NAVAL SUPPLY SYSTEMS COMMAND
5450 Carlisle Pike
P.O. Box 2050
Mechanicsburg, PA 17055-0791

NAVY GUIDANCE MANUAL FOR THE HAZARDOUS MATERIAL SUBSTITUTION PROCESS

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Alvin F. Meyer

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Supply Systems Command
5450 Carlisle Pike
P.O. Box 2050
Mechanicsburg, PA 17055-0791

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The Manual provides guidance for use of the Naval Hazardous Material (HM) Substitution Process. That process was developed over the course of several years by a special Chief of Naval Operations N451 (CNO N451) Working Group and proof tested by the Naval Supply Systems Command (NAVSUP).

The HM Substitution Process consists of three phases. Phase I includes identification of technically suitable substitutes for existing or planned HMs. Phase II involves selection of environmentally and economically feasible candidate materials. Candidate materials are selected by applying the HM Substitution Algorithm and the NAVFAC P-442 Economic Analysis Model. Phase III requires implementation of the process result. This involves a decision as to whether the status quo material should be eliminated, replaced, or retained. All technical documents that govern use of the material or process must be changed accordingly.

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EXECUTIVE SUMMARY

Hazardous Materials (HMs) are used widely in the Navy in connection with all phases of the System Acquisition process. The requirements for using HMs are contained in technical manuals and specifications that govern the processes and procedures for weapons systems operation and support. The HM Substitution Process is a procedure developed by the Chief of Naval Operations N451 (CNO N451) and a Working Group to identify, select, and implement a HM substitution process, thereby preventing pollution.

The HM Substitution Process occurs in three phases. Phase I involves identifying potential substitute materials to replace existing HMs, and determining their technical feasibility. This phase requires an analysis of existing technical requirements governing the use of an existing HM, and then searching for potential substitutes that conform to the same technical requirements that govern the use of HMs in Navy processes.

Phase II involves selecting an environmentally and economically sound substitute material using the Pollution Prevention (P2) System. This phase includes collecting environmental, safety, health, and economic data for existing HMs and potential substitutes, and performing risk and economic analyses. These analyses are performed by the P2 System through application of the HM Substitution Algorithm and the NAVFAC P-442 Economic Analysis Model, to assess the relative hazards and economic feasibility of each potential substitute material.

The third and final phase involves implementing the results of the HM Substitution Process. A decision must be made as to whether to eliminate an existing HM because it is not operationally necessary, to retain the existing HM because substitution is not technically or economically feasible, or to replace the existing HM with a technically and economically feasible substitute. Once a decision has been made, the material or process change is formalized by modifying all technical and related documents governing the use of the material and/or process.

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CHAPTER 1

THE HAZARDOUS MATERIAL SUBSTITUTION PROCESS

1.0 Introduction

Hazardous Materials (HMs) are widely used in the Navy for a variety of purposes. Throughout the Navy, most HM usage occurs in connection with the Operations and Support Phase of the System Acquisition process. In other words, HMs are used in processes related to the operation, maintenance, repair, and support of ships, aircraft or other weapons systems. The requirements for using HMs are contained in technical manuals and specifications that govern the processes and procedures for weapons systems operation and support. For example, a technical manual for the repair of aircraft landing gear may require that the wheel bearing be cleaned using a parts cleaning solvent (HM) that meets Federal Specification (FED-SPEC) P-D-680, prior to reassembly of the component parts. Any product proposed as an environmentally benign replacement for the parts cleaning solvent must also meet FED-SPEC-P-D-680. To a lesser degree, HMs are used under circumstances where there are no technical requirements in force, or the technical requirements are less rigorous. Examples of these situations include janitorial services, facilities maintenance and automotive maintenance.

The HM Substitution Process is a procedure developed by the Naval Supply Systems Command (NAVSUP) to identify, select, and implement a HM substitution within the constraints of the technical documents governing its use. The HM Substitution Process prevents pollution by replacing HM used in Navy processes with less hazardous or non-hazardous materials. If possible, HMs are eliminated altogether. When a HM cannot be replaced or eliminated, the substitution process serves to quantify the risk and cost of the HM's usage and ensure that controls exist to properly manage the HM's use. Substitutions may be made on a product-for-product basis, or they may be coupled with procedural or process changes that facilitate the use of a substitute material.

System Commands and other Navy organizations with authority to make process changes or material substitutions should consider substituting a candidate material for an existing material when all of the following conditions are met:

1. A need exists to replace or eliminate an existing HM due to environmental, economic, safety and health, or other considerations.
2. Potential substitutes for the existing HM are available, or can be identified.
3. At least one of the potential substitutes meets the minimum technical requirements for the purpose for which it will be used.
4. A systematic analysis of the characteristics of the potential substitute material shows that it is less hazardous than the material currently in use.
5. A Life-Cycle Cost (LCC) analysis of the candidate material vs. the existing HM indicates there is no net cost associated with the substitution, or that a net economic benefit will result from the substitution.

The HM Substitution Process is a means of determining that the conditions on the previous page have been met. This process generally occurs in three phases:

- ⇒ Phase I: Identifying Substitute Materials,
- ⇒ Phase II: Selecting a Substitute Material, and
- ⇒ Phase III: Implementing the Results of the Substitution Process.

The flow chart on the next page illustrates these three phases of the substitution process along with the individual elements that comprise each phase. This flow chart is provided as a generic guide for the HM Substitution Process: it should be tailored to suit the specific circumstances of the organization contemplating a substitution. The remainder of this Chapter contains a general discussion of each phase of the HM substitution process, followed by detailed guidance in subsequent chapters.

1.1 Identifying Substitute Materials.

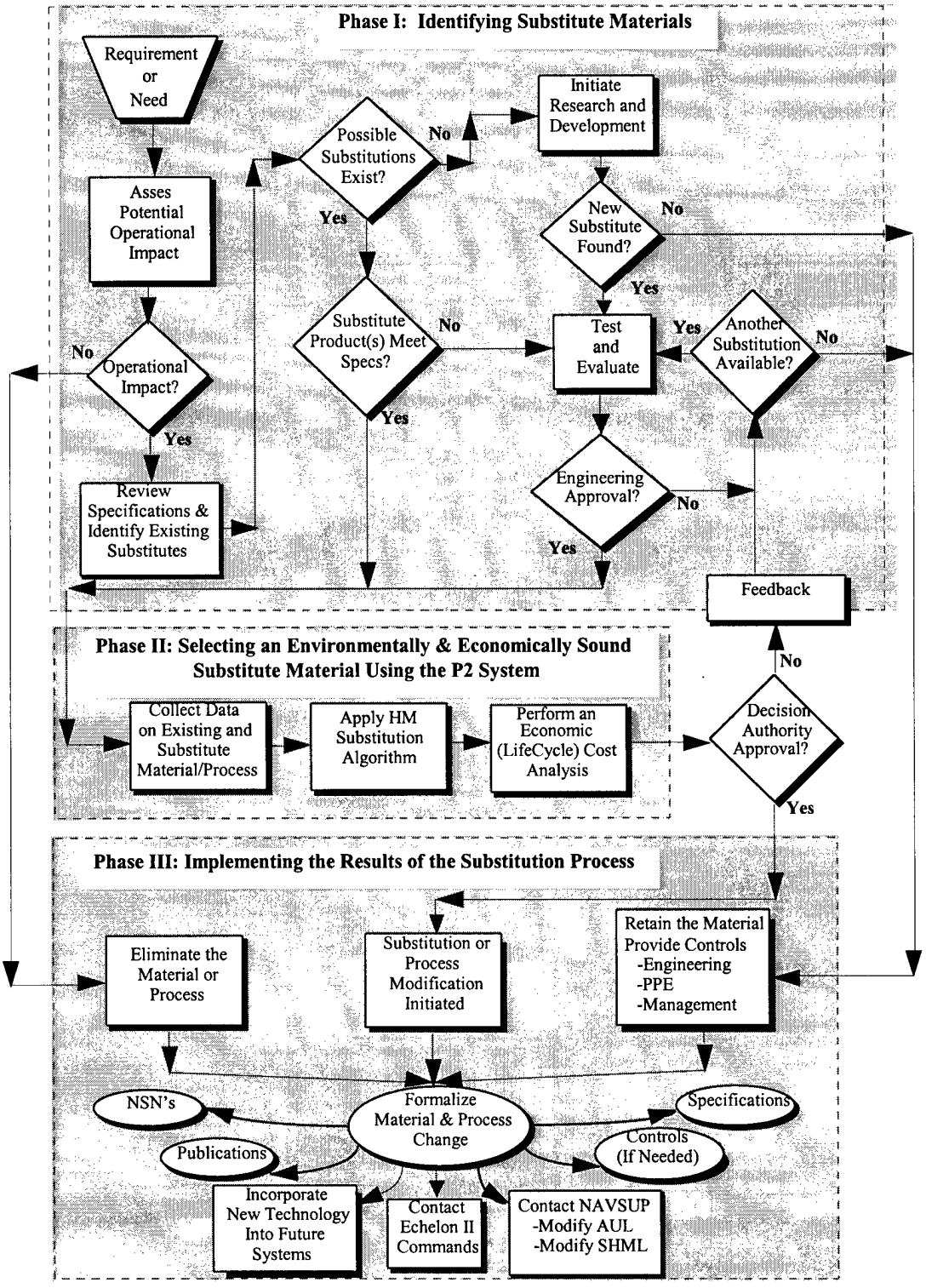
Identification of substitute materials means finding potential alternatives for an existing HM, and determining their technical feasibility for the application at hand. There are several ways to locate potential substitutes for HM as described in Chapter 2.

The technical feasibility of a potential substitution is a major constraint in the substitution process that presents significant challenges in the identification phase. Since the use of HMs in Navy processes often arises from technical manuals and specifications, potential substitutes must also conform to the same technical requirements. Research and Development (R&D) may be necessary to formulate less hazardous substitute materials, and Testing and Evaluation (T&E) may be required to determine that an available substitute meets existing specifications. R&D and T&E can be costly and time consuming, with no guarantee that a viable substitute material will be identified. If a viable substitute material is found and approved for use, personnel who will use it need to know that it is authorized and approved for the intended application. Therefore, the appropriate technical manuals and specifications may need to be revised to ensure that the substitution is implemented where and when authorized.

1.2 Selecting an Environmentally and Economically Sound Substitute Material Using the Pollution Prevention System

Following the identification of technically feasible substitutes for an existing HM, a single substitute material is selected for implementation based upon an a analysis of the relative hazards and economic feasibility of each potential substitute. The first step in this phase of the substitution process is data collection. The Material Safety Data Sheets (MSDSs) for each potential substitute as well as the existing HM are required to assess the relative hazards associated with the status quo conditions vs. potential substitutions. The MSDS data may be available from the Hazardous Substance Management System (HSMS) for

Figure 1. Flow Chart of the Hazardous Material Substitution Process



the existing HM. For the economic analysis, all of the life-cycle costs associated with the proposed substitution and/or associated process changes will be required. Product vendors are a good source for much of the economic data needed. The second step in the selection phase is application of the HM Substitution Algorithm, a procedure developed by NAVSUP in conjunction with the HM Substitution Process. It provides a means of ranking the relative hazard posed by each candidate material according to numeric scores derived from information contained in its MSDS. The higher the score, the more hazardous the product. By comparing the scores of two or more potential substitutes, the relative hazard of each can be determined.

Naval Facilities Engineering Command Publication 442 (NAVFAC P-442) contains guidance used to determine the economic feasibility of each candidate material. There are two types of economic analysis that may be used - Type I or Type II. The type of analysis depends on the circumstance involved in the potential substitution. A Type I economic analysis is used when a choice exists between continuing operations unchanged, or changing operations for the purpose of achieving cost savings. A Type II economic analysis can be used when several possible alternatives (substitutions) are being evaluated. For either type of economic analysis, a substitution is considered economically feasible if there is no net cost associated with the material substitution or related process changes.

NAVSUP has developed a PC-based program, called the Pollution Prevention (P2) System, that automates both the HM Substitution Algorithm and the NAVFAC P-442 Economic Analysis for the substitution process. This program simplifies the process of selecting a substitute material by automating the time consuming calculations associated with the substitution algorithm and the economic analysis portions of the second phase. In addition, the P2 System is capable of retrieving MSDS data on existing HMs from the HSMS.

1.3 Implementing the Results of the Substitution Process

Implementing the results of the substitution process occurs in two steps. First, the appropriate approval authority must make a decision to:

- eliminate the HM currently used (with no replacement), or
- retain the HM currently in use and ensure adequate controls are in place to control risk associated with its use, or
- replace the HM currently used with a less hazardous substitute and/or modify the process using the material.

Second, the material or process change is formalized by modifying all technical and related documents governing the material's use and/or the process in question. This includes notifying NAVSUP, other System Commands and Program Offices, as appropriate, regarding changes made to materials or processes used.

1.4 Relationship Between Material Substitutions and Process Changes

Making a material substitution often involves changes to processes because materials and processes are interrelated. For instance, switching to a less-hazardous solvent for parts cleaning may require additional mechanical cleaning such as hand scrubbing or wiping parts. This represents an increase in labor that must be considered as part of the substitution. Process changes related to substitutions potentially affect the life-cycle cost and the quantity of HM used in a process. For example, a solvent substituted for one more hazardous may increase Hazardous Waste (HW) generation if the quantity of solvent needed triples in order to achieve the same degree of cleaning. These types of issues must be weighed on a case-by-case basis when considering a substitution.

Similarly, processes that use HM are also governed by technical requirements that specify how they are carried out. Changing a process for P2 purposes often involves HM substitution or elimination and modification of technical documents pertaining to the process (and possibly the materials used). Process changes need to be evaluated for technical and economic feasibility in a manner similar to substitutions. Therefore, process changes and HM substitutions are considered synonymous for purposes of this guidance manual.

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CHAPTER 2

IDENTIFYING SUBSTITUTES FOR HAZARDOUS MATERIALS

2.0 Introduction

The first, and most difficult phase of the HM Substitution Process, involves identifying substitutes for existing HM, or contemplated for use in the design of new weapon systems. The challenges in this phase arise from issues related to technical requirements as outlined in Chapter 1. Technical requirements are established to ensure that the minimum performance and safety standards associated with weapon system operations and support are met. Substitutions cannot be made unless the substitute product satisfies all the technical requirements for its intended use. For example, low Volatile Organic Compound (VOC) paint substitutes are not acceptable for exterior use on Navy ships unless they can withstand extended exposure to salt water spray. At the conclusion of the identification phase one of three possible outcomes will result:

1. The existing HM will be targeted for elimination because its withdrawal presents no operational/mission impact (proceed to Phase III),
2. The existing HM will be approved for continued use (proceed to Phase III), or
3. One or more potential substitutes will be identified (proceed to Phase II).

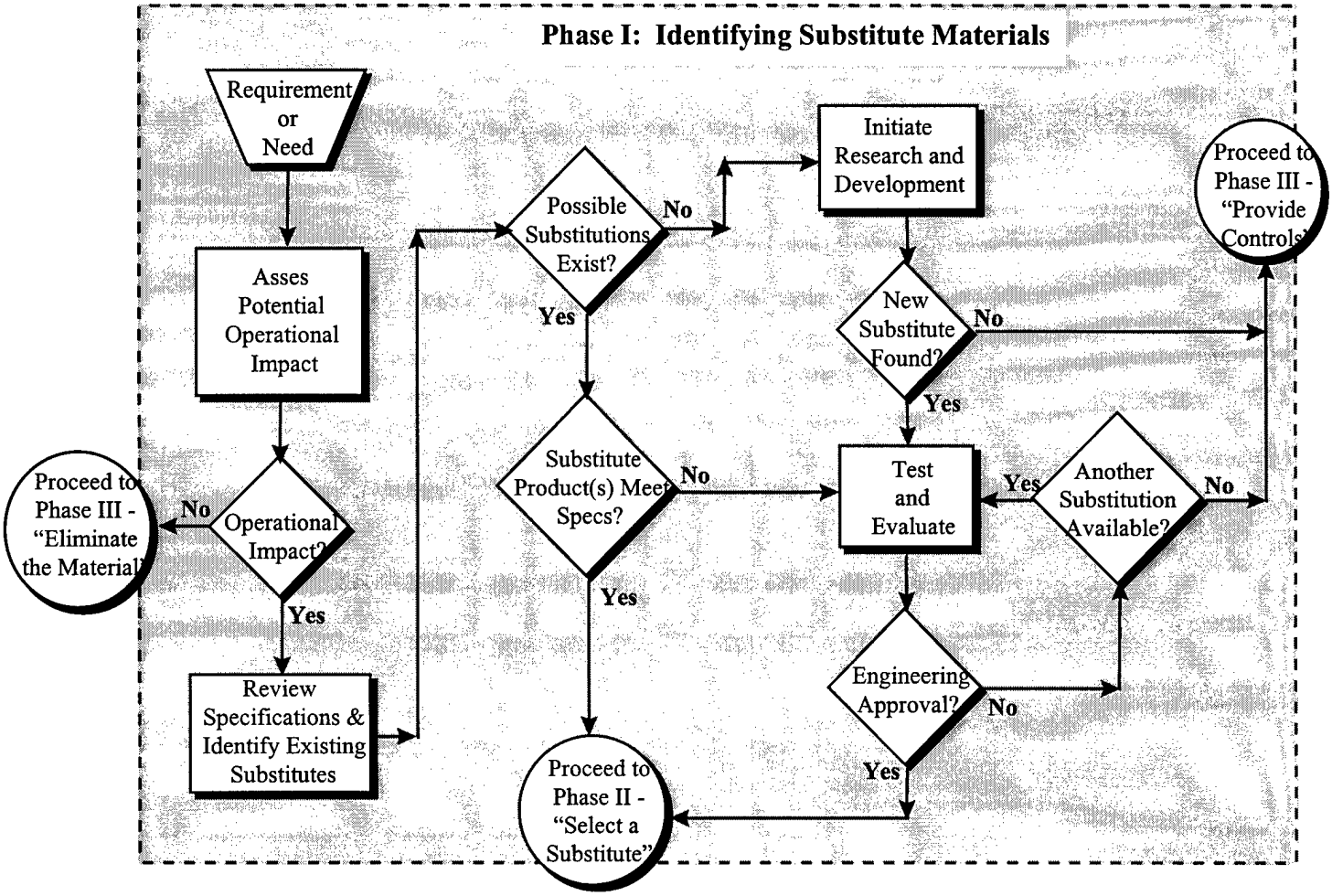
The preferred outcomes of this phase are the elimination of the existing HM, or identification of potential substitutes.

Figure 2 on the next page, illustrates the general procedures involved in identifying substitutes for HM, and should be used as a generic guide when considering possible substitutions. Figure 2 assumes that specifications or other technical requirements govern the material or process being considered in the substitution process. In many instances, specifications may not exist for the HM or process under consideration, making the identification phase much simpler. Examples include cleaning supplies used for janitorial services or carpenter's glue used in a base hobby shop. For these situations, any material designed for the same purpose may be considered as a potential candidate for substitution (e.g., a water-based carpenter's glue as a potential substitute for one containing VOCs).

The remainder of this chapter will be devoted to a discussion of the key Phase I elements of the substitution process, as depicted in Figure 2:

- Requirement or Need for a Substitution,
- Assessing the Operational Impact of a Potential Substitution,
- Specification Review and Identifying Existing Substitutes,
- Research and Development,
- Testing and Evaluation, and
- Engineering Approval.

Figure 2. Flow Chart of Phase I: Identifying Substitute Materials



2.1 Requirement or Need for Substitution

Many factors are responsible for the requirement or need to substitute less or non-hazardous materials for HMs. The Pollution Prevention Act and Executive Order 12856 require P2 efforts, and they cite substitution as a preferred means of P2. Other laws and regulations prohibit or discourage the use of HMs such as Ozone Depleting Substances (ODSs) and lead paint, making substitution necessary by default. The Navy's P2 policy is to reduce the amount of HM used and HW generated at shore facilities using substitution as well as other methods (OPNAVINST 5090.1B, 3-5.2). Ultimately, as with all HM control

and management initiatives, substitution actions are driven by the desire to protect the health and safety of Navy personnel, safeguard the environment, and save money.

In practice, the requirement or need for substitution typically arises when:

⇒ facilities conduct a baseline assessment of HM and/or processes pursuant to development of P2 plans or Toxic Release Inventory (TRI) Reporting,

⇒ a HM previously used in a process or application is no longer available, is phased out, or becomes prohibitively costly due to legal or regulatory restrictions, or

⇒ a HM is being considered for use in conjunction with the design, or logistics and support of a weapon system under development.

2.2 Assessing Operational Impacts

Once a requirement or need for substitution becomes known, the operational impact of eliminating the existing HM altogether, or providing a technically feasible substitute must be assessed. This is done by conducting a survey of other system commands, acquisition programs, users of the HM, and engineering activities for the following information:

- existing data on potential substitute materials,
- potential operational impacts of eliminating or replacing the existing HM,
- technical references that require the use of the existing material,
- potential substitutes known to be incompatible with other materials in the operational environment, and
- any unique or special need for the existing material.

CNO-N45 should be contacted to identify additional sources of information within the Navy, the Department of Defense (DoD), and the other Military Services.

From the information gathered, the operational impact, if any, of eliminating or replacing the existing material should be evident. Operational impact will result if any of the following conditions are true:

- the Navy has valid uses for the existing HM,
- there are technical requirements in force mandating its use, or
- operational time frames or objectives would be impeded from withdrawal of the material.

When operational impacts are indicated, the existing HM cannot be eliminated. However, substitution is still possible, as long as any proposed alternative meets the specifications for the HM or process being studied.

If no operational impacts can be identified, and no further need exists for the HM or a process in which it is used, it can be eliminated. If the HM is to be eliminated, proceed to Phase III - "Eliminate the Material or Process."

2.3 Specification Review/Identify Existing Substitutes

When a HM cannot be eliminated because of operational impacts, further research will be necessary to identify potential substitute materials. First, the specifications (and any other technical documents) governing the use of the material are reviewed to determine whether alternative product formulations are allowed. Many specifications are performance based, which allows substitution of any material or formulation meeting the minimum criteria of the specification.

If specifications are in force, and they allow for alternative materials or formulations, potential substitute materials may already be available. Potential candidates may be identified by checking the Qualified Products List (QPL) under the National Stock Number (NSN) of the existing HM. Materials with the same NSN as the existing HM, that are listed on the QPL, have already met all the requirements of the specifications in question. **These materials are the best candidates for substitution because R&D, T&E, and Engineering Approval are unnecessary prior to using them as substitutes.**

When potential substitutes cannot be identified from the QPL, further investigation will be required to locate candidate materials. Potential substitutes can be identified by:

- investigation of materials known to be used in similar applications,
- review of articles and advertisements in professional trade publications,
- discussions with manufacturers or vendors,
- review of data contained in MSDSs, the HMIS, and specifications for insight to possible substitutes,
- review of alternative products listed by EPA, DLA or GSA as potential substitutes,
- use a "Sources Sought" advertisement in the Commerce Business Daily,
- contact R&D and Engineering activities inside and outside the Navy, or
- review the Tri-Service Pollution Prevention Opportunity Handbook for possible substitutes.

Any candidate material identified using the methods listed above must demonstrate that it meets the specification(s) for the material or process in question. In the absence of any proof that the candidate material meets specifications, T&E is required to ensure that operational requirements are not compromised by substitution involving the candidate material. Manufacturers or vendors may be able to provide evidence that their products meet the appropriate specifications, or even be willing to sponsor the necessary T&E to validate their product for a particular application.

2.4 Research and Development

Research and Development is the last resort to identify potential substitutes for existing HMs, and should only be used when existing substitutes cannot be found or are not technically feasible. It is a very costly, time consuming process that provides no guarantee that a viable substitute will be found. For example, it took two years of R&D sponsored by NAVSEA to develop a substitute for CFC-113.[1] Only System Commands and Acquisition Programs should engage in R&D activities. Lower level activities should notify their System Command or Major Claimant if a need for R&D is identified.

In general, R&D should be initiated by System Commands or Acquisition Programs to identify substitute materials that will have potential application Navy-wide. System Commands or Acquisition Programs contemplating R&D should contact CNO-N45 to identify other interested parties for possible Joint Service efforts. In very basic terms, R&D proceeds as follows:

1. The scope and desired results of the R&D effort are defined.
2. Funding is identified, consistent with the scope and desired results.
3. An organization or activity is selected to perform the R&D.
4. R&D is conducted, per the scope defined in 1, above.
5. The outcome of the R&D efforts are evaluated against the desired results.

For detailed information on conducting R&D, consult the "Department of Navy Research Development and Acquisition (RD&A) Management Guide - P-2457."

If the R&D fails to identify or create a potential substitute, the need for the existing HM should be reexamined and the HM should be retained, if possible. If the existing HM will be retained, proceed to Phase III - "Provide Controls." Otherwise, the R&D effort may be repeated until one or more potential substitutes are identified. Caution is strongly advised due to the high cost of R&D work. Unless the need for a substitute material is extremely critical, repeated R&D efforts are seldom warranted.

If the R&D efforts result in one or more potential substitute materials, the next concern in this phase of the substitution process is T&E.

2.5 Testing and Evaluation

The purpose of T&E is to ascertain that a potential substitute meets the technical criteria set forth in specifications or other technical documents. It is similar to R&D in many respects,

[1] "Safetyline," No. 81, June-July-August 1997

and is often conducted at R&D laboratories in conjunction with R&D efforts. Testing and Evaluation is necessary when there is no data to validate that a potential substitute meets the appropriate technical requirements or specifications.

The need for T&E in the substitution process usually occurs when:

1. An existing, potential substitute has been identified, but from a source other than a QPL, or
2. R&D efforts have produced a new potential substitute, and therefore, no data exists yet to determine its suitability for the intended use.

T&E typically involves both laboratory testing and field studies planned and conducted to answer the following questions:

- Does the potential substitute meet the minimum performance standards as stated in the technical documents and/or specifications?
- Is the durability/mean time to failure satisfactory from a mission and operational ability viewpoint?
- Does the material create a new safety, health, environmental, etc., hazard? For example, does the substitution of a less toxic material increase the fire hazard associated with a process?
- Would the potential substitute adversely affect scheduled maintenance or operational cycles?
- Would a major process or equipment change be necessary if the potential substitute were approved for use?
- Is the potential substitute chemically compatible with other materials used in the same process/process equipment?
- Would the potential substitute result in a new waste stream or greater volume of less hazardous waste streams?

As with R&D, T&E is costly and time consuming with no guarantee that the material being considered will prove to be a viable candidate for substitution. The decision to conduct T&E should be governed by the same proscriptions cited previously for R&D. Upon completion of T&E, proceed to Engineering Approval.

2.6 Engineering Approval

Engineering approval is required whenever a potential substitute, not already certified to meet the appropriate specifications, is being studied as a replacement for an existing HM/ process. Normally, Engineering Approval occurs after T&E of a material produced through R&D or identified from a source other than a QPL. Approval is granted based on a review of documentation supporting the technical merits of the potential substitute material. In most cases, the approval will come from the engineering staff of the cognizant System Command or Acquisition Program.

In some instances, the existing HM or process is governed by locally instituted technical requirements. If so, then engineering approval authority remains at the local level.

If a potential substitute fails to receive approval at this point, other candidates must be considered, tested, and evaluated.

If one or more potential substitutes gain approval, then proceed to Phase II of the substitution process.

2.7 Phase I Summary

The purpose of Phase I in the HM Substitution Process is to find technically acceptable substitutes for HM currently in use. Phase I begins with an analysis of the technical requirements, if any, governing the use of the existing HM. Based on the results of this analysis, a search for potential substitutes begins. Potential substitutes already qualified for the specifications are sought first. If none are found, other materials that can qualify via T&E are identified. If no potential substitutes exist, R&D may be used to develop one or more. R&D and T&E are avoided, if possible, because of the time and expense involved. After technically feasible substitute materials are identified, Phase II of the HM Substitution Process can begin.

Sometimes during Phase I, it is possible to eliminate a HM altogether. Conversely, a material may be determined to be so operationally important or unique that there is no reasonable substitute. In either case, Phase II of the substitution process is omitted, and the results (retain or eliminate the HM) are implemented in Phase III.

Appendix A contains examples of technical considerations in the HM Substitution Process that illustrates the issues involved in identifying feasible substitute materials.

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CHAPTER 3

SELECTING A SUBSTITUTE / USING THE POLLUTION PREVENTION SYSTEM

3.0 Introduction

The second phase of the HM substitution process involves selecting a substitute(s) material to replace an existing HM. Phase II includes collecting environmental, safety, health, and economic data for both existing HMs (referred to hereafter as status quo materials) and for the potential substitute material(s) identified in Phase I. Once collected, this information is entered into the P2 System, which performs risk and economic analyses to identify environmentally-sound, cost-effective P2 alternatives.

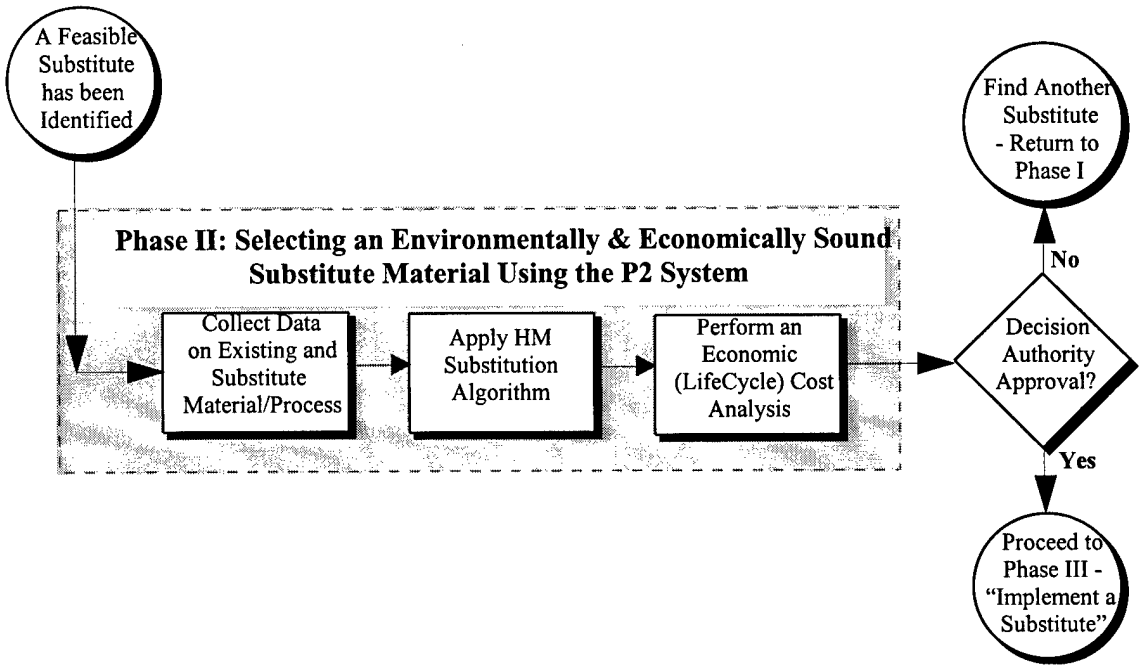
Figure 3 on the next page illustrates the general procedures involved in selecting substitutes for existing HMs using the P2 System. The P2 System applies the HM Substitution Algorithm to status quo and substitute materials to assess their relative hazards to the environment and human safety and health. This Algorithm calculates the hazardous material selection factor (HMSF), a numerical score assigned to each material based on such factors as toxicity, medical effects, and environmental impact attributes.

The P2 System also applies the NAVFAC P-442 Economic Analysis Model to status quo and substitute materials to perform a life cycle cost (LCC) analysis on each and determine the economic efficiency of each material. This analysis is designed to maximize the use of available resources, while identifying the most cost-effective substitute materials.

The results of risk and economic analyses are evaluated to rank status quo and substitute materials and select environmentally-sound alternatives that are consistent with engineering suitability, operational needs, and cost considerations. This chapter includes a discussion of the key Phase II elements of the HM Substitution Process, including:

1. Data collection.
2. Using the P2 System to apply the HM Substitution Algorithm and perform risk analyses.
3. Using the P2 System to apply the NAVFAC P-442 Economic Analysis Model and perform economic analyses.
4. Evaluating the results of risk and economic analyses to select an environmentally-sound, cost-effective substitute material(s).

Figure 3. Flow Chart of Phase II: Selecting an Environmentally and Economically Sound Substitute Material Using the Pollution Prevention System



3.1 Data Collection

Environmental, safety, health, and economic information for existing HMs and for potential substitutes must be collected and entered into the P2 System prior to performing risk and economic analyses. This information may be obtained from a number of sources, as discussed in Chapter 2.

3.1.1 Environmental, Safety, and Health Information

The following list of environmental, safety, and health information is not an exhaustive compilation of all applicable factors that must be considered for a potential substitution, and should be expanded or condensed as appropriate to provide the necessary level of detail:

1. The material's / chemical's most current MSDS
2. Activity Authorized Use List (AUL)
3. Existing Specifications
4. Environmental Protection Agency (EPA) / Resource Conservation and Recovery Act (RCRA) / State / Local Environmental Requirements
5. The EPA Title III "List of Lists" (40 CFR, Part 302)
6. The Clean Air Act Amendments (CAAA) Class I (CFCs) and Class II (HCFCs) Lists (CAAA Section 602)
7. Air Toxic List of Hazardous Air Pollutants (CAAA of 1990, Section 301)

8. Process Information
9. Weekly Duration of Exposure to HMs
10. Number of Personnel Potentially Exposed to HMs
11. Volatile Organic Content (VOC) Information
12. Shelf Life Information

Most of the data required for risk analyses are available from the MSDS, including constituent chemical information, exposure restrictions, medical effects, flammability, personal protective equipment (PPE) requirements, and volatility. If a status quo or substitute material's MSDS lacks any of this critical information, the National Institute for Occupational Safety and Health (NIOSH) "Pocket Guide to Chemical Hazards," or the "Hazardous Chemicals Desk Reference," should be consulted for the necessary data as it applies to that material's worst case constituent chemical.

3.1.2 Economic Information

The following list of economic information includes tangible costs, which comprise a potential substitute's one-time initial investment costs, and all recurring annual costs associated with status quo and substitute materials. Tangible costs are those which can be identified in terms of real cost savings over the economic lives of the materials under analysis. Although difficult to quantify, intangible costs should also be included in economic analyses. These costs provide a potential measure of benefits (or disbenefits) associated with status quo and substitute materials. The following list of expenditures is not an exhaustive compilation of all applicable factors that must be considered for a potential substitution, and should be expanded or condensed as appropriate to provide the necessary level of detail:

Tangible Costs (One-Time and Recurring)

1. Research and Development (R&D)
2. Facility Investment (acquisition of equipment, real property, nonrecurring services, nonrecurring operations, maintenance / startup costs, etc.)
3. Design Engineering (structural, electrical, mechanical, construction, etc.)
4. Design Support (reliability, maintainability, human factor engineering and safety, value engineering, etc.)
5. Value of Existing Assets to be Used, Replaced, or Eliminated
6. Residual or Terminal Value
7. Procurement of Materials and Supplies
8. Transportation, Receipt, Storage, Labeling, Issue and Handling of Materials
9. Training
10. PPE
11. Legal/Environmental
12. Permitting
13. Medical

14. Emergency Response
15. Support Equipment
16. Utilities
17. Operation and Maintenance
18. Support
19. Disposal
20. Direct Labor
21. Cost Avoidance
22. Insurance
23. Waste Reduction

Intangible Costs

1. Safety
2. Health
3. Morale
4. Environmental and Community Impacts
5. Quality of Defense
6. Efficiency/Productivity Increases
7. Accuracy
8. Maintainability
9. Manageability
10. Quality
11. Reliability

Note: Only those cost factors that are sensitive to changes in the parameters of an economic analysis should be considered (Refer to Chapter 7 of the NAVFAC P-442 Economic Analysis Model Handbook).

3.2 The Pollution Prevention System

The P2 System is a unique HM management tool developed by the Navy as a mechanism for conducting P2 alternative assessments. The system was designed to support NAVSUP, the Executive Agent for the Navy's Hazardous Material Control and Management (HMC&M) Program, with its responsibility of providing guidance for a uniform approach to the "up-front" reduction or elimination of HMs, consistent with engineering suitability, operational needs, and cost considerations.

The P2 System integrates three Navy-developed systems, the Hazardous Substance Management System (HSMS), the HM Substitution Process, and the NAVFAC P-442 Economic Analysis Model, described in Sections 3.2.1, 3.2.2, and 3.2.3, below. The system uses these tools to evaluate existing HMs and potential substitute materials by performing risk and economic analyses. These analyses are designed to promote compliance with Executive Order (EO) 12856, OPNAVINST 5090.1B, SECNAVINST

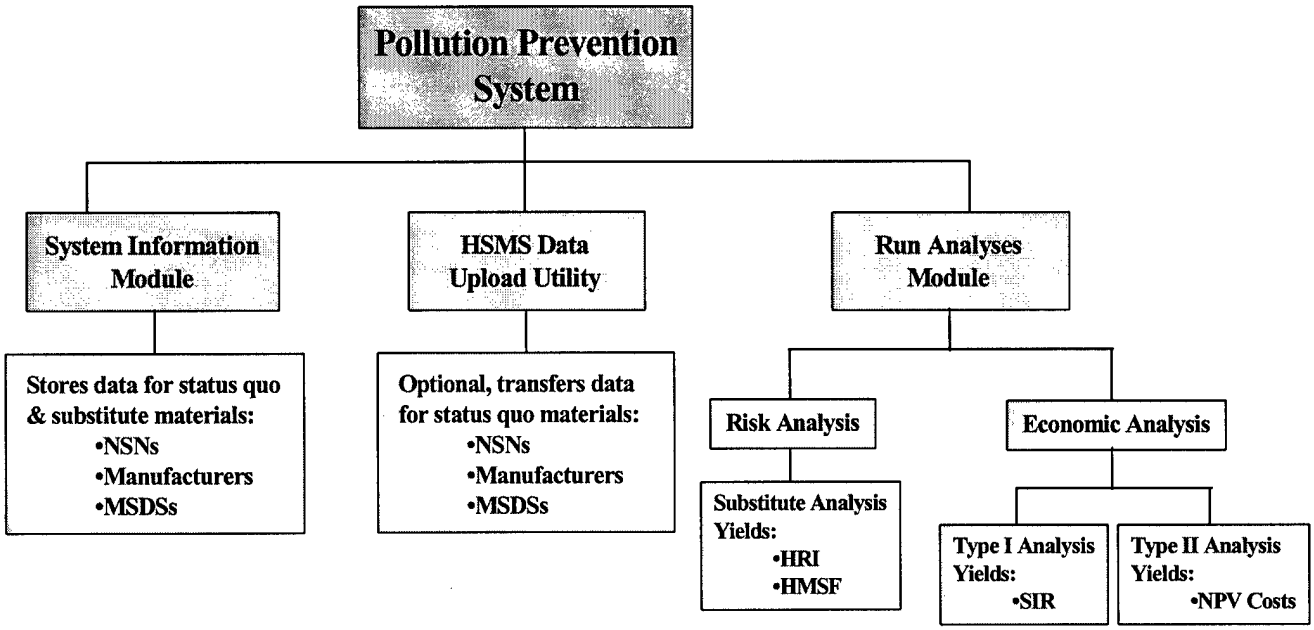
5002.2B, and DoDI 4715.4, by supporting the reduction or elimination of pollution at the source. The P2 System also promotes economical inventory management and control to minimize the use of HMs.

As shown in Figure 4 on the next page, the P2 System comprises two modules. In the System Information Module, environmental, safety, and health information for status quo and substitute materials is entered and stored. This data includes NSNs, manufacturers and their Commercial and Government Entity (CAGE) numbers, and MSDS-related information, and is incorporated into risk and economic analyses. The P2 System also features an optional HSMS data upload utility, which transfers environmental, safety, and health information for status quo materials from the HSMS to the P2 System for incorporation into risk and economic analyses. This utility precludes entering and maintaining two sets of identical data.

The Run Analyses Module applies the information entered into the System Information Module, or transferred from the HSMS, to the HM Substitution Algorithm and the NAVFAC P-442 Economic Analysis Model, Type I and Type II formats. In addition, specific information for status quo and substitute materials is entered into a limited subset of required fields at the time the risk and economic analyses are performed. For each analysis, the P2 System generates an output report comparing a status quo material with a potential substitute material, and indicates the more environmentally-sound, cost-effective P2 alternatives.

Use of the P2 System for risk and economic analyses ensures that management controls are applied to the procurement and use of less hazardous or non-hazardous materials; contributes to operational readiness by reducing risks to Navy personnel, the civilian population, and the environment; and supports DoD and Congressional requirements for increased use of commercially-available equipment and materials. The P2 System satisfies these needs by analyzing the environmental, safety, health, and economic benefits associated with status quo and substitute materials, to identify optimum value P2 alternatives. Refer to Appendix B for more detailed information on using the P2 System.

Figure 4. The Pollution Prevention System Modules



3.2.1 The Hazardous Substance Management System

The HSMS is a major environmental initiative being implemented at DoD installations to track HMs, hazardous wastes (HWs), and their constituent chemicals from cradle-to-grave within base operations. The HSMS is the principle software system used at shore installations for implementing the Navy's Consolidated Hazardous Material Reutilization and Inventory Management Program (CHRIMP), in support of centralized HMC&M. A Windows-compliant, Relational Database Management System, the HSMS maintains data on all processes that use HM and generate HW. The system tracks both individual and cumulative quantities of hazardous substances at any location and at any time, and alerts users when chemical usage has exceeded the cumulative threshold reporting value.

The HSMS was developed to meet the reporting requirements of EO 12856, the Pollution Prevention Act (PPA) of 1990, and the Emergency Planning and Community-Right-to-Know Act (EPCRA); the hazard communication requirements of the Occupational Safety and Health Agency (OSHA); and the chemical tracking and reporting requirements of the EPA. The HSMS upholds the Navy's mission of reducing or eliminating HM and HW volumes through source reduction methods, by providing chemical usage and process data in support of P2 initiatives at reduced costs; monitoring the procurement, use, release, and disposal of all hazardous substances; reducing environmental reporting costs; protecting personnel and the environment; and integrating smart business practices into HMC&M.

3.2.2 The Hazardous Material Substitution Algorithm

The HM Substitution Process consists of a Substitution Algorithm which assigns numerical points to status quo and substitute materials for such factors as toxicity, duration of expected exposure, medical effects, and environmental control and impact. This screening device performs a risk analysis to rank materials based on their relative risks to the environment and human safety and health.

The Substitute Analysis is carried out in the P2 System's Run Analyses Module, which generates a HM Substitution Algorithm Worksheet for each analysis performed. Refer to Table 1 for a description of the elements calculated by the P2 System for status quo and substitute materials.

Table 1. Elements of the HM Substitution Algorithm Worksheet

	Element	Determining Factors
1	Hazard Severity Code (HSC)	* Medical Effects * Exposure Restrictions * Environmental Impact Attributes
2	Hazard Probability Code (HPC)	* Weekly Exposure Time to HMs
3	Hazard Risk Index (HRI)	* HSC * HPC
4	Hazardous Material Selection Factor (HMSF)	* HSC * Flash Point * Boiling Point * Vapor Pressure

The P2 System typically generates a comparison of a status quo material (Material A) and a substitute material (Material B), although two potential substitute materials may be compared, if desired. The P2 System calculates the HMSF for each material, and displays these factors on the HM Substitution Algorithm Worksheet; the recommended material with the lower HMSF is also displayed at the bottom of the worksheet, representing the more environmentally-sound material of the two analyzed. Refer to Appendix C for examples of the output reports for risk analyses.

The following sections detail the step-by-step procedure for using the HM Substitution Algorithm from within the P2 System.

Step 1. General Information

The following information will appear in the first section of the HM Substitution Algorithm Worksheet for Material A and Material B:

A. Material/Product Name
B. Whether the Material/Product is Located on the activity AUL
C. The Operational Use of the Product/Material
D. NSN
E. MSDS Number and Manufacturer's CAGE Number
F. Worst Case Constituent Chemical

Items A, B, D, and E are either entered into the P2 System's System Information Module, or are transferred to the system from the HSMS, prior to performing risk analyses. Item C is entered into the P2 System's Run Analyses Module at the time of analysis, unless the HSMS data upload is utilized, in which case this information is automatically transferred to the P2 System. Item F is identified at the time of analysis.

Step 2. Hazard Severity Code Element

A. Exposure Restrictions Evaluation

The status quo and substitute materials' constituent chemicals and their percent composition and exposure restrictions, are entered into the P2 System's System Information Module, or are transferred to the system from the HSMS, prior to performing risk analyses. Two scenarios must be addressed.

1. A status quo or substitute material that is a pure chemical - The P2 System automatically assigns a point value to the chemical based on its listed time-weighted average (TWA) Permissible Exposure Limit (PEL) (29 CFR 1910.1000) or Threshold Limit Value (TLV) (American Conference of Governmental Industrial Hygienists (ACGIH)). The P2 System displays these points on the HM Substitution Algorithm Worksheet. The PEL / TLV units are given in either parts per million (ppm) or milligrams per cubic meter (mg/m^3). (Refer to Table 2a for point allocations if the PEL / TLV units are given in ppm, and Table 2b for point allocations if the PEL / TLV units are given in mg/m^3).

Table 2a. Permissible Exposure Limit / Threshold Limit Value in Parts Per Million

Parts Per Million	Points
0 to 100	16
101 to 175	14
176 to 250	12
251 to 335	10
336 to 417	8
418 to 500	6
501 to 1000	4
Greater than 1000	2

Table 2b. Permissible Exposure Limit / Threshold Limit Value in Milligrams Per Cubic Meter

Milligrams Per Cubic Meter	Points
0.00 to 0.5	16
0.51 to 2.0	14
2.01 to 3.5	12
3.51 to 5.0	10
5.01 to 7.0	8
7.01 to 8.0	6
8.01 to 10.0	4
Greater than 10.0	2

2. A status quo or substitute material that is a mixture - the constituent chemical with the **lowest** listed TWA PEL / TLV is selected for evaluation (referred to as the worst case constituent chemical). Do not select a worst case constituent chemical with a PEL / TLV of de minimus concentration. De minimus is defined as a concentration that is less than:

   - 1.0 percent (1%) of the mixture
   - 0.1 percent (0.1%) of the mixture is a chemical carcinogen

   The P2 System automatically assigns a point value to the selected worst case constituent chemical based on its TWA PEL / TLV. The P2 System displays

these points on the HM Substitution Algorithm Worksheet. (Refer to Table 3 for point allocations).

Note: If two or more potential worst case constituent chemicals have the same TWA PEL / TLV, select the chemical that is higher in percent composition for analysis. If two or more potential worst case constituent chemicals have the same TWA PEL / TLV and the same percent composition, consultation with appropriate environmental, safety, and health personnel is required.

Table 3. Permissible Exposure Limits / Threshold Limit Values

% of worst constituent chemical	Permissible Exposure Limit / Threshold Limit Value							
	Greater than 1000 ppm or 10.0 mg/m^3	501 to 1000 ppm or 8.01 to 10.0 mg/m^3	418 to 500 ppm or 7.01 to 8.0 mg/m^3	336 to 417 ppm or 5.01 to 7.0 mg/m^3	251 to 335 ppm or 3.51 to 5.0 mg/m^3	176 to 250 ppm or 2.01 to 3.5 mg/m^3	101 to 175 ppm or 0.51 to 2.0 mg/m^3	0 to 100 ppm or 0.0 to 0.5 mg/m^3
88 - 100	5	5	6	6	7	7	8	8
76 - 87	4	5	5	6	6	7	7	8
63 - 75	4	4	5	5	6	6	7	7
51 - 62	3	4	4	5	5	6	6	7
38 - 50	3	3	4	4	5	5	6	6
26 - 37	2	3	3	4	4	5	5	6
13 - 25	2	2	3	3	4	4	5	5
0 - 12	1	2	2	3	3	4	4	5

B. Medical Effects Evaluation

Medical effects information for status quo and substitute materials is entered into the P2 System's System Information Module, or transferred to the system from the HSMS, prior to performing risk analyses. This information should include both acute and chromic health hazards.

There are five condition numbers for which point values are assigned, based on each material's relative degree of health hazard; there is also an option to indicate that no medical effects information is available. The P2 System displays these points on the HM Substitution Algorithm Worksheet (Refer to Table 4 for point allocations).

Table 4. Medical Effects Evaluation

Condition Number	Description	Points
0	No medical effects available	0
1	No medical effects, such as nuisance noise and nuisance odor	0
2	Temporary reversible illness requiring supportive treatment, such as eye irritation and sore throat	4
3	Temporary reversible illness with a variable but limited period of disability, such as metal fume fever	8
4	Permanent, non-severe illness or loss of capacity, such as permanent eye damage	12
5	Permanent, severe, disabling, irreversible illness or death, such as asbestosis and lung cancer	16

C. Environmental Impact Attributes Evaluation

Status quo and substitute materials and/or their worst case constituent chemicals are assessed in terms of environmental impact attributes, based on the various reporting and permitting requirements discussed below. Items 1, 2, and 3 are either entered into the P2 System's System Information Module, or are transferred to the system from the HSMS, prior to performing risk analyses. Items 4 and 5 are addressed at the time of analysis in the Run Analyses Module. The P2 System assigns a point value for each item listed below. These points are displayed on the HM Substitution Algorithm Worksheet (Refer to Table 5 for point allocations).

1. EPA / State / Locally Regulated HM Lists - Identify whether a material's worst case constituent chemical is listed on the EPA Title III "List of Lists," the CAAA Class I (CFCs) and Class II (HCFCs) lists, and/or other EPA / State / Activity lists.

2. RCRA Waste Not Otherwise Listed in 1 above - Identify whether a material's worst case constituent chemical is on the RCRA list and requires a separate permit and additional training for waste removal.

3. Federal / State Permits Required - Identify whether the intended use of a material will require air or water quality permits, or will be subject to any State Implementation Plan (SIP) requirements.

4. Reportable Quantities (RQ) - Identify whether a material's worst case constituent chemical is listed on the EPA Title III "List of Lists" in the RQ columns for releases of extremely hazardous substances as regulated by EPCRA,

and as regulated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). "Not on List" and "Unknown" are also options available in the P2 System, and are selected if appropriate.

5. CAA Permissible Air Emissions - Identify whether a material's worst case constituent chemical is listed in the Clean Air Act (CAA) (40 CFR 52.21 (b) (23) and (b) (30)) for Pollutant and Emission Rates. Also refer to SIPs, where state reporting requirements may be more stringent than those of the CAA. "Not on List" and "Unknown" are also options available in the P2 System, and are selected if appropriate.

Table 5. Environmental Impact Attributes

Item Number	Environmental Impact	Points for "Yes"	Points for "No"
1	EPA/State/Locally Regulated HM Lists	8	0
2	RCRA Waste Not Otherwise Listed in (1)	4	0
3	Federal/State Permits Required	6	0
4	Reportable Quantities (lbs)		
	1.00 or less	10	
	1.01 to 10	8	
	10.01 to 100	6	
	100.01 to 1000	4	
	1000.01 to 5000	2	
	Not on the List	0	
5	CAA Permissible Air Emissions (tons/year)		
	7.00 or less	10	
	7.01 to 25	8	
	25.01 to 40	6	
	40.01 to 100	4	
	100.01 or greater	2	
	Not on the List	0	

Step 3. Establish the Hazard Severity Points and Hazard Severity Code

The P2 System totals the point values assigned to status quo and substitute materials based on the results of the exposure restrictions, medical effects, and environmental impact attributes evaluations. These totals for Material A and Material B are displayed on the HM Substitution Algorithm Worksheet, along with corresponding HSCs. The

lower the HSC for a material, the greater the potential for that material to impose severe impacts to the environment and human health and safety. These codes are assigned to materials as follows:

Hazard Severity Point Totals	Hazard Severity Code
30 or higher	I
19 - 29	II
10 - 18	III
0 -9	IV

Step 4. Establish the Hazard Probability Code

The typical weekly duration of exposure time to status quo and substitute materials is entered into the P2 System's Run Analyses Module at the time the risk analysis is performed. The P2 System displays this exposure time for Material A and Material B on the HM Substitution Algorithm Worksheet, along with corresponding HPCs. The longer the weekly expected exposure time to a material, the greater the potential for that material to impose severe impacts to the environment and human health and safety. These codes are assigned to materials as follows:

Exposure Time (hours/week)	Hazard Probability Code
40 or more	A
20 - 39	B
8 - 19	C
1 -7	D
Less than 1	E

Step 5. Establish the Hazard Risk Index

The P2 System automatically calculates HRIs for status quo and substitute materials based on the HSC and HPC generated for each (Refer to Table 6 for HRI point allocations). The P2 System displays the HRIs for Material A and Material B on the HM Substitution Algorithm Worksheet. The lower the HRI for a material, the greater the potential for that material to impose severe impacts to the environment and human health and safety (Refer to Table 7 for a detailed interpretation of the HRI).

Table 6. The Hazard Risk Index

Hazard Probability Code	Hazard Severity Code			
	I	II	III	IV
A	1	1	2	3
B	1	2	3	4
C	2	3	4	5
D	3	4	5	5
E	4	5	5	5

Table 7. Interpretation of the HRI

HRI	Risk Level	Risk Interpretation
1	High	Death, system loss, or severe environmental damage
2	Serious	Severe injury, severe occupational illness, or major system or environmental damage
3	Moderate	Minor injury, minor occupational illness, or minor system or environmental damage
4	Low	Less than minor injury, less than minor occupational illness, or less than minor system or environmental damage
5	Negligible	Negligible amount, insignificant impacts

Step 6. Flammable/Combustible Liquids Evaluation

The flash points (FPs) and boiling points (BPs) for status quo and substitute materials are entered into the P2 System's System Information Module, or are transferred to the system from the HSMS, prior to performing risk analyses (in units of Fahrenheit, Celsius, or Kelvin). A material with a low FP (below 73 °F) and a low BP (below 100 °F) may present extreme fire and explosion hazards as compared to a material with a high FP (above 73 °F). Further, when a material packaged in an aerosol can is considered as a potential substitute, special consideration must be given to the possibility that the can's contents (i.e., propellants) are flammable.

If the FP and/or BP for a material or its worst case constituent chemical is not available, "None Listed" is selected and a default score of 0 is assigned to that material or constituent chemical. The P2 System uses this information to evaluate the flammability

and combustibility of Material A and Material B at the time of analysis, and displays the point values on the HM Substitution Algorithm Worksheet (Refer to Table 8 for point allocations).

Table 8. Flammable/Combustible Liquids Points

Flash Point °F (°C)		Boiling Point °F (°C)		Points
At or Above	Less Than	At or Above	Less Than	
---	73 (22.8)	---	100 (37.8)	10
---	73 (22.8)	100 (37.8)	---	9
73 (22.8)	100 (37.8)	No Boiling Point Constraints		8
100 (37.8)	120 (48.9)			7
120 (48.9)	140 (60.0)			6
140 (60.0)	170 (76.6)			5
170 (76.6)	200 (93.3)			4
200 (93.3)	230 (110.0)			3
230 (110.0)	260 (126.7)			2
260 (126.7)	---			1
No Flash Point Listed				0

Step 7. Personal Protective Equipment Evaluation

PPE requirements for status quo and substitute materials are entered into the P2 System's System Information Module, or are transferred to the system from the HSMS, prior to performing risk analyses. There are ten condition numbers for which point values are assigned, based on the amount of PPE required for the safe handling and use of each material; there is also an option to indicate that no PPE requirements are available. The P2 System displays these points for Material A and Material B on the HM Substitution Algorithm Worksheet (Refer to Table 9 for point allocations).

Table 9. Personal Protective Equipment Evaluation

Condition Number	Description	Points
0	No PPE requirements available	0
1	One point skin protection (either faceshield, gloves, apron or bootees)	1
2	Multiple point skin protection (one or more combination of faceshield, gloves, apron, and/or bootees)	2
3	Eye protection only (goggles or glasses)	3
4	Eye and skin protection (combination of goggles or glasses and gloves, apron and/or bootees)	4
5	Respiratory protection (cartridge/canister respirator, one-half face-piece for gas, vapor, and/or particulate contamination)	5
6	Respiratory and eye protection (cartridge/canister respirator, full face-piece for gas, vapor, and/or particulate contamination)	6
7	Respiratory, eye and skin protection (cartridge/canister respirator, full face-piece for gas, vapor, and/or particulate contamination, and gloves, apron, and/or bootees)	7
8	Respiratory and eye protection (supplied air respirator or self contained breathing apparatus)	8
9	Respiratory, eye and skin protection (combination of supplied air respirator or self contained breathing apparatus, and gloves, apron, and/or bootees)	9
10	Complete protection (supplied air respirator or self contained breathing apparatus and full impervious suit)	10

Step 8. Volatility Evaluation

The vapor pressures (VPs) for status quo and substitute materials are entered into the P2 System's System Information Module, or are transferred to the system from the HSMS, prior to performing risk analyses (in units of millimeters mercury at 70 °F). A material with a high VP is likely to disperse more readily into the environment than a material with a low VP, and poses particularly severe health hazards when used in a confined work area.

If the VP for a material or its worst case constituent chemical is not available, "None Listed" is selected and a default score of 0 is assigned. The P2 System uses this information to evaluate the volatility of Material A and Material B at the time of analysis, and displays the point values on the HM Substitution Algorithm Worksheet (Refer to Table 10 for point allocations).

Table 10. Volatility Evaluation

Vapor Pressure	Points
201 and higher	15
101 to 200	12
91 to 100	10
81 to 90	9
71 to 80	8
61 to 70	7
51 to 60	6
41 to 50	5
31 to 40	4
21 to 30	3
11 to 20	2
1 to 10	1
Below 1	0

Step 9. Identify the Hazardous Material Selection Factor

The P2 System automatically totals the point values assigned to status quo and substitute materials from Steps 3, 6, 7, and 8. This includes HSC elements, flammability / combustibility, PPE requirements, and volatility. This total point value represents the HMSF, which is the final and most important indicator of each material's environmental, safety, and health benefits. The P2 System displays these factors for Material A and Material B on the HM Substitution Algorithm Worksheet. The material with the lower HMSF represents the more environmentally-sound substitute, and is also displayed at the bottom of the worksheet.

Step 10. Recommend a Substitute Material

The P2 System displays the material with the lower HMSF as the more environmentally-sound material at the bottom of the HM Substitution Algorithm Worksheet. However, other factors must be considered before recommending a material with a low score as a feasible substitute for an existing HM. The HRI must be taken into account before recommending a substitute material. A material with a low HMSF, but with a low HRI, should not be recommended as a P2 alternative, because potential risks to the environment and human health and safety are likely to be more severe than those of the existing situation.

Shelf life considerations must also be taken into account prior to recommending a substitute material. For example, a substitute material should not replace a status quo material if its shelf life is significantly shorter, as the potential for increased costs (i.e., procurement, transportation, disposal, etc.) is likely to result. VOC content should be taken into account before recommending a substitute material, where applicable. For example, recommending a paint substitute with a VOC content significantly higher than that of the existing HM may not be feasible because of regulatory compliance issues, more frequent applications, increased costs, etc. Further, the specific gravities of the materials should be considered prior to recommending a substitute, as a material with a specific gravity less than 1.0 may present greater fire hazards as compared to a material with a specific gravity greater than 1.0.

Finally, chemical characteristics should be taken into account before recommending a substitute material. Properties to consider include stability, reactivity with other chemicals (i.e., is the material an oxidizer or is it corrosive), and solubility in water and other media. Further, any organic chemicals in a potential substitute material should be identified as either aromatic or aliphatic, and considered in terms of potential fire and explosion hazards.

3.2.3 The NAVFAC P-442 Economic Analysis Model

The P2 System performs economic analyses by applying the NAVFAC P-442 Economic Analysis Model to status quo and substitute processes or materials. This Model is an iterative procedure that assists with the investment decision-making process by qualifying and quantifying the circumstances affecting an investment decision. The Model systematically investigates and relates all LCC and benefit implications (direct, indirect, externalities, etc.) in achieving an objective(s), to identify cost-effective P2 alternatives. The impacts of alternative actions are clarified by exploring all reasonable means to satisfy an objective, documenting all costs and benefits, and testing the uncertainties.

The NAVFAC P-442 Economic Analysis Model is applied to status quo and substitute processes or materials to identify those alternatives that will provide the most benefits or outputs for the least resources or inputs to be expended. The Model provides two economic analysis formats, depending on the type of investment proposal under analysis:

1. The Type I format is selected when evaluating potential process changes to determine whether an existing situation should be changed to take advantage of dollar savings available through another alternative.
2. The Type II economic analysis format is selected when evaluating potential material substitutions to determine which of several P2 alternatives would most economically satisfy an unmet need or a deficiency.

3.2.3.1 The NAVFAC P-442 Type I Economic Analysis Format

The Type I economic analysis format compares status quo and substitute processes in terms of the Savings to Investment Ratio (SIR), which represents the amount of savings generated by each dollar of investment. The following sections provide a step-by-step procedure for using this format.

Step 1. General Information

The following information will appear on the Type I economic analysis worksheet for status quo and substitute processes:

A. Process/Equipment Name
B. Economic Life
C. Annual Interest Rate

Item A is either entered into the P2 System's System Information Module, or is transferred to the system from the HSMS, prior to performing economic analyses. Items B and C are entered into the P2 System's Run Analyses Module at the time of analysis. The P2 System defaults to a five year economic life and a 6.65% interest rate. These entries may be changed as necessary to meet the specific requirements of each individual analysis.

Step 2. Economic Information

The P2 System contains two fields for entry of economic data into the Run Analyses Module, material annual costs and PPE costs. At the time of analysis, all recurring annual costs associated with status quo and substitute processes are entered into the material annual cost data field (i.e., procurement, transportation, operation and maintenance, etc.), with the exception of PPE costs. Annual PPE costs are entered separately; this information includes quantities of each type of required PPE, a description of each type of PPE (i.e., neoprene gloves, safety glasses, etc.), unit price for each type of PPE, and total price for each type of PPE. The number of employees for which PPE must be purchased and worn is also entered into the Run Analyses Module. The P2 System calculates the total PPE cost per employee, and the total PPE cost, accordingly. The total recurring annual costs for status quo and substitute processes are calculated by the P2 System as the sum of material annual costs and PPE costs, and are displayed on the worksheet as annual costs.

The initial investment cost of the proposed alternative must also be entered into the P2 System's Run Analyses Module at the time of analysis. This information is entered into the initial cost field, and may include costs for R&D, facility investment, design engineering, design support, etc. Other costs which should be considered when identifying initial investment costs include working capital changes; the value of existing

assets to be used, replaced, or eliminated; and residual or terminal value. This information will appear on the Type I economic analysis worksheet at time zero.

Step 3. Discounted Cost Savings

The P2 System calculates the difference between the recurring annual costs of status quo and substitute processes. This differential cost is evaluated by a discount factor, which accounts for the economic life and interest rate specified for the economic analysis. The discount factor translates the expected costs and benefits of status quo and substitute processes over the course of the economic life into its present value (Refer to NAVFAC P-442 Economic Analysis Handbook, Appendix C, for discount factors). The result of this calculation is the Discounted Cost Savings, or the Net Present Value (NPV) of Savings.

Step 4. The Savings to Investment Ratio (SIR)

The final calculation generated by the P2 System is the SIR. This ratio represents the amount of savings generated by each dollar of investment in a proposed alternative. The SIR is equal to the Discounted Cost Savings, or NPV of Savings, divided by the present value of the initial investment for the proposed alternative, less the present value of any residual or terminal value (NPV of Investment). The SIR is displayed on the Type I economic analysis worksheet, and indicates the more cost-effective process of the two analyzed. If the SIR is greater than one, the proposed alternative is preferred because its annual savings will exceed the cost of implementation.

The SIR calculated for each individual economic analysis should be used to calculate the discounted payback period, which determines how quickly cost savings will accrue upon implementation of a proposed alternative. Payback is achieved when the total accumulated present value savings are sufficient to offset the discounted investment cost of a proposed alternative. The payback period is calculated by determining when the SIR would be equal to one for a given analysis, using Appendix C of the NAVFAC P-442 Economic Analysis Handbook.

Step 5. The Recommendations Field

The P2 System features an optional recommendations field, accessible while entering economic data into the Run Analyses Module for either the status quo or the substitute processes. This field allows the user to identify the more cost-effective process, to address assumptions and/or engineering estimates made while performing the economic analysis, and/or to describe the individual costs factoring into the analysis. This information is displayed at the bottom of the output reports, which may be viewed on the screen, printed, or saved to a file. Refer to Appendix C for examples of the NAVFAC P-442 Type I economic analysis worksheets.

3.2.3.2 The NAVFAC P-442 Type II Economic Analysis Format

The Type II economic analysis format compares status quo and substitute materials in terms of their Net Present Value (NPV) costs, which represent all costs associated with materials in terms of today's dollars. The following sections provide a step-by-step procedure for using this format.

Step 1. General Information

The following information will appear on the Type II economic analysis worksheet for status quo and substitute materials:

A. Material Name
B. Economic Life
C. Annual Interest Rate

Item A is either entered into the P2 System's System Information Module, or is transferred to the system from the HSMS, prior to performing economic analyses. Items B and C are entered into the P2 System's Run Analyses Module at the time of analysis. The P2 System defaults to a five year economic life and a 6.65% interest rate. These entries may be changed as necessary to meet the specific requirements of each individual analysis.

Step 2. Economic Information

The P2 System contains two fields for entry of economic data into the Run Analyses Module, material annual costs and PPE costs. At the time of analysis, all recurring annual costs associated with status quo and substitute materials are entered into the material annual cost data field (i.e., procurement, transportation, operation and support, maintenance, etc.), with the exception of PPE costs. Annual PPE costs are entered separately; this information includes quantities of each type of required PPE, a description of each type of PPE (i.e., face shield, air line respirator, etc.), unit price for each type of PPE, and total price for each type of PPE. The number of employees for which PPE must be purchased and worn is also entered into the Run Analyses Module. The P2 System calculates the total PPE cost per employee, and the total PPE cost, accordingly. The total recurring annual costs for status quo and substitute materials are calculated by the P2 System as the sum of material annual costs and PPE costs, and are displayed on the worksheet as annual costs.

Step 3. Discount Costs

The P2 System evaluates the recurring annual costs of status quo and substitute materials by a discount factor, which accounts for the economic life and interest rate specified for the economic analysis. This discount factor translates the expected costs and benefits of status quo and substitute materials over the course of the economic life into its present

value (Refer to the NAVFAC P-442 Economic Analysis Handbook, Appendix C, for discount factors). The results of these calculations are the Discount Costs, or the NPV costs.

Step 4. The Net Present Value Costs

The final calculations generated by the P2 System are the NPV costs. These costs represent the discounting of all cost elements for status quo and substitute materials as they occur. The two NPV costs are displayed on the Type II economic analysis worksheet, and indicate the more cost-effective material of the two analyzed. The material with the lower NPV cost is preferred because it will result in a greater annual budget reduction.

Step 5. The Recommendations Field

The P2 System features an optional recommendations field, accessible while entering economic data into the Run Analyses Module for either status quo or substitute materials. This field allows the user to identify the more cost-effective material, to address assumptions and/or engineering estimates made while performing the economic analysis, and/or to describe the individual costs factoring into the analysis. This information is displayed at the bottom of the output report, which may be viewed on the screen, printed, or saved to a file. Refer to Appendix C for examples of the NAVFAC P-442 Type II economic analysis worksheets.

3.3 Interpretation of the Risk and Economic Analyses Results

For risk analyses, the P2 System ultimately calculates HRIs and HMSFs for status quo and substitute materials. The Type I economic analysis format yields SIRs for status quo and substitute processes, and the Type II economic analysis format yields NPV costs for status quo and substitute materials. Combined, these results must be compared and evaluated to select those cost-effective alternatives that pose the least risks to the environment and human health and safety.

When evaluating the results of risk and economic analyses, HRIs and HMSFs take priority over SIRs or NPV costs. In general, materials with high costs, and high HRIs and low HMSFs are carefully compared to materials with low to moderate costs, and low to moderate HRIs and moderate to high HMSFs. That is, substitute processes or materials are not selected as replacements for existing HMs based solely on the results of risk analyses, because implementing an alternative that would incur higher costs relative to the existing situation is not economically efficient. The objective of Phase II is to select the least hazardous alternatives that will provide the most results or outputs for the least resources or inputs to be expended upon implementation.

3.4 Decision Authority Approval

Decision authority approval is required before environmentally-sound, cost-effective substitutes identified using the P2 System can be implemented. Approval is granted based on a review of output reports generated by the P2 System for risk and economic analyses, which either support or discount the environmental and economical feasibility of a potential substitute material. In most cases, approval will come from the engineering staff of the cognizant System Command or Acquisition Program. Local level approval is required for potential substitutes not governed by specifications or technical requirements, for example, cleaning supplies for janitorial services or carpenter's glue.

If a potential substitute material fails to receive decision authority approval, return to Phase I to identify another technically-feasible substitute. If one or more potential substitutes are approved, proceed to Phase III of the HM Substitution Process to implement the substitute(s).

3.5 Phase II Summary

The purpose of Phase II in the HM Substitution Process is to select environmentally-sound, cost-effective substitutes for existing HMs. Phase II begins with the collection of environmental, safety, health, and economic data for status quo and substitute materials. This information is most readily obtained from MSDSs and manufacturers or vendors, and is entered into the P2 System. The P2 System performs risk analyses using the HM Substitution Algorithm to evaluate materials and their relative hazards to the environment and human health and safety. The system also applies the NAVFAC P-442 Economic Analysis Model to status quo and substitute processes or materials to evaluate the economic efficiency of replacing an existing HM with a proposed substitute. The combined results of risk and economic analyses, the HRIs, HMSFs, SIRs, and NPV costs, are then assessed to select most the environmentally-sound, cost-effective alternatives for implementation.

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CHAPTER 4

IMPLEMENTING THE RESULTS OF THE SUBSTITUTION PROCESS

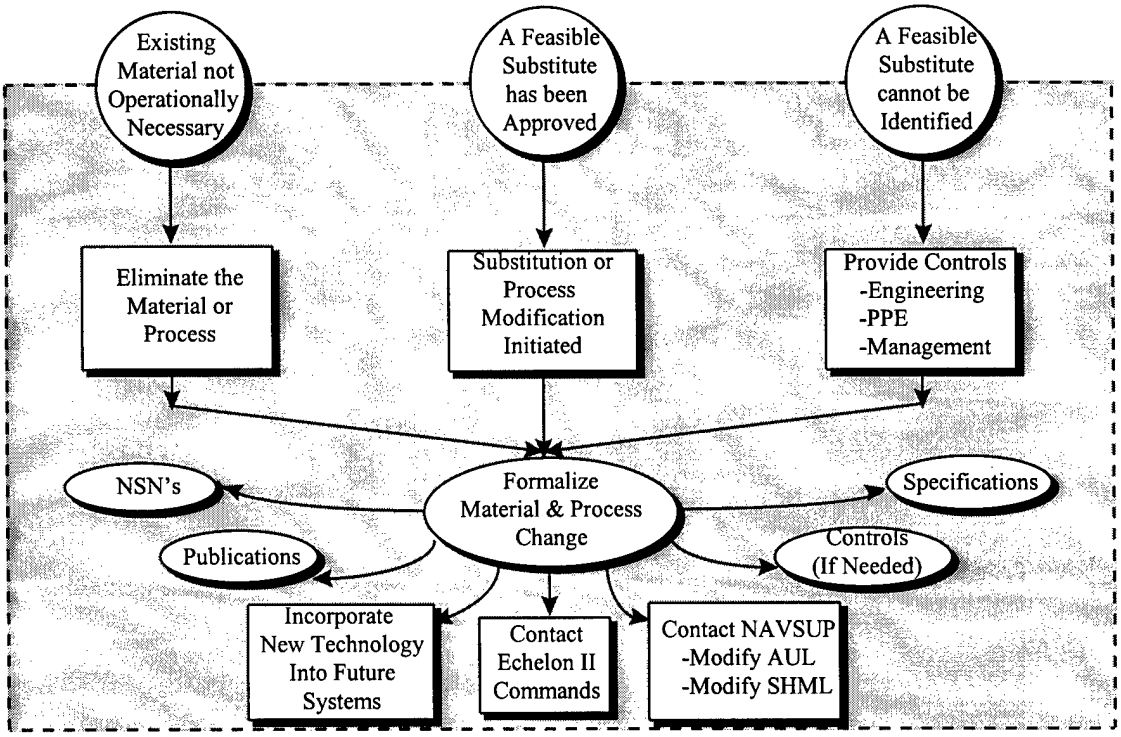
4.0 Introduction

Phase III, the final phase of the substitution process, incorporates the three potential outcomes of the substitution process:

- Eliminating the existing HM because it is not operationally necessary (no replacement),
- Retaining the existing HM because substitution is not technically, or economically feasible, or
- Adopting a substitute material that is a technically and economically feasible replacement for the existing HM.

Figure 5, below, shows the progression of events undertaken in the implementation phase of the substitution process. The primary focus is disseminating information concerning the results of the process, and changing technical documents governing the material or process. Note that regardless of the outcome of the substitution process, the implementing elements of Phase III are the same.

Figure 5. Flow Chart of Phase III: Implementing the Results of the Substitution Process



4.1 Eliminate the Material or Process

When a HM can be withdrawn from use without operational impacts, that material can be eliminated, along with any associated process. Since the material is being eliminated, there is no need to apply the HM Substitution Algorithm or conduct an economic analysis. However, an economic analysis may be performed to document pollution prevention savings that result from the elimination of the material. The following steps are taken to formalize the deletion of the material and/or process:

1. Deleting references to the material or its specifications in technical documents such as Maintenance Record Cards (MRC's) and other publications.
2. Notifying NAVSUP that the material is no longer necessary. NAVSUP will modify the SHML accordingly, delete the stock numbers for the material, and stop any automated procurements of the material.
3. Notifying other System Commands, Acquisition Programs and activities that the material/process is no longer authorized for use. New systems or processes will not be allowed to use the material unless a unique need for it is identified.
4. If the material is only used locally, delete it from the AUL and eliminate its local stock number. Make sure any local directives or instructions calling for the use of the material are modified appropriately.

A typical example of a material eliminated for lack of operational impact (local level) would be insect repellent sprayed at recreational areas. The insect repellent can be eliminated along with the process of spraying it prior to events held at the recreational site. Individuals would then be cautioned (in notification of events held at the recreational area) to bring personal insect repellents, if they feel the need. Any local instructions, service contracts for the spraying, or standing orders to spray the recreation area would need to be changed to reflect these changes.

4.2 Retain the Material

If a material with a valid operational requirement cannot be eliminated or replaced with a substitute, it must be retained. The decision to retain an existing HM should be followed by an examination of current engineering, management and PPE governing its use. Adequate controls are necessary to ensure that use of the existing HM does not endanger the health and safety of personnel or harm the environment. If the current controls can be improved or enhanced, immediate action should be taken to do so.

Following any changes to HM controls, documents governing them will need to be modified appropriately. Instructions, technical manuals or specifications that describe the current system of controls must be updated to reflect any changes.

Mission critical ODSs provide a good example of HMs that must be retained for use, but with stringent controls. In response to the phase-out of ODS production, the Navy has published its policies and procedures for compliance in Chapter 6 of OPNAVINST 5090.1B "Management of Ozone Depleting Substances." Procurement of ODSs for non-mission critical uses is prohibited, and mission critical uses require strict management oversight (demand quantity reporting, review of practices, recycling, recovery, etc.).

4.3 Substitution Initiated

Substitution of a less or non-hazardous material for an existing HM is the usual outcome of the substitution process. When a technically and economically viable substitute material has been approved for use, two things have to happen. First, the HM being replaced must be eliminated following the guidance in section 4.1 above. Second, the following actions must be taken:

- specifications for the new material must be developed and published,
- new stock numbers for the material must be obtained and published,
- references and technical manuals must be changed to include the new material,
- other System Commands and Acquisition Programs must be notified of the material change, and
- users must be notified that the new material has been authorized for use.

If the material is already in the Federal Supply System and/or already meets an existing specification, specifications and stock numbers will already be in place, simplifying the implementation process.

When a substitution is made at the local level, for locally controlled materials or processes, the implementation is analogous to the description above. However, the documents affected will be locally controlled, and are unlikely to involve changes to specifications. For example, substituting water-based exterior house paint for oil-based paints at family housing should require changes only to locally controlled documents pertaining to procedures for house painting. New local stock numbers may be required, and painters need to be notified that only water-based paints are allowed for exterior use in the family housing areas. Notification of Systems Commands and Acquisition Programs is (obviously) unnecessary.

For an example of the actions necessary to implement a substitution Navy-wide, see the second part of Appendix A, "Substitutes for Dry Cleaning and Degreasing Solvent."

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APPENDIX A

EXAMPLES OF TECHNICAL CONSIDERATIONS IN THE SUBSTITUTION PROCESS

EXAMPLES OF TECHNICAL CONSIDERATIONS IN THE SUBSTITUTION PROCESS

Technical considerations in the substitution process, as stated in Chapter 2, can be complex. For this reason, substitutes that already meet the specifications for a particular application are preferred. Two examples of substitution efforts are included in this Appendix that illustrate this point:

Example 1. Substitutes for Lubricants Containing CFCs or Lead

Pages A-3 through A-6 contain a Pollution Prevention Opportunity Data Sheet from the *Tri-Service Pollution Prevention Opportunity Handbook* (NFESC SP-2003-ENV) that addresses potential substitutes for lubricants containing CFCs and/or lead. Many of the potential substitutes listed are known to meet certain specifications. Fore example, in the table on page A-5, Break Free CLP is known to meet MIL SPEC L-63460. Therefore, only local approval is necessary to make the "within specification" substitution of this product for one containing CFCs. Note that from an economic standpoint, this substitute may cost more than the product currently in use. However, due to the production ban on CFC's, continuing to use a product containing CFC's may be impossible.

Example 2. Substitutes for Dry Cleaning and Degreasing Solvent (FED-SPEC P-D-680 Type II)

The Navy's Hazardous Material Afloat Program initiated efforts to reduce or eliminate dry cleaning solvent as chronicled in the "Excerpts From Pollution Prevention Afloat Reduction of P-D-680 Type II in Planned Maintenance System, 1994" reprinted here starting on page A-7. This document illustrates the need to identify technical requirements that drive the use of a particular HM, as well as the complexity and difficulty of identifying and testing/evaluating potential substitutes. Some of the substitution efforts described have been implemented, and more are underway as part of a Joint Service initiative to minimize petroleum distillate solvents for military applications.

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TRI-SERVICE POLLUTION PREVENTION OPPORTUNITY DATA SHEET

SUBSTITUTE LUBRICANTS (NON-LEAD, NON-OZONE-DEPLETING SUBSTANCES)

Revision: 1/96
Process Code: Navy: N/A; Air Force: N/A; Army: N/A
Substitute for: Lead Based or Ozone Depleting Substances
Applicable EPCRA Targeted Constituents: Lead, Ozone-Depleting Substances

Overview: Substitute lubricants that contain no or reduced amounts of lead, ozone-depleting compounds, or other hazardous or toxic substances are preferable over conventional formulations, because they reduce the consumption and disposal of these harmful substances.

Hazardous and toxic compounds should be avoided in products where possible, or a formulation that uses reduced amounts of these compounds should be employed. Product content is checked using the material safety data sheet (MSDS). In Section II of the MSDS, chemical components and their percentage (or range of percentage) of the product is presented. By comparing MSDSs for multiple products with the same MIL SPEC and NSN, a more environmentally friendly product may be selected. As a starting point, the list of hazardous and toxic compounds that should be avoided include the ozone-depleting compounds (ODCs) and the "EPA 17" list. Both of these lists are presented below.

<u>Ozone-Depleting Compounds</u>
Trichlorofluoromethane (CFC-11)
Dichlorodifluoromethane (CFC-12)
Trichlorotrifluoroethane (CFC-113)
Dichlorotetrafluoroethane (CFC-114)
Chloropentafluoroethane (CFC-115)
Bromochlorodifluoromethane (Halon 1211)
Bromotrifluoromethane (Halon 1301)
Dibromotetrafluoroethane (Halon 2402)
Chlorotrifluoromethane (CFC-13)
Pentachlorofluoroethane (CFC-111)
Tetrachlorodifluoroethane (CFC-112)
Heptachlorofluoropropane (CFC-211)
Hexachlorodifluoropropane (CFC-212)
Pentachlorotrifluoropropane (CFC-213)
Tetrachlorotetrafluoropropane (CFC-214)
Trichloropentafluoropropane (CFC-215)
Dichlorohexafluoropropane (CFC-216)
Chloroheptafluoropropane (CFC-217)
Carbon Tetrachloride

Trichloroethane
Dichlorofluoromethane (HCFC-21)
Chlorodifluoromethane (HCFC-22)
Tetrachlorofluoroethane (HCFC-121)
Trichlorodifluoroethane (HCFC-122)
Dichlorotrifluoroethane (HCFC-123)
Chlorotetrafluoroethane (HCFC-124)
Trichlorofluoroethane (HCFC-131)
Dichlorodifluoroethane (HCFC-132)
Chlorotrifluoroethane (HCFC-133)
Dichlorofluoroethane (HCFC-141)
Chlorodifluoroethane (HCFC-142)

EPA 17 List
Benzene
Cadmium and compounds
Carbon Tetrachloride
Chloroform
Chromium and compounds
Cyanides
Dichloromethane
Lead and compounds
Mercury and compounds
Methyl Ethyl Ketone
Methyl Isobutyl Ketone
Nickel and compounds
Tetrachloroethylene
Toluene
Trichloroethane
Trichloroethylene
Xylene(s)

Note: The number in parentheses is the halocarbon number formula.

Potentially applicable substitute lubricants are presented below. MIL SPEC approval where known is presented.

MIL SPEC	Product	NSN	Comment
N/A	Break Free CLP (Non-Chlorinated in US since April 1993) Break-Free, Inc.	9150-01-054-6453 (Liquid) 6850-00-105-3089 (Aerosol)	Substitute for general purpose lubricants and corrosion prevention
N/A	Cloveland Maint: No. 81246 Silicone Lubricant	9150-00-823-7860	ODC-Free Substitute
N/A	Borden Inc. Lubricating Compound 1349 Silicone Lube	9150-00-823-7860	ODC-Free Substitute
L-23398D Amend 1, Type I and II	Molykote 3402C (Low Lead) Dow	9150-00-142-9361	
L-46010D Type III	#099 Solid Film Lubricant Sandstrom Products Co.		Low VOC, Lead-Free Dry Film
L-46010D Type III	Everlube 9002 Solidfilm Lubricant E/M Corporation		Low VOC, Lead-Free Dry Film
L-46147A	No Lead-Free Substitute Available		
L-46147B Type III	Available Soon; Contact: Ms. Ellen Purdy Belvoir, DSN 654-3722		
L-63460	Break Free CLP Non-Chlorinated (Liquid)	9150-01-054-6453	Non-Chlorinated
C-81302	Break Free CLP Non-Chlorinated (Aerosol)	6850-00-105-3084	Non-Chlorinated

Materials Compatibility: N/A

Safety and Health: The concerns vary with the type of lubricants being used. Proper personal protective equipment should be used, if needed. Consult your local health and safety personnel, and the appropriate MSDS prior to making a substitution.

Benefits: The benefits of using environmentally preferable products are as follows:

- Reduced consumption of hazardous substances,
- Reduced worker exposure to hazardous substances, and
- Wastes generated by product use may not be classified as hazardous wastes

Disadvantages:

- Substitute lubricants may cost more
- More of a substitute lubricant may be required to do the same job as the original lubricant

Economic Analysis: Economics depends upon the substitute lubricant chosen. An economic analysis should compare the cost of the environmentally friendly product to the previously used product. The analysis should account for different product consumption rates (i.e., used to take 1 ounce of spray, now it requires 2 ounces), and for different labor amounts required to use the product.

Approval Authority: Navy: Approval is controlled locally and should be implemented only after engineering approval has been granted. Major claimant approval is not required.

Points of Contact:

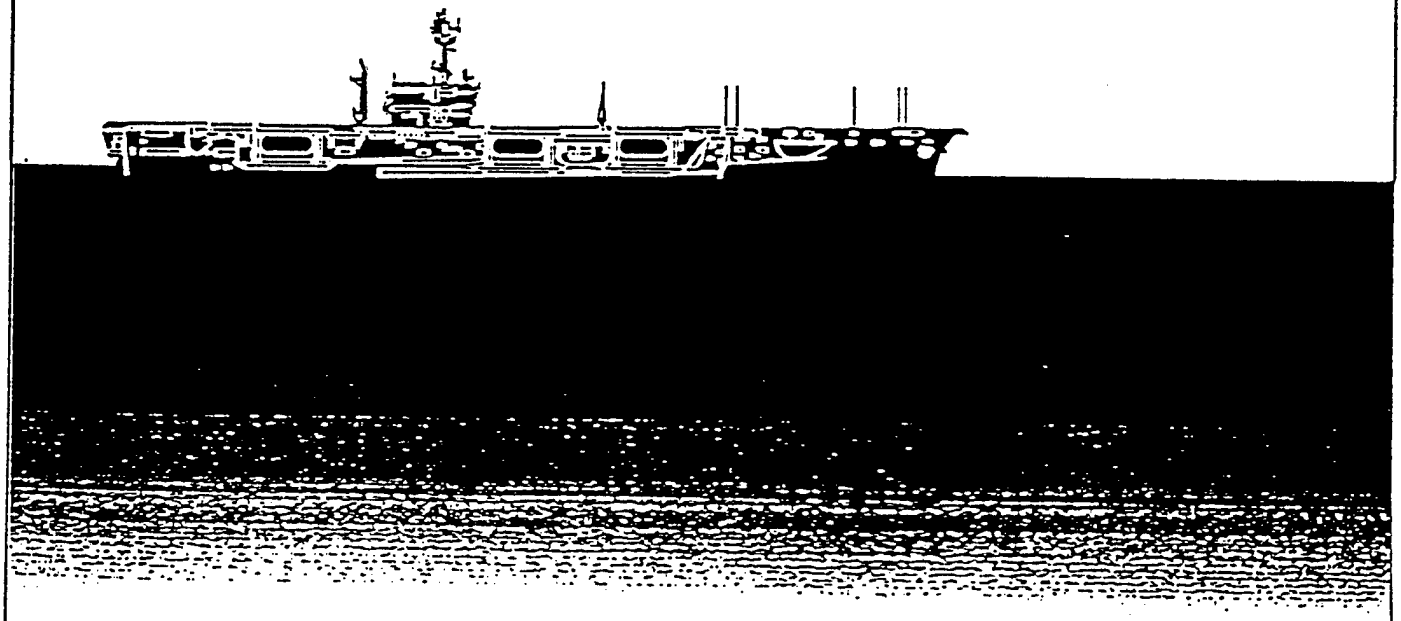
Luis Reyes
Code 422
Naval Facilities Engineering Service Center
1100 23rd Ave.
Port Hueneme, CA 93043-4370
(805) 982-6514, DSN 551-6514, Fax (805) 982-4832

Vendors: Vendors should be consulted regarding their product lines to see if they are developing environmentally preferable products. Most companies are developing alternative products and are working with the DOD to obtain MIL SPEC and QPL approval. Vendor names are readily obtained from the MSDS.

EXCERPTS FROM

POLLUTION PREVENTION AFLOAT

REDUCTION OF P-D-680 TYPE II IN PLANNED MAINTENANCE SYSTEM



AUGUST 1994

Developed by
Naval Sea Systems Command
Ship Environmental Engineering Group
(Code 03V)

EXECUTIVE SUMMARY

A top priority of the Navy Hazardous Material Afloat Program is the reduction of hazardous material (HM) in the shipboard workplace. Solvents are one class of shipboard HM for which substitution/elimination will result in a significant reduction of hazards to the environment and personnel safety and health. Based upon the recommendations of the Fleet Commanders in Chief, the Chief of Naval Operations (N45), the Navy Environmental Health Center, and the Naval Safety Center, the Naval Sea Systems Command established a task force to evaluate shipboard use of FEDSPEC P-D-680 Type II, Dry Cleaning and Degreasing Solvent (P-D-680) with a goal of identifying methods of minimizing use through material substitution and process change. P-D-680 Type II was chosen for evaluation due to the large number of applications; its frequent use outside of the Planned Maintenance System (PMS); and the environmental, safety, and health hazards associated with its use.

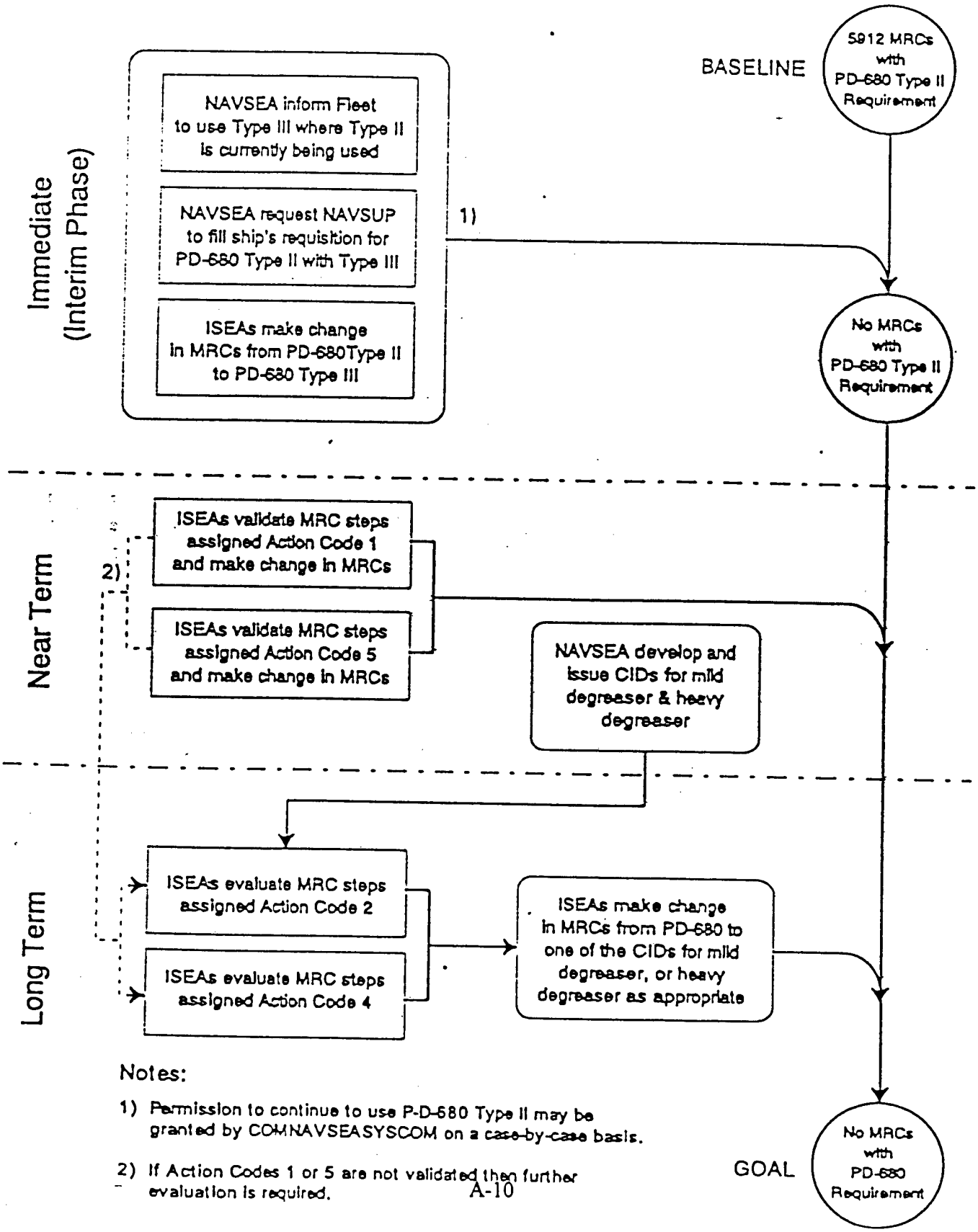
A thorough evaluation of the PMS use of P-D-680 Type II was accomplished. Employing the Shipboard Hazardous Material Database developed at Carderock Division, Naval Surface Warfare Center, Annapolis, 5912 maintenance requirement cards (MRCs) specifying the use of P-D-680 Type II were identified. Each MRC was reviewed, and the processes requiring the use of the solvent were characterized. A collection of alternative cleaners was developed, and alternates were evaluated against the identified processes. Ship surveys were conducted to receive fleet input regarding P-D-680 Type II use, to determine non-PMS usage of the solvent, to identify other alternatives, and to validate assessments (i.e., how the solvent was actually used in performing the maintenance action) made during the MRC review.

This document provides In-Service Engineering Agents (ISEAs) with a recommended action for solvent elimination or minimization for equipment under their auspices that currently specify the use of P-D-680 Type II. This action can be to:

- Replace P-D-680 Type II with solvent approved under FEDSPEC P-D-680 Type III (a solvent specification that improves safety and decreases environmental impact).
- Eliminate the use of any solvent to perform the maintenance
- Dispose of the part rather than cleaning as a more economical approach.
- Replace P-D-680 Type II with an alternative mild degreasing agent (similar to household cleansers). Examples of possible alternatives are presented.
- Replace P-D-680 Type II with an alternative heavy degreasing agent. Examples of possible alternatives are presented.

This document proposes alternative cleaning substances and processes that can be use in place of P-D-680 Type II. To begin the implementation phase of the project, recommended actions for each MRC have been stored on the enclosed diskette for evaluation by the appropriate ISEAs. Guidance for determining the recommended actions has also been included.

Summary of Recommendations for Reduction of P-D-680 Type II in PMS Afloat



Notes:

1) Permission to continue to use P-D-680 Type II may be granted by COMNAVSEASYSCOM on a case-by-case basis.

2) If Action Codes 1 or 5 are not validated then further evaluation is required.

3.0 APPROACH

A thorough evaluation of Fleet use of the solvent was required in order to make appropriate decisions regarding the substitution or elimination of P-D-680 Type II for PMS applications. NAVSEA chartered a task force consisting of (1) industrial hygienist and chemists to review formulations and assess environmental, safety, and health issues associated with P-D-680 Type II, (2) engineers to review and develop proposed process changes, (3) systems analysts to organize and generate PMS-related data, and (4) former Navy personnel to provide practical operational experience. This multi-disciplinary approach ensured a thorough assessment of P-D-680 Type II and its usage.

Environmental, safety, and health aspects of the solvent were determined as an initial step of the project. This information confirmed that the potential hazards associated with P-D-680 Type II use are sufficient to warrant its substitution or elimination. The environmental, safety, and health information also familiarized the task force with the undesirable properties of P-D-680 Type II which aided the process for selecting possible alternatives for the dry cleaning solvent. Detailed environmental, safety, and health information on P-D-680 Type II is provided in Appendix A.

The evaluation of Fleet P-D-680 Type II shipboard operation and maintenance usage consisted of several elements. As a first step, procurement records were obtained to give an indication of the Fleet's overall requirements. Next, a review of the maintenance requirement cards (MRCs) that specify the use of P-D-680 Type II was conducted to identify the equipment and systems maintained with P-D-680 Type II. Finally, ship surveys were conducted to validate the MRC review and to obtain Fleet inputs regarding actual solvent requirements, potential substitutes, and operational impacts.

Statistics on the quantity of P-D-680 Type II procured by the Fleet were obtained from Ship's Parts Control Center (SPCC) Mechanicsburg, Pennsylvania, in two formats. First, the total volume procured by the Fleet for the one year period prior to May 1993 was obtained. In addition, procurement records for quantities of P-D-680 Type II procured by each ship in the Fleet were received. These procurement records served to give the task force a better appreciation of quantities of solvent currently required by the Fleet and to provide a baseline as a possible index of success for the project.

To complete the remaining elements in the Fleet usage evaluation, the Shipboard Hazardous Materials Database (SHMD), developed by Carderock Division, Naval Surface Warfare Center, Annapolis (CDNSWC-Annapolis), was utilized. This database enabled the task force to assemble and obtain a variety of information regarding P-D-680 Type II with regard to its use on active ships. According to the SHMD, a total of 5912 MRCs specifying P-D-680 Type II are used in the Fleet. This database also identified a total of 91 ship types and 30 classes requiring P-D-680 Type II and the associated MRCs for each ship. This information was used to select ships and generate questionnaires for the ship surveys.

Critical to the evaluation of Fleet usage of P-D-680 Type II was the review of the MRCs that specify P-D-680 Type II. This review thoroughly examined PMS applications and enabled the task force to closely evaluate equipment, systems, and processes. Each of the 5912 MRCs

The alternative solvents and cleaning compounds provided in this document are representative of the products available either through the Federal Supply System or in the open market. Provision of a specific product name is not an endorsement of the product. Products with similar formulations and characteristics may exist or will be developed in the near future. The alternatives are provided as a guide that illustrates the available array of safer and sometimes more capable replacements for P-D-680 Type II.

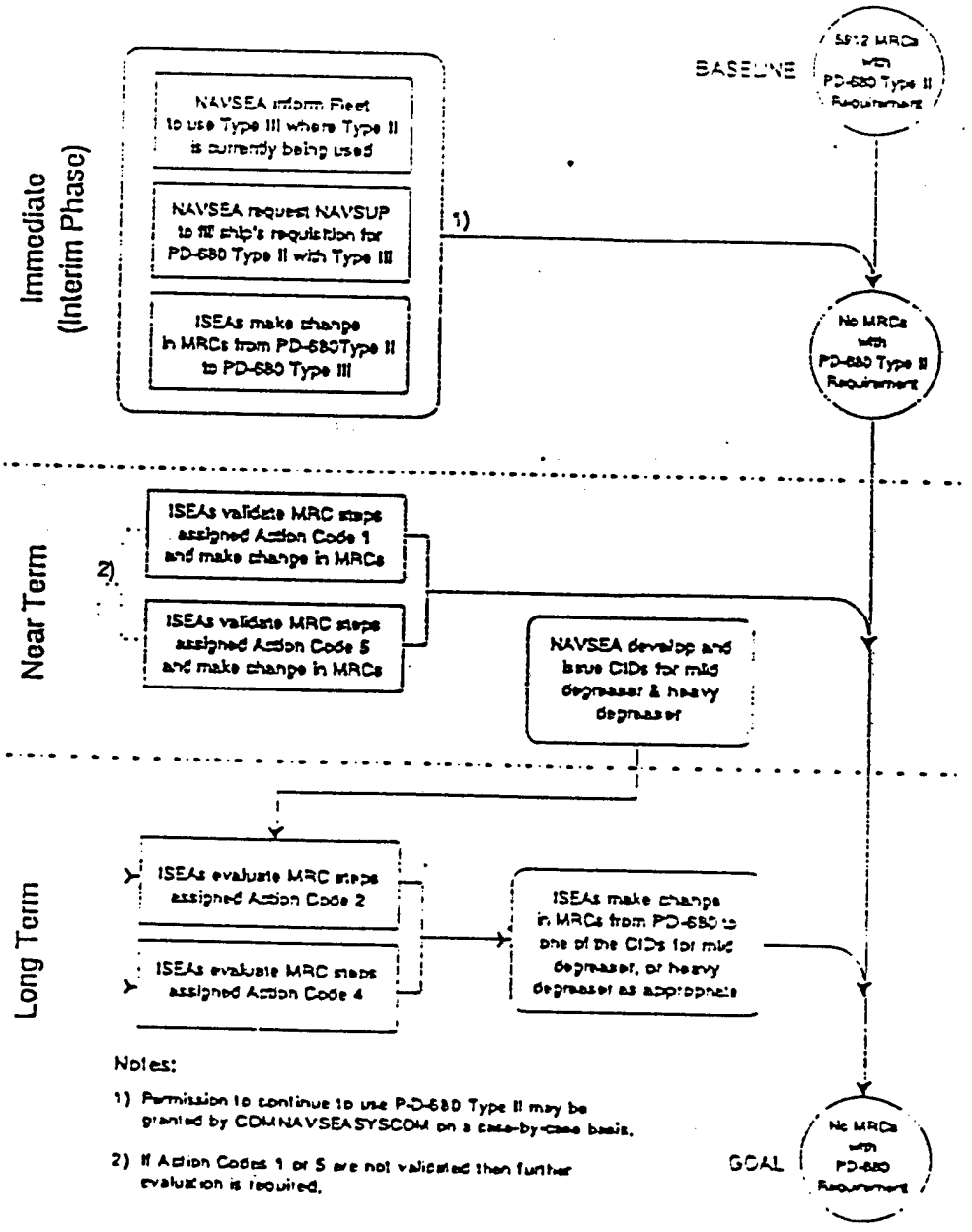
Since the task force approach was to evaluate shipboard usage of P-D-680 Type II to eliminate its use, alternatives for every cleaning application currently requiring P-D-680 Type II have been suggested. Based upon on the MRC Review results, P-D-680 Type III can replace P-D-680 Type II in a majority of the applications. Approximately 10 percent can be performed without the use of any cleaner. Approximately 20 percent can be accomplished using a mild cleaner. The remaining 70 percent will require an alternative a heavy degreaser to replace P-D-680 Type II (which may include P-D-680 Type III). Final estimates for reduction of P-D-680 Type II in PMS Afloat will be determined after the ISEAs complete their review.

The accomplishments of the task force have shown that a significant reduction in the shipboard use of P-D-680 Type II can be achieved through elimination, substitution, and process change.

6.0 RECOMMENDATIONS

The recommendations provided in this section are based on the results of the task force's evaluation of MRCs that required the use of P-D-680 Type II. Figure 6.1 below illustrates the baseline and the major recommended actions which contribute to the intended goal: "No MRCs with PD-680 Requirement". The figure shows the general time order of the recommended actions and the relationship among the immediate (interim phase), near term, and long term actions.

Figure 6.1 Recommended Actions for the Reduction of P-D-680 Type II in Planned Maintenance Systems



specifying P-D-680 Type II were reviewed using the Navy PMS Compact Disc (CD) for Hull, Mechanical, and Electrical Systems and for Combat Systems, 1-93 Semi-Annual Force Revision (SFR). A database was created to tabulate the information collected during the review. At the conclusion of the review, current solvent applications were assigned one of five Action Codes for elimination or substitution of the solvent.

In addition to the MRC review, Fleet usage of P-D-680 Type II was evaluated through ship surveys. The intent of the surveys was to validate the MRC review, determine any non-PMS uses of the solvent, and identify any possible alternative cleaners the Fleet may suggest. In addition, Fleet input regarding the operational impacts of replacing P-D-680 Type II were solicited. During the ship surveys, information was collected from Division Officers as well as deckplate sailors who regularly work with P-D-680 Type II.

Concurrent with the effort to evaluate Fleet use of P-D-680 Type II, an effort was undertaken to identify possible cleaning materials and processes that could replace P-D-680 Type II. Key considerations for alternatives included the following: safety, toxicity, usage requirements, waste disposal, corrosion resistance, material compatibility, and logistical burden. In coordination with the assignment of the Action Codes, alternative products were identified and characterized. Descriptions of example products for each general cleaning class have been tabulated and are included in Appendix C.

Throughout the course of the project, there was an effort to coordinate with other organizations, both armed services and government agencies, to save time and to avoid duplication of efforts.

While the goal of this project was to examine Fleet usage of P-D-680 Type II to identify opportunities for reduction, implementation of the recommended changes proposed in this document has also been considered. In addition, the provisions of the FEDSPEC have been reviewed and revisions proposed. Recommendations for implementation of P-D-680 Type II reduction and specification changes are included in Section 6.0, Recommendations.

6.1 P-D-680 Type III

As a first step in the improvement of safety, health, and environmental protection on board ship and to achieve the maximum impact in the shortest period of time, it is recommended that COMNAVSEASYSCOM inform afloat units to substitute P-D-680 Type III for P-D-680 Type II. Its increased flashpoint, lower aromatic content, and lower vapor pressure will reduce hazards to the individual and to the environment. P-D-680 Type III can be used in place of P-D-680 Type II for accomplishment of planned and corrective maintenance and shipboard housekeeping. In the exceptional cases where ships force (or the ISEA) determines that P-D-680 Type III is not adequately suited for a specific maintenance action (drying time too long, surface residues, or solvency ability), permission to continue to use P-D-680 Type II may be granted by COMNAVSEASYSCOM on a case-by-case basis.

Ship forces can begin using P-D-680 Type III upon depletion of current stocks of P-D-680 Type II. It is recommended that COMNAVSEASYSCOM request COMNAVSUPSYSCOM to fill ship requisitions for P-D-680 Type II with P-D-680 Type III.

The following NSNs and associated container sizes for P-D-680 Type III are currently available:

6850-01-331-3349	(5 gallon)
6850-01-331-3350	(55 gallon)
6850-01-377-1808	(1 quart)
6850-01-377-1809	(1 gallon)
6850-01-377-1811	(1 pint)
6850-01-377-1812	(bulk, gallons)
6850-01-377-1916	(4-ounce)

The following sub-sections identify and describe the recommendations:

- Section 6.1, P-D-680 Type III: Recommends P-D-680 Type III as an immediate and interim substitute in place of P-D-680 Type II.

- Section 6.2, Commercial Item Description (CID): Recommends the development and issue of CIDs which will allow the ISEA to select the most technically appropriate solvent/cleaning compound as a substitute for P-D-680.

- Section 6.3, In-Service Engineering Agent Actions: Provides recommended actions to ISEAs for the minimization or elimination of P-D-680 Type II from maintenance requirements, technical manuals, and instructions as well as procurement, operational, and technical specifications.

- Section 6.4, Other Recommended Actions: Addresses other efforts that will contribute to the reduction of P-D-680 use.

6.2 Commercial Item Description Development

It is recommended that commercial item descriptions be developed and issued based on the four primary cleaning groups identified in Section 5.2 as potential substitutes for P-D-680 Type II. These cleaning groups include aqueous, semi-aqueous, organic, and petroleum-based cleaning compounds and solvents. The development of CIDs will allow for the selection of the most technically appropriate solvent/cleaning compound for the specific application and associated cleaning process. The CIDs will cover the projected maintenance and cleaning requirements that currently specify P-D-680 Type II. In addition, CIDs can be written to eliminate the undesirable chemical constituents and characteristics currently permitted under the P-D-680 Type II or Type III specification. The adoption of CIDs will allow for competition to ensure cost effective procurement. Proposed characteristics for the CIDs have been provided in Section 5.3.

Development of CIDs is crucial prior to the implementation of the recommendations that follow. CIDs will serve as a guide during the ISEA review of the MRC steps so that the most appropriate cleaning compound can be selected according to the soil type and the equipment being cleaned.

6.3 In-Service Engineering Agent Actions

Implement Elimination or Substitution. As illustrated in Figure 6.1, it is recommended that the ISEAs review the Action Codes proposed for each MRC step currently stipulating the use of P-D-680 Type II. A review of those MRC steps designated as Action Code 1 or 5 can begin immediately. The review of MRC steps identified as Action Code 2, 3, or 4 can be accomplished once CIDs, discussed in Section 6.2, have been developed, approved, and issued so that the appropriate cleaning compounds can be substituted for P-D-680 Type II. The following summarizes the Action Codes assigned during the MRC review (Section 4.2) and the order in which the Action Codes should be reviewed:

- Review all MRC steps with designated Action Code 1. These maintenance actions do not require the use of any cleaner for effective accomplishment of the maintenance. Verification of this action should be the easiest of any Action Code. This action will immediately improve safety and health and result in pollution prevention on board ship. Furthermore, it will eliminate the use of a hazardous material altogether for seven percent of maintenance actions.

- Review all MRC steps assigned Action Code 5. These maintenance action require cleaning a part where it may be less expensive to replace the part with a new item. Action Code 5 has been assigned in conjunction with either Action Code 2 or 4 as an alternative to cleaning the part. Cost analysis will be critical for determining implementation.

- Review all MRC steps designated with Action Code 2. These maintenance actions have been determined to require a mild degreaser or detergent. Approximately 20% of the MRC steps currently requiring P-D-680 Type II have been assigned Action Code 2. Shipboard safety and health will improve and the potential for environmental pollution will be reduced because the hazards associated with the substitute materials are considerably less than those associated with either P-D-680 Type II or P-D-680 Type III.

- Review all MRC steps designated with Action Codes 3 and 4. These maintenance processes require a cleaning compound that can remove heavy grease, oils, hydraulic fluid, etc. Alternative solvents and cleaning compounds identified under the CIDs to satisfy this Action Code will require qualification by CDNSWC-Philadelphia. Testing and evaluation will ensure the proposed substitutes adequately perform the required maintenance action without an adverse impact upon system operation. Substitution will result in improved safety and health and reduce the impact on the environment since the materials being considered have better safety, health, and environmental characteristics than P-D-680. This pollution prevention effort could result in the elimination of P-D-680 use in 70 percent of the planned maintenance actions currently employing this solvent/dry cleaning agent.

Implementation of alternative solvents and elimination of P-D-680 Type II for Action Codes 2, 3, and 4 will require close coordination with COMNAVSUPSYSCOM to obtain NSNs and approval for new materials.

6.4 Other Recommended Actions

Navy Solvent Substitution Coordination. Solvent substitution efforts are currently underway within the Naval Facilities Engineering Command, the Naval Supply Systems Command, and the Naval Air Systems Command. Informal liaison with these organizations during the course of the project provided useful solvent substitution information including some potential replacements for P-D-680 Type II. To successfully eliminate hazardous solvents and avoid duplication of effort within the Navy, it is recommended that a Navy systems command solvent substitution working group be established. Such an effort may also prevent counter-productive actions, such as the identification of P-D-680 Type II as a substitute for ozone depleting substances (ODS). It is recommended that NAVSEASYSCOM assume a leadership role in such an effort.

Armed Services Coordination. While an effort to coordinate with Army and Air Force Commands occurred during this project, it is anticipated that coordination among the armed services will be critical during implementation of P-D-680 Type II minimization actions. It is therefore recommended that an Armed Services Working Group on Solvent Substitution be established to foster a transfer of information and technology among the services and to avoid duplication of effort. It is also recommended that NAVSEASYSCOM assume a leadership role in the working group for the Navy.

Education of Ship's Force. It is recommended that NAVSEASYSCOM distribute guidance to ship's force for reduction of P-D-680 Type II use for non-PMS activities. This guidance should include a message to the Fleets on alternatives to use in place of P-D-680 for facilities maintenance and cleanup operations. Similar information could be provided during shipboard indoctrination of new personnel or training of personnel who have been routinely using this solvent during ship maintenance actions. Information on process modifications and material substitutions which will reduce the use of P-D-680 Type II should also be disseminated through the Defense Environmental Network for Information Exchange (DENIX), and various Navy safety and health bulletins, newsletters, and other publications. Increased awareness should result in a move away from incidental usage of P-D-680 Type II toward more environmentally acceptable cleaning agents.

Measurement of Effectiveness. It is recommended that NAVSEASYSCOM adopt the task force method for measuring the effectiveness of the elimination of P-D-680 Type II use in planned maintenance actions. The task force considered several indices of success and selected "number of MRCs modified to eliminate or replace P-D-680, expressed as a percentage of the total number of MRCs (5912)" as the best index.

In its deliberations, the task force also considered "reduction in volume of P-D-680 Type II used aboard ships" as an index of success. However, the task force concluded that this measure of effectiveness would also encompass the results of other Navy hazardous material control and management initiatives implemented aboard ship (e.g., the Hazardous Material Inventory Control System (HICS)).

Once the ISEAs have completed their review of the MRCs and all testing and evaluation of substitutes has been accomplished, revisions to the MRCs will need to be completed.

MRC Revisions. Two administrative changes can be accomplished which will reduce the quantity of solvent required to complete planned maintenance. The first is to extend the maintenance periodicity where possible, and the second is to provide guidelines for quantities of solvent required to accomplish a specific maintenance step or process.

- Maintenance Periodicity Revision. It is recommended that ISEAs evaluate the specified maintenance periodicity during the MRC review described above. Interviews with shipboard personnel indicated that many of the planned maintenance actions that require P-D-680 Type II could be accomplished less frequently without an adverse affect on system operation. Extending the intervals between maintenance actions, where possible, will reduce the volume of hazardous, as well as other, materials required.

- Identification of P-D-680 Volume Requirements. It is recommended that the ISEAs determine the volume of solvents/cleaning compounds required for each maintenance action and modify MRCs accordingly. During the ship surveys, it was noted that personnel with less experience used appreciably more solvent than experienced personnel. The inclusion of volume estimates on MRCs will result in a reduction in the overall amount of solvent used.

Minimization of Further Introduction of P-D-680 Type II into PMS. To further reduce P-D-680 Type II shipboard requirements, it is recommended that P-D-680 Type II not be specified for use in new maintenance processes nor be recommended as an approved substitute for other hazardous materials (e.g., CFC solvents). Alternative classes of solvents and cleaners identified in this document can serve as a source of less hazardous, technically acceptable solvent substitutes.

SPIN [2407]. During the final stages of the MRC review, SPIN [2407] was discovered to be a possible identifier for P-D-680 Type II. SPIN [2407] is described as "Approved safety solvent. Workcenter provide." It is specified on 300 MRCs, eight of which also specify P-D-680 Type II (SPIN [2283]) for a portion of the system maintenance. In addition to those eight MRCS, it is probable that shipboard personnel could be selecting P-D-680 Type II for many [2407] applications due to its presence in shipboard workcenters and its excellent cleaning properties. Since SPIN [2407] was discovered late in the project, the task force did not have the opportunity to review the 300 associated MRCs. Therefore, it is recommended that all applications of SPIN [2407] be reviewed with the intention of eliminating [2407] and replacing it with a specific and less hazardous alternative.

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APPENDIX B

USING THE POLLUTION PREVENTION SYSTEM

1.0 Introduction

The Pollution Prevention (P2) System was developed as a Hazardous Material (HM) management tool for the evaluation of status quo and substitute materials based on performing risk and economic analyses. The P2 System represents the integration of three Navy-developed systems, the Hazardous Substance Management System (HSMS), the HM Substitution Process, and the NAVFAC P-442 Economic Analysis Model; to provide for the direct comparison of status quo and substitute materials. The P2 System generates an output report for each risk and economic analysis performed; these worksheets may be viewed on the screen, printed, or saved to a file.

1.1 System Requirements

The P2 System is a Windows©-based, relational database management system for use on a single PC, local area network or wide area network. Version 1.0 was developed in Visual FoxPro™ 3.0, and is currently in the Beta stage. Recommended system requirements include the following:

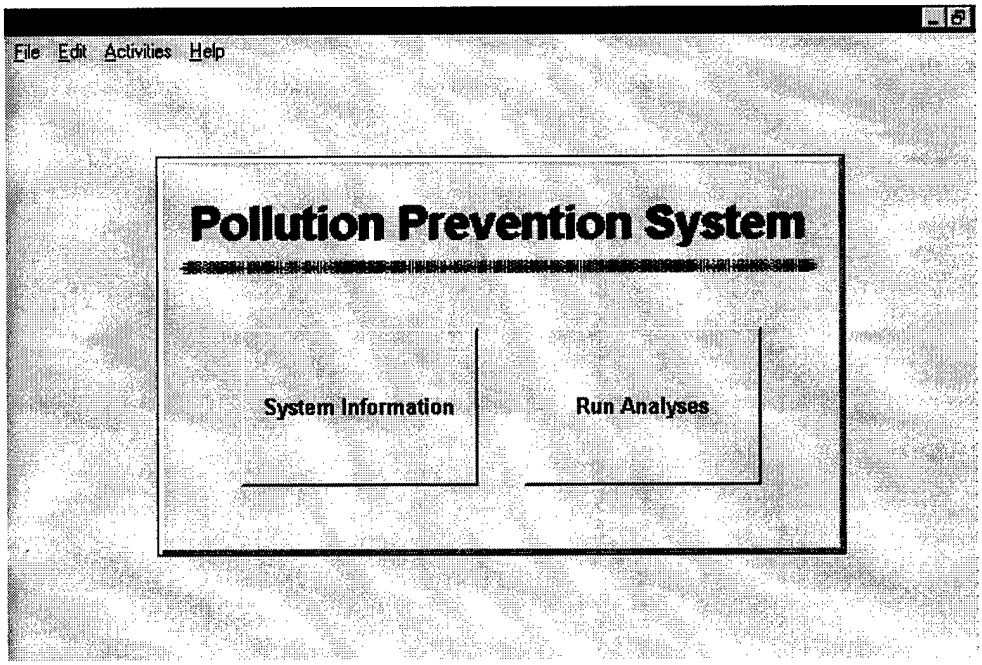
1. Windows 3.1 or higher, Windows for Workgroups 3.11, Windows 95
2. 486SX or higher Processor
3. 8 - 16 MB RAM
4. 10 MB Permanent Swap File
5. 10 MB of hard disk space to install the program

2.0 Getting Started

This section describes the basic procedures for operating the P2 System, including starting the system, using the button bar, and exiting the P2 System.

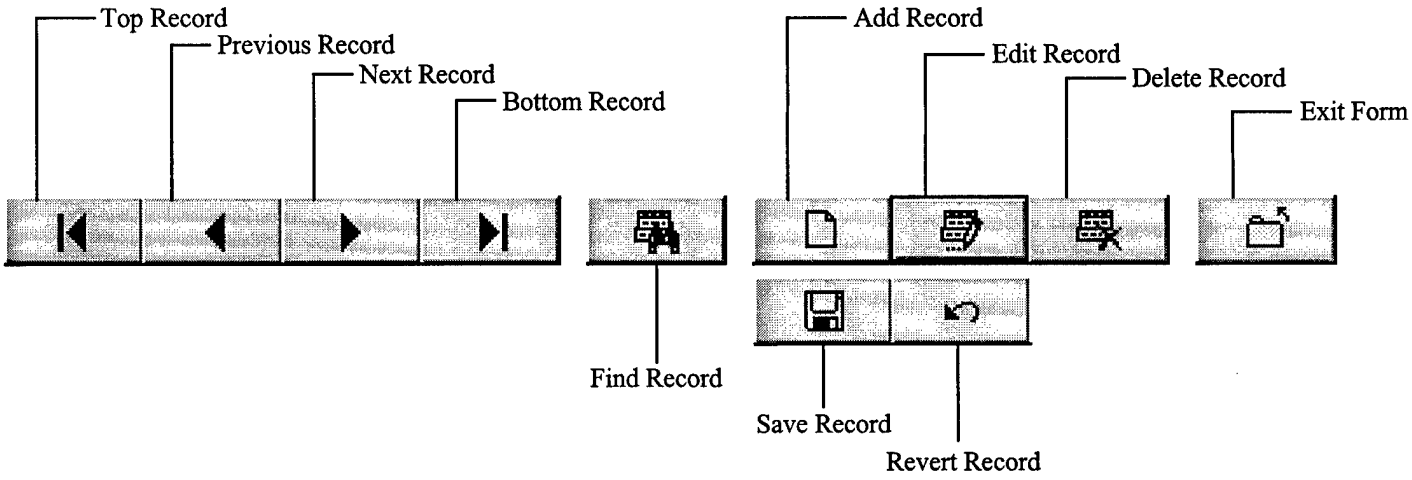
2.1 Starting the Pollution Prevention System

The P2 System is started by double clicking the P2 icon with the mouse. The system's two modules, the System Information Module and the Run Analyses Module, are displayed on the screen, along with the main menu options, File, Edit, Activities, and Help.



2.2 The Button Bar

The P2 System button bar is located at the bottom of each data entry screen. By placing the mouse cursor over each button, the P2 System will display a description of that button's function, as shown on the next page.

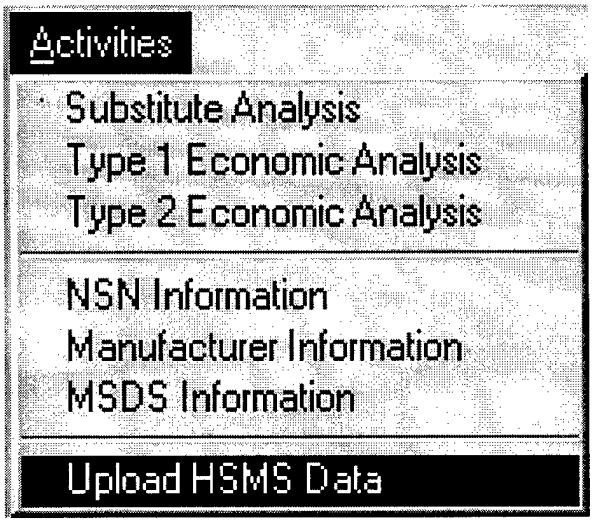


2.3 Exiting the Pollution Prevention System

The P2 System is exited by either selecting the File menu option and Exit P2 from the pull down menu, or by typing the command ALT + F + E.

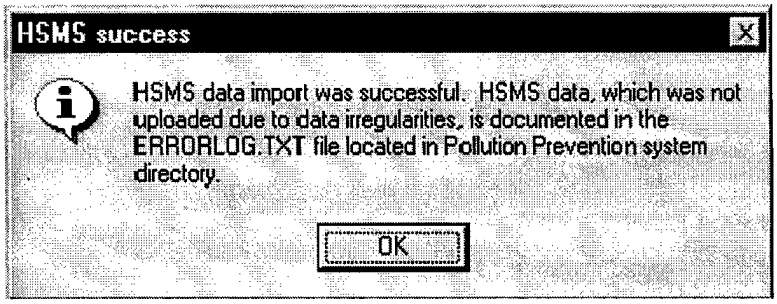
3.0 Uploading Hazardous Substance Management System Data

This section describes the steps required for uploading environmental, safety, and health information for status quo materials from the HSMS to the P2 System for incorporation into risk and economic analyses. This Upload HSMS Data utility precludes entering and maintaining two sets of identical data. This optional feature is available whether the HSMS and P2 System are installed on the same PC, or on two different PCs.



The "Upload HSMS Data" utility is accessible from the P2 System's Activities pull-down menu. The P2 System guides the user through the upload process, which copies certain batch and query files from the P2 System onto a diskette. These files extract the necessary environmental, safety, and health information for status quo materials from the HSMS and transfers this data to the P2 System, where it is stored in the System Information Module.

This data merge takes a few minutes, and once complete, a message will be displayed indicating that the HSMS upload was successful. During the data transfer, an ERRORLOG.TXT file is generated, and contains a listing of inconsistent data in the HSMS, as identified during the upload process. Data inconsistencies may include duplicate data or missing key information. This information is not transferred to the P2 System. Corrections to the inconsistencies may be made, and the Upload HSMS Data utility may be performed again to transfer accurate environmental, safety, and health information to the P2 System.

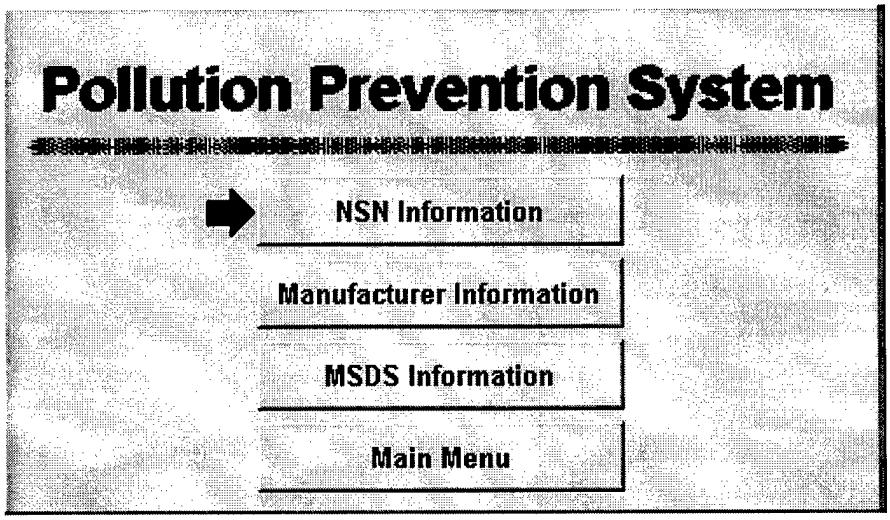


4.0 System Information Module

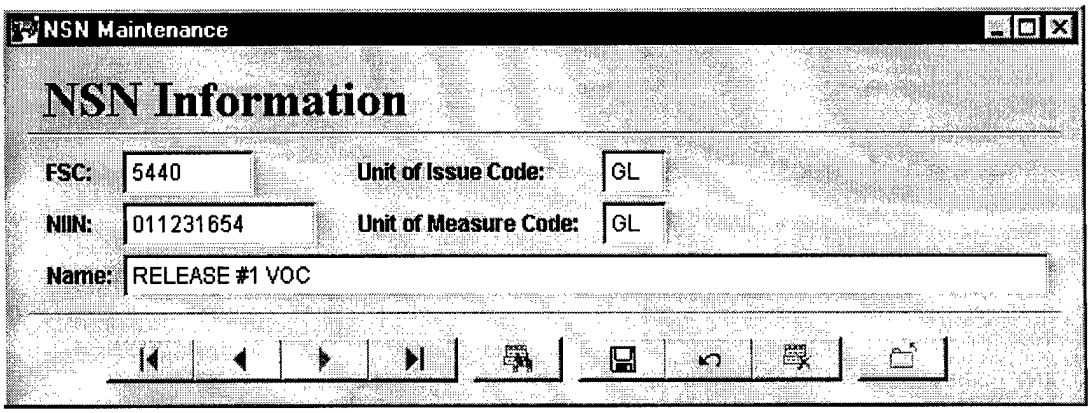
This section describes the procedure for entering environmental, safety, and health information for substitute materials (and status quo materials if the Upload HSMS Data utility is not applied) into the System Information Module. This information includes National Stock Numbers (NSNs), Manufacturer data, and Material Safety Data Sheet (MSDS) -related information.

4.1 National Stock Number Information

To access the NSN Information screen, select the System Information Module from the main menu, and then the NSN Information button.

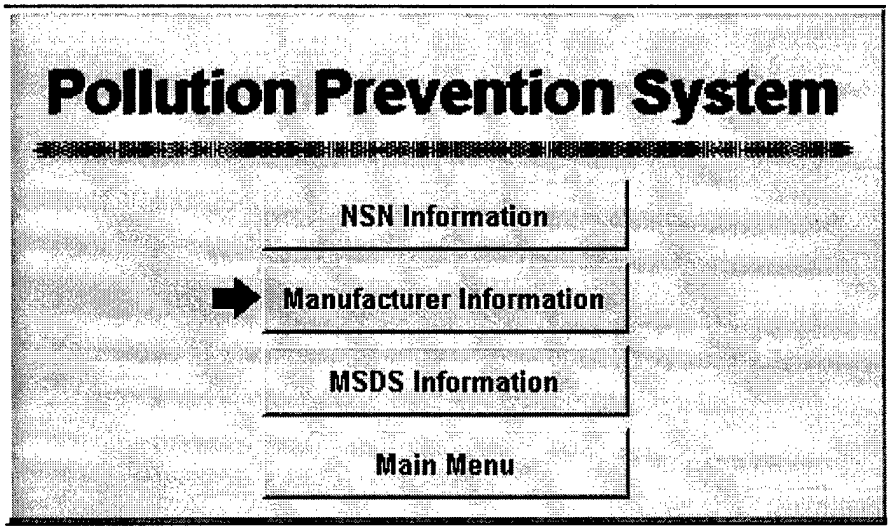


The NSN Information screen is displayed. This screen may also be accessed by selecting the Activities main menu option and NSN Information from the pull-down menu. Required data includes a material's Federal Stock Code (FSC) and National Item Identification Number (NIIN); a material's name, and unit of issue and unit of measure codes are optional fields. From this screen, NSN records may be searched for and/or updated/edited or viewed, added, saved, or deleted.

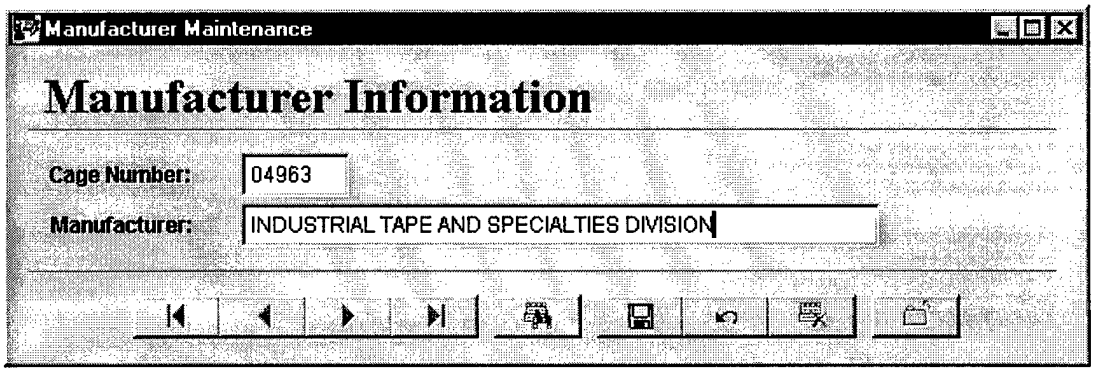


4.2 Manufacturer Information

To access the Manufacturer Information screen, select the System Information Module, and then the Manufacturer Information button.

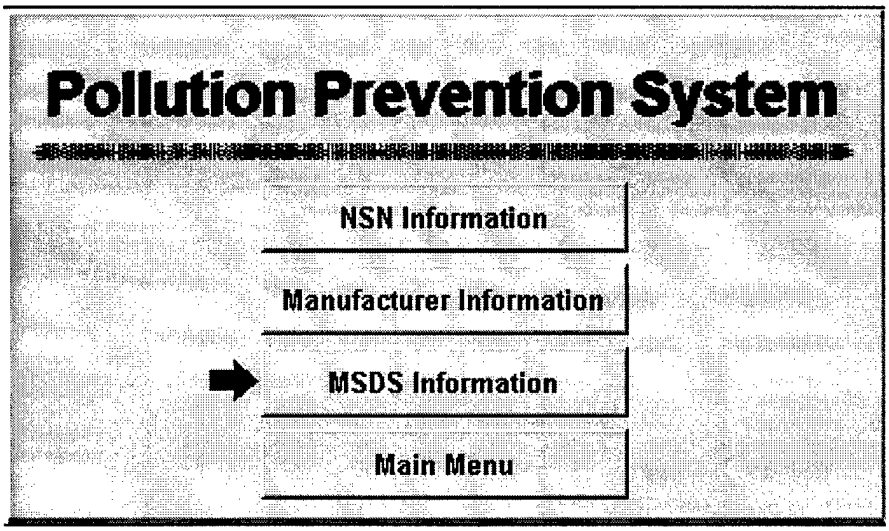


The Manufacturer Information screen is displayed. This screen may also be accessed by selecting the Activities main menu option and Manufacturer Information from the pull-down menu. A manufacturer's Commercial and Government Entity (CAGE) Number is required, and a manufacturer's name is optional. From this screen, Manufacturer records may be searched for and/or updated/edited or viewed, added, saved, or deleted.



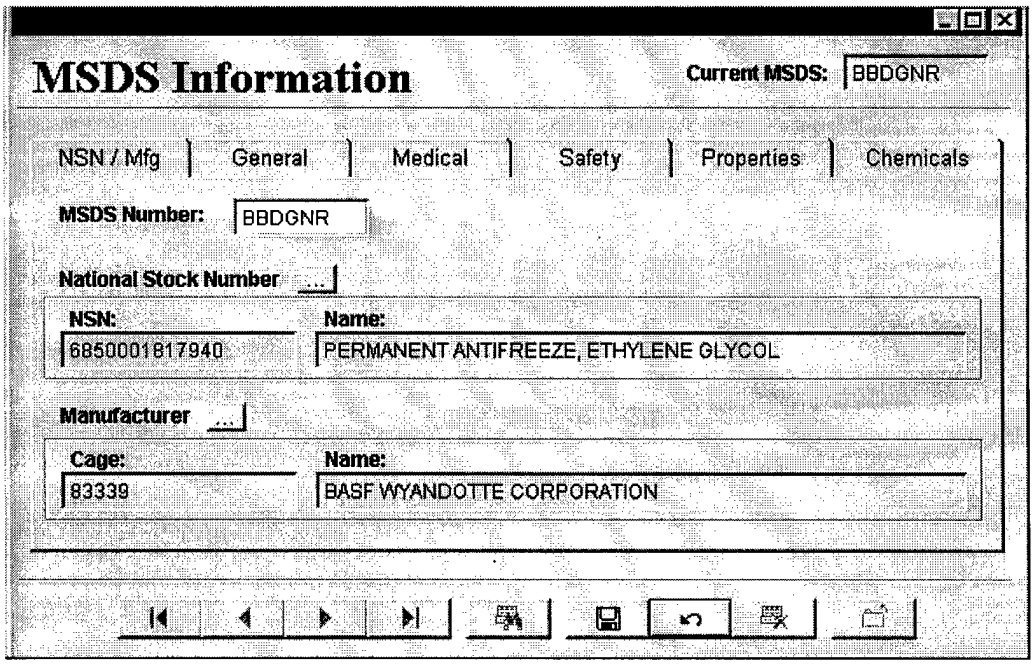
4.3 Material Safety Data Sheet Information

To access the MSDS Information screen, select the System Information Module, and then the MSDS Information button.

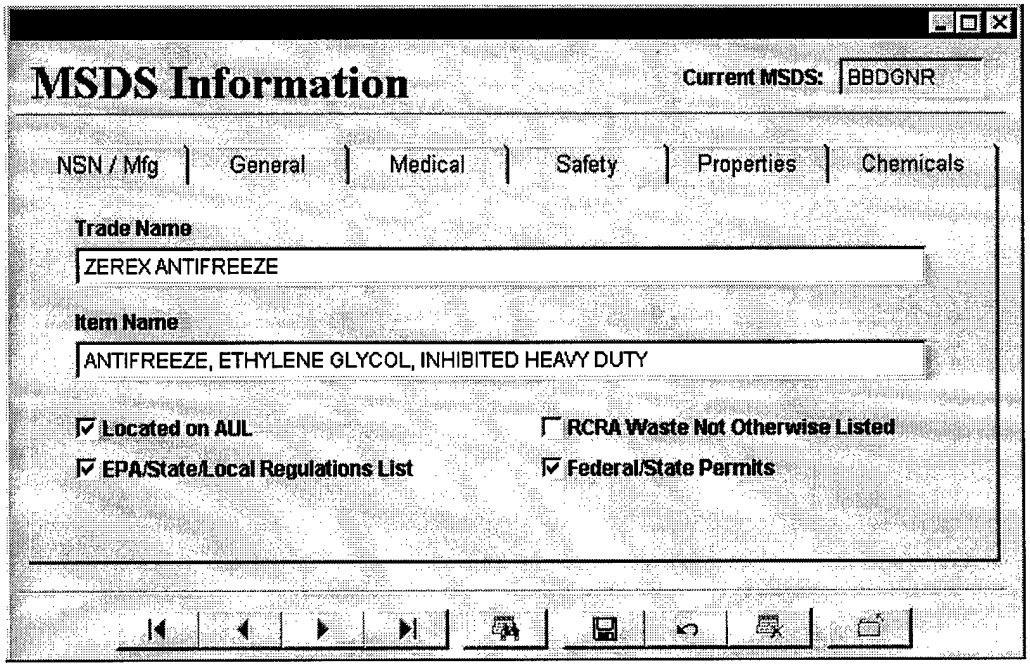


The MSDS Information screen is displayed. This screen may also be accessed by selecting the Activities main menu option and MSDS Information from the pull-down menu. There are six tabs containing required and optional data entry screens, as described below. From this screen, MSDS records may be searched for (by NSN) and/or updated/edited or viewed, added, saved, or deleted.

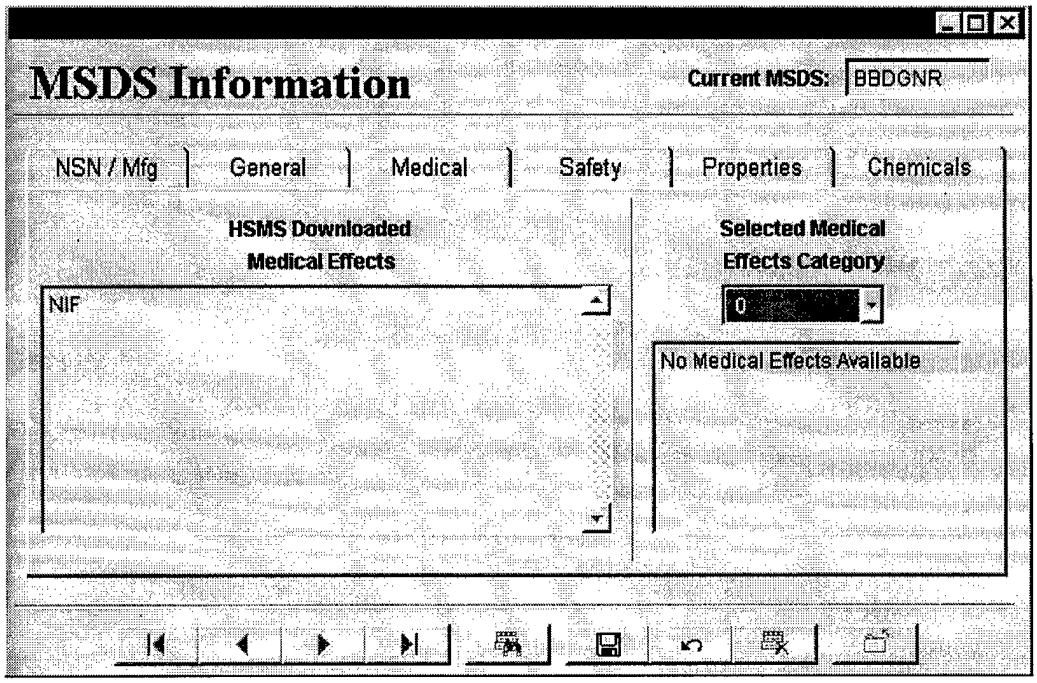
Tab 1: NSN/Mfg - Required data for a material includes a MSDS Number, a NSN and a CAGE Number.



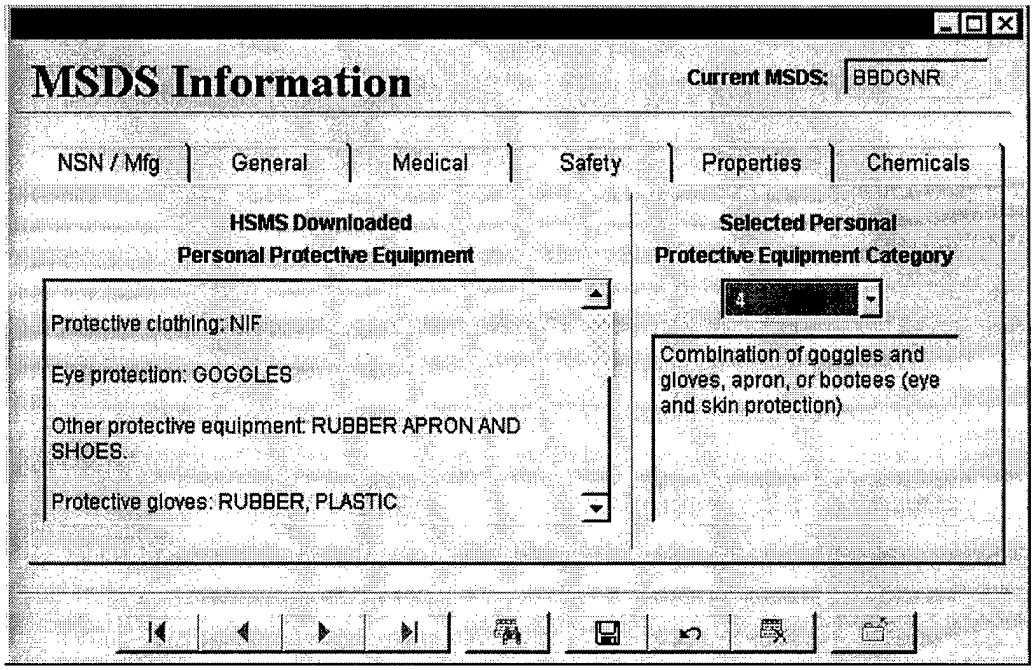
Tab 2: General - Optional data for a material includes trade and items names, Authorized User List (AUL) information, and environmental reporting and permitting requirements.



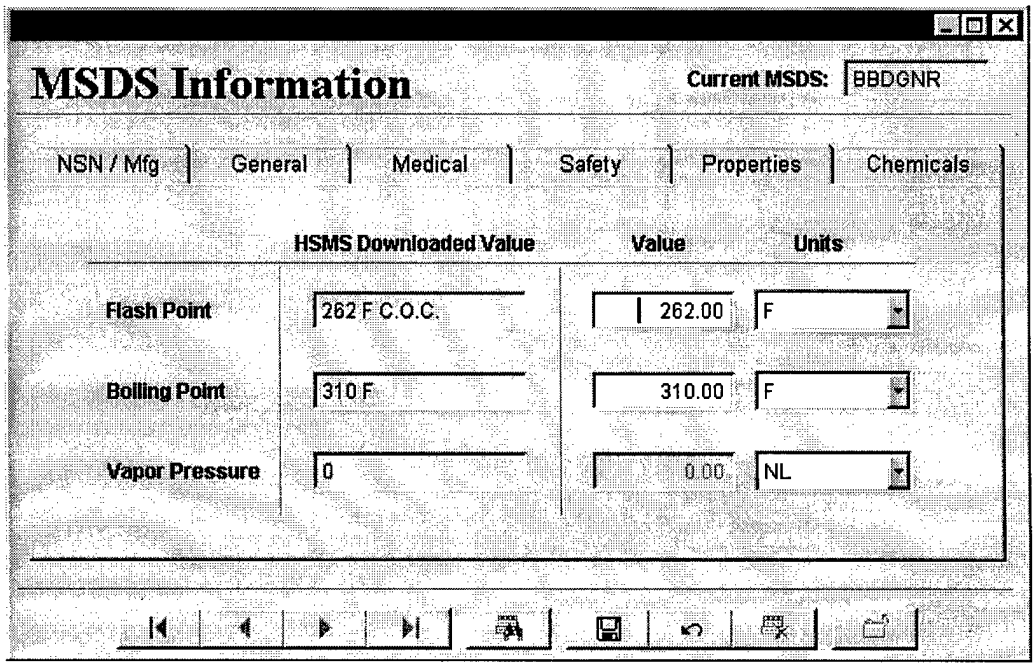
Tab 3: Medical - Tab 3 displays six medical effects categories (including acute and chronic health hazards) and corresponding descriptions. These categories range from 0 to 5; 0 represents no information available, 1 represents no harmful medical effects, and 5 represents severe/fatal medical effects. If the Upload HSMS Data utility is applied, medical effects information for status quo materials, as entered into the HSMS, is available for reference purposes. To carry out a Substitute Analysis, a Medical Effects Category must be manually selected and entered into the P2 System for these materials, a function which ensures that the HSMS data is accurate. Selecting a Medical Effects Category for any material (status quo or substitute) for which environmental, safety, and health information is entered directly into the P2 System, is not required to save a MSDS record; however; if a category is not selected, the P2 System defaults to a score of zero, for no information available.



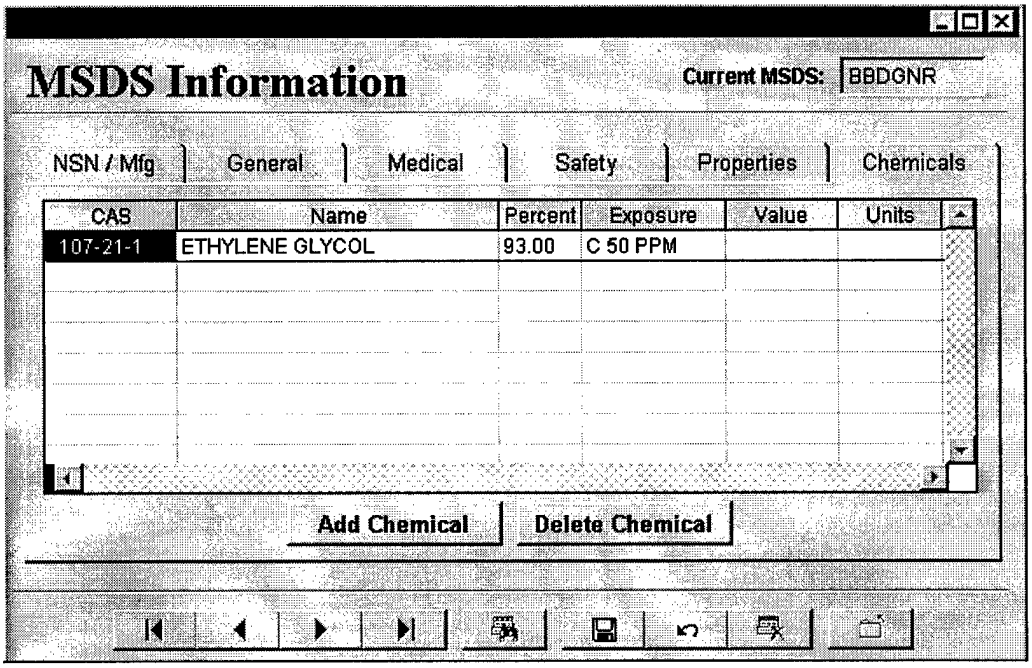
Tab 4: Safety - Tab 4 displays eleven PPE categories and corresponding descriptions. These categories range from 0 to 10, 0 representing no PPE information available or required, and 10 representing complete protection. If the Upload HSMS Data utility is applied, PPE requirements for status quo materials, as entered into the HSMS, are available for reference purposes. To carry out a Substitute Analysis, a PPE Category must be manually selected and entered into the P2 System for these materials, a function which ensures that the HSMS data is accurate. Selecting a PPE Category for any material (status quo or substitute) for which environmental, safety, and health information is entered directly into the P2 System, is not required to save a MSDS record; however, if a category is not selected, the P2 System defaults to a score of zero, for no information available or required.



Tab 5: Properties - Data entered into the Properties Tab for a material includes flash point and boiling point (in units of Fahrenheit, Celsius, or Kelvin), and vapor pressure (in units of millimeters mercury at 70 °F). If the Upload HSMS Data utility is applied, this physical properties information for status quo materials, as entered into the HSMS, is available for reference purposes. To carry out a Substitute Analysis, this information must be manually entered into the P2 System, a function which ensures that the data in the HSMS is accurate. Physical properties information for any material (status quo or substitute) for which environmental, safety, and health information is entered directly into the P2 System, is not required to save a MSDS record; however, this information is required to carry out a Substitute Analysis, at which time the P2 System will prompt the user to enter this information.



Tab 6: Chemicals - Data entered into the Chemicals Tab for a material includes each constituent chemical's Chemical Abstracts Service (CAS) registry number, chemical name, percent composition, and exposure restrictions. If the Upload HSMS Data utility is applied, this constituent chemical information for status quo materials, as entered into the HSMS, is available for reference purposes. To carry out a Substitute Analysis, this information must be manually entered into the P2 System, a function which ensures that the data in the HSMS is accurate. Constituent chemical information for any material (status quo or substitute) for which environmental, safety, and health information is entered directly into the P2 System, is not required to save a MSDS record; however, this information is required to carry out a Substitute Analysis, at which time the user must update that material's MSDS record from within the System Information Module.

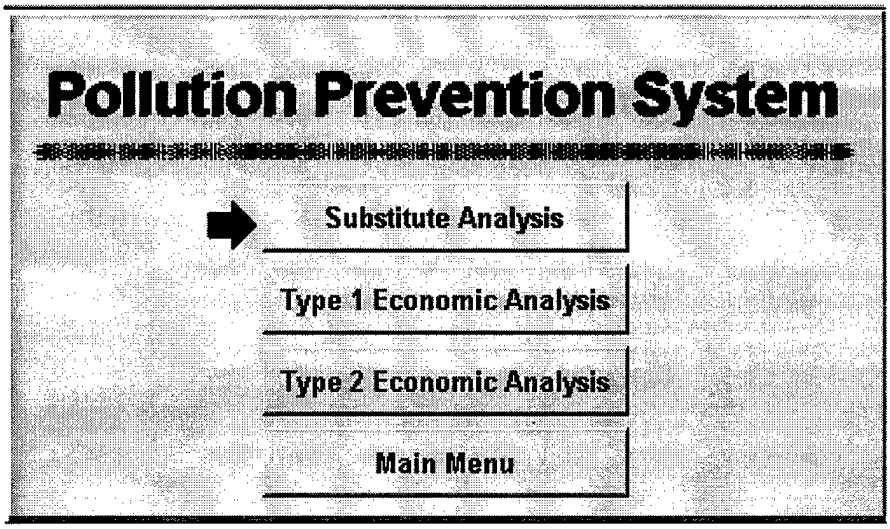


5.0 Run Analyses Module

This section describes the procedure for selecting status quo and substitute materials and performing risk and economic analyses in the Run Analyses Module. Analyses selections include the Substitute Analysis, the Type I Economic Analysis, and the Type II Economic Analysis.

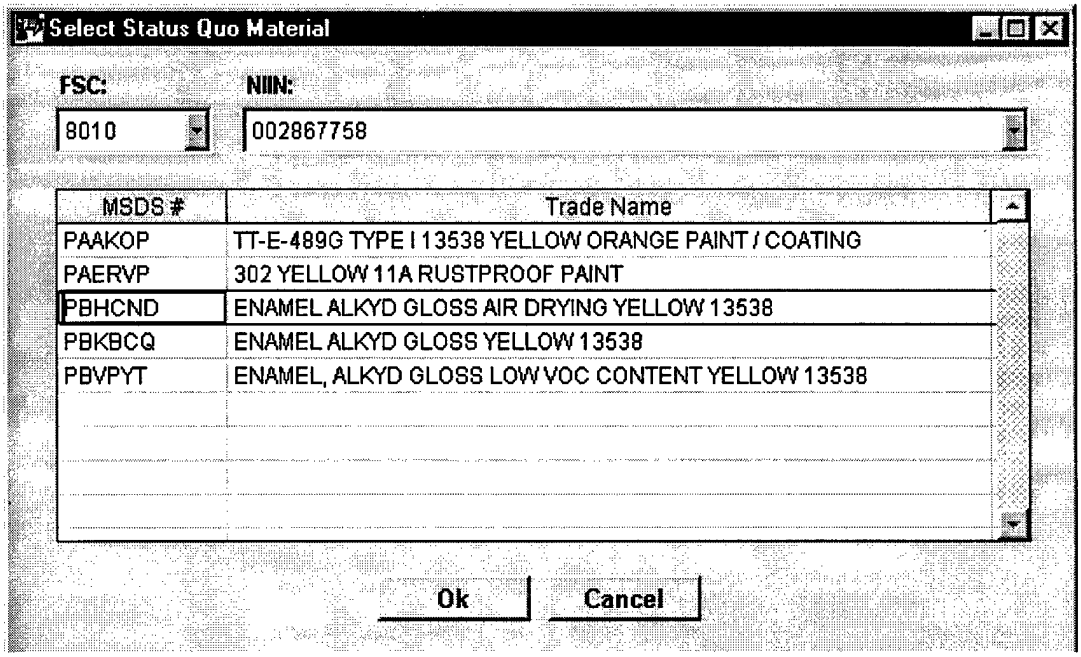
5.1 Substitute Analysis

To access the Substitute Analysis screen, select the Run Analyses Module from the main menu, and the Substitute Analysis button. This analysis may also be accessed from the Activities pull-down menu.



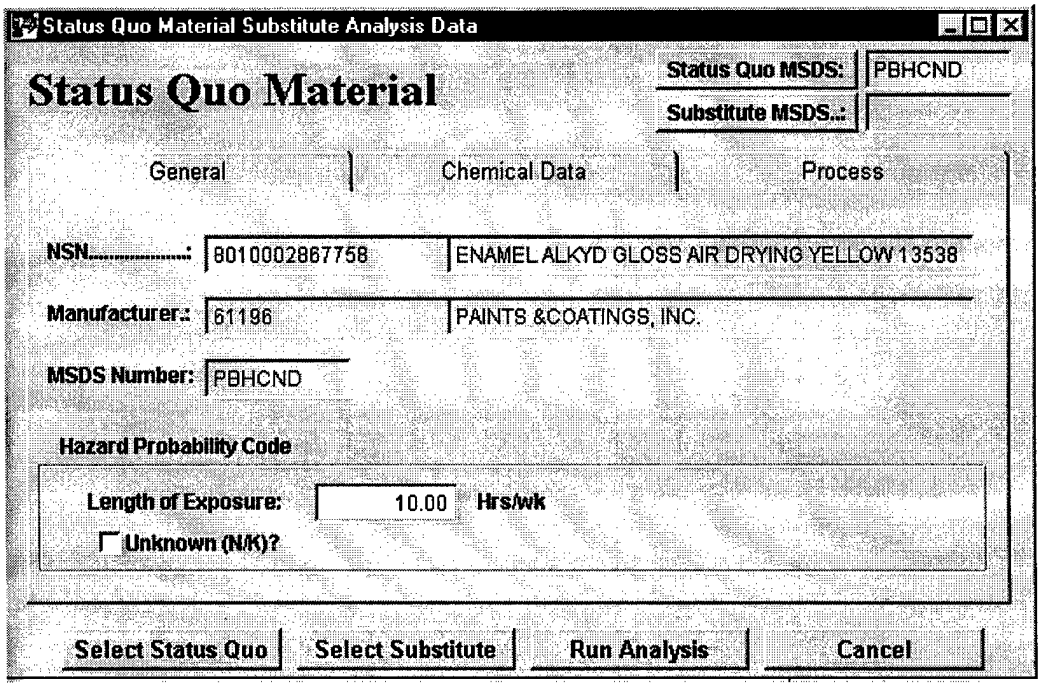
5.1.1 Selecting a Status Quo Material

To perform a risk analysis, a status quo material is selected first, according to its NSN. Because different materials may have the same NSN, MSDS Numbers and Trade Names associated with a selected NSN are displayed to facilitate the identification of a desired material.

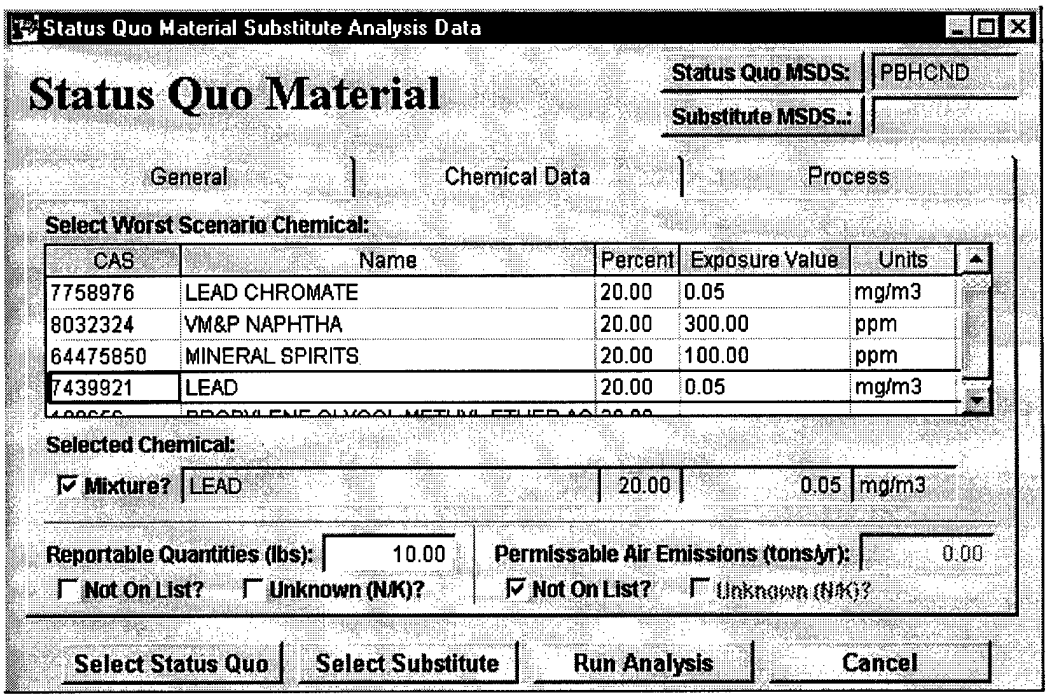


The Substitute Analysis includes three tabs on which a minimal amount of information for a status quo material must be entered.

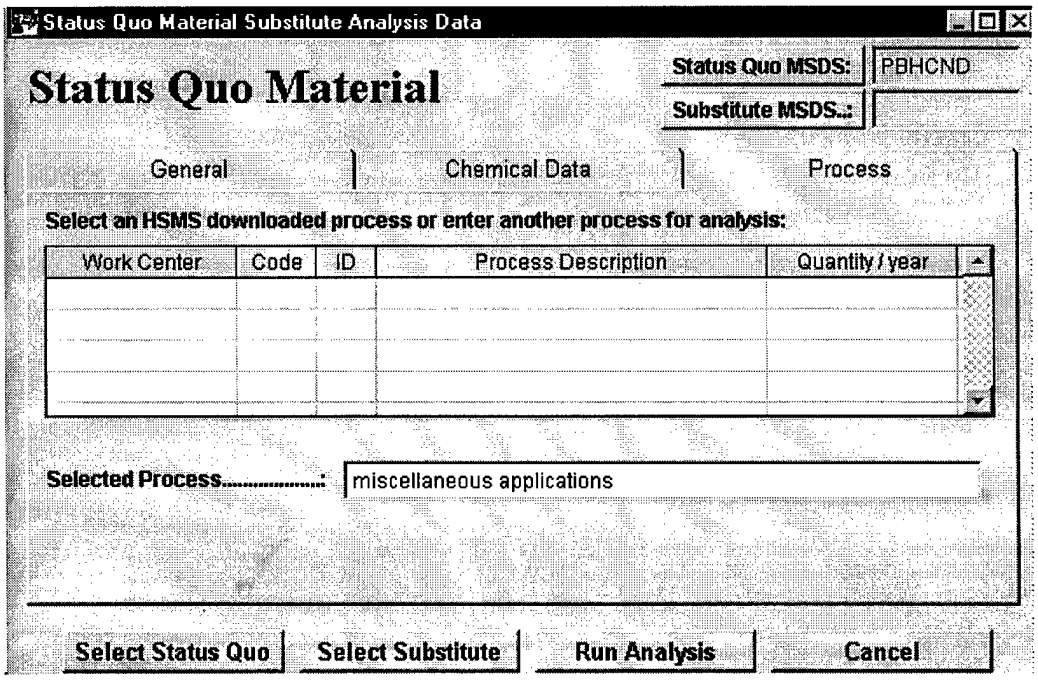
Tab 1: General - Tab 1 displays general information about a material. The length of exposure time to a material (hours/week) is entered on this tab. "Unknown" may be selected if this information is not available.



Tab 2: Chemical Data - The worst case constituent chemical for a material is selected on this tab. A material is identified as being either a mixture or a pure chemical, and reportable quantities (lbs) and permissible air emissions (tons/year) limits are entered, or "Not on List" or "Unknown" is selected, as appropriate.

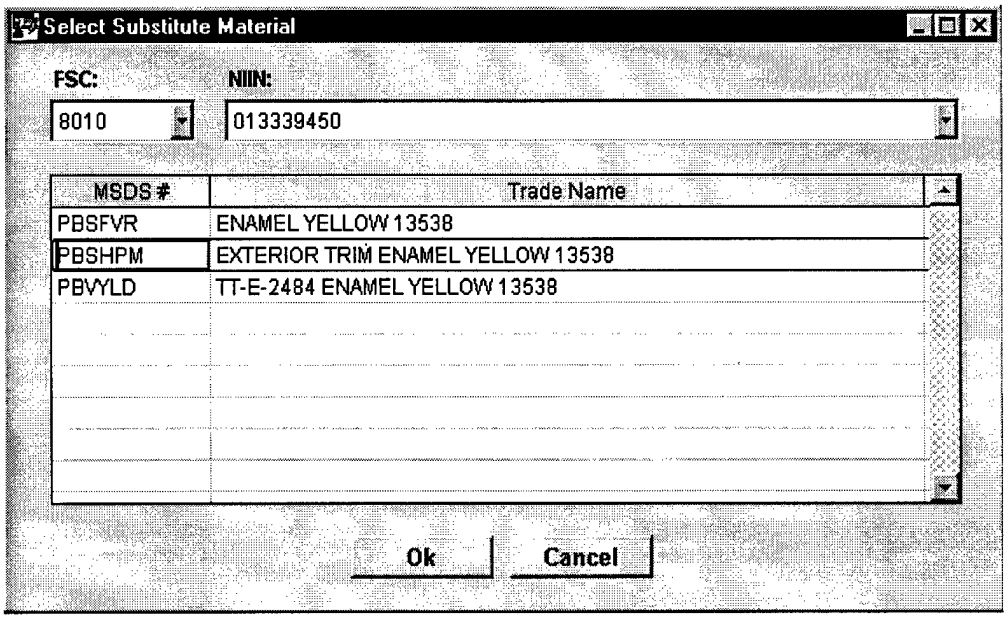


Tab 3: Process - Process information as it pertains to a status quo material is entered on this tab; this data may be selected from a list of process information uploaded from the HSMS, if the Upload HSMS Data utility was applied.



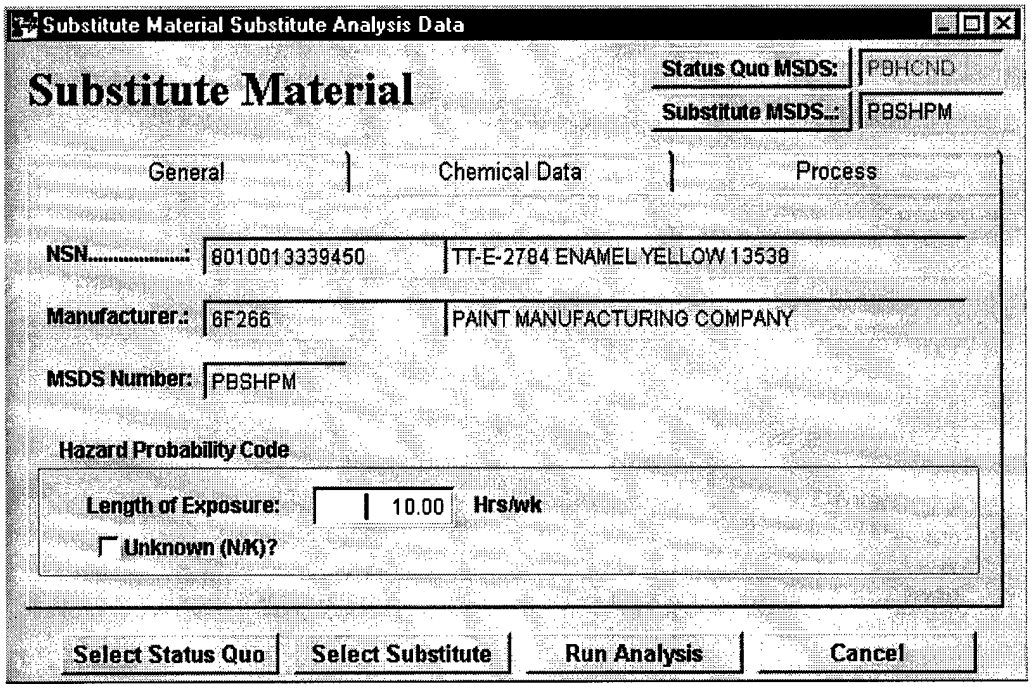
5.1.2 Selecting a Substitute Material

To complete a risk analysis, a substitute material is selected according to its NSN, by choosing the Select Substitute button on the Substitute Analysis screen. As in the case for selecting a status quo material, MSDS Numbers and Trade Names associated with a selected NSN are displayed to facilitate the identification of a desired substitute material.

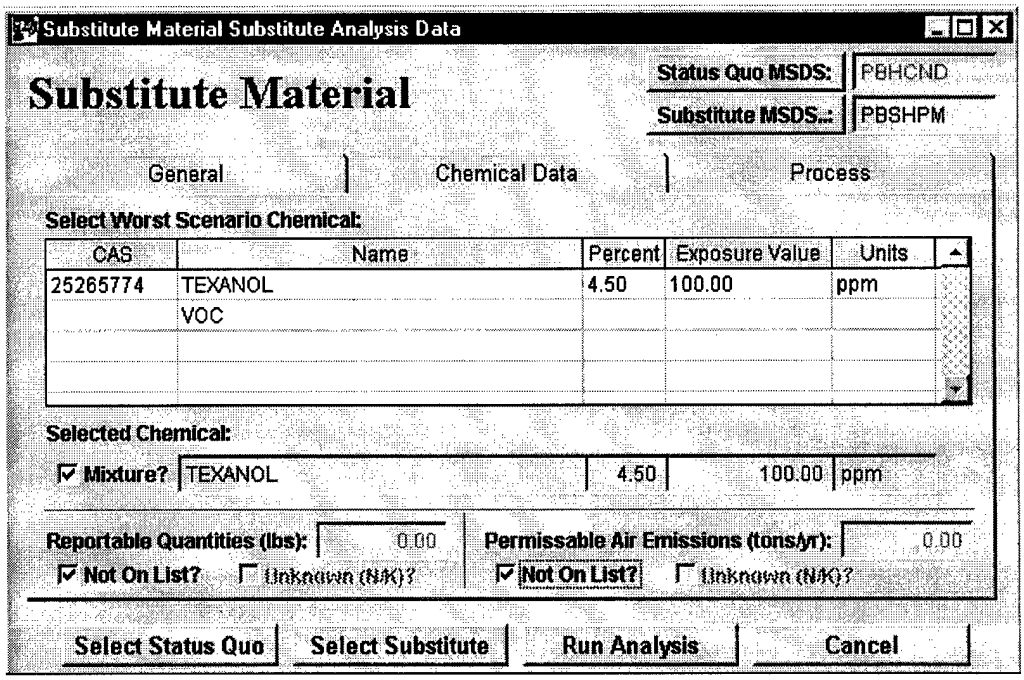


As in the case for a status quo material, a minimal amount of information for a substitute material must be entered on three identical tabs.

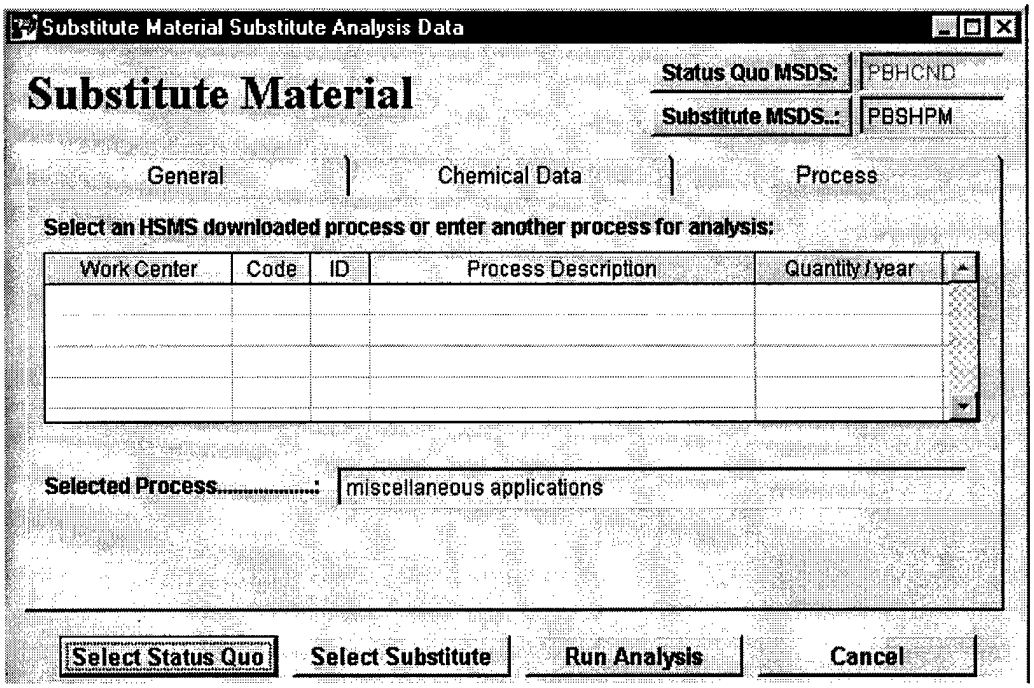
Tab 1: General - Tab 1 displays general information about a material. The length of exposure time to a material (hours per week) is entered on this tab. "Unknown" may be selected if this information is not available.



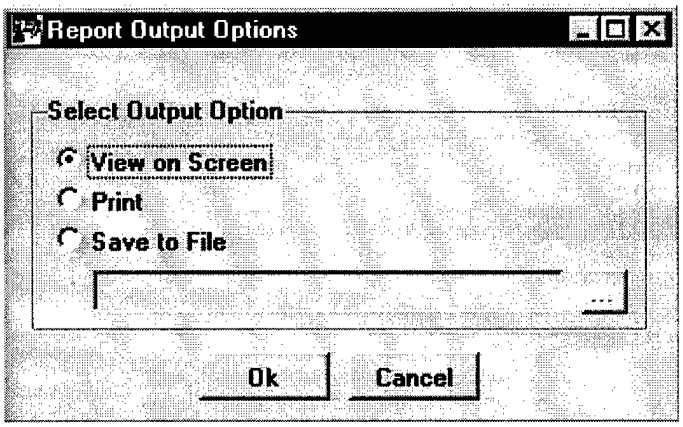
Tab 2: Chemical Data - The worst case constituent chemical for a material is selected on this tab. A material is identified as being either a mixture or a pure chemical, and reportable quantities (lbs) and permissible air emissions (tons/year) limits are entered, or "Not on List" or "Unknown" is selected, as appropriate.



Tab 3: Process - The P2 System defaults to the same process information as entered / selected for a status quo material Section 5.1.1.

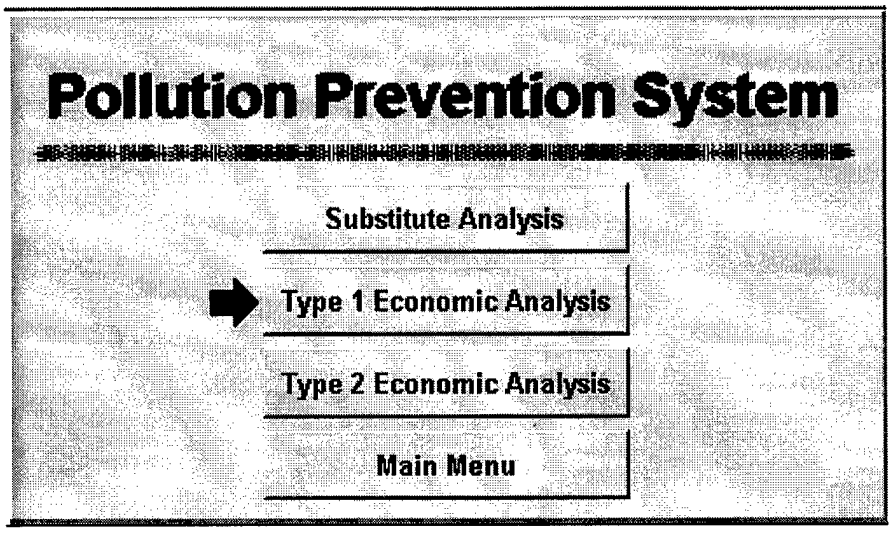


For the P2 System to perform the necessary calculations and carry out a risk analysis, the "Run Analysis" button on the Substitute Analysis screen is selected. There are three output options available, view on screen, print, or save to a file. Any or all of these options may be selected.



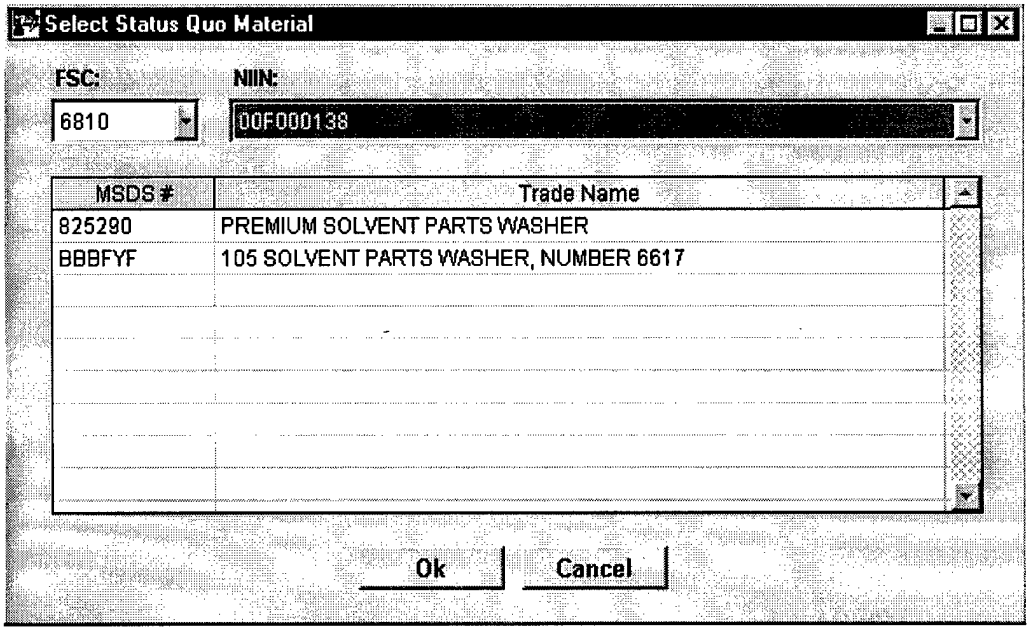
5.2 The NAVFAC P-442 Type I Economic Analysis

To access the Type I Economic Analysis format, select the Run Analyses Module from the main menu, and the Type I Economic Analysis button. This analysis may also be accessed from the Activities pull-down menu. To perform a Type I economic analysis, a thirteen digit identifier must first be assigned to each status quo and substitute process from within the System Information Module. This identifier is necessary for selecting processes for analysis, similar to the necessity of a NSN to select materials for analysis (Version 2.0 will address this deficiency). For purposes of this section, the thirteen digit identifier will be referred to as a NSN.



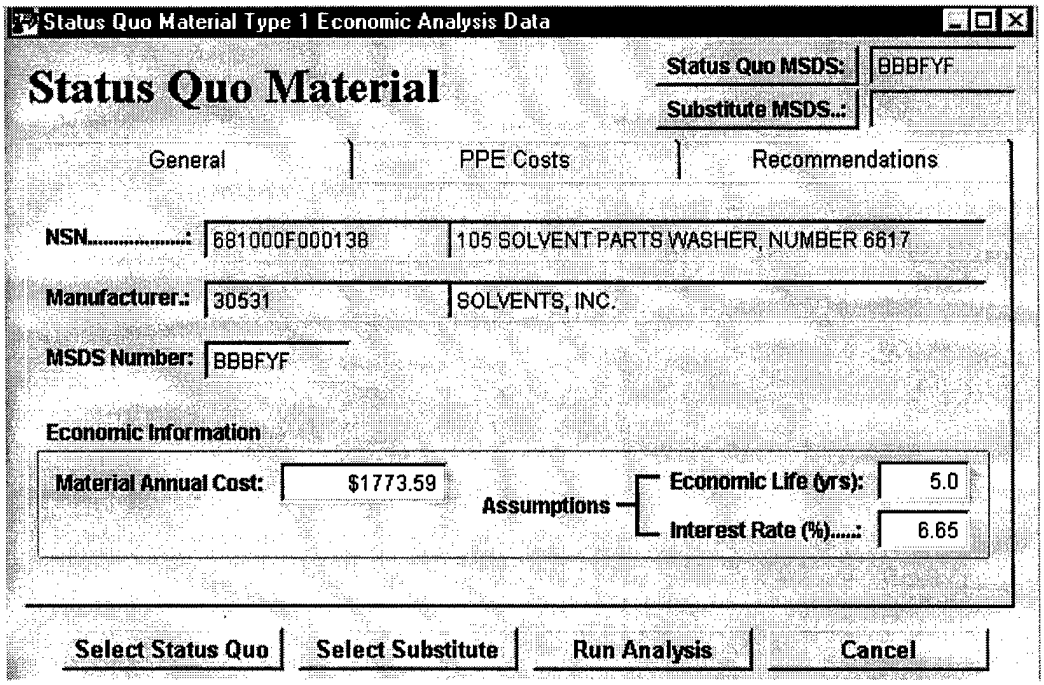
5.2.1 Selecting a Status Quo Process

To perform a Type I economic analysis, a status quo process is selected first, according to its NSN. Because different processes may have the same NSN, MSDS Numbers and Trade Names associated with a selected NSN are displayed to facilitate the identification of a desired process.

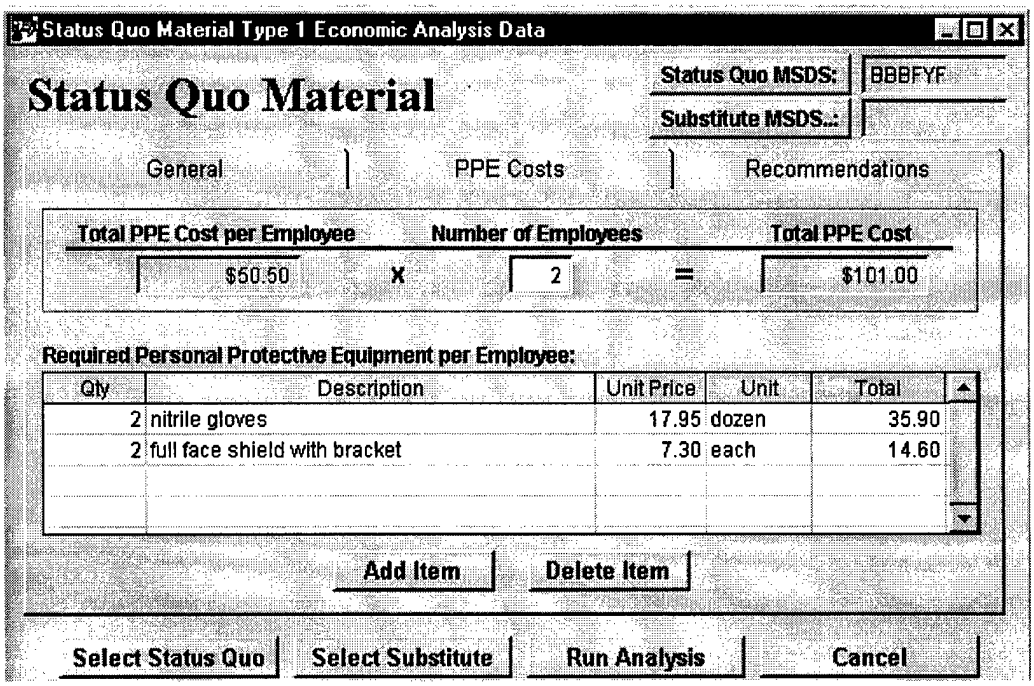


The Type I economic analysis format includes three tabs on which a minimal amount of economic data for a status quo process must be entered.

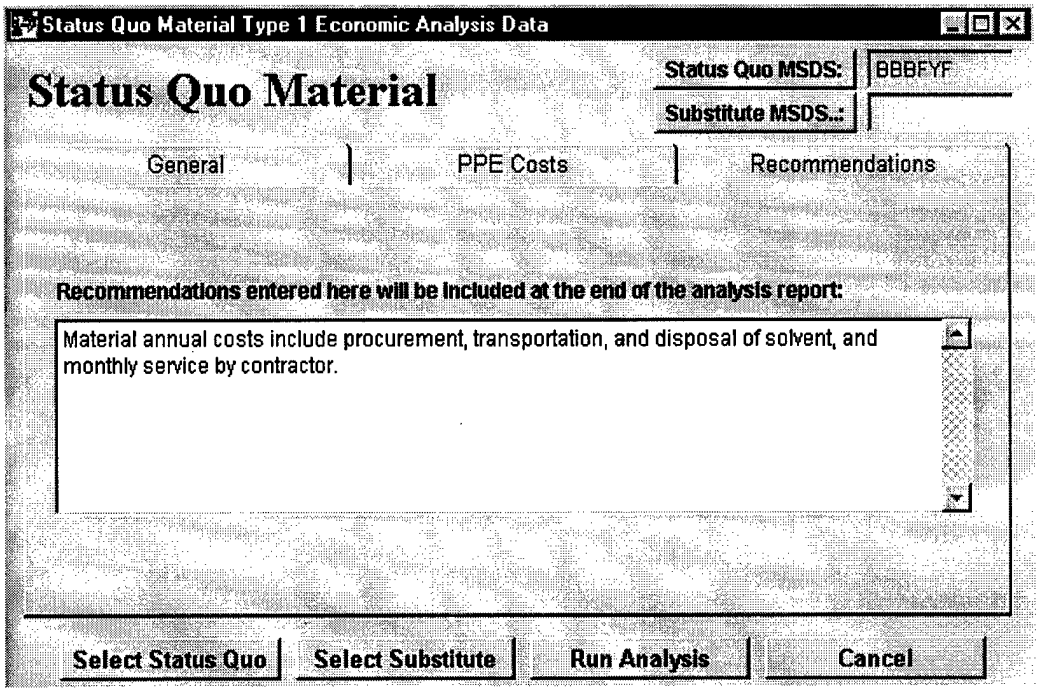
Tab 1: General - Tab 1 displays general information about a process. The material annual costs for a process (including all recurring annual costs, with the exception of PPE costs), and the appropriate economic life and interest rate, are entered on this tab.



Tab 2: PPE Costs - Annual costs for the PPE required for safe handling and use of a status quo process are entered on this tab. This information includes quantities and descriptions of each type of PPE, unit prices, and total price for each type of PPE. The number of employees for which PPE must be purchased and worn is also entered; the P2 System calculates the total PPE cost per employee, and the total annual PPE cost, accordingly.

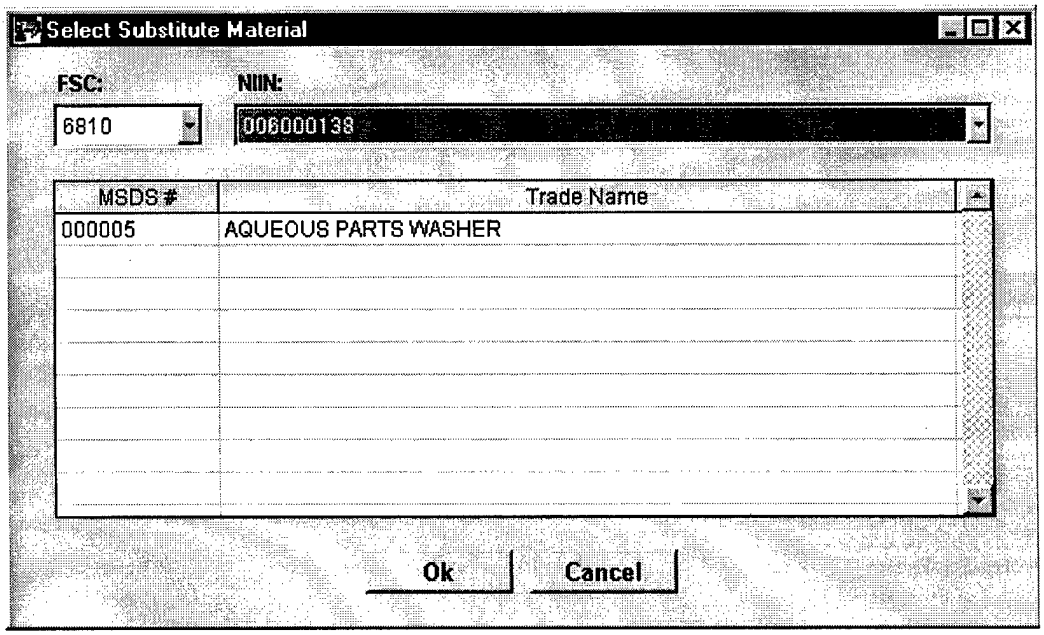


Tab 3: Recommendations - Tab 3 is an optional recommendations field. This field allows a user to identify the more cost-effective process, to address assumptions and/or engineering estimates made while performing an economic analysis, and/or to describe the individual costs factoring into an analysis. This information will appear on the Type I economic analysis worksheet.



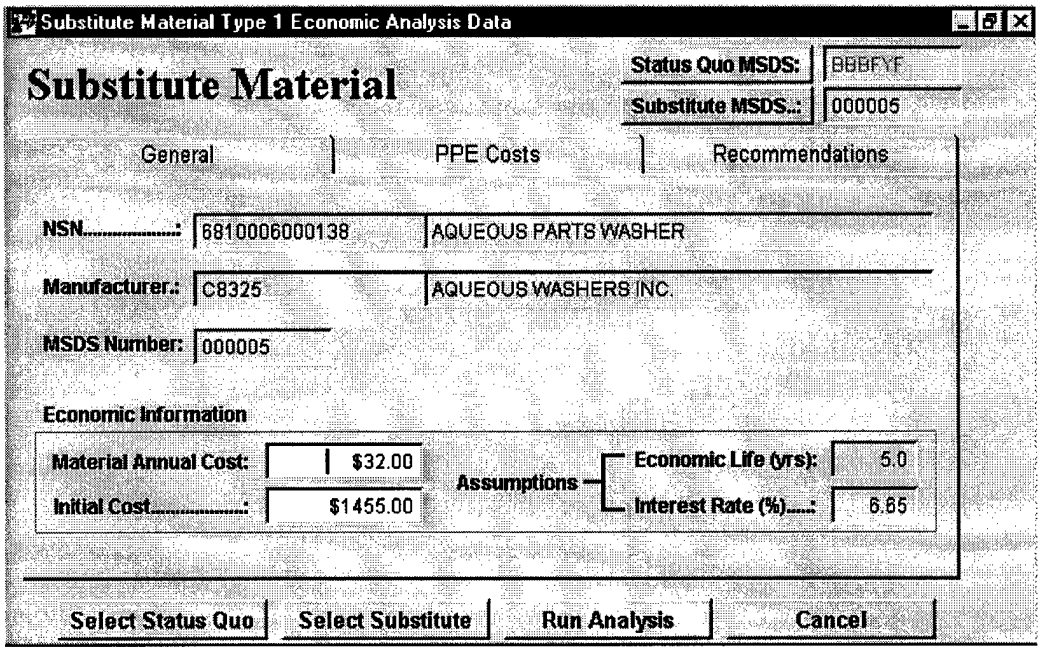
5.2.2 Selecting a Substitute Process

To complete a Type I economic analysis, a substitute process is selected according to its NSN, by choosing the Select Substitute button on the Type I economic analysis screen. As in the case for selecting a status quo process, MSDS Numbers and Trade Names associated with a selected NSN are displayed to facilitate the identification of a desired substitute process.

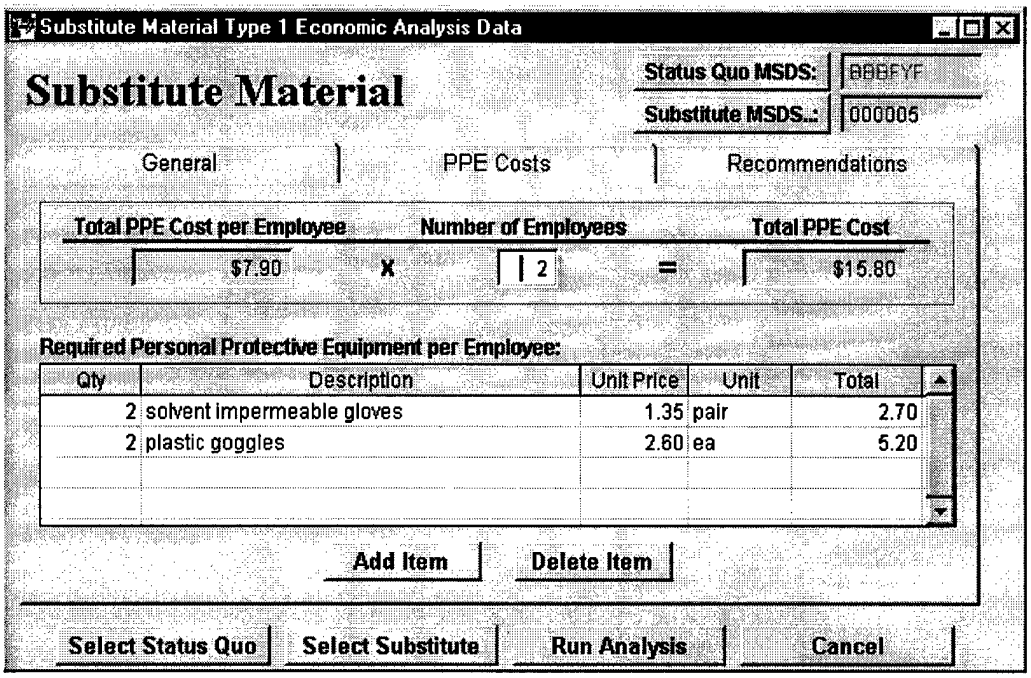


As in the case for a status quo process, a minimal amount of economic data for a substitute process must be entered on three identical tabs.

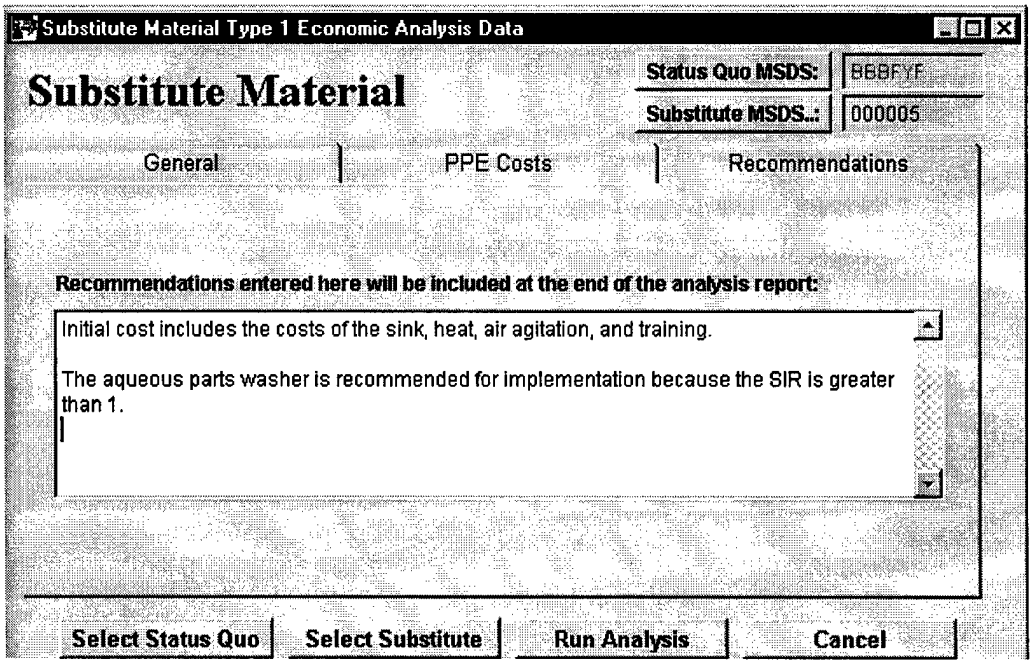
Tab 1: General - Tab 1 displays general information about a substitute process. The material annual costs (including all recurring annual costs, with the exception of PPE costs) for a process, and initial investment costs are entered on this tab. The P2 System defaults to the same economic life and interest rate entered for a status quo process in Section 5.2.1.



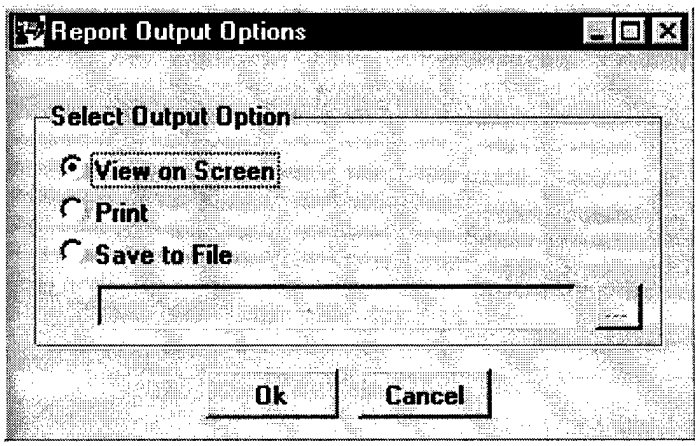
Tab 2: PPE Costs - Annual costs for the PPE required for safe handling and use of a substitute process are entered on this tab. This information includes quantities and descriptions of each type of PPE, unit prices, and total price for each type of PPE. The number of employees for which PPE must be purchased and worn is also entered; the P2 System calculates the total PPE cost per employee, and the total annual PPE cost, accordingly.



Tab 3: Recommendations - Tab 3 is an optional recommendations field. This field allows a user to identify the more cost-effective process, to address assumptions and/or engineering estimates made while performing an economic analysis, and/or to describe the individual costs factoring into an analysis. This information will appear on the Type I economic analysis worksheet.

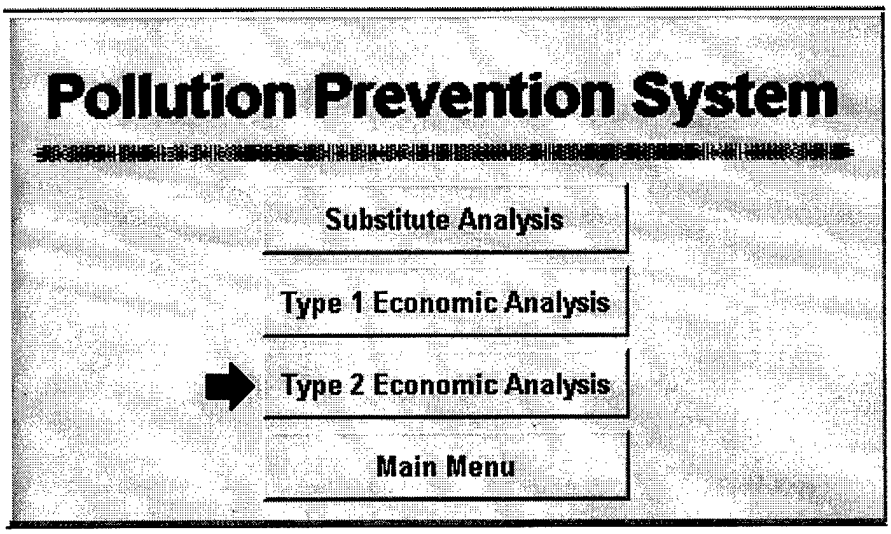


For the P2 System to perform the necessary calculations and carry out a Type I economic analysis, the "Run Analysis" button on the Type I analysis screen is selected. There are three output options available, view on screen, print, or save to file. Any or all of these options may be selected.



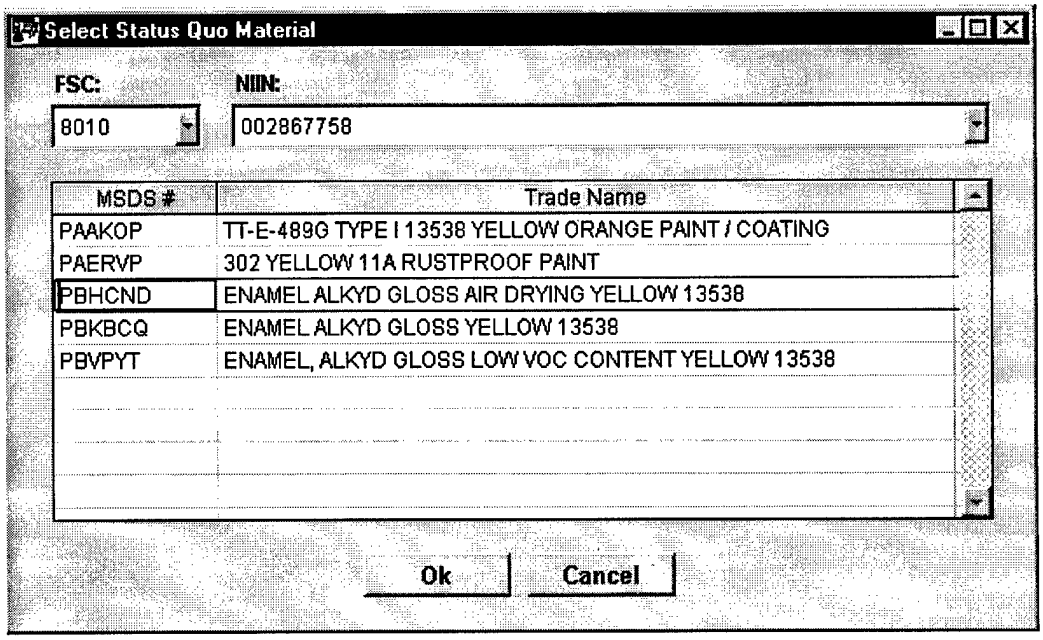
5.3 The NAVFAC P-442 Type II Economic Analysis

To access the Type II Economic Analysis format, select the Run Analyses Module from the main menu, and the Type II Economic Analysis button. This analysis may also be accessed from the Activities pull-down menu.



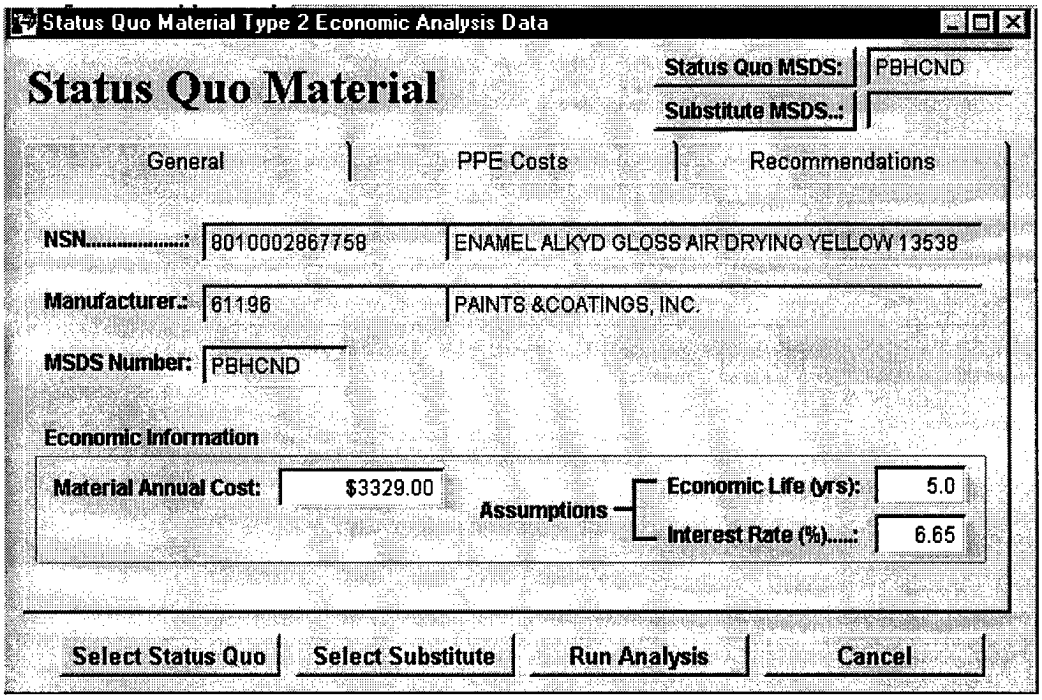
5.3.1 Selecting a Status Quo Material

To perform a Type II economic analysis, a status quo material is selected first, according to its NSN. Because different materials may have the same NSN, MSDS Numbers and Trade Names associated with a selected NSN are displayed to facilitate the identification of a desired material.

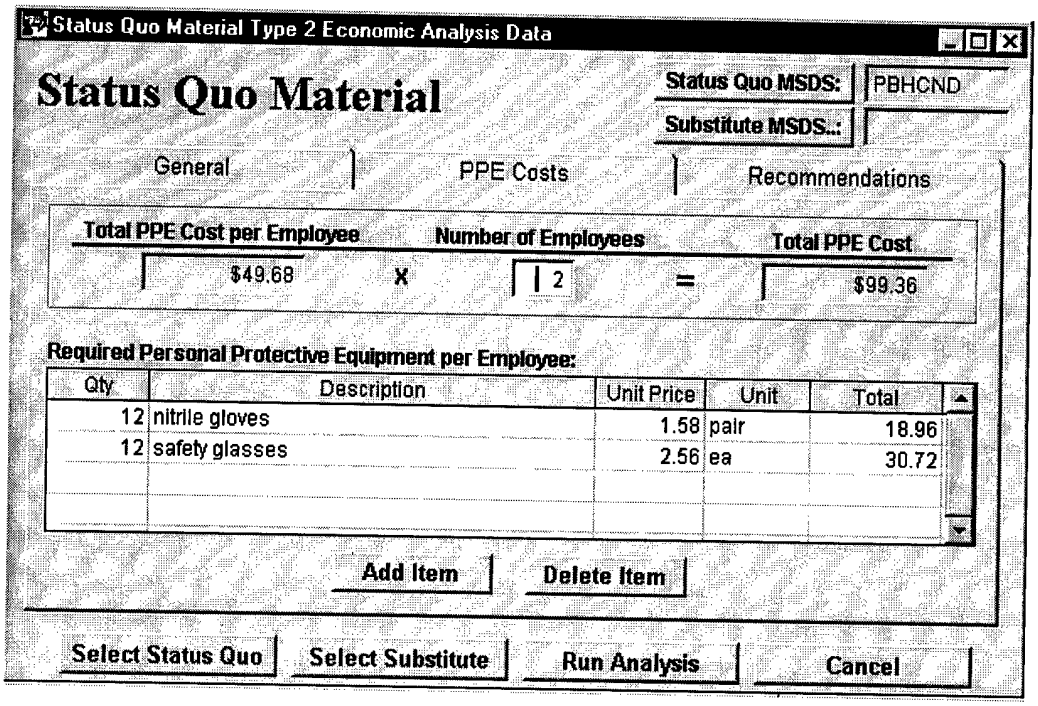


The Type II economic analysis format includes three tabs on which a minimal amount of economic data for a status quo material must be entered.

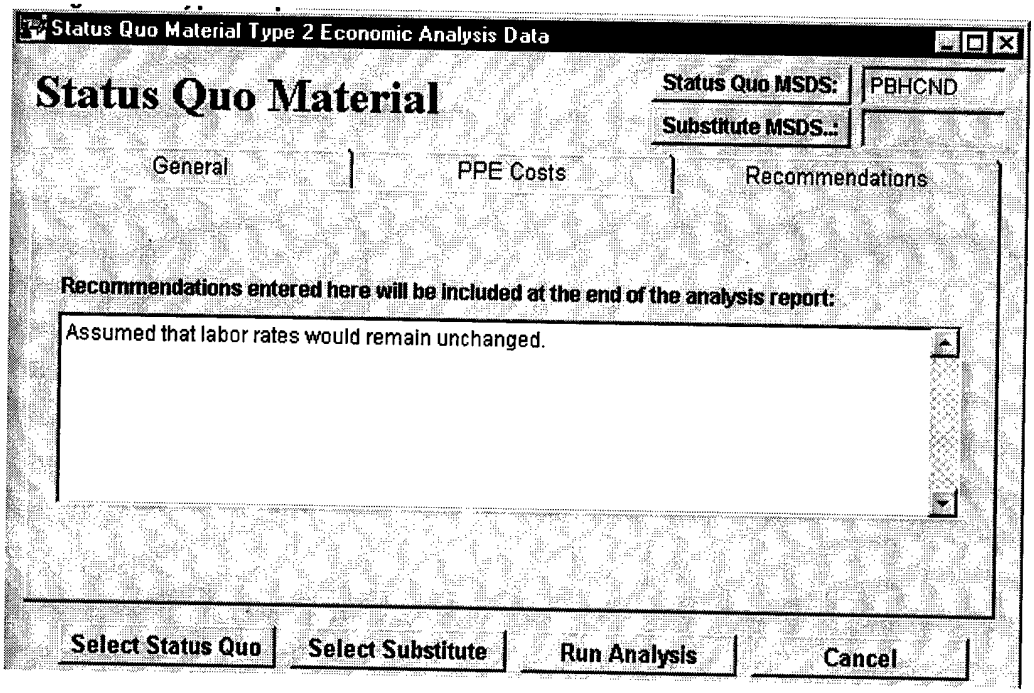
Tab 1: General - Tab 1 displays general information about a material. The material annual costs (including all recurring annual costs, with the exception of PPE costs), and the appropriate economic life and interest rate, are entered on this tab.



Tab 2: PPE Costs - Annual costs for the PPE required for safe handling and use of a status quo material are entered on this tab. This information includes quantities and descriptions of each type of PPE, unit prices, and total price for each type of PPE. The number of employees for which PPE must be purchased and worn is also entered; the P2 System calculates the total PPE cost per employee, and the total annual PPE cost, accordingly.

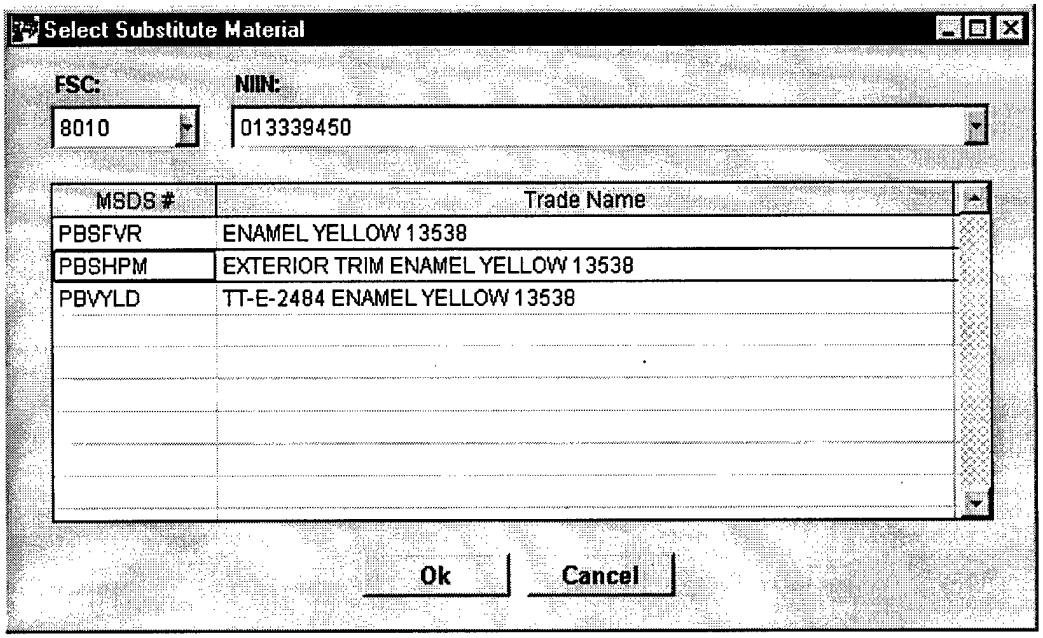


Tab 3: Recommendations - Tab 3 is an optional recommendations field. This field allows a user to identify the more cost-effective material, to address assumptions and/or engineering estimates made while performing an economic analysis, and/or to describe the individual costs factoring into an analysis. This information will appear on the Type II economic analysis worksheet.



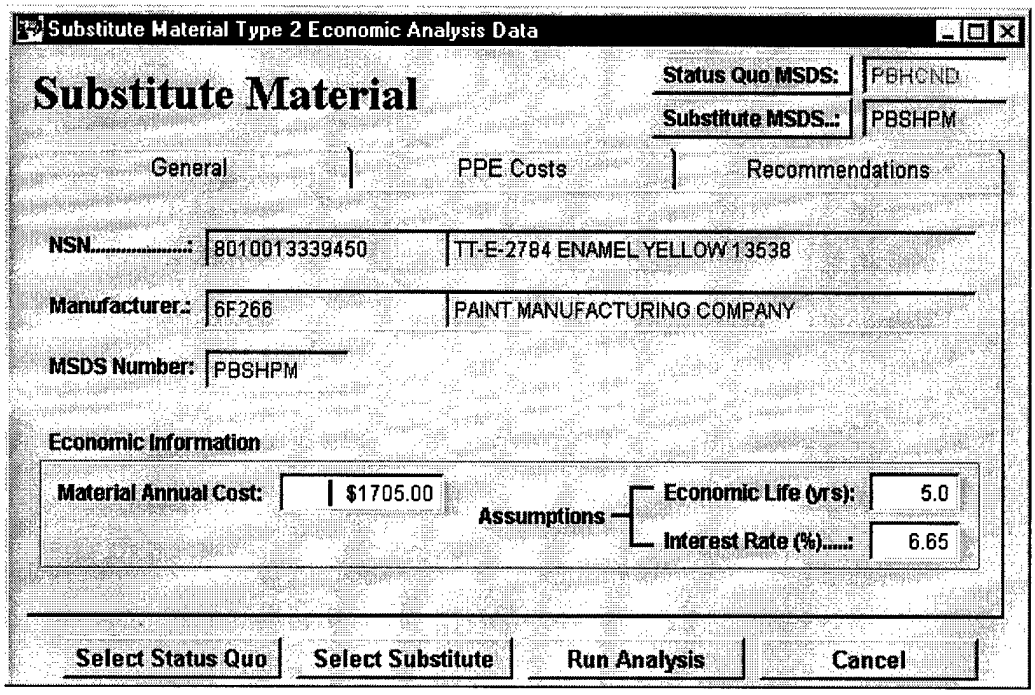
5.3.2 Selecting a Substitute Material

To complete a Type II economic analysis, a substitute material is selected according to its NSN, by choosing the Select Substitute button on the Type II economic analysis screen. As in the case for selecting a status quo material, MSDS Numbers and Trade Names associated with a selected NSN are displayed to facilitate the identification of a desired substitute material.

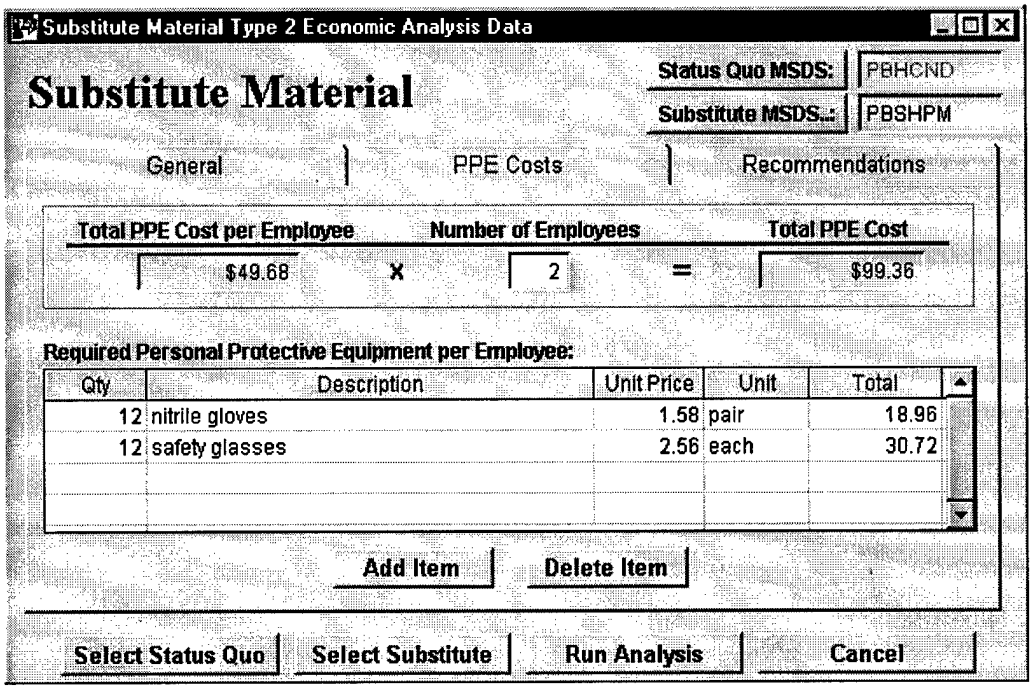


As in the case for a status quo material, a minimal amount of economic data for a substitute material must be entered on three identical tabs.

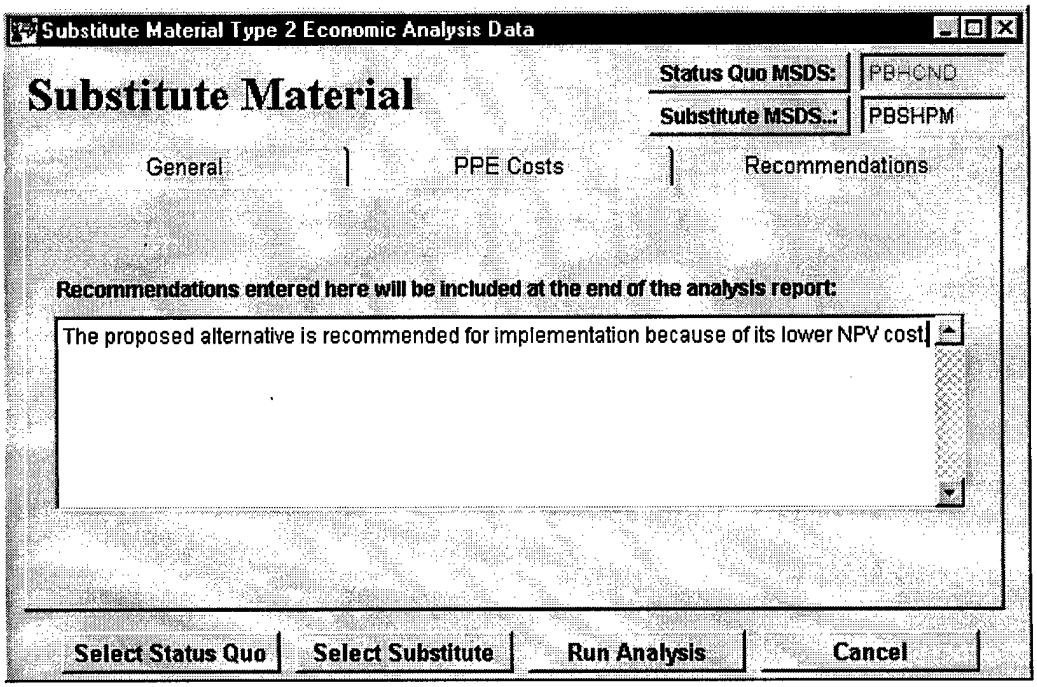
Tab 1: General - Tab 1 displays general information about a substitute material. The material annual costs (including all recurring annual costs, with the exception of PPE costs) are entered on this tab. The appropriate economic life and interest rate are also entered on this tab.



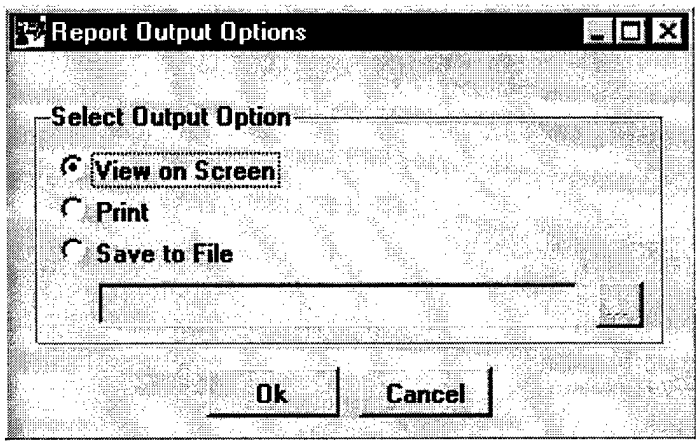
Tab 2: PPE Costs - Annual costs for the PPE required for safe handling and use of a substitute material are entered onto this screen. This information includes quantities and descriptions of each type of PPE, unit prices, and total price for each type of PPE. The number of employees for which PPE must be purchased and worn is also entered; the P2 System calculates the total PPE cost per employee, and the total annual PPE cost, accordingly.



Tab 3: Recommendations - Tab 3 is an optional recommendations field. This field allows a user to identify the more cost-effective material, to address assumptions and/or engineering estimates made while performing an economic analysis, and/or to describe the individual costs factoring into an analysis. This information will appear on the Type II economic analysis worksheet.



For the P2 System to perform the necessary calculations and carry out a Type II economic analysis, the "Run Analysis" button on the Type II analysis screen is selected. There are three output options available, view on screen, print, or save to file. Any or all of these options may be selected.



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APPENDIX C

EXAMPLES OF RISK AND ECONOMIC ANALYSES WORKSHEETS

HAZARDOUS MATERIAL SUBSTITUTION ALGORITHM WORKSHEET

Line #	ALGORITHM STEP FOR EVALUATION	Material A			Material B		
1	1. Information Needed	INFORMATION	Pts	Code	INFORMATION	Pts	Code
2	A. Candidate Material/Product Name	ENAMEL ALKYD GLOSS AIR DRYING YELLOW 13538			EXTERIOR TRIM ENAMEL YELLOW 13538		
3	B. Located on AUL?	Yes			No		
4	C. Similar Operational Use	miscellaneous applications			miscellaneous applications		
5	D. National Stock Number (NSN), if any	8010002867758			8010013339450		
6	E. MSDS, Cage Number	PBHCND, 61196			PBSHPM, 6F266		
7	F. Specific Chemical Constituent Analyzed	LEAD (20.00%)			TEXANOL (4.50%)		
8	2. Hazard Severity Code (HSC) Element						
9	A. Exposure Restrictions (PEL/TLV) (Tables 2a, 2b, & 3)	0.05 mg/m3	5		100.00 ppm	5	
10	B. Medical Effects (Table 4)	Permanent	16		Temporary	4	
11	C. Environmental Impact Attributes						
12	(1) EPA/State/Local Regulations Lists (Table 5)	Yes	8		No	0	
13	(2) RCRA Wastes Not Otherwise Listed (Table 5)	No	0		No	0	
14	(3) Federal/State Permits (Table 5)	No	0		No	0	
15	(4) Reportable Quantities (RQ) (Table 5) RQ in EPA "List of Lists"	10.00 lbs	8		Not On List	0	
16	(5) Permissible Air Emissions (Table 5) Air Emissions in 40 CFR 52.21(b)(23)	Not On List	0		Not On List	0	
17	(6) Total Environmental Impact Attributes						
18	3. Hazard Severity Code (HSC) Elements Sum of 9 + 10 + 12 + 13 + 14 + 15 + 16		37	I		9	IV
19	4. Hazard Probability Code (HPC) Length of Exposure	10.00 Hrs/wk		C	10.00 Hrs/wk		C
20	5. Hazard Risk Index (HRI) (Tables 6 & 7)			2			5
21	6. Flammable Combustible Liquids (Table 8)						
22	A. Flash Point (FP)	102.00 F			Not Listed		
23	B. Boiling Point (BP)	388.00 F			212.00 F		
24	Flammable Combustible Liquids Points		7			0	
25	7. Personal Protective Equipment (PPE) (Table 9) PPE Requirements	Eye and Skin Protection	4		Eye and Skin Protection	4	
26	8. Volatility (Table 10) Vapor Pressure (VP)	1.00 mmHg	1		23.80 mmHg	3	
27	9. Hazardous Material Selection Factor (HMSF) Sum of 18 + 24 + 25 + 26		49			16	
28	10. Material Selection Recommendation	EXTERIOR TRIM ENAMEL YELLOW 13538					

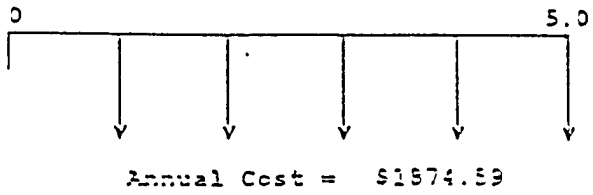
HAZARDOUS MATERIAL SUBSTITUTION ALGORITHM WORKSHEET

Line #	ALGORITHM STEP FOR EVALUATION	Material A			Material B		
1	1. Information Needed	INFORMATION	Pts	Code	INFORMATION	Pts	Code
2	A. Candidate Material/Product Name	NEOPRENE N-11 PRIMER			EF PRIMER 49		
3	B. Located on AUL?	Yes			No		
4	C. Similar Operational Use	Bonding Rubber			Bonding Rubber		
5	D. National Stock Number (NSN), if any	8030LLL010010			8030013885604		
6	E. MSDS, Cage Number	NAAAAE, 15466			PAEFPR, 61603		
7	F. Specific Chemical Constituent Analyzed	XYLOL (77.00%)			ISOPROPYL ALCOHOL (10.00%)		
8	2. Hazard Severity Code (HSC) Element						
9	A. Exposure Restrictions (PEL/TLV) (Tables 2a, 2b, & 3)	100.00 ppm	8		400.00 ppm	3	
10	B. Medical Effects (Table 4)	Temporary	8		Temporary	4	
11	C. Environmental Impact Attributes						
12	(1) EPA/State/Local Regulations Lists (Table 5)	Yes	8		Yes	8	
13	(2) RCRA Wastes Not Otherwise Listed (Table 5)	No	0		No	0	
14	(3) Federal/State Permits (Table 5)	No	0		No	0	
15	(4) Reportable Quantities (RQ) (Table 5) RQ in EPA "List of Lists"	1000.00 lbs	4		Not On List	0	
16	(5) Permissible Air Emissions (Table 5) Air Emissions in 40 CFR 52.21(b)(23)	Not On List	0		Not On List	0	
17	(6) Total Environmental Impact Attributes						
18	3. Hazard Severity Code (HSC) Elements Sum of 9 + 10 + 12 + 13 + 14 + 15 + 16		28	II		15	III
19	4. Hazard Probability Code (HPC) Length of Exposure	20.00 Hrs/wk		B	20.00 Hrs/wk		B
20	5. Hazard Risk Index (HRI) (Tables 6 & 7)			2			3
21	6. Flammable Combustible Liquids (Table 8)						
22	A. Flash Point (FP)	80.00 F			17.00 F		
23	B. Boiling Point (BP)	281.00 F			Not Listed		
24	Flammable Combustible Liquids Points		8			0	
25	7. Personal Protective Equipment (PPE) (Table 9) PPE Requirements	Eye and Skin Protection	4		Eye and Skin Protection	4	
26	8. Volatility (Table 10) Vapor Pressure (VP)	29.00 mmHg	3		173.00 mmHg	12	
27	9. Hazardous Material Selection Factor (HMSF) Sum of 18 + 24 + 25 + 26		43			31	
28	10. Material Selection Recommendation	EF PRIMER 49					

The NAVFAC P-442 Economic Analysis Model
Type I Economic Analysis Format

SAVINGS TO INVESTMENT RATIO (SIR)

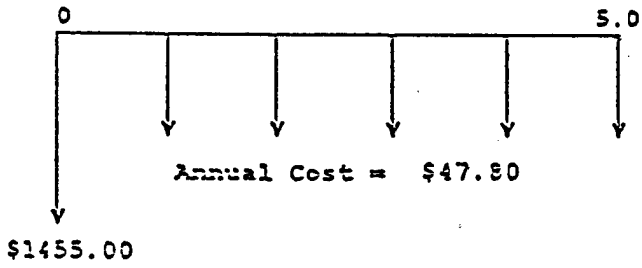
Status Quo Alternative: 105 SOLVENT PARTS WASHER, NUMBER 6617



Assumptions:

Economic Life = 5.0
Interest Rate = 6.65 %

Proposed Alternative: AQUEOUS PARTS WASHER



Assumptions:

Economic Life = 5.0
Interest Rate = 6.65 %

Project Year(s)	Recurring Cost Present	Recurring Cost Proposed	Differential Cost	Discount Factor	Discounted Cost Savings
1 -5.0	$1874.59	$47.80	$1826.79	4.13905	$7561.18

$$SIR = \frac{NPV\ (SAVINGS)}{NPV\ (INVESTMENT)} = \frac{\$7561.18}{\$1455.00} = 5.197$$

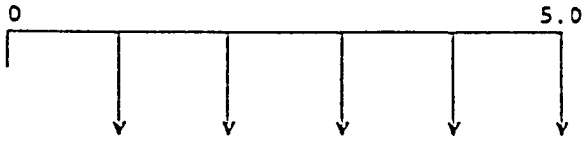
Initial cost includes the costs of the sink, heat, air agitation, and training.

The aqueous parts washer is recommended for implementation because the SIR is greater than 1.

The NAVFAC P-442 Economic Analysis Model
Type I Economic Analysis Format

SAVINGS TO INVESTMENT RATIO (SIR)

Status Quo Alternative: DISPOSE OF ANTIFREEZE

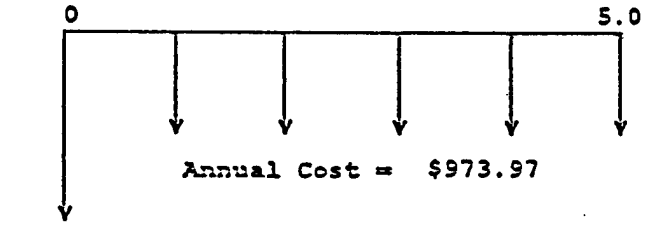


Annual Cost = $1211.18

Assumptions:

Economic Life = 5.0
Interest Rate = 6.65 %

Proposed Alternative: ANTIFREEZE RECYCLER



Annual Cost = $973.97

$1569.00

Assumptions:

Economic Life = 5.0
Interest Rate = 6.65 %

Project Year(s)	Recurring Cost Present	Recurring Cost Proposed	Differential Cost	Discount Factor	Discounted Cost Savings
1 -5.0	$1211.18	$973.97	$237.21	4.13905	$981.82

$$SIR = \frac{NPV\ (SAVINGS)}{NPV\ (INVESTMENT)} = \frac{\$981.82}{\$1569.00} = 0.626$$

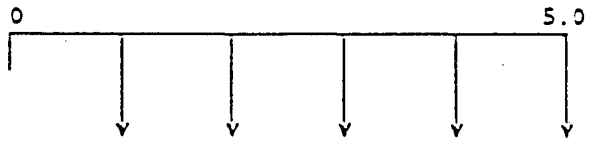
The proposed alternative is not recommended because the SIR is less than 1.

Identify another alternative for analysis.

The NAVFAC P-442 Economic Analysis Model
Type II Economic Analysis Format

NET PRESENT VALUE COMPARISON
(Equal economic lives and equal or no lead time)

Status Quo Alternative: ENAMEL ALKYD GLOSS AIR DRYING YELLOW 13538

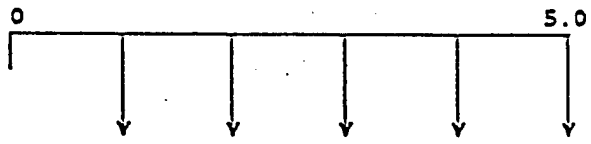


Annual Cost = $3428.36

Assumptions:

Economic Life = 5.0
Interest Rate = 6.65 %

Proposed Alternative: EXTERIOR TRIM ENAMEL YELLOW 13538



Annual Cost = $1804.36

Assumptions:

Economic Life = 5.0
Interest Rate = 6.65 %

Project Year(s)	Cost Element	Amount	Discount Factor	Discount Cost
1 - 5.0	Product and PPE	$3428.36	4.13905	$14190.15

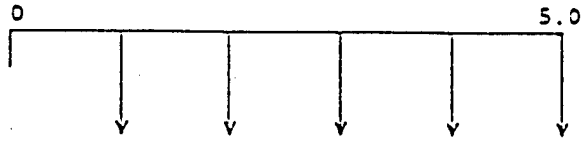
Project Year(s)	Cost Element	Amount	Discount Factor	Discount Cost
1 - 5.0	Product and PPE	$1804.36	4.13905	$7468.34

The proposed alternative is recommended for implementation because of its lower NPV cost.

The NAVFAC P-442 Economic Analysis Model
Type II Economic Analysis Format

NET PRESENT VALUE COMPARISON
(Equal economic lives and equal or no lead time)

Status Quo Alternative: NEOPRENE N-11 PRIMER

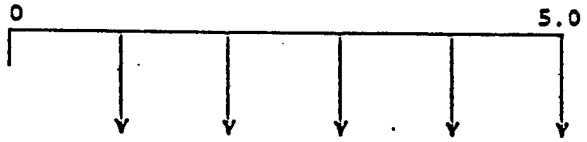


Annual Cost = $203.76

Assumptions:

Economic Life = 5.0
Interest Rate = 6.65 %

Proposed Alternative: EF PRIMER 49



Annual Cost = $1075.52

Assumptions:

Economic Life = 5.0
Interest Rate = 6.65 %

Project Year(s)	Cost Element	Amount	Discount Factor	Discount Cost
1 - 5.0	Product and PPE	$203.76	4.13905	$843.37

Project Year(s)	Cost Element	Amount	Discount Factor	Discount Cost
1 - 5.0	Product and PPE	$1075.52	4.13905	$4451.63

The proposed alternative is not recommended for implementation because of its high NPV cost as compared to that of the existing situation.

Identify another potential substitute material for analysis.

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APPENDIX D

GLOSSARY OF TERMS

Acute Exposure - A dose of HM that a person is exposed to once or over a short period of time.

Alternatives - Different means of reaching the objective or goal. In an economic analysis, objectives and goals are defined so that the consideration of different options or alternatives is not precluded.

Assets - Property, both real and personal, and other items having monetary value.

Assumptions - Judgments concerning unknown factors and the future which are made when analyzing alternative courses of action.

Authorized Use List (AUL) - The list of all HM that is required to support a command or facility. Ensures compliance with HM and HW requirements.

Benefit - Result attainment in terms of the goal or objective of output.

Benefit Analysis - Analysis to identify, measure, and evaluate the benefits for status quo and substitute alternatives.

Benefit, Direct - Result attained which is closely related with a project/program in a cause and effect relationship.

Benefit, Indirect - Result attainment circuitously related to a project/program.

Benefit, Secondary - See: Externalities

Benefit, Social - Result attained for society as a whole. Benefits which accrue to society as a result of a project/program which may or may not be conducted primarily for the benefit of those who are required to act under the program. Sometimes expressed in terms of aesthetic, recreational, and intellectual benefits. See: Externalities

Boiling Point (BP) - Temperature at which a liquid changes to a vapor state at a given pressure. For mixtures, the initial boiling point or the boiling point range may be given.

Candidate Material - Refers to a material that is being evaluated in the HM Substitution Algorithm.

Carcinogens - Substances which are known to cause, or are suspected of causing cancer.

Chemical Abstracts Service (CAS) Registry Number - A number assigned to material by the American Chemical Society's CAS. This number is used to identify specific chemicals or mixtures.

Chemical Hazard - Any chemical or material that can cause health problems, fire explosion, or other dangerous situations.

Chronic Exposure - Long-term exposure to a HM.

Combustible - A term used to classify certain liquids that will burn based on flash points. See: Flammable Liquid

Combustible Liquid - Any liquid having a flash point at or above 100 °F (37.8 °C) but below 200 °F (93.3 °C), except any mixture having components with flash points of 200 °F (93.3 °C) or higher, the total volume of which make up ninety-nine percent (99%) or more of the total volume of the mixture.

Commercial and Government Entity Code (CAGE) - A 5-digit manufacturer's identifier, consisting of a combination of letters and/or numbers.

Concentration - The relative amount of a substance when combined or mixed with other substances.

Constituent Chemical - A chemical in a mixture.

Controls - Examination of current engineering, training, work practices, management, PPE, and monitoring, to reduce or eliminate exposures.

Corrosive - A chemical that causes visible destruction of, or irreversible alterations in living tissue by chemical action at the site of contact.

Cost - The value of things used up or expended in producing a good or a service. Also the value of things that must be given up in order to adopt a course of action.

Cost, Actual - Cost incurred in fact as opposed to "standard" or projected costs. May include estimates based on necessary assumptions and prorations concerning outlays previously made. Excludes projections of future outlays.

Cost, Differential - In a Type I economic analysis, the difference in the recurring annual costs of status quo and substitute processes.

Cost, Direct - Any cost which is identified specifically with a particular final cost objective or goal. Varies with level of operation.

Cost, Discount - See: Costs, Net Present Value (NPV)

Cost-Effective Alternative (Process or Material) - That alternative(s) which (1) maximizes benefits and outputs when costs for each alternative are equal; (2) minimizes costs when benefits and outputs are equal for each alternative; or (3) maximizes

differential output per dollar difference when costs and benefits of all alternatives are unequal.

Cost Elements - Cost projected for expected transactions, based upon information available. Does not pertain to estimates of costs already incurred. See: Cost, Actual

Cost, Indirect - Any cost, incurred for joint objectives, and therefore not usually identified with a single final cost objective. Includes overhead and other fixed costs and categories of resources other than direct costs.

Cost, Initial Investment - A one-time, non-recurring cost projected for implementation of a potential alternative. May include facility investments, R&D, and the value of existing assets.

Cost, Intangible - Cost factors whose consequences cannot be quantified; influences bearing on the use of HM, which may not be reduced to monetary terms.

Cost, Life Cycle (LCC) - The sum total of the direct, indirect, recurring, nonrecurring, and other related costs incurred or estimated to be incurred, in the design, development, production, operations, maintenance, support, and disposal of a major system over its anticipated useful life span.

Cost, Net Present Value (NPV) - In a Type II economic analysis, represents all costs associated with existing HMs and potential alternatives in terms of today's dollars. Used to select cost-effective substitute materials.

Cost, Recurring Annual - Any cost identified specifically with a particular final cost objective or goal, which is expected to accrue over a one-year period. Includes the procurement of materials and supplies, transportation, and disposal.

Cost, Tangible - See: Cost, Direct

Costs, Total - Sum of fixed and variable costs at each level of output during a specified time period. See: Cost, Life Cycle

Data - Numeric information or evidence of any kind.

Degree of Hazard - Measure of how serious an exposure is based on what can happen as a result; takes into account the chemical, exposure route, dosage, number and length of exposures, and individual differences.

De Minimus - A constituent chemical with a PEL / TLV concentration that is less than 1.0 percent (1%) of a mixture, or 0.1 percent (0.1%) of a mixture where the chemical is a carcinogen.

Disbenefit - Undesirable result; an offset against positive benefits.

Discount Factor - The multiplier for any specific discount rate which translates expected costs or benefits in any specific future year into its present value.

Economic Analysis - A systematic approach for determining how to employ scarce resources and for investigating the full implications of achieving a given objective in the most efficient and effective manner.

Economic Efficiency - That mix of alternative factors of production which results in maximum outputs, benefits, or utility for a given cost; that mix of productive factors which represents the minimum cost at which a specified level of output can be obtained.

Economic Life - The period of time covered in an economic analysis. Should be the following limiting time parameters: (1) mission life, or the period over which a need for an asset is anticipated; (2) physical life, or the period over which an asset may be expected to last physically; or (3) technological life, or the period before obsolescence would dictate replacement of an existing or proposed asset.

Engineering Controls - Use of substitution, isolation, or ventilation to reduce exposure to chemical hazards and the injury or illness caused by such exposure.

Engineering Estimate - An estimate of costs or benefits based on detailed measurements or experiments and specialized knowledge and judgment.

Environmental Hazards - Relative risks imposed on the environment by a material, based on that material's toxicity, quantity used, applications, and method of entry into the environment.

Environmental Impact - The implications and effects on the environment after using HMs and generating the resultant HW.

Environmentally-Sound Alternative (Process or Material) - That alternative(s) which poses the least harm to the environment and human safety and health, relative to the existing situation.

Evaluation - An appraisal of the effectiveness of a decision made in the past.

Expenditures - Generally refers to expenses paid and all other kinds of outlays made during a fiscal period.

Exposure or Exposed - State of being open and vulnerable to a hazardous chemical in the course of employment by inhalation, ingestion, skin contact, absorption, or other course.

Externalities - Costs and benefits involuntarily received or imposed on a person or group as a result of an action by another, and over which the recipient has no control.

Extremely Hazardous Substance (EHS) - Any substance listed in Appendices A and B of 40 CFR 355, "Regulations for Emergency Planning and Notification Under CERCLA."

Flammable Liquid - Any liquid having a flash point below 100 °F (37.8 °C), except any mixture having components with flash points of 100 °F (37.8 °C) or higher, the total of which make up 99 percent (99%) or more of the total volume of mixture.

Flash Point (FP) - The minimum temperature at which a material (liquid) gives off sufficient vapor to form an ignitable mixture with the air near the surface of the liquid.

Hazard - The likelihood that a chemical or material will cause injury under circumstances of ordinary use.

Hazard Probability Code (HPC) - An indicator of the possible occurrence of exposure to a material based on the typical weekly duration of possible exposure time (in hours).

Hazard Risk Index (HRI) - An indicator of the overall risk of a material based on the HSC and the HPC, thereby assessing the material in terms of its severity and probability for exposure. The HRIs of two candidate materials are most accurately compared when their use, exposure time, application, and number of people exposed is the same.

Hazard Severity Code (HSC) - An indicator of the severity of the material, based on the medical effects, exposure restrictions, and environmental impact attributes of a material.

Hazardous Constituent - A chemical in a mixture that presents either a physical hazard or a health hazard.

Hazardous Material (HM) - Any material that is regulated as a HM per OPNAVINST 5100.23D, requires a MSDS, or which during end use, treatment, handling, packaging, storage, transportation, or disposal meets or has components which meet or have the potential to meet the definition of a HW. In general, HM is any material which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may pose a substantial hazard to human health or the environment.

Hazardous Material Selection Factor (HMSF) - The final and most important indicator of a material's environmental, safety, and health effects. It is based on the combination of addressing all of the information used to determine the HSC, plus flash point, boiling point, PPE, and volatility.

Hazardous Material (HM) Substitution Algorithm - An element of the HM Substitution Process. A step-by-step procedure and guidance to compare two or more

HMs by assigning numerical points to materials for toxicity, medical effects, environmental impact, length of exposure, fire and explosion potential, PPE and vapor pressure. The points are evaluated to assess the materials' relative hazards to the environment and human safety and health.

Hazardous Waste (HW) - Any discarded or abandoned hazardous substance which, because of its quantity, concentration, or physical, chemical or infectious characteristics may either cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or pose a substantial present or potential hazard to human health and safety or the environment when improperly treated, stored, transported, disposed of or otherwise managed.

Health Hazard - Any chemical or material that can cause illness or injury when a person is exposed by ingestion, skin or eye contact, skin absorption, or inhalation.

High Toxicity - Description applying to chemicals that can produce either life-threatening or seriously disabling health effects.

Input - Resources, including personnel, funds, and facilities utilized to obtain a specific output.

Interest Rate - Used to calculate the present value of expected yearly costs and benefits; represents the price or opportunity cost of money. See: Present Value

Investment - An acquisition of a capability or capacity in the expectation of realizing benefits.

Investment, Net Present Value (NPV) of - In a Type I economic analysis, the present value of the initial investment for an alternative, less the present value of any residual/terminal value.

Iterative Process - A series of computations in a repeating cycle of operations designed to bring the results closer to the desired outcome with each repetition.

Low Toxicity - Description applying to chemicals that produce only minor health effect; effects that usually go away with or without medical attention when exposure stops.

Material Safety Data Sheet (MSDS) - Written document that identifies a chemical material; gives its physical properties; describes known physical hazards, health hazards, and required controls; and identifies correct procedures for putting out a fire, cleaning up a spill or leak, disposing of waste, and handling/storing the material safely.

Milligrams Per Cubic Meter (mg/m^3) - Unit used to express exposure limits; defines the mass of chemical contaminant (in milligrams) allowed in each cubic meter volume of air.

Mixture - Any combination of two or more constituent chemicals if the combination is not, in whole or part, the result of a chemical reaction.

Moderate Toxicity - Description applying to chemicals that produce health effects requiring medical attention; damage may be permanent but is neither life-threatening nor seriously disabling.

National Stock Number (NSN) - A material with a NSN is to be used in the manufacture of an item on a specified parts list. The NSN consists of a Federal Supply Code (FSC) and a National Item Identification Number (NIIN).

Objective - Statement of what is to be accomplished and why, set forth in measurable terms, if possible. In analysis, objectives are stated in a manner which does not preclude alternative approaches.

Output - Project/program results such as goods produced and services performed expressed in quantities relatable to specific inputs, organizational missions, and functions; provides a basis for evaluating the productivity and efficiency of an organization or activity. See: Benefit

Oxidizer - A chemical other than a blasting agent or explosive that initiates or promotes combustion in other materials, causing fire either by itself or through the release of oxygen or other gases.

Parts Per Million (ppm) - Unit used to express exposure limits; defines parts of the chemical allowed in each one million (1,000,000) parts of the air-chemical mixture.

Payback Period - The length of time over which an investment outlay will be recovered.

Permissible Air Emissions - The specified quantity of any pollutant which, when released in excess of that amount to the environment, requires reporting under the CAA (40 CFR 52.21 (b) (23) and (b) (30)).

Permissible Exposure Limit (PEL) - The time-weighted average concentrations that must not be exceeded during any 8-hour work shift of a 40-hour work week; expressed in ppm and/or mg/m^3.

Personal Protective Equipment (PPE) - Equipment that protects an individual by placing a barrier between that individual and a hazard; includes protective eyewear, face shields and masks, gloves, boots, hats, clothing, and respirators.

Physical/Chemical Characteristics - Information on the MSDS that describes the appearance, odor, boiling point, vapor pressure, specific gravity, and water solubility of a chemical or material.

Physical Hazard - Any chemical material that can cause fire, explosion, violent chemical reactions, or other similarly hazardous situations.

Pollution Prevention (P2) - Source reduction and other practices that reduce or eliminate the creation of pollutants.

Pollution Prevention (P2) Alternative - Any material, process, system, design, or procedural change that results in a reduction of HM use and HW generation.

Present Value - The present worth of past or future costs and benefits determined by applying discount procedures to make alternative projects/programs comparable regardless of time differences in the money flows. See: Discount Factor

Reactivity - A chemical reaction with the release of energy; undesirable effects such as pressure buildup, temperature increase, etc. may occur because of the reactivity of a substance to heating, contact with other materials, etc.

Reportable Quantity (RQ) - The specified quantity of any EHS or hazardous substance which, when released in excess of that amount to the environment, requires reporting under EPCRA Section 304.

Research and Development (R&D) - Used as a last resort to identify potential substitutes for an existing HM.

Residual/Terminal Value - The estimated value of an asset at the end of its economic life.

Resources - Assets available and anticipated for operations. Includes items to be converted into cash and intangibles such as bonds authorized but unissued, people, equipment, and other things used to plan, implement and evaluate projects/programs.

Risk - The probability that a material will cause harm to the environment and/or human safety and health.

Risk Analysis - An evaluation of materials to assess the relative environmental, safety, and health hazards an alternative poses relative to the existing situation.

Savings - Reductions in costs.

Savings, Discounted Cost - See: Savings, Net Present Value (NPV) of

Savings, Net Present Value (NPV) of - In a Type I economic analysis, the present value of the reduced amount of annual expenditures from replacement of an existing process with an alternative.

Savings to Investment Ratio (SIR) - In a Type I economic analysis, the amount of savings generated by each dollar of investment in a proposed alternative; equal to the NPV of savings divided by the NPV of investment. Used to select cost-effective alternatives.

Sensitive - Pertains to a cost factor that changes significantly as a result of a change in a parameter in an economic analysis.

Shelf Life - A storage time period assigned to a material possessing deteriorative or unstable characteristics, to ensure that the material will perform satisfactorily in services. There are two types of shelf life materials:

1. Type I - Material determined through an evaluation of technical test data and/or actual experience to be an item with a definite non-extendible period of shelf life.
2. Type II - Material having an assigned shelf life time period that may be extended after completion of an inspection, test, or restorative action.

Solubility in Water - The ability of a material to form a homogeneous solution with water.

Specific Gravity - Refers to the weight of a solid or liquid substance, compared to the weight of an equal volume of water.

Stability - The ability of a material to remain unchanged.

Status Quo Material - An existing HM for which environmental, safety, and health data are collected for risk analysis; referred to as Material A on the HM Substitution Algorithm Worksheet.

Status Quo Process - An existing process for which economic data are collected for a Type I economic analysis.

Substitute Material - A potential substitute material for which environmental, safety, and health data are collected for risk analysis; referred to as Material B on the HM Substitution Algorithm Worksheet.

Status Quo Process - A potential substitute process for which economic data are collected for a Type II economic analysis.

Substitution - An engineering control that involves replacing a chemical, material, process, or piece of equipment with less hazardous or non-hazardous one.

Systemic Poisons - Attack specific organs or systems of organs, sometimes with toxic mechanisms.

Systemic Toxicity - Adverse effects caused by a substance which affects the body in a general rather than local manner.

Test and Evaluation (T&E) - Used to determine the suitability of a candidate material to satisfy a needed or intended use; includes laboratory testing and field engineering studies.

Threshold Limit Values (TLV) -The time-weighted average concentrations for a normal 8-hour workday and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect; expressed in ppm and/or mg/m^3.

Time-Weighted Average (TWA) Exposure - The airborne concentration of a material to which a person is exposed averaged over the total exposure time, generally the total workday (8 to 12 hours).

Time Zero - Year 0 or the base year; all estimates of costs and benefits are made in terms of the general purchasing power of the dollar in the base year.

Toxic Chemical - Any substance listed in 40 CFR 372, "Toxic Chemical Release Reporting Regulations."

Toxicity - The ability of a chemical to cause injury once it reaches a susceptible site in or on the body.

Trade Name - The trademark name or commercial trade name for a material or product.

Type I Economic Analysis Format - Evaluates potential process changes to determine whether an existing situation should be changed to take advantage of dollar savings available through another alternative.

Type II Economic Analysis Format - Evaluates potential material substitutions to determine which of several P2 alternatives will most economically satisfy an unmet need or a deficiency.

Uncertainty - State of knowledge about outcomes in a decision which is such that it is not possible to assign probabilities in advance.

Unit Price - Cost of any type, per unit of output.

Vapor Pressure (VP) - Refers to the pressure built up in the limited space above the liquid by escaping molecules (vapors) of the material.

Volatile Organic Compound (VOC) - A photochemically reactive organic compound which evaporates readily under normal temperature and pressure conditions. As a result

of the tendency to evaporate readily, VOCs are primary contributors to the formation of ground level ozone.

Volatility - A measure of how quickly a substance forms a vapor at ordinary temperatures.

Working Capital - Money tied up in liquid funds, assets on hand, or assets on order, generally in some form of inventory of consumables or similar resources held in readiness for use or in stock. Working capital changes that result from implementation of a proposed alternative can be positive, representing additional funding requirements, or negative, representing a reduction in funding requirements.

Worst Case Constituent Chemical - In a mixture, the constituent chemical with the lowest listed TWA PEL / TLV, which is selected for the environmental impact attributes evaluation portion of the risk analysis; does not include a constituent chemical that is of de minimus concentration.

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APPENDIX E

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MIL-STD-1388-2B, DoD Requirements for a Logistic Support Analysis Record.

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