario is defined by attaining the required flow of material while minimizing cost. These techniques can be applied not only to determine optimal movement strategies through a given network but also in determining how to construct a network to gain optimal (minimum cost) flow. Examples from industry illustrate the potential of these techniques.

The first industry example is that of Yellow Freight Systems, one of the largest motor freight carriers in the United States, handling over 15 million shipments over a network of 630 terminals. This company concentrates on the less-than-truckload (LTL) market. LTL shipments are typically less than 10,000 pounds. Since tractor-trailer trucks normally accommodate about 45,000 pounds, LTL shipments are consolidated to form economical, full truck shipments. This requires an extensive network of terminals where individual LTL shipments are consolidated for shipment and broken down for individual delivery in the area. To manage its increasingly complex terminal network system, Yellow Freight developed a network modeling approach called SYSNET. SYSNET improves customer service and reliability, while increasing productivity and lowering costs. Using SYSNET, Yellow Freight Systems was able to generate over $7.3 million in annual operational savings. [Ref. 53:p. 147]

A second example is that of Digital Equipment Systems Inc. (DEC). In the late 1980s, DEC had to realign its production system in response to changing customer preferences. DEC switched from manufacturing mainframe computers to manufacturing personal computer networks. While mainframe systems contain millions of components and thousands of human inputs, personal computers require comparatively few components and almost no human input. This meant that DEC required less infrastructure and capacity. In order to be successful, Digital had to cut its infrastructure. To do this, DEC developed and applied a network flow model named the Global Supply Chain Model (GSCM). This model was incorporated into Digital's Strategic Business Plan and used to re-structure company infrastructure. Savings from applying this model are estimated to be in excess of $100 million. [Ref. 54:p. 69]

The applicability to DOD in both these examples is particularly intriguing. Yellow Freight is a company that is trying to find optimal methods to move material across a nationwide distribution system. Digital, on the other hand, is a company rapidly restructuring and downsizing in order to adapt to a changing environment. DEC had to restructure supply chains and transportation routes. The Navy and DOD are faced with both of these problems.

These models are also applicable to the more specific HAZMAT management context. As mentioned earlier, a method to minimize hazardous material flowing into this system is to redistribute material around the network and reduce redundant inventories across HAZMIN Centers. As previously stated, RHMMS attempts to address this issue. However, as currently designed, RHMMS is primarily a communications and inventory visibility system. While there is an effort underway to develop a redistribution module for this system, it does not employ these optimization techniques to assign the flow of material around the network. Furthermore the network of HAZMIN Centers is not constructed to provide the optimal flow of material.

In the context of JIT, there are even greater possibilities associated with these network models. The Navy, selected industries, and JIT providers all have distribution networks with sources, nodes, and customers. Integrating these networks could potentially eliminate redundancies and more efficiently move material across a wide spectrum of activities, both DOD and commercial. Buyer-supplier JIT partnerships could demonstrate several network integration strategies. For example, data presented in Chapter IV demonstrate that linking HAZMIN Centers within a region provides for greater efficiencies and cost reduction. In fact, BCAs demonstrate that savings increase as activities are partnered with FISC HAZMIN Centers [Ref. 24]. Conceivably a HAZMIN network that serviced both Navy activities and regional industries could provide for even greater efficiencies. This would benefit both the Government and regional businesses, as well as the community. This is evidenced in Prime Vendor programs already employed for subsistence and pharmaceutical supplies.

C. JUST-IN-TIME AND THE HAZARDOUS MATERIAL MINIMIZATION MODEL

As described, the CHRIMP Model incorporates many JIT features. One such feature -- partnering -- was described in the previous section. This section reviews some of the other JIT features currently incorporated into CHRIMP, as well as some of the JIT concepts not addressed by CHRIMP.

1. The Manufacturing Chain

As stated in Chapter II, JIT emphasizes efficiency and ease of production [Ref. 2:p. 10]. This applies to supplies, services, and finished goods [Ref. 4:p. 454]. From the data presented, it is apparent that the Navy, through CHRIMP, has improved efficiency through material delivered just-in-time. When this chain is broken, confidence is lost and work centers, along with their parent activities, will resume maintaining safety inventory stocks. Recognizing this, the CHRIMP manual specifically states that: "Responsiveness to the initial request is the key to a successful program." [Ref. 21:p. 3-13]

CHRIMP programs are also going a long way toward delivering material designed to fit in the next stage of production. Under CHRIMP, if a maintenance requirement calls for five ounces of solvent, five ounces is delivered instead of a 55 gallon drum. Every effort is made to supply material in amounts required to accomplish specific maintenance actions or provide one day's supply [Ref. 21:p. 3-13]. This goes beyond tailored issues. HAZMIN Centers are tailoring services and materials to fit customer needs. By means of example, FISC San Diego actively works with deploying activities to assemble load-outs of material tailored to deployment cycles. They close the loop by reclaiming any unused material. FISC San Diego has also instituted programs such as distributing free shop towels and instituting a toner cartridge refill program. Both these programs save new procurement costs [Ref. 30]. In another example, FISC Norfolk is exploring the potential of mixing paint, on site, to match exact customer requirements [Ref. 24]. Designing material to fit the next stage of production is a mainstay of JIT [Ref. 1:p. 36].

2. Elimination of Waste

One of the primary tenants of the CHRIMP model is eliminating waste, specifically, eliminating hazardous waste by effectively managing hazardous material stocks [Ref. 21:p. 3-1]. In an effort to reduce hazardous wastes, CHRIMP has also developed mechanisms to reduce production wastes. It is interesting to note that JIT is usually used to increase efficiency. Here is a case where JIT features resulted from efforts to incorporate efficiencies; not the other way around. CHRIMP's impact on elimination of waste can be examined in the context of the seven areas of waste identified by Toyota [Ref. 1:p. 34].

a. Process and Design

As demonstrated by the data, CHRIMP represents a more efficient method to acquire, control, and deliver HAZMAT than was the case under traditional management techniques. Re-design of this process, to centralize inventory control and issue, reduced the material entering the waste stream, eliminated redundant functions across activities, and provided for more efficient resource allocation. This is validated by acquisition and disposal cost avoidance figures gathered from the four primary data collection sites. This information is provided in Table 5.1.

Acquisition and Disposal Cost Avoidance for Fiscal Year 1996		
Site	**Acquisition Cost Avoidance**	**Disposal Cost Avoidance**
FISC Norfolk	$2,931,877	$2,315,233
FISC San Diego	1,000,157	1,428,657
FISC Puget Sound (through May 1996)	289,000	469,000
FISC Pearl Harbor	1,321,712	3,070,572
Total	$5,542,746	$7,283,462

Table 5.1. Acquisition and Disposal Cost Avoidance for Fiscal Year 1996. Source: After [Ref. 41:p. 8]

Total cost avoidance across both areas is $12,826,208 for fiscal year 1996 alone. The savings could be even greater if more activities were brought into the network. Clearly, CHRIMP represents an improved process by which to manage HAZMAT.

b. Transportation

As discussed above, this represents an area where CHRIMP could be refined to achieve even greater savings. Modeling the system as an integrated network would allow management science techniques to be applied to optimize material flow patterns, lowering cost and improving customer service. These techniques could also be used to structure the optimal layout of the HAZMIN Network. Efficient transportation reduces the cost of moving bulk material and the costs associated with double

handling of material. It also facilitates further inventory reduction by exploiting regional inventory coverage, instead of relying on local coverage.

c. Time

This central tenant of JIT is also a central tenant of CHRIMP. As stated previously, the success of CHRIMP relies on response. CHRIMP focuses on response time [Ref. 21:p. 3-17]. JIT, on the other hand, minimizes waiting times by focusing on machine efficiency, labor efficiency, and transportation efficiency [Ref. 1:p. 35]. This amounts to a step beyond the CHRIMP philosophy -- from management by results to management by system optimization [Ref. 6:p. 13].

d. Overproduction/Over-purchase

Although there has been great improvement under CHRIMP, DOD and the Navy still buy too much HAZMAT. There were redundant stocks of material at all sites visited. FISC, through the HAZMIN structure, maintains customer stocks of HAZMAT, while DLA warehouses contain the same materials. This is particularly evident in Norfolk, where FISC collects HAZMAT turned in for redistribution in Building X218. This represents material no longer needed by local activities. The FISC accepts this material and attempts to provide it to authorized users, free of charge, so that it can be used rather than disposed of. Under material turn-in procedures, DLA screens this inventory before it goes to Building X218 to determine whether it will fill a wholesale stock shortage [Ref. 24]. As of 31 August 1996, the cost avoidance inventory value in X218 was $1,151,203 [Ref. 41:p. 6]. While FISC actively works to broker this material, it represents only a portion of the redundant material still carried in the supply system. Ironically, DLA shares Building X218 with FISC. A walk through the DLA portion of the warehouse demonstrates the amount of HAZMAT DLA carries locally and the overlap between this material and material turned in for re-use. The same observations were made at San Diego and Puget Sound.

Another factor cited in interviews was the problems caused by a lack of centralized purchase. Until recently, PWC in Norfolk procured their own material independent of FISC [Ref. 24]. This meant that purchases were not screened to see if the requirement could be filled by material currently

held on station. Additionally, PWC typically buys in excess, turning in unused materials to the HAZMIN Center for re-use. San Diego HAZMIN managers cited the same problem, stating that their biggest source of hazardous material stock was PWC excess, not DLA [Ref. 30].

One last problem associated with over-purchase is the increased use of the International Merchant Purchase Agreement Card (IMPAC). This simplified purchase initiative allows activities to obtain materials with a minimum of paperwork but it also means that hazardous materials are easier to acquire because IMPAC purchases are not screened through local purchasing operations. HAZMIN Centers are increasingly receiving this material, sometimes without Material Safety Data Sheets. In many cases, these purchases are redundant to material already carried in HAZMIN Centers [Ref. 25].

Here is one of the many areas where the Navy is seeking to satisfy its customers' needs, while trying to address larger organizational concerns. It also provides a way to examine what is necessary for JIT systems to operate effectively. Generally, rational people seek the most economical means of obtaining needed resources. In the case of the IMPAC card, purchases are made outside the defense supply system because material is not available or the lead time needed to maintain material is prohibitive [Ref. 25]. JIT is about having the right supplies available on demand [Ref. 1:p. 28]. Flexibility and rapid response to customer demands attracts customers. The goal of these systems is 100% satisfaction. This enticement precludes using non-value added activities, such as enforcement structures required to compel individuals and organizations to use the "right" procedures [Ref. 6:p. 80].

e. Defective Goods

The critical problem in HAZMAT management is that these materials typically have limited shelf lives [Ref. 24]. The term defects, in this case, does not apply to inferior products in the traditional sense, but to quality products that become defective by sitting on the shelf. Expired shelf life material must be disposed of, at a cost that often exceeds the acquisition cost [Ref. 32]. As stated in Chapter II, buying material, paying for receipt and storage, only to pay to dispose of it represents inefficiency and waste in the extreme. CHRIMP seeks to alleviate this problem by maintaining small stocks of material and turning them over rapidly. This represents a mechanism to fix an individual

process. JIT, as a subset of Total Quality Management Principles, seeks to fix the overall system [Ref. 7:p. 37]. In the context of HAZMAT management, this would entail integrating the efforts of all players including DLA, hazardous material vendors, HAZMIN Centers, HAZMAT users, PWC, DRMO, and disposal vendors. CHRIMP only addresses a small aspect of this overall system.

f. Motion

Beyond transportation, CHRIMP addresses inefficiencies of motion. HAZMIN programs are streamlined and customer oriented. Additionally, CHRIMP dictates efficient facility layout and logical task assignments [Ref. 21:p. 3-7]. Unnecessary checks or internal paperwork were seldom observed at any of the sites visited. This is driven, in large part, by the need of these facilities to be responsive.

g. Inventory

As stated earlier, while excessive inventory was not observed at any HAZMIN site, the problem of excessive HAZMAT inventories still exists within DOD. This is indicated by the steady flow of material to DRMO and PWC. While CHRIMP has had a marked impact on material going into these waste streams, the continued reliance on inventories has provided a steady business flow to many disposal agencies [Ref. 24].

3. Total Quality

The CHRIMP Manual spells out a commitment to operate under the concepts of Total Quality Management [Ref. 21:p. 3-1]. Site observations reveal this espoused commitment is also practiced. At all sites, management coordinates activities with a customer focus. Additionally, there a desire to continuously improve operations. The only problem observed was an inability to integrate more process owners into the overall HAZMAT minimization strategy. Supply activities such as DLA, and customer activities such as NAS Oceana, still play outside the FISC network.

D. JUST-IN-TIME AND PRIVATIZATION

As stated earlier, the Navy is studying several privatization initiatives, including privatizing some hazardous material management functions. These concepts can be examined using two perspectives. One perspective holds that as DOD organizations move along the privatization spectrum, there is increasingly less opportunity to apply JIT techniques. The second perspective holds that the two concepts actually complement one another.

1. Perspective One: Competing Concepts

As Government agencies move along the privatization spectrum, they bring commercial activities increasingly closer to Government activities until, eventually, the Government activity is completely replaced by a private activity. This can be observed in several areas. For example, many Navy hazardous material warehousing functions are currently contracted out using Intra-fleet Supply Support Operations Program (ISSOP) services. Fort Huachuca has moved further along the spectrum. Its HAZMIN Center is run on a GOCO basis. A contractor operates the center, managing Government stocks of materials under the CHRIMP concept. This could be further privatized through a Privatization-in-Place (PIP) program where the contractor would operate the facility, taking custody of -- or buying -- Government inventory and taking responsibility for replenishment actions through commercial sources. The Government would not own this material until time of issue. At the far end of the spectrum, the HAZMIN Center would be a totally private entity.

Movement along this spectrum equates to fewer and fewer opportunities to employ individual JIT relationships. Back to the metaphor of the bucket brigade, JIT relationships are represented by each individual along the line cooperatively passing buckets of water to extinguish a fire. Movement along the privatization spectrum essentially brings the river closer to the burning house.

2. Perspective Two: Complementary Concepts

This second perspective holds that privatization reduces individual opportunities for establishing JIT relationships, but introduces more powerful, cost effective JIT relationships. More direct buyer-

supplier relationships facilitate a continuous flow of material and better integrate activities [Ref. 1:p. 124]. JIT is about having material or services delivered just-in-time, neither too early nor too late. In this regard, inventory timing is a critical factor [Ref. 1:p. 204]. As suppliers are moved further away from end-users, this timing becomes more and more difficult. This leads to breakdowns in the supply chain. As discussed in Chapter II, these breakdowns often result in wasteful activities, such as over-purchase and the compilation of inventories.

Privatization in this area offers other advantages. As discussed previously, there are strict regulations for handling and disposing of hazardous materials. Using a commercial contractor who specializes in managing these materials applies the full force of their expertise to the Navy's HAZMAT program. This is a critical point since the Navy's commitment to comply with environmental policies is a relatively new step compared to private sector organizations. Private organizations have essentially been committed to compliance since the genesis of modern environmental regulations in the late 60's and early 70's. Only one of the Navy HAZMAT Managers interviewed possessed an advanced degree in an area related to environmental management. Comparatively, advanced degrees were the norm in the majority of hazardous material management firms. Navy HAZMAT managers are novices, in both education and experience, compared to their counterparts in commercial industry.

Additionally, integrating private contractors could conceivably provide increased vigilance over environmental programs. Privatization would introduce both private and Navy oversight. As stated earlier, ensuring environmental compliance will remain a Governmental function once material enters a fenceline, regardless of whether it is commercial or Government material. Administering any type of HAZMAT contract, be it JIT, privatization, or a combination of the two, would require strict Governmental oversight. At the same time, appropriate private management of these materials requires the same degree of vigilance. This first and second check method, if done cooperatively, could potentially reduce risk to the Government and accountable officers by ensuring these materials are properly handled.

Finally, an argument can be made that these concepts are complementary because they potentially allow for greater efficiency through increased economies of scale. A contractor servicing a

multitude of business and Government entities in a given area can attain the same efficiencies the Navy captures as the FISC HAZMIN Network is expanded. Secondly, to be viable, JIT requires a reasonably predictable demand for this material [Ref. 4:p. 436]. As the population of customers brought into a system increases, the ability to statistically predict demands becomes more accurate. This means that the contractor who services a region can provide more accurate, cost effective JIT services.

E. A SYSTEMS APPROACH TO BUILDING JUST-IN-TIME RELATIONSHIPS

Instead of viewing JIT as merely a mechanism designed to smooth the flow of materials as they pass from buyer to seller, JIT can be viewed in a more comprehensive context. It is important to think beyond individual processes and relationships. The focus of JIT is producing efficiently by integrating systems, eliminating waste, and focusing on total quality [Ref. 1:p. 32]. In this regard, JIT fits in nicely with privatization. Bringing suppliers closer to end users promotes quality and eliminates much of the waste JIT techniques seek to address.

One of the key elements of total quality is its focus on the customer or the end-user of a good or service [Ref. 6:p. 65]. Toward this end, the supplier should be aware of the end-users and the environment in which they operate. Manufacturers delivering material to DLA or Navy supply activities, even on a JIT basis, are only aware of what the purchasing agent wants. However, if these manufacturers are placed side-by-side with the end-user, a more complete picture emerges regarding the customer's needs.

Additionally, JIT seeks to eliminate inefficient activities. Close integration of suppliers and users allows the supplier to understand the end-user's needs. In this position, suppliers are in a better position to apply value design and value analysis techniques; align efficient, cost effective transportation systems; reduce wait times; quickly identify defective goods; streamline task assignments; and provide materials as they are required.

Reducing the delivering carrier's transportation time is also an important objective of JIT. Consequently, locating suppliers near or within the buyer's operations may offer distinct advantages [Ref.

4:p. 437]. Suppliers can set up and service small working stocks on-site to facilitate daily production while maintaining a production and delivery system off-site. This is essentially the strategy NADEP North Island is pursuing, except they are using FISC rather than a commercial supplier. As stated in Chapter Four, it would be relatively easy for a commercial contractor to step in and manage this system on-site.

Both JIT and TQ approaches focus on integrating suppliers to make them part of the overall system. The biggest opportunities for improvement lie in the system, not in individual elements. Focusing on a systems approach allows managers to focus on issues that cause sub-optimum performance. Dr. Deming characterized some of these issues that plague organizations in his 14 points. They include: [Ref. 6:p. 36]

- Lack of a clear aim for the organization
- Barriers between departments for businesses; failure to optimize the company as a whole
- Management by rewards and punishments on achievement of goals
- Reliance on inspection and rework to fix problems rather than on effective prevention
- Failure to understand that suppliers are part of our system

While CHRIMP has pushed for a clear aim, it still does not integrate Public Works activities, DRMO or, most importantly, DLA. Broadening CHRIMP's focus to integrate these activities with HAZMAT providers and hazardous waste disposal companies will provide a common focus. Consider the vendor who, currently, seeks to provide the maximum amount of material possible in order to increase revenues. Then consider the possibility that these providers are incorporated into the system contractually on a fixed-price basis. Now the incentive is not to provide more material. Instead, the contractor would seek to minimize the amount of material provided in order to decrease cost and increase profit.

Barriers between departments are a problem with the current model. This includes activities that do not want to participate in FISC HAZMIN programs. It also includes activities such as DLA that, despite Defense Reorganization Management Decisions (DRMDs), still have competing missions with FISCs and other supply activities [Ref. 24]. As one Navy HAZMAT manager put it:

> Activities that don't partner with FISC do so for reasons of autonomy and because they see self-contained [HAZMIN] programs as a way to demonstrate the impact they can have as managers to their superiors. These programs save money and they're a topic that's in vogue. [Ref. 43]

Organizations establish local, self-contained HAZMIN initiatives even when greater savings are available through the larger FISC network.

This is one example of a reward scheme gone awry. Another example, as stated earlier, is the reward system that compels hazardous material providers to sell as much to the Government as possible, even when the vendor knows that supplies exceed the requirement for the material. Currently, there is no incentive for these companies to share their expertise in developing minimizing strategies. The same is true for hazardous waste disposal. There is no incentive for these firms to share ideas they might have to minimize the generation of hazardous waste. Systems approaches take this into account and push for solutions that benefit the entire team, not the individual players [Ref. 6:p. 28].

This is why JIT and TQM seek to integrate suppliers and recognize they are part of the overall team. In this context, JIT and privatization concepts go hand-in-hand. The challenge is to develop contractual mechanisms that promote consistency of purpose throughout the entire system [Ref. 6:p. 36]. These include developing long term relationships with suppliers and providing contractual incentives that focus their efforts on the overall system goals.

F. POTENTIAL FOR JUST-IN-TIME

JIT has considerable potential for hazardous materials management. Its focus on eliminating waste reflects the CHRIMP philosophy [Ref. 21:p. 3-1]. As such, these concepts blend neatly together. In fact this represents a unique opportunity. As discussed previously, CHRIMP already incorporates many JIT features. In this regard, CHRIMP is already structured so that it can be brought into a larger JIT system.

This is also a unique opportunity because HAZMIN programs are so new. As such, they are still adaptive and not locked into rigid policies and procedures [Ref. 34:p. 3]. In fact, managers interviewed

were constantly evaluating ways they could adjust their programs to better meet customer needs [Ref. 23]. Applying JIT supply concepts in this fertile environment would be far easier than applying these concepts to organizations with long established standard operating procedures.

There is nothing to indicate that JIT concepts could not be integrated into the Navy's hazardous material management program. JIT and environmental compliance have no contradictory or competing concepts. In fact, the two strategies complement each other in many ways.

G. SUMMARY

This chapter analyzed data regarding JIT and environmental compliance. This was done by constructing a model to represent the Navy's hazardous material minimization program and examining that model as a system of activities. This discussion described the model and ways to potentially improve it. Next, the HAZMIN model was compared to JIT techniques described in Chapter II.

Following this, the concept of privatization was related to JIT. This demonstrated that the two concepts do not compete with one another. They are, in some ways, two sides of the same coin. Finally, this chapter described the systems approaches necessary for successful JIT applications and evaluated the potential for JIT in the Navy's hazardous material management system. The next chapter will provide conclusions and recommendations concerning this research, along with follow-on research questions.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

This thesis has examined JIT concepts and environmental compliance issues to identify strategies for applying JIT techniques to hazardous materials management. This examination highlights the advantages JIT has over traditional material warehousing techniques. JIT represents a proven system for efficiently moving, distributing, and developing materials. When understood and applied correctly, JIT lowers cost and improves overall product quality. JIT accomplishes this by:

- Integrating the entire manufacturing chain and focusing on it as a continuous process -- not as a collection of individual elements
- Seeking to eliminate waste and non-value added activities wherever possible; and
- Incorporating concepts of total quality in producing supplies and services

In so doing this, JIT systems provide for the efficient flow of resources, eliminating the need to carry large inventories. JIT represents a strategy for shifting away from depot warehousing concepts and their associated costs. These costs include storage, loss, obsolescence (primarily due to the rapid pace of technology), deterioration, and disposal.

JIT's benefits are particularly appealing in the area of hazardous materials because the costs and liabilities of maintaining large HAZMAT inventories are particularly daunting. They require special storage facilities, have limited shelf lives, and the disposal cost is generally greater than the original purchase cost. Additionally, mishandling these materials may result in fines and penalties levied against both organizations and specific individuals. Excessive inventories of these materials drain limited financial resources and increase the likelihood they will be mishandled.

Recognizing this, strategies for integrating JIT methodologies and hazardous materials management concepts were researched in this thesis. Special attention focused on identifying business practices within the Navy and evaluating the best way to arrange buyer-supplier relationships incorporating JIT purchasing techniques.

B. CONCLUSIONS

After studying JIT and its potential application to hazardous material management, the following conclusions are drawn from the data collected and presented here.

1. Shared Aims and Objectives

JIT and environmental regulatory policies focus on the same things. Specifically, minimizing inventories and eliminating waste. This makes JIT a particularly appropriate tool for managing hazardous materials. This is particularly evident in the mechanisms the Navy has set up to manage these materials. They parallel JIT practices. CHRIMP, in particular, incorporates many JIT features. Interestingly, this management structure was set up to address environmental issues but, in many ways, it achieves the same aims as JIT. Related Navy management practices, such as FISC partnering, also closely parallel commercial JIT practices.

2. Excess Inventories Remain

While the Navy has taken great strides toward reducing stocks of hazardous materials, there is still excessive material in inventory. This includes horizontally redundant stocks across activities and vertically redundant stocks between DLA, FISC, and end-users.

3. Economies of Scale

Effectiveness and savings increase as more activities are brought into the FISC HAZMIN network. However, faced with more economical business practices, some activities resist FISC partnering arrangements. Additionally, linking HAZMIN sites in a regional network, increases the potential for developing optimal distributions and further reducing inventories.

4. Potential for Integrating Just-in-Time

Because JIT and Navy HAZMAT management practices have shared aims and objectives, incorporating JIT will not require significant restructuring of current Navy strategies. JIT purchasing systems can be readily incorporated with minimal, or no, impact on end users.

5. Privatization

Privatizing the HAZMIN network offers unique opportunities for constructing optimal JIT delivery systems. Privatizing the network simplifies the overall system by eliminating redundant processes; it provides a more efficient material flow and brings suppliers in closer alignment with customers. Additionally, it allows the Navy to divest itself of these inventories and the associated costs.

C. RECOMMENDATIONS

Drawing on data collected through this research, the following recommendations are offered.

1. Eliminate Tiered Inventories

DLA and FISCs should cease carrying wholesale and customer stocks of hazardous materials. Instead all these materials should be carried in a FISC-type HAZMIN system. This reduces inventories down to two month working stocks, wholly contained within HAZMIN centers.

2. Broaden the FISC HAZMIN Center Charter to Include Afloat Units

Broadening the FISC HAZMIN Center charter would provide afloat units with a source of supply and DLA stockscould be eliminated. Additionally, it would link HAZMIN centers with an important customer base and include these centers in deployment planning and offload coordination (one ship's offload is potentially another ship's load-out). This increases the savings potential of the FISC HAZMIN system by drawing in a wider customer base and allowing non-deployed ships to reduce the material they carry.

3. Incorporate a Supporting Contractor

In order to further empower HAZMIN Centers to meet customer needs, a supporting contractor concept should be integrated into the regional HAZMIN network. This contractor would act as a source of supply and transportation, brokering material on a JIT basis. Award should be made on a long term fixed-price type contract. This would give the contractor an incentive to minimize the amount of material brought into the network through mechanisms such as:

- Entering into long term relationships with vendors
- Developing commercial customers to broaden their base and gain market power
- Exploring optimal transportation and distributions systems and
- Applying their expertise to assist the Navy with its overall HAZMAT management program

The specific contract mechanism can range from a Firm Fixed-Price (FFP) contract to a Fixed-Price Award Fee (FPAF) arrangement with additional rewards, provided through the award fee, for the contractor to minimize material flows and reduce waste.

4. Explore Further Privatization Options

As demonstrated by the Army at FT Huachuca, HAZMIN operations are a legitimate candidate for outsourcing. The Navy should continue to study the business case for public vs. private operation of this function. As stated, privatization offers the Government many potential advantages. These advantages should be pursued in areas where it is determined that the private sector can provide quality service at a better value.

D. THE RESEARCH QUESTION

The preceding chapters as well as the conclusions and recommendations presented above address the questions presented in Chapter I. The following provides a further summation.

1. Structure

The primary research question asked: "How should the Department of the Navy structure a hazardous material management and delivery system that uses the full capabilities of Just-in-Time (JIT) concepts and what are the benefits of applying Just-in-Time techniques to the comprehensive management of Hazardous Materials inventories at Navy activities?" As was described in the data, CHRIMP represents a hazardous material management system that already incorporates many JIT features. As such, the Navy does not have to restructure its management and delivery system to incorporate a JIT supply of these materials. Building JIT relationships at the regional level is a good match for programs already in place. The real potential for building powerful and effective JIT relationships lies in the alignment, through privatization, of commercial JIT providers with the Navy's FISC sponsored HAZMIN structure.

2. Goals and Objectives of Hazardous Materials Management

A secondary research question asked: "What are the specific goals and objectives for HAZMAT management as they exist today?" As stated, the goals and objectives of HAZMAT management are remarkably similar to the goals and objectives of JIT: eliminate waste, provide material as needed, and use it efficiently. HAZMAT management policies, like JIT, believe inventories should be avoided wherever possible.

3. Concept of Just-in-Time

"What is the concept of JIT procurement and how is it currently utilized by DOD activities?" JIT is about having material available as it is needed. As such, it avoids the expense and waste associated with inventory. JIT, through its focus on the manufacturing process as a system, emphasizes efficient material flow and producing quality goods and services.

4. Current Private Sector Initiatives

"What are current practices within the private sector regarding JIT and HAZMAT management?" The data indicate that commercial companies are increasingly relying on JIT concepts to effectively manage HAZMAT. This is evidenced by the recent growth in the HAZMAT management market. This growth is sparked by companies that realize hazardous material management does not represent a core competency and should therefor be outsourced.

5. Explicit Governmental Functions

"Given current regulations, which HAZMAT management requirements represent explicit Governmental functions and which functions could be outsourced to commercial industry?" The data suggest that there is one primary area where the Government has an explicit function in managing hazardous materials: that is oversight. It is inherent that the Government maintain vigilance over these materials regardless of whether they are self managed or managed via commercial sources. This entails carefully monitoring the management of these materials from the time they are brought within the base fenceline until they are properly disposed of.

6. Capabilities of Private Industry

"To what extent could private industry satisfy Government's HAZMAT management needs using JIT concepts?" The data indicates private industry has the capability to deliver and manage these materials more cost effectively than the Government. This is primarily because companies that specialize in providing these services have broader education and experience than their Navy counterparts. Additionally, they have at their disposal operational management information systems still under development within the Navy. Lastly, they employ management techniques, such as network modeling, that can improve efficiencies, serve a broader customer base and reap associated economies of scale.

7. Benefits of Just-in-Time

"What benefits accrue under JIT management of HAZMAT inventories?" JIT provides for more efficient material flow by integrating a series of processes into an overall production system. Material does not sit idle. Instead, it moves from one process to the other with a minimum of waste. Commercial industry is incorporating JIT techniques because they allow flexible, quality production at a lower cost than traditional production methods. Navy activities are also utilizing JIT concepts in programs such as Prime Vendor. The data suggest JIT techniques are also applicable to hazardous materials management and, by applying these techniques, the Navy will reduce the cost of supplying this material and contribute to environmental compliance.

E. AREAS FOR FURTHER RESEARCH

While this study focused on applying JIT to the management of hazardous materials it did not quantify the benefits at a specific site. A logical continuation of this research is to gather costs of materials and operations from one region (e.g., San Diego, Puget Sound, Norfolk) and determine the specific savings available by using a supporting contractor to broker material locally on a JIT basis.

A second aspect is to gather commercial cost estimates for running a GOCO or fully privatized operations within a specific region and then compare them to the cost of Government operations. This would help build a business case for or against HAZMIN privatization.

As part of hazardous material management, this thesis focused primarily on supplying these materials. Related to this is the impact of JIT and/or privatization in hazardous material disposal. As this thesis suggested, it is possible to construct contract incentives to align the goals and objectives of HAZMAT providers with the Government's goals and objectives. There is a similar potential for waste disposal contractors that warrants further research.

A related area of research would be constructing draft statements of work for JIT delivery/disposal contracts that incorporate the concerns of all stakeholders. Stakeholders include: base

environmental personnel, supply activities, supported units, safety offices, EPA, OSHA, and DOT. This would be a key step in developing JIT systems for these commodities.

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