Analysis of the Electronics Department: improving efficiency and standardizing procedures

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Improving Efficiency and Standardizing Procedures in the Electronics Department

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SUMMARY

A research and development facility, such as the Institute for Ocean Technology (IOT), is continuously searching for areas for improvement. With projects following a detailed schedule, and demanding the availability of facilities and highly educated personnel with ocean engineering expertise, requires an efficient environment. Therefore, it is essential to ensure that the procedures, within each individual department, are operating effectively and according to predetermined standards. In order for a research and development facility to maintain its success, the evaluation of each separate facility is required.

The Electronics department previously recognized the need for change in order to run a more effective department. The evaluation of the consumables inventory control, equipment, plant layout, and a documentation requirement was a step in the right direction. This resulted in the offer of recommendations that would improve efficiency and standardize procedures in the Electronics department. The department has maintained the electronics aspect of successful ocean engineering projects for many years, but this does not imply that the operation sand procedures are the most effective.

Observation from a manufacturing engineering student who has studied many aspects of industrial engineering, offers a new perspective on ideas for improvement. To continue with the commitment to improve the department, while incorporating the recommendations of this report, would greatly benefit the entire institute.

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I would like to take this opportunity to thank NRC – Institute for Ocean Technology (IOT) for providing a Manufacturing Engineering Technology student with the opportunity to be part of their research and development facility.

In addition I would like to acknowledge the persons involved in making this report possible. Fortunately, the entire Electronics group at IOT contributed to my analysis of the their department. I evaluated various components of the department where I offered recommendations to improve efficiency and standardize procedures. This is an aspect that requires the commitment of all employees; therefore, it required a contribution of everyone for the completion of this report. However, I would like to extend a special thanks to the Quality Systems Group, Pat Dunphy and Walter Tilley, for their respect for my opinion and their assistance in completion of this report.

Although much of the contribution was through my own observation and involvement, it was made possible by management and the technical officers in the Electronics department.

Thank You

Summary

A research and development facility, such as the Institute for Ocean Technology (IOT), is continuously searching for areas for improvement. With projects following a detailed schedule, and demanding the availability of facilities and highly educated personnel with ocean engineering expertise, requires an efficient environment. Therefore, it is essential to ensure that the procedures, within each individual department, are operating effectively and according to predetermined standards. In order for a research and development facility to maintain its success, the evaluation of each separate facility is required.

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Improving Efficiency and Standardizing Procedures in the Electronics Department

1.0 INTRODUCTION

1.1 Background

The Institute for Ocean Technology (IOT) is one of 20 research and development institutes and programs located across Canada, which combine to form the National Research Council of Canada (NRC). IOT, an international leader in ocean engineering research, conducts research through "modeling ocean environments, predicting and improving the performance of marine systems, and developing innovative technologies that bring benefits to Canada's marine industries."[1] The facilities utilized for such testing includes the Offshore Engineering Basin, Towing Tank, Ice Tank, Cavitation Tunnel, Model Milling Machine, and Yacht Dynamometer. In addition to the outstanding facilities, the institute is equipped with a group of exceptionally talented people who excel in the study of various aspects of ocean technology.

Research and Development (R&D) plays an important role in developing new products and advancing technology. Partnerships between industry, government, and university researchers exist for the purpose of improving science and technology. Many large organizations in industries such as electronics, chemicals, aircraft, and automotive maintain extensive R&D groups. High costs are involved in performing R&D because expensive equipment and highly qualified personnel are essential.

IOT's facilities section is divided into several groups such as Mechanical/Naval Design and Fabrication, Software Engineering, and Electronics and the overall project interaction[2] is depicted in Appendix A (pp.A-1). Typical projects involve design, fabrication, and testing of large-scale models in open ocean environments. The engineering design and functionality of a project depends on the organization of each

[1] www.imd.nrc.ca
[2] Appendix A – Graphical Representation of Overall Project Interaction

department, and how it interfaces with neighboring departments. To ensure that the Electronics department is operating effectively and utilizing standard procedures, this department must be evaluated thoroughly.

1.2 Electronics Department

The Electronics department consists of one Shop Operations Supervisor, four level III Technical Officers and one level II Technical Officer. This group interfaces with the other facilities groups throughout the project research and development offering their guidance and expertise in the electronics aspect of each project.

The group recognizes the advantage to improve efficiency and standardize internal procedures, which in turn, would benefit the entire institute. The proposal to improve the Electronics department initiated the involvement of the Quality Systems Group (QSG) in the internal evaluation. This permitted the QSG to offer suggestions to guide the evaluation and implementation process to meet the requirements of the quality system. This initial proposal was to focus mainly on documentation in the Electronics department and generate a documentation system. However, with the guidance from the QSG and the Electronics supervisor, this proposition was tailored to fit the actual scope of this report. This presented a new outlook on the evaluation of the Electronics department by examining various aspects of the department and suggesting improvement possibilities.

The Electronics group is responsible to design, assemble, and test any electronics utilized in test models and equipment. The successful completion of a project requires a combination of organizational and managerial skills with expertise in the ocean technology research and development field. Department supervisors need defined systems, procedures, or practices to guide the processes. This study is limited to the examination of the consumables inventory control in section 2.0, equipment in section 3.0, plant layout in section 4.0, and documentation requirements in section 5.0 and their relationship with project development, which will identify areas that need improvement.

Improving efficiency and standardizing procedures in these facets of the Electronics department is the first step to "providing quality services in efforts to define, interpret, and meet or exceed requirements." [3]

2.0 CONSUMABLES INVENTORY

Inventory control can be defined as the management of the supply, storage and availability of items to ensure a sufficient quantity. To monitor the availability of parts, an inventory system must be developed, and maintained. This will not only organize the inventory within a department, it will also provide all other departments with the necessary information regarding the availability of parts.

The consumables inventory is composed of supplies that are bought regularly because they wear out or are used up, such as resistors, connectors, cable, cleaners, and chemicals. The inventory is stored on industrial shelving, storage bins, and cabinets that will be further discussed in section 2.3 Consumables Inventory Storage and Disposal. This inventory, which contributes to the fabrication of electronic aspects of a project, is called a manufacturing inventory. These materials are essential in the successful completion of a project and should be readily available upon request. All inventories must be effectively monitored with a controlled system that has demonstrated to be an effective method for the environment in which it exists.

In order to evaluate the consumables inventory in the Electronics department at IOT, a complete review of the existing control process is essential to provide an accurate study. This also involves the examination of problems that occur periodically, and the storage and disposal practices for the consumables inventory. This is clearly outlined in section 2.1 Consumables Inventory Control, section 2.2 Consumables Inventory Inefficiencies, and section 2.3 Consumables Inventory Storage and Disposal.

[3] IOT Quality Policy (located on the intranet web page)

2.1 Consumables Inventory Control

To facilitate the evaluation of the consumables inventory, a questionnaire was developed and distributed to all the Electronics technical officers to ensure accurate information was gathered regarding the consumables inventory. The feedback[4] from questionnaires provided more than enough information to determine the consumables inventory processes. So this poses the question, how is the consumables inventory in the Electronics department controlled?

The entire Electronics group is responsible for the control of the consumables inventory, which really indicates that the inventory is not controlled with certainty. Although, there are processes established, this does not guarantee that they are the most effective. However, it has been recognized that the consumables inventory should be evaluated in order to implement a more effective system. A system must be created to fit the needs of the environment at IOT, where many inventory control industry standards do not apply and cannot be enforced.

Because IOT manufactures various components for many of their projects, there tends to be an emphasis on enforcing manufacturing techniques. However, after a careful review of production planning in a manufacturing environment, it is clear that the inventory management standards do not apply in the Electronics department. IOT is a research and development facility and, although it is very similar to manufacturing facilities, it is also very different. This makes it very difficult to supply a clear-cut answer to the problems.

Because IOT is a research and development facility, the projects requirements differ each time they are produced, upon which the organization of resources and coordination of tasks using management techniques is required. It is evident that ongoing projects at IOT particularly differ from the fabrication of products in a

[4] Appendix B – Consumables Inventory Questionnaire Feedback

manufacturing facility. While IOT does not have the main characteristics of a manufacturing facility, the project development still involves design, manufacturing and fabrication for completion. In order to gain from a consumables inventory system with the integration of industry standards, the characteristics of projects at IOT must be determined.

Electronics Projects

- No consistency in project flow.
- Flexibility is very high.
- Unique Products.
- Cost is high and often varies.
- Expertise and Talent requirement very high.
- Quantity is normally limited to one.

The processes relating to the consumables have been summarized to clarify the level of the inventory control. These processes were clearly outlined in the response from the consumables questionnaire, which was carefully reviewed. And although it appeared that the entire Electronics group was aware of the established inventory control processes, they do not completely adhere to these processes; therefore the processes need to be reviewed.

Current Ordering Process

Check the stock to determine what needs to be ordered.

OR

Record items that need to be ordered on the white board in the lab.

Retrieve the part number of the item from the bins, the catalog, or online.

Determine the quantity of parts and price of the order based on budget constraints or project requirements.

Create a purchase order (PO) and obtain the appropriate approval signature (Electronics supervisor or Project Manager)

AND

Obtain a PO number from the Finance department.

Order the parts.

Current Invoicing Process

Record all consumable parts removed from the inventory on the Electronics Shop Consumable Control Sheet[5].
Transfer this information into an excel spreadsheet with the correct pricing
Forward the information to the Finance department.

Other than an incomplete custom database, there is no electronic system used to control the consumables inventory. There is no specified ordering point and a safety stock is not monitored, or maintained. Although an actual ordering process has been established, there is no process regarding when the ordering should be carried out, which is the real control of the inventory. There is no particular individual responsible for controlling this inventory because it was decided that it was best to share the responsibility between everyone in the lab. As a result there is very little control of the consumables inventory within the Electronics department, which causes inefficient use of employee time and a negative work environment. These inefficiencies require some modifications for improvement, which are detailed in the following sections.

[5] Appendix C - Electronics Shop Consumable Control Sheet

2.2 Consumables Inventory Inefficiencies

Although the inefficiency of the consumables inventory control has not caused any chaotic events relating to project delays, this does not mean that it is the most effective system. The Electronics group has a negative attitude toward the ordering and billing processes because it tends to be tedious and time consuming. Evidently, it is imperative that an improvement of the consumables control be emphasized. The current invoicing procedure has been left unattended for at least 9 months, and it is now too late to invoice for the consumables removed from the inventory during this time. As a result, there has been a capital loss and an increase in frustration toward the consumables control. If this task had been designated to one of the Electronics group members, this loss could have been prevented. These are simple tasks that can be scheduled monthly and will not consume a great deal of time. In order to implement an effective inventory control system, the problems with the existing processes must be determined and resolved. This requires the examination of the inventory control practices, which is detailed in section 2.2.1 Inventory control proposal, section 2.2.2 Supplier relationships, and section 2.2.3 Consumables inventory database.

2.2.1 Inventory control proposal

The consumables inventory should be the responsibility of one individual and be strictly controlled. The task of ordering stocked items should be scheduled on a regular quarterly basis and be completed by one individual on behalf of the Electronics group. Any additional ordering that is unscheduled and requires immediate attention should only be executed after consulting the consumables inventory representative. This does not require a formal meeting; it only involves is a quick e-mail or conversation. If an individual is assigned to control the consumables, it is only fair to ensure they are aware of ongoing activities concerning the inventory. Incorporating this into the current ordering process would be a step in the right direction; however, until the inventory is more easily controlled it would be unreasonable to designate a representative at this time.

To acquire the most effective system requires the incorporation of some industry standards with respect to inventory control. In order to maximize the system effectiveness, the existing process must be redefined with the integration of industry standards. Materials Requirement Planning (MRP) is a form of inventory management, which is a computerized information system commonly practiced in a manufacturing environment. This technique is used to plan and manage manufacturing inventories with three key inputs: master production schedule (MPS), inventory records, and bill of materials (BOM). However, this system does not exactly apply to the operations that take place at IOT. The MPS is the amount of complete products that must be produced in order to meet the anticipated demand and the BOM is a structured parts list illustrating the relationships between components and the amount of parts required during assembly.[6]

However, there are many techniques of the inventory control industry standards that can be used in order to structure a system to meet the requirements of the research and development facility. These practices would help to configure an inventory control system that would be effective, consistent, and practical.

Proposed Inventory Control Techniques

INVENTORY FILES (electronic or paper)

Inventory records should be established for all the consumables in the Electronics department including the part numbers, quantity on-hand, quantity on-order, pricing, suppliers and lead-time. This information should be incorporated in the consumables database that continues in the developmental stages.

SAFETY STOCK

A safety stock is determined and maintained to reduce stockouts caused by the variation in demand. The safety stock for each component varies according to the

[6] Applied Production and Operations Management, Fourth Edition (text)

frequency of use. A simple way to maintain this stock is to label bins and shelves with the amount of parts that should be on hand. In order for this system to work, everyone removing the items from these bins and shelves must be conscientious of this and request an order for any items that are below their specified safety stock. This request can be recorded on the white board in the Electronics lab so the consumables inventory representative will be aware that a part must be ordered.

SCHEDULED INVENTORY CHECK

A scheduled inventory check would ensure the safety stock for each component is maintained and verify that the parts removed from inventory are accounted for on the Consumable Control Sheet. However, once everyone utilizing the consumables inventory becomes accustomed to these procedures, this task may become redundant.

By using some of these techniques when creating an inventory control system, it will make the new system effective and reliable, which will greatly benefit the Electronics department. It would be beneficial to implement these recommendations on a trial basis to determine the effectiveness of the system, and this would provide the Electronics group with the opportunity to make any additional changes. If the inventory control revisions are taken seriously, the outcome will provide the Electronics department with an efficient control system.

2.2.2 Supplier relationships

Suppliers are vital in the progress of a project whether it's in a manufacturing facility or a research and development facility. It is imperative that suppliers and dealers form a friendly, but professional, relationship based on trust. This is important because the operations at IOT depend on the availability of the resources required to complete a project. Once a good relationship is established, the reliance on suppliers becomes easier.

Supplier and Dealer Relationships

GET TO KNOW SUPPLIERS

Become familiar with suppliers – speak on a first name basis and be able to recognize suppliers over the telephone and in person if possible.

DETERMINE EXPECTATIONS

Outline expectations of both parties to avoid any confusion.

The Electronics group at IOT deals with a range of companies that provide a variety of parts needed to complete projects. These companies vary from local companies to international companies based on the nature of the part required. Although, IOT strives to deal with local companies, occasionally international business is unavoidable. In addition, IOT must follow strict government procedures for purchasing. Since IOT commenced in 1985, they have had almost 20 years to develop strong relationships with their suppliers and it is crucial that these relationships continue. It is essential that the suppliers are punctual, well informed, and most importantly, reliable.

2.2.3 Consumables inventory database

Presently, there is an incomplete electronic system that was developed with the intent to implement an ordering and invoicing system for the consumables inventory. Continuing with the development of this database with the goal of implementing the system is a step in the right direction. However, the continuation of this project should be discussed and reviewed with the QSG to ensure that this goal meets the overall goals of the institute. It would be disheartening for the Electronics group to waste time and effort developing a system that would eventually be dominated by a new global system within the institute. Otherwise, the implementation of this system on the basis that it would serve only as an internal tool to control the consumables inventory would be beneficial to the Electronics department and the entire institute.

The initial step to continuing with this process is establishing the status of the incomplete database[7] and determining if it will meet the internal goals of Electronics department and the external goals of the institute. Once this is accomplished, the project can be assigned to the appropriate individual and the completion and implementation date can be scheduled.

2.3 Consumables Inventory Storage and Disposal

2.3.1 Consumable parts

The storage of the consumable parts in the Electronics department is reasonably organized with proper industrial shelving, cabinets, and storage bins. However, to maximize the storage area for the consumable parts requires at least four scheduled cleanup days. This is discussed further in section 4.0 Plant Layout. This section focuses on the designation of a specific consumables storage area and some quick fix solutions to optimize the storage area within the department.

Contradictory to the storage of the consumable parts, the disposal of these items does not pose as an issue for the Electronics department. Most of the consumable parts are discarded through regular garbage disposal and transported to the public waste disposal site. Any parts that could pose a threat are dismantled or disabled before being placed in the trash, for example connectors are removed. However, there is an issue with the disposal of batteries, not only in the Electronics department but also throughout the entire institute. There are documented battery disposal procedures available on the Government of Newfoundland and Labrador website which also links to The 'Battery Act' from the United States Environmental Protection Agency.[8] These references provide the information necessary to begin disposing of batteries properly.

[7] Appendix D – Electronics Consumable Database Description
[8] Appendix E – Battery Disposal Processes

2.3.2 Hazardous materials

All IOT employees are required to perform their duties in a safe and efficient manner as per the national hazard communication system for Canada, Workplace Hazardous Materials Information System (WHMIS). The three main components of this system are the supply of material safety data sheets (MSDS), labeling hazardous products with cautionary information, and educational training programs.[9] The objective of this system is to provide the appropriate health and safety information to workers so that the necessary safety measures will be taken to avoid injury, illness and death.

During normal operations in the Electronics lab, approximately 70 hazardous materials[10] are on hand and should be stored in a secure area and labeled accordingly. The WHMIS binder containing all the MSDS files should be readily accessible, and remain in its designated location at all times. Any facility must take the appropriate precautions to ensure the safety of all their employees. As a result, the Electronics group recognized the need to deal with this matter, and have it resolved.

Steps to Complete the WHMIS Task

Designate an appropriate area to store the hazardous materials and WHMIS manual.

Clean out the area by removing any items not classified as hazardous materials.

Organize the products according to category, manufacturer, etc.

The MSDS manual is presently updated and requires the designation of a new location to ensure the manual is readily accessible to the Electronics group. To ensure consistency, one representative should be assigned to maintain the manual, which is not time consuming, nor difficult. The chemicals still remain stored in several different

[9] www.hc-sc.gc.ca/hecs-sesc/whmis
[10] Appendix F – Hazardous Materials List

areas, which is an issue that should be considered. The task of organizing an area to store the hazardous materials should be assigned immediately to completely resolve this matter. Any concern regarding the storage or disposal of these materials can be resolved by referring to the WHMIS manual.

3.0 EQUIPMENT

In any research and development facility, the equipment is the backbone of the actual completion of a successful project. The equipment, which can be defined as any electronic or mechanical device, plays a major role in the success of the planning and execution of all projects. The equipment is used for modeling ship systems, data acquisition and other various project requirements.

The equipment used in the successful completion of projects at IOT is classified into the following categories.

- Acceleration
- Angle
- Communications
- Computer
- DAS
- Displacement
- DYNO
- Gyros
- Load Cells
- Motor Controllers
- Pressure
- Remote Control
- Test Equipment
- Tools
- Wave Height

An Electronics technical officer either allocates equipment to a project during their design or assembly of components, or authorizes a piece of equipment to be removed from the lab by a project representative. The Electronics department has approximately 1350 pieces of equipment, which supports the ocean engineering research accomplished at IOT. In order to improve the efficiency and standardize procedures within the department, the electronic equipment requires a thorough examination of the current equipment control procedures which is described in section 3.1 Equipment Control and section 3.2 Equipment Inefficiencies.

3.1 Equipment Control

The Electronics department at IOT has developed an Electronic Equipment Database in order to control the movement of equipment throughout the institute. Although the database requires some additional modifications, it is quite capable of controlling the equipment. The database is structured so the equipment information can be searched using various forms of tracking information such as a barcode, serial number, model number, name, manufacturer, etc. The system is designed to record the location and status of each piece of equipment in order to provide a better service internally and externally. This system is globally available within the institute where the information can be viewed through the internal website at IOT. However, the availability of such a system is only as effective as the individuals controlling the administrative aspects. Like the consumables inventory, the entire Electronics group is responsible for the control of the equipment. Control procedures have been established with the utilization of the database to effectively monitor the equipment; however, the database is not effective if individuals do not conform to these procedures.

The equipment control procedures are clearly outlined in the form of a flowchart in Appendix G (pp.G-1), Equipment Flow.[11] In addition these processes are outlined in detail below.

EQUIPMENT "SIGN OUT" PROCEDURE:

Obtain the required equipment from the storage area.
Perform the standard functional check for the equipment (these functional checks vary according to the type of equipment).
Sign out the equipment using the Electronic Equipment Database.

EQUIPMENT "SIGN IN" PROCEDURE:

Sign in the equipment into quarantine on the database.

[11] Appendix G – Equipment Flow

Place the equipment in the quarantine area.

Perform the standard functional check for the equipment (these functional checks vary according to the type of equipment).

Place the equipment back in the storage area.

QUALITY SYSTEM:

Equipment moved from the storage area for a project

Contains a yellow tag that displays – DO NOT USE UNTIL CALIBRATED.

Equipment moved from the Electronics lab for a project

Contains a yellow tag that displays – DO NOT USE UNTIL CALIBRATED.

Contains an INSPECTED tag that has been dated.

Equipment calibrated for a project

The yellow tag is replaced with a green CALIBRATED tag that has been dated.

Equipment returned from a project

The green tag and inspected tag is replaced with a yellow – DO NOT USE UNTIL CALIBRATED.

The system that has been created offers a very effective method to the control of the equipment control in the Electronics department. And although there are some areas for improvement and flaws in this system, it provides a structured management of the equipment.

3.2 Equipment Inefficiencies

In order for an equipment control system to work successfully, the importance of the system must be enforced so everyone involved is aware of the expectations. A strong commitment from management would compel the Electronics group, and the entire IOT group, to dedicate their efforts to ensuring that all processes are followed according to the set standard. Unfortunately, even with the availability of a very capable control system with respect to the equipment, inefficiencies exist. These inefficiencies are

described in section 3.2.1 Policy enforcement, 3.2.2 Database additions, and 3.2.3 Equipment maintenance.

3.2.1 Policy enforcement

The National Research Council is well equipped with a strong management team who are highly educated and dedicated to ocean engineering research. Dr. W. E. Deming, founder of the Total Quality Management (TQM) approach, recognized the importance of an effective management team as outlined in the following points, extracted from Deming's 14 Points.[12]

- Break down barriers between departments. People in research, design, sales, and production must work as a team, to foresee problems of production and in use that may be encountered with the product or service.
- Create constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business, and to provide jobs.
- Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

In order to maximize the equipment control system, several processes must be enforced and followed to keep the system working efficiently. If management dedicated some time to ensure that the database and other equipment procedures were being utilized properly, in a synchronized fashion the equipment control inefficiencies would be eliminated. The utilization of the database, the application of the quality tagging system, and the procedural operations must be deemed as standard policy within the lab for the system to be efficient. This requires an emphasis on the following elements.

[12] http://www.deming.org/theman/teachings02.html

The equipment information must be clear and accurate in the database for the system to work effectively on the internal web page for the entire institute.
The information entered into the database (such as the loan status and working condition) must be accurate and modified if necessary.
The time at which the equipment is signed out must be acknowledged with a specified return date.
The overdue items must be recognized and recorded for invoicing purposes.
The database must be always used to control the equipment.
Upon accepting returned equipment, a record of project equipment should be printed as a checklist to verify that all pieces are there.

The current inefficiencies with respect to the equipment control need to be addressed in order to maximize the equipment control system. This involves following the set standard procedures and using the quality system properly. This improvement, and the additions discussed further, would create an equipment control system that exemplified consistency and reliability for the entire institute.

3.2.2 Database additions

The Electronics Equipment Database is structured to control the equipment efficiently and accurately. It is an excellent method to control equipment and it helps to keep the Electronics group organized and knowledgeable with respect to the status of their equipment. However, the group is very familiar with the electronic system and has recognized some imperfections that should be eliminated to improve the system. These changes,[13] illustrated in Appendix H (pp.H-1), were discussed with the Software Engineering Group to determine the level of difficulty of the modifications and an implementation time. In addition, a questionnaire was generated to determine the overall opinion of making some changes to the database in order to provide a more

[13] Appendix H –Electronic Database Improvements

user-friendly system for the entire institute. The response[14] from this questionnaire was common among the participants and all comments and suggestions were considered. The Software Engineering Group is aware of the request for changes to the database; however, it has not been dealt with at this time. These changes should be distinguished as a higher priority and addressed in the near future, to continue with the improvement of the equipment control.

3.2.3 Equipment maintenance

Preventive maintenance proposes the idea of performing practical maintenance tasks in order to prevent unscheduled equipment problems. The establishment of a Preventive Predictive Maintenance (PPM) program has become more widespread in the industrial environment. The PPM program not only prevents breakdowns, it also predicts when the breakdowns will occur which enables certified technicians to fix the problem before it escalates. It has been proven that a PPM program saves time and money, which are the fundamentals of any organization. Once a program is in place, it eliminates the cost of unscheduled maintenance and downtime. In addition, statistics confirmed that the cost to implement a PPM program is actually equal to the accumulated cost of unscheduled maintenance for only one year. Therefore, these funds can be used to implement and sustain an effective maintenance program.

The Electronics department continuously performs functional verifications on the equipment during project research and development. This can involve troubleshooting a problem, replacing parts, or recalibrating for accuracy, which are tasks performed on a regular basis. However, the Electronics group does not document any of these operations using a standard format. It may be recorded on a sheet of paper that eventually disappears or buried in a daily logbook, never to be seen again. This is not an effective approach to the documentation of the maintenance performed on the equipment in the Electronics department.

[14] Appendix I –Equipment Database Modifications Questionnaire Feedback

The consequences of not documenting maintenance tasks includes the following:

- Wasted time
- Increased costs
- Lost project time
- Complaints
- Increased troubleshooting costs

Although a full-fledged PPM program is not necessary to monitor the maintenance performance, some elements of this type of program can be used to develop the most effective system to meet the requirements of the Electronics environment. In addition, the group has previously identified some of the initial components of a PPM program. The equipment function, description, and parts list can be found in the equipment files maintained in the lab. The implementation of a maintenance log would be the first step to establishing a standard maintenance program. By recording maintenance tasks, troubleshooting attempts, and the results would be worthwhile and beneficial to the Electronics group. Although it may take a substantial amount of time before the benefit becomes evident, once the maintenance log has been in place long enough it will build a maintenance history for each piece of equipment. The fundamental result of a maintenance log is lower maintenance costs, reduced downtime, and increased productivity and reliability.

Currently there is no tracking system in place to monitor the maintenance performed on the equipment, where a maintenance log would eliminate this problem. This system would eventually provide enough information to draw conclusions on equipment problems. It would answer the following questions.

Has this happened before?
How was it fixed?
Has there been a similar problem with other equipment?
Are there reoccurring problems with a type of equipment?
Who has experience with this type of problem?

How much time will it take to fix it?

How much will it cost?

With a maintenance log in place and a history of equipment failures available, these questions will be answered quickly and accurately. And eventually, the history will help in the establishment of scheduled inspections and part replacement in order to prevent reoccurring problems with the equipment.

4.0 PLANT LAYOUT

The recent renovations and additions to the IOT building in the last year have provided the Electronics group with the opportunity to utilize a complete new office area, while continuing to maintain most areas which were previously designated for their department. With these changes, the Electronics department can now focus more on the details involved in fine-tuning their designated areas which is described in detail in section 4.1 Existing Layout of the Electronics Department and section 4.2 Layout Inefficiencies.

The Electronics department is outfitted with two main areas that are completely isolated from each other, the Electronics lab and the office area. These areas can be further divided into each specific section outlined in Table 1.0 – Electronics Department.

Electronics lab consists of:	**Electronics office area consists of:**
The lab	3 occupied offices
1 occupied office	1 unoccupied office
2 storage rooms	An open cubical area (without the actual cubicles)
A mezzanine storage area	

Table 1.0 – Electronics Department

Any additional changes with respect to the layout of the Electronics department must be thoroughly evaluated in order to implement the most efficient layout. This involves the

careful consideration of plant layout, ergonomics, and the physical capacity of the designated areas. Plant layout "encompasses the design and location of production lines, machinery and equipment, inventory storage and shipping facilities."[15] Optimizing department layouts can improve a facility's ability to operate effectively with a well-organized workflow, improved safety and reduced costs. The implementation of an effective, feasible layout would positively affect inventory control, process flow, and the general organization within the Electronics department. In addition, ergonomics involves the creation of a working environment to fit the people in it. Following ergonomic principles, such as avoiding long reaches or muscle overloading, helps reduce stress and eliminates potential injuries within the workplace. Designing tasks, workspaces, tools, and equipment to fit the employee's physical capabilities and limitations creates an ergonomic environment.

4.1 Existing Layout of the Electronics Lab

As previously identified, there are several areas within the Electronics department, which requires a detailed description in order to evaluate the existing layout, and offer recommendations. To optimize the layout, the Quarantine area and Storage area must be defined and its purpose must be supported with valid reasoning, which is discussed in section 4.1.1 and 4.1.2.

4.1.1 Quarantine area

The Quarantine Area is designated for the equipment returned from a project, which can be categorized as follows.

A) Equipment returned from a project, which has not been "checked in" on the inventory database.

[15] www.eng.buffalo.edu/Research/tcie/fr-plant.htm

B) Equipment returned from a project, which has been “checked in” on the inventory database but not functionally checked.

C) Equipment returned from a project, which has been “checked in” on the inventory database and functionally checked, but is not working properly and requires further repairs.

As a result of the broad classification of equipment in the current Quarantine Area, it is common for the area to be overcrowded and disorganized. Equipment is frequently left on the floor or left on workbenches, which creates an extremely cluttered workspace. The Quarantine Area acts as two separate areas, the actual “quarantine area” and the “damaged equipment area”.

The purpose of the Quarantine Area is to store equipment that had been returned from project testing, and requires a functional verification. It is actually a short term holding area for the equipment that requires decommissioning. The decommissioning can vary from a functional check to verify that a component is working properly to dismantling an item to salvage parts and check components. To repair the damaged equipment a technical officer must troubleshoot the problem, verify if parts are available, or determine the future of the equipment. However, it is evident that the current state of the Quarantine Area must be evaluated and the purpose of the area should be defined and enforced.

4.1.2 Storage area

The storage areas, for the Electronics department, holds equipment and parts in the following categories:

A) Electronics Equipment (load cells, motor controllers, etc.)

B) Electronics Testing Equipment (oscilloscopes, multi-meters, etc.)

C) Electronic Consumable Parts (resistors, cable, etc.)

D) Hazardous Materials (cleaners, sealant, etc.)

The existing storage area does not distinguish between the storage of each type of equipment or parts. The storage area consists of the lab, two storage rooms, and mezzanine, which provide the Electronics department with a large area enabling the implementation of a first-rate storage system. Although, the Electronics department is equipped with a large area for storage, an organization system that separates each category has not been implemented.

4.2 Layout Inefficiencies

After careful analysis, the ineffectiveness of the layout of the lab became clearly evident. To those who have become accustomed to the layout, it may seem to be very effective. This is only because there is a tendency to easily become very content with your surroundings, and to change what is second nature to people poses a problem. However, many of the inefficiencies are caused by poor organization and storage, which only requires a quick fix to solve the problems discussed in section 4.2.1 Short-term solutions. Although there are other areas of concern that requires a longer-term dedication to eliminate the inefficiencies discussed in section 4.2.2 Long-term solutions.

4.2.1 Short-term solutions

Short-term solutions provide a quick way to improve the layout with very little planning or dedication. The Electronics group should address some organization problems prior to any renovations of the actual layout. Good organizational skills and logical thinking are required while incorporating the following principals: accessibility of supplies, maximizing the use of space, and improving safety.

After evaluating the layout of the Electronics department, the following problems were identified and recommendations for improvement were offered.[16]

A) Organization of Cable Spools

There are approximately 25 spools of cable that have gathered in the storage rooms of the Electronics department. Subsequent to the scheduled Cleanup Day, the spools were moved to the second storage room and placed under the industrial shelving. In spite of the efforts made on the Cleanup Day, the storage of the spools is not maximizing the use of space. They now occupy a relatively large area, approximately 5 shelves (13 ft of wide by 2ft deep).

A more efficient solution to the cable spool storage would be the Cable Reel Racks that are illustrated in Appendix J (pp.J-1). The racks are available in a floor model and a wall-mounting version and can be purchased, or manufactured internally. Either option would provide the Electronics with more storage shelving and offer a more orderly storage area.

B) Shelving Organization

Cardboard boxes are frequently used as storage bins on the shelves in the storage area. These boxes are not built to withstand the wear and tear of a storage room; they buckle, tear and fall apart. There is also the possibility of a cardboard box being filled with small, heavy items and the box may collapse when removed from a shelf. This can result in damaged equipment or a serious injury. A quick and easy solution is to replace these cardboard boxes with industrial bins that would eliminate the problem with shelving organization as illustrated in Appendix J (pp.J-3).

[16] Appendix J – Short-term Solutions

C) Wasted Space

In the storage room adjacent to the Electronics lab there are four very large shelves that contain four storage bins. As illustrated in Appendix J (pp.J-5), there is space wasted while having these storage bins placed on these shelves. These bins should be mounted to the wall, which would free the shelving space for a more practical use.

D) Loose Cable Organization

There is a large amount of cable used within the Electronics department, which results in the accumulation of loose cable pieces. These pieces are obviously useful to projects at IOT but can be left unattended for long periods of time. Because projects are generally unique or sporadic, some materials are not used for a very long time; however, this does not mean the materials are scrap. Nevertheless, it does mean that the storage of these types of items should be well organized.

One answer to this problem requires first determining which cable is still valuable to the Electronics operations, and then finding a method of storing the cable. Cable ties offer a very neat organizational option, which would manage the loose cable issue. The lab already has various types of plastic cable ties in stock; however, the technical officers use electric tape more often. It is possible that the implementation of the more durable ties, as illustrated in Appendix J (pp.J-6), would aid in the organization of the loose cable.

4.2.2 Long-term solutions

Long-term solutions to the layout inefficiencies involve much more dedication and commitment from the Electronics group and management. It requires the physical rearrangement of equipment and relocation of various areas; which in turn would, result in the implementation of new processes. Proceeding with any long-term solutions

would result in the completely restructuring the department and would be an ideal solution.

A) Structure of the Electronics Lab

As outlined in section 4.1 Existing Layout of Electronics Lab, there are two designated areas in the Electronics lab with respect to the equipment flow through the lab. These areas, Quarantine and Storage, are definitely necessary to maintain the control of equipment in the lab; however, the implementation of additional areas would further organize the operations within the lab. This implementation is clearly summarized in a flowchart format, which is easy to read and comprehend.[17]
The following is a list of areas with detailed descriptions on how they would support a new layout for the Electronics department.

- **Inventory Storage** would be designated to hold only the inventory, including equipment and consumables.
- **Reserved Equipment** would store equipment that has been verified or prepared for a specific project and has been "signed out" on the inventory database.
- **Quarantine Area** would be a temporary holding area for equipment that has been returned from a project and requires a functional check or inspection.
- **Damaged Equipment** would be the designated area for equipment that is not functioning properly and requires further attention.
- **Disposal** would be a holding area for equipment pending approval to be discarded.

The implementation of these designated areas in a new layout of the lab would greatly benefit the Electronics department. It would generate a working environment similar to that created in a manufacturing facility by focusing on the flow of operations and

[17] Appendix K – Plant Layout Organization

procedures. This is clearly identified in 4.2.2 Long Term Solutions, Part B) New Layout Proposal.

B) New Layout Proposal

In addition to the sort-term solutions for the Electronics department layout inefficiencies, there are also some long-term solutions that would unquestionably enhance the entire layout. These long-term solutions require a great deal of effort and commitment from management and the Electronics group to facilitate these changes. These changes are depicted in the following plant layout drawings[18]

- Existing Electronics Layout (DWG NO. 2004-001)
- Ideal Electronics Layout (DWG NO. 2004-002)
- "2nd Best" Electronics Layout (DWG NO. 2004-003)

5.0 DOCUMENTATION REQUIREMENTS

Documentation requirement for the Electronics department refers to establishment of an internal system to standardize the documentation of electronics aspects of project development. This documentation system primarily involves the documentation of internal procedures and work instructions. In addition, the system involves the documentation of project development and procedures. The group recognized the benefit of documenting the details of a project and creating a paper trail of information for future reference.

5.1 Documentation Procedures

Documentation is writing technical reports, keeping maintenance logs, sending e-mails, filing project information, and estimating the work breakdown structure. This information

[18] Appendix L – Plant Layout Drawings

relates to the project research and development documentation in each facility at IOT. The Electronics group is aiming to establish a standard system to capture the electronics aspects of the ocean technology projects completed at the institute.

The Electronics group has discussed generating project documentation by producing lab memos after the completion of each project. Lab memos "are reports intended primarily for internal use to document preliminary or partial research results, proposals, surveys, procedures, descriptions of instrumentation, computer programs, user manuals or other substantial information of general interest".[19] An electronic template has been created on the electronics drive as a guide for the group to follow so the documentation conforms to an internal standard. A technical officer created this template in an attempt to make the documentation process more efficient. This provides a great opportunity to initiate the implementation of documentation requirement system.

5.2 Documentation Requirement Proposal

The Electronics group has not conformed to any specific approach in attacking the documentation processes in their department where it would be beneficial to consider any suggestions in the decision-making. It would be advantageous to temporality continue with the current approach to control the documentation and then improve on this system to fit the needs of the environment. The implementation of paper files with metal bindings for the project filing system would also be helpful in controlling the file information. In addition, the use of NRC notepads would also help in the tracking of project information. These notepads are complete with a NRC header, where the project number, project name, date and other valuable information can be recorded.

As a result of time constraints, the element documentation requirements was not one of the main focal points in improving efficiency and standardizing procedures in the

[19] IOT Reports – Style Guide (located on the intranet web page)

Electronics department. This is an issue that requires more intense concentration in the future.

6.0 RECOMMENDATION, IMPLEMENTATION, AND ACTION

Throughout the work term, recommendations were offered in an attempt to improve efficiency and standardize procedures within the Electronics department, and some action resulted. This section summarizes all recommendations and the current implementation status. It also contains the details of the any future action required to complete the desired upgrading for each topic.

6.1 Consumables Inventory

Recommendations:

1. Follow the current ordering process by using the white board in the lab to record items that need to be ordered
2. Follow the current invoicing process by assigning the task to a technical officer and scheduling it to be completed on a monthly basis.
3. Configure an inventory control system with the integration of the following industry standards: inventory files, safety stock, and scheduled inventory checks.
4. Determine the best time for ordering stocked items, and assign and schedule the task to a technical officer.
5. Continue to maintain strong relationships with suppliers.
6. Resume the development of the consumables inventory database and schedule a completion date and an implementation date.
7. Implement proper battery disposal processes.
8. Complete the WHIMS tasks by updating the availability of MSDS, designating an area to store the hazardous materials, establishing an appropriate location for the WHMIS manual, and assign an individual to maintain the manual.

Implementation Status:

The current ordering process and invoicing process concerns have been addressed by cleaning the white board and designating a section for consumables ordering and an individual has been tasked with the responsibility of the invoicing process, which is scheduled as a monthly task. The status of the consumables inventory database has been identified and a discussion of the completion of the database has occurred; a more detailed discussion is pending. The WHMIS manual has been updated and an effective home location for the manual would be next to the eyewash station in the lab.

Future Action:

1. Develop an inventory control system with the integration the industry standards previously identified as outlined in section 2.2.1 Inventory control proposal.
2. Implement the electronic consumables database.
3. Implement the proper battery disposal processes.
4. Assign an individual to maintain the WHMIS manual and ensure that it is readily available at all times. An effective location would be next to the eyewash station in the lab.

6.2 Equipment

Recommendations:

1. The importance of the equipment control system to work as a global system within the institute requires the commitment from the entire management team.
2. The utilization of the database, the application of the quality tagging system, and the procedural operations must be deemed as standard policy within the lab for the system to be efficient.
3. The changes to the Electronic Equipment Database must be categorized as a higher priority, which would enable the continuation of the improvement to equipment control.
4. A type of maintenance program must be implemented with the incorporation of a maintenance log.

5. Upon the return of equipment from a project, print a record of project equipment to ensure that all pieces are returned.

Implementation Status:

With the implementation of a newly defined Quarantine Area and Damaged Equipment Area, the utilization of the database and quality tagging system will be more effective. The request for changes to the database has been submitted to the Software Engineering Group and is pending an implementation date. Included in these changes is the request for the incorporation of a maintenance log to begin the process of gaining a maintenance history for the equipment. A maintenance log has been created by an Electronics technical officer and is currently under review. This would include temporarily storing these logs on the electronics drive until the database modifications are addressed.

Future Action:

1. Task the Electronics Equipment Database modifications as a higher priority to enable the continuation with the improvement of equipment control.
2. Encourage proper utilization of the database.
3. Upon the return of equipment from a project, print a record of project equipment to ensure that all pieces are returned.

6.3 Plant Layout

Recommendations:

1. Any further changes should involve the careful consideration of plant layout, ergonomics, and physical capacity.
2. The current state of the Quarantine Area requires a thorough evaluation and the purpose of the area should be defined.
3. More cleanup days should be scheduled.
4. In the storage area, an organization system should by created to clearly identify the separate storage areas and what type of equipment or parts that it contains.

5. The short-term solutions should be considered and implemented (organization of cable spools, shelving organization, wasted space, and loose cable organization).
6. The long-term solutions of creating new physical areas to store the equipment and parts should be implemented.
7. The proposal for the new layout of the designated Electronics department areas should be considered and implemented.

Implementation Status:

The actual purpose of the Quarantine Area was evaluated and a new area was designated for damaged equipment. This new area was implemented after the reorganization of the storage rooms in the lab. Two cleanup days were scheduled to discard old equipment and clear out the storage rooms to better organize the storage of the equipment and parts. This enabled the relocation of the Quarantine Area and the designation of the Damaged Equipment Area and the Reserved Equipment Area.[20] In addition the loose cable issue was reviewed and sorted through to discard any unnecessary pieces.

Future Action:

1. Implement the long-term Ideal Solution.

OR

2. Modify the Ideal Solution and use some of the ideas in the changes to the department.
3. Schedule more cleanup days, keeping in mind the separation of the equipment, consumables, and hazardous materials.

[20] Appendix M – Implementation Results

6.4 Documentation Requirements

Recommendations:

1. The Electronics group should implement the generation of project documentation by producing lab memos after the completion of each project.
2. Implement the use new projects files, which provide the option to bind the information and encourage the use of the NRC notepads.
3. It would be advantageous to temporality implement a system to control the documentation and then improve on the system to fit the needs of the environment.

Implementation Status:

The group has begun to use the documentation format established by one of the Electronics technical officers and further changes are expected.

Future Action:

1. A temporary system should be officially implemented to control the documentation and then improvements on the system to fit the needs of the environment will eventually follow.
2. The use new projects files, which provide the option to bind the information and NRC notepads, should be implemented.

7.0 CONCLUSION

The objective of this report was to identify possible problems that limit the efficiency of operations and procedural standards in the Electronics department. After much consideration, recommendations were presented with respect to the consumables inventory control, equipment, plant layout, and documentation requirements that would result in an overall improvement to the department. This resulted in a wide range of

recommendations that consisted of general industrial engineering techniques and very specific, detailed strategies.

IOT is a very successful research and development facility that is internationally known for its involvement in the applied research of Ocean Technology. This facility has been involved with the ocean engineering industry for almost 20 years and has celebrated many successes during this time. It must be understood that any criticism toward the existing processes or recommendation for major changes in the Electronics department, is made with the intent to benefit the department and the entire institute.

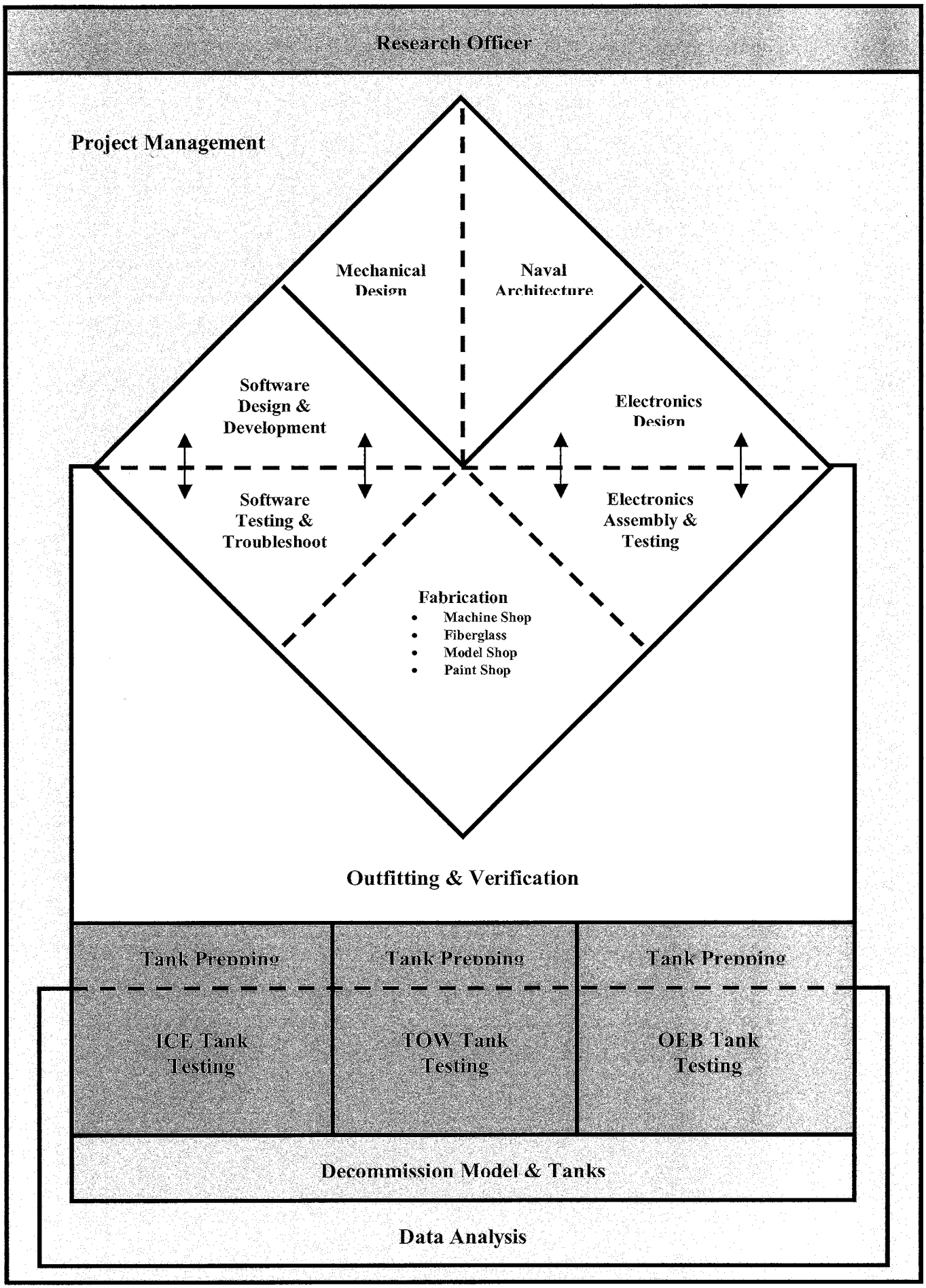
The outcome of the evaluation of the department resulted in some immediate changes, the attempt to complete larger scale changes, and the opportunity to continue with further recommendations. The recommendations supplied through this report and the introduction to a different way of thinking will hopefully prompt the continuation of improving efficiency and standardizing procedures in the Electronics department.

Appendix A

Graphical Representation of Overall Project Interaction

APPENDIX A

GRAPHICAL REPRESENTATION OF OVERALL PROJECT INTERACTION



Appendix B

Consumables Inventory Questionnaire Feedback

Consumables – supplies that are bought regularly because they wear out or are used up, such as resistors, connectors, cable, cleaners, chemicals, etc.

1. How do you know what consumables will be required for a project and if they are available? Are projects ever delayed due to lack of available product?

JF

- The only way to know what's required is to take the time to do a thorough analysis of the project.
- Then check stock and order as necessary.

JW

The person(s) responsible for the project would decide what is needed for the project. That person would usually order the parts for the project on their account. If the $ amount of the parts is small, and we have them in stock, we would charge them out to the project.

PH

Project planning meetings, PIP, Detailed Tasks List for project. Availability is verified by checking of stock in storage room when requirement by project is identified and project is begun. Projects are rarely delayed due to lack of availability, but the potential is certainly there for a problem. Most stock items require a short lead-time for restocking (1-2 weeks).

VB

If there to be any special items needed for a particular project, or a lot of items needed (i.e. connectors, cable, etc), we would catch this usually in the planning meetings, and make note of it there for ordering purposes, as well as project budget purposes. I cannot remember a project delayed due to a lack of common inventory items. Due to a lack of budget over the last few years, we have to charge all consumables used to particular projects.

TE

Knowing what consumables are required for a project comes from experience, and having a general idea of what supplies are on hand. Sometimes however, we don't realize we are out of stock on a certain item until we try to find it. When this happens, depending on the item and what the delivery times are, it is possible that a project may be delayed.

2. How do you know when you need to order consumables? How is the decision made? Is there a "safety stock" maintained? In other words, is there a specified ordering point? (For example: Do you reorder item X when there are only 30 left?)

JF

- Order consumables when there is none, few, or a large quantity is required for a project. Once or twice a year a "major" order is performed in the lab.
- Decision is made by checking funds with Pete and then ordering.
- No safety stock and no reorder point.

JW

When the stock is low it is usually marked on one of our white boards in the shop as "needing to be ordered". When enough items are on the board, an order would be issued. If the items needed, an order would also be issued.

PH

Normally people create a list on the white board outside my office and jot down items known to be in short supply. There is no specified ordering point, but maybe we should have one listed for each bin as applicable OR in the database. A safety stock is a good idea but this has not been implemented. Budget constraints govern the restocking level also.

VB

No, ordering is done usually 3 or 4 times a year when someone checks out the current inventory. In between, when items run low, people make note and we order as we need to.

TE

When we run out of an item, or we are running low on a very common item, we usually write it down on the whiteboard in the lab. When there are a large number of parts that have to be restocked, an order will be placed. Also, if a certain part is needed right away then we will usually check to see what else needs to be ordered and add that to the order as well. I don't know that there are an absolute minimum number of parts to maintain; it kind of depends on the part.

3. What is the process for ordering consumable materials? (Answer in the form of bullets here will be fine) Who is responsible for the ordering?

JF

- Check stock at one of the distributors (Electro-sonic, etc).
- Create PO.
- Get Pete's signature.
- Get PO # from Cecilia.
- Place order.
- All people responsible for ordering, but for the past 2 years I (Jody) have been tasked with the "major" orders.

JW

- Part # looked up in catalog.

- Parts checked for availability and process confirmed.
- PO written up.
- Signature for PO approval obtained from Project Manager.
- PO faxed to supplier.
- Parts received are checked against PO.
- If for general shop consumption, parts are placed in proper location for storage.

If the order is for a certain project, the person assigned to that project is responsible. For shop consumables, Pete assigns a person to do the ordering when $ is available or parts are required.

PH

- Retrieve part # from bin label or the actual part.
- If a new part/product, get the # online or in their catalog.
- Decide on quantity while considering budget constraints. If for research or other project besides1014 Electronics and requires significant $ then write the PO against the project and have signed by Project Manager. Other items from consumable stores get recorded on a log sheet and periodically get transferred to a spreadsheet and forwarded to Finance Dept for reimbursement from the project.
- No one individual is responsible; we try to spread the pain around. Everyone has a hand in throughout the year.

VB

Check inventory, make a list and send a request for quotes to known suppliers. Anyone can do the ordering.

TE

- Identify what parts need to be ordered (and the quantity).
- Send a list of items to supplier(s) to verify price and availability.
- Adjust order based on quote from supplier(s).
- Order parts.

4. What type of tracking system for the consumable materials is in place? What does this system entail? Who is responsible for maintaining this system?

JF

No tracking system.

JW

The tracking system in place right now is a "sign out" sheet. Basically if you take a part for a project it is signed out on the "sign out" sheet. Pete would assign a person to make up a list of these parts according to project numbers. This list would be forwarded to the finance section to bill to the necessary projects.

PH

The random system with the "sign out" sheet.

VB

No tracking system as such. We check and make note of low stock items, and order as needed. Anyone can do this.

TE

Apparently JW has some sort of database that he is working on which tracks consumables. I have not seen or used it.

5. How is the billing/invoicing for these materials handled? Who is responsible for the billing/invoicing?

JF

Cecilia Kennedy

JW

Pete would assign a person to make up a list of "sign out" part according to project #. This list would be forwarded to the finance section to bill to the necessary projects.

PH

The sheet on the clipboard is transferred to a spreadsheet and sent to the Finance Dept.

VB

Whoever places the order is the one who looks after that order. It arrives in their name, and they make sure that all items are accounted for. Billing and invoicing goes to Cecilia Kennedy.

TE

When a part is needed directly for a specific project, we write it down on the clipboard outside the back storage room in the lab. Every so often, Pete then handles the rest of the invoicing to the various projects.

6. Where can you find a complete list of all consumable materials? Is the list from the database complete?

JF

- Didn't know there was a database for consumables.
- There is a somewhat complete excel sheet somewhere, I believe.

JW
A list is being developed as a consumables parts database. This list is not complete but is being worked on. The list will include suppliers and part numbers to enhance the ordering process.

PH
A complete list of the consumables does not exist.

VB
No list that I know of, database being worked on.

TE
I assume that JW's database contains all of the consumable materials.

7. Consumable materials are obviously stored in:
   - The cabinets (next to Jody's bench and next to the computer) in the lab
   - The storage rooms
   - Flammable stores

Are there any other areas where consumables are stored?

JF
Sometimes on the tech's bench.

JW
The person assigned to that project stores some consumables for that particular project. These parts are not usually available for other projects.

PH
No!

VB
Piled on and under Ed's bench!!!

TE
I think that covers it.

8. Are there any standard disposal processes for consumable materials? For example: How do you dispose of M Coat-A or broken parts? If there are several different disposal processes, just list them.

JF
Not that I'm aware of!

JW

I do not know of any processes to dispose of consumable materials. If a part is damaged it is replaced with a good part. The old part is thrown in the garbage. For outdated chemicals, a disposal process needs to be developed.

PH

No!

- Implement battery disposal process.
- Implement chemical disposal processes (according to MSDS).
- Work together with S. Reid when he disposes hazardous materials.
- Clean up the Flammable storage.

VB

Chemicals are disposed of by Scott Reid a couples times a year or when needed. Broken parts (consumables) are just garbage.

TE

Not answered.

Appendix C

Electronics Shop Consumables Control Sheet

APPENDIX C

Sheet1

ELECTRONICS SHOP CONSUMABLES CONTROL SHEET

DATES COVERED:

PROJECT #	DESCRIPTION	QUANTITY	DATE	SIGNATURE	COST
Lew Hill	Alligator clips small	2			
Lew Hill	Alligator clips large	2			
	680Ω resistor	1			
	82Ω resistor	1			
	LM317T regulators	1			
"	LM317T regulators	2			
"	1N4005	4			
"	2200uF 50V cap	1			
"	2.2uF 63V cap	1			
"	0.1uF bypass cap	1			
"	10,000 uF 40V cap	2			
Facilities	AC Plugs (Male) #4	2	15 Apr 03	L. Simms	
~~4Z~~ 2012	6 Pin Female Bendix	2	28 Apr 03	A Bugden	
2012	4 wire Shielded	60'		A Bugden	
2012	1.2KΩ 0.6W	4		A B	
Oceanic	Heat Shrink 1/16"	1'	26 MAY 03	M Curtis	
"	" 3/32"	1'	"	"	
JDM	BNC to 10 Pin adapter	1	June 2	A Bugden	
421010	Scotchcast Splicing Compound	1	JUNE 03	J. Emms	
Oceanic	Heat Shrink 1/16"	1'	July 04/03	MATTCUR	
"	4 pin head	1	14	MATTCUR	
Lew Hill	1,2SCV Polyster	8	July 15	Nick Rose	
Oceanic	Heat Shrink 3/16"	1'	July 17	MATTCUR	
Oceanic	Heat Shrink 1/4"	1'	July 17	MATTCUR	
"	Banana Plug	2	Jun 21	MATTCUR	
VIV	8723	50ft	July 22		
"	10 Big Boards	1	"		
Lew Hill	732 ohm Resistor (1%)	5	July 31		
"	750 ohm Resistor (1%)	6	"		
421013	Scotchcast 2130	1	Aug 8		
421010	9V Batt Clip	1	Aug 18	A Bugden	
429008	1 Box 1591 BBK Horn	1	Aug 26	M Mahar	
421008	4-Pin Bendix Box Mount	4	Aug 27	M. MAHAR	
421008	4-Pin Bendix Cable Mount	4	Aug 27		
421008	Solder Lug Binding Posts	6	Aug. 28	M. MAHAR	
Lew Hill	6.9K Resistor	5	Sep 2	N. Rose	
"	68K Resistor	5	Sep 2	N. Rose	
421010	37 Pin Female "D" connector	1	Oct 09		
"	" " D Shell	1	"		
"	BNC "Bulkhead"	1	"		
Oceanic	3/16 Clear Heat Shrink	2'	Oct 17		
"	3/32 Black Heat Shrink	1'	"		
421013	DB-9 Male Connector	2	Oct. 20/03	Jim E. FOR M. MAHAR	
421013	DB-9 Female Conn.	2	"	Jim E	
421013	DB-9 Hoods	4	"	Jim E	

APPENDIX C

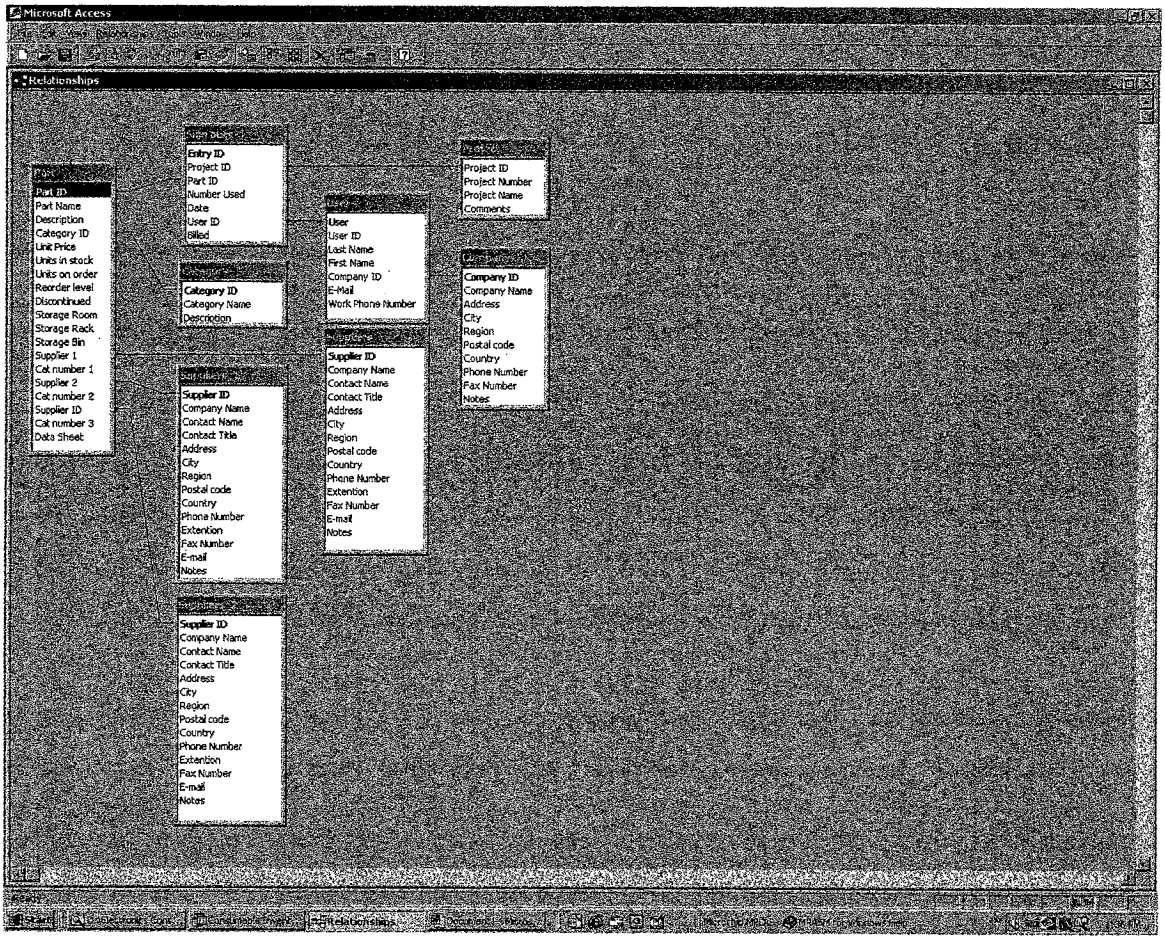
roject	DESCRIPTION	Quantity	DATE	SIGN
iV	Bendax 14 pin male		Oct 23/03	
11	" 4pin male		11	
11	Soft 8733	soft	Oct 23/03	
r.acated	Bendix 4-pin male	3	Oct. 28/03	
Moorings	Bendix 6-pin male	3	Oct. 28/03	
3M	Heat Shrink	36"	Nov. 3/03	Melvin M
VIV	Bendax 14 pin male		Nov 4/03	
2010	3/8 water proof Heat	6"	05 Nov 03	A. Bugden
2010	1/4	6"	05 Nov 03	A. Bugden
2010	1/8 Heat shrink	3 Feet	05 Nov 03	A. Bugden
21008	DB9 Male solder	1	09 Dec 03	M-Mahar
	DB9 Female solder	1	" " "	
"	Connector Hoods DB9	2	" " "	
21	DB15 Male Solder	2	09 Dec 03	
"	DB15 Female Solder	1	Pete Hackett	
"	DB15 connector Hood	3	" "	
"	10 Pin Bendix Female PT01	1	" " "	
039	RG 174 Male Crimp	1	Blaine Stockwood	Dec 10/03
X BNC	1/8 Heat Shrink	1'	MATT CURTIS	JAN 22/04
whill	15V Zener Diode	8	Tom Lovik	
1008	4pin Female inline PT06A-8-4S SR		D. K.	Jan 28/04
BNC	3/16" Heat Shrink	1'	Feb 02	MATT C
ERNAL Project 056	3/16 Heat Shrink	1'	Feb 11	MATT C
Int 056	25 conductor cable	20'	Feb 12	B. Stockwood
Leuhill	IN5245B	1	Feb 17	
Leuhill	LM 337N	2	Feb 17	

Appendix D

Electronics Consumables Database Description

Electronics Consumable Database Description

As of March 29, 2004 the Electronics Consumable Data Base is structured as shown below



The Database allows for the storing of information about the Parts that are used and who/what project has sign them out.

Under the **Sign outs** table the database records sign out information and links it to Parts use, User and Project. This information would be used to bill Projects for parts used.

The **Parts** table keeps track of parts by:

- Common names
- Description
- Storage location
- Current IOT electronics shop charge out price.
- Up to there suppliers for the part and the suppliers catalogue part numbers

- Link for data sheet (for future use)

The **Projects table** keeps track of project number and name as well as any other necessary information.

The **User table** keeps track of contact information of the user

The **Company table** keeps track of the company information of the user.

The **Category table** keeps track of the category of the parts. (i.e. connectors, resistors, etc.)

The **Suppliers** table keeps track of supplier information such as contact name, phone numbers and addresses.

Right now the Database has a switchboard interface that a former student developed. It is functional but needs work to implement the intended function of the database. It has the ability to print out billing information based on Project number but does not exclude sign outs that have been billed.

The Database has been filled with 487 parts in the electronics shop that are used by Projects.

In the future the Consumable Database can be used to produce quote requests for parts as well as generate PO's with some added work.

By: Jim Williams

Appendix E

Battery Disposal Processes

NLIS 3
July 4, 2001
(Environment)

The following is being distributed at the request of the Rechargeable Battery Recycling Corporation:

Charge Up To Recycle! – Now More Convenient to Recycle Used Rechargeable Batteries

Changes to the *Charge Up To Recycle!* program now make it more convenient for Newfoundlanders and Labradorians to recycle used rechargeable batteries. The program has expanded to include additional rechargeable chemistries, as well as more retail and community drop-off locations in the province. The announcement was made today by Susan Antler, Canadian program coordinator, Rechargeable Battery Recycling Corporation (RBRC) at an event at the Avalon Mall, St. John's. Environment Minister Ralph Wiseman, Andy Wells, mayor, City of St. John's, and Stan Glynn, manager, Radio Shack Avalon Mall also attended the event.

"The province of Newfoundland and Labrador was the first jurisdiction in Canada to approve the *Charge Up To Recycle!* program in 1997, and it is exciting to see the program grow and expand. We are looking forward to encouraging other provinces and cities across the country to take the same kind of recycling action," said Susan Antler.

Initially only accepting nickel cadmium (Ni-Cd) rechargeable batteries, the *Charge Up To Recycle!* program now accepts, nickel metal hydride (Ni-MH), lithium ion (Li), and small sealed lead (Pb) rechargeable batteries commonly found in cellular phones, laptop computers, camcorders, power tools, cordless phones, and children's toys. In Newfoundland and Labrador, consumers can drop-off used rechargeable batteries at a number of retail locations including Radio Shack, Canadian Tire, Future Shop, and NewTel Mobility. There is no charge for disposing of batteries at any of these locations.

In addition to retail locations, the Government of Newfoundland and Labrador and the City of St. John's have introduced programs to enable employees to recycle used rechargeable batteries. At a ceremony this morning at the Confederation Building, Environment Minister Ralph Wiseman launched the rechargeable battery stewardship program for provincial government employees. With collection boxes distributed to all government offices throughout Newfoundland and Labrador, government employees now have an easy and convenient way to participate in the program.

The City of St. John's launched a similar program for its employees in April setting up collection sites at a number of city buildings including, City Hall, Public Works Depot, fire stations and the scale house at the Robin Hood Bay landfill site.

"Recycling programs are a great way to help our environment by reducing the amount of waste sent to landfill sites. Participating in this program diverts rechargeable batteries from landfill sites which in turn keeps harmful by-products out of those sites, and I encourage everyone to recycle their used rechargeable batteries," said Minister Wiseman.

"I am very pleased to see that the battery recycling program has been expanded to include other types of rechargeable batteries and I hope consumers take advantage of the opportunity to recycle these products. The general public may also drop off their used rechargeable batteries at the Robin Hood

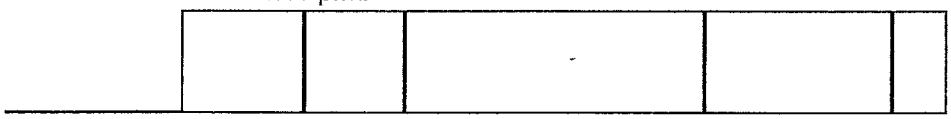
Bay landfill scale house during regular landfill hours," said Mayor Wells.

The *Charge Up To Recycle!* program is operated by RBRC, a non-profit service organization funded by more than 300 manufacturers and marketers of portable rechargeable batteries and products. These companies are committed to preserving the environment and pay a fee to place the RBRC Battery Recycling Seal on rechargeable batteries and product packaging. RBRC's public education campaign and battery recycling program is the result of the rechargeable power industry's commitment to conserve natural resources and prevent rechargeable batteries from entering the solid waste stream. For more information, visit www.rbrc.org.

Media contact:

Susan Antler RBRC, (416) 535-9210
Diane Keough Department of Environment, (709) 729-2575
Gerri King City of St. John's, (709) 576-8613.

2001 07 04 1:10 p.m.



United States Environmental Protection Agency | Office of Enforcement and Compliance Assurance (2248A) | EPA 300-N-02-002

EPA Enforcement Alert

Volume 5, Number 2 | Office of Regulatory Enforcement | March 2002

The 'Battery Act'

Law Creates Public Health, Environmental Safeguards Through PhaseOut of Mercury Batteries and Other Important Requirements

The Environmental Protection Agency believes that some manufacturers of rechargeable batteries and rechargeable consumer products may not be complying with the Mercury-Containing Rechargeable Battery Management Act, 42 U.S.C 14301-14336 ("Battery Act") while others may be unaware of the Act's requirements.

This issue of *Enforcement Alert* discusses the Battery Act's importance in protecting human health and the environment, and its requirements for collection, disposal, recycling, labeling and 'easy removability' of regulated batteries. In addition, several national and state recycling and collection programs are highlighted.

About Enforcement Alert

Enforcement Alert is published periodically by the Office of Regulatory Enforcement to inform and educate the public and regulated community of important environmental enforcement issues, recent trends and significant enforcement actions.

This information should help the regulated community anticipate and prevent violations of federal environmental law that could otherwise lead to enforcement action. Reproduction and wide dissemination of this publication are encouraged.

For information on how you can receive this newsletter electronically, send an email to the editor.

Editor: Virginia Bueno
(202) 564-8684
bueno.virginia@epa.gov

Law Promotes Proper Recycling, Disposal, Labeling, and Mercury Battery Phaseout

To prevent the release of hazardous substances into the environment, the Battery Act was signed into law on May 13, 1996. The law serves two purposes: to phase out the use of mercury in batteries, and to provide for the efficient and cost-effective collection and recycling or proper disposal of used nickel cadmium (Ni-Cd) batteries, used small sealed lead-acid (SSLA) batteries, and certain other regulated batteries.

Among other requirements, the Battery Act also establishes national, uniform labeling requirements for "regulated batteries" and for "rechargeable consumer products" that are manufactured domestically or imported and sold for use in the United States.

Health Risks Caused By Batteries Improperly Disposed

More than 350 million rechargeable batteries are purchased annually in the United States. Rechargeable batteries, like nickel-cadmium (Ni-Cd) or small sealed lead-acid (SSLA) batteries, contain toxic heavy metals such as cadmium, mercury, and lead. These heavy metals present no threat to human health or the environment while the battery is being used. When thrown away, however, these batteries can cause serious harm to human health and the environment if they are discarded with ordinary household or workplace waste.

The Battery Act applies to Battery and Product Manufacturers, Battery Waste Handlers, and certain Battery and Product Importers and Retailers

Approximately 73 percent of municipal solid waste is either land-filled or incinerated. Neither of these methods is suited for the disposal of rechargeable batteries. In landfills, heavy metals from rechargeable batteries have the potential to leach slowly into the soil, ground water, and surface water. When incinerated, the heavy metals can enter the air through smokestack emissions and can concentrate in the ash produced by combustion. When the incinerator ash is disposed of, the heavy metals in the ash can enter the environment.

Although these batteries account

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for a relatively small portion of the total wastes generated in the United States, Ni-Cd batteries accounted for 75 percent of the cadmium found in municipal solid waste in 1995. Similarly, SSLA batteries accounted for 65 percent of the lead found in municipal solid waste in 1995.

When introduced into the environment through landfill disposal or incineration, these heavy metals make their way into the food chain. The presence of these heavy metals in the food chain presents very serious consequences. The possible health effects associated with ingestion or inhalation of heavy metals through water, food, or air include headaches, abdominal discomfort, seizures, and comas. Additionally, several heavy metals, such as cadmium, are known carcinogens.

The Battery Act removes certain barriers to the recycling of Ni-Cd, SSLA, and other rechargeable batteries. Prior to passage of the Battery Act, a battery recycling program spanning across several states had to comply with varying, and sometimes conflicting, state labeling and waste management regulations.

Recycling programs for Ni-Cd and SSLA rechargeable batteries can significantly reduce the dangers these batteries pose to human health and the environment by diverting them from landfills and incinerators. Once the rechargeable batteries arrive at the recycling facility, the heavy metals are recovered during the recycling process and the remainder of the product is recycled or discarded safely.

Key Battery Act Terms Defined

Regulated batteries are rechargeable Ni-Cd and SSLA batteries, as well as rechargeable batteries found in consumer products like cellular phones and laptop computers. EPA may expand the scope of regulated batteries if it determines that batteries other than Ni-Cd and SSLA batteries are toxic and may cause substantial harm to human health and the environment if land disposed or incinerated.

Rechargeable batteries are those batteries with one or more voltaic or galvanic cells, electrically connected to produce electric energy, that are designed to be recharged for repeated uses. This definition also includes any type of enclosed device or sealed container consisting of one or more such cells, including what is commonly called a battery pack.

The Battery Act exempts from the definition of "rechargeable battery":

- Lead acid batteries used to start an internal combustion engine or as the principal electrical power source for a vehicle;
- Lead acid batteries used for load leveling or for storage of electricity generated by an alternative energy source, such as a solar cell or wind-driven generator;
- A battery used as a backup-power source for memory or program instruction storage, timekeeping, or any

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Labeling Requirements

Labeling requirements in Title I of the Battery Act include the following:

1. Regulated batteries must bear the three chasing arrows or a comparable recycling symbol.

2. Regulated nickel-cadmium batteries must be labeled "nickel-cadmium" or "Ni-Cd," with the phrase "BATTERY MUST BE RECYCLED OR DISPOSED OF PROPERLY."

3. Regulated lead-acid batteries must be labeled "Pb" or with the words "LEAD," "RETURN," and "RECYCLE" and, if the regulated batteries are sealed, the phrase "BATTERY MUST BE RECYCLED."

4. Rechargeable consumer products containing Ni-Cd batteries that are not easily removable must be labeled with the phrase "CONTAINS NICKEL-CADMIUM BATTERY. BATTERY MUST BE RECYCLED OR DISPOSED OF PROPERLY."

5. Rechargeable consumer products containing regulated lead-acid batteries that are not easily removable must be labeled with the phrase "CONTAINS SEALED LEAD BATTERY. BATTERY MUST BE RECYCLED."

6. The required labeling also must be carried on the packaging of rechargeable consumer products containing regulated batteries that are not easily removable, and on the packaging of regulated batteries that are sold separately from such products, if the labeling on the product or battery is not visible through the packaging.

7. Battery and product manufacturers may apply for EPA certification to use a different label that conveys the same information as described above or conforms with a recognized international standard that is consistent with the overall purposes of the Battery Act. (Up until May 13, 1998, no certification was needed if the label was in "substantial compliance" with the labeling requirements.)

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similar purpose that requires uninterrupted electrical power in order to function if the primary energy supply fails or fluctuates momentarily; or

- A rechargeable alkaline battery.

Rechargeable consumer products are products that, when sold at retail, include a regulated battery as a primary energy supply and are primarily intended for personal or household use. Examples of products for "personal or household use" include cellular phones, laptop computers, cordless power tools, personal computers, and video cameras. The products include external uninterruptible power source (UPS) devices that enable electrically powered devices to continue to operate temporarily in the event of a power outage.

Rechargeable consumer products do not include an internal uninterrupted power supply (UPS) device. Such products use a battery solely as a source of backup power for memory or program instruction storage, timekeeping, or any similar purpose that requires an uninterrupted electrical power in order to function if the primary energy supply fails or fluctuates momentarily. Internal UPS devices and their batteries are also exempt from the Act's definition of "rechargeable battery".

Easily removable means that regulated batteries must be detachable or easily removable from a rechargeable consumer product at the end of the life of the battery, by a consumer using common household tools (see box on right for more information).

Mercury Batteries

The Battery Act also phases out the use of batteries that contain mercury. Mercury has been found to be extremely harmful to human health and the environment. Title II of the Act prohibits any person from selling, offering for sale, or offering for promotional purposes the following batteries:

- Alkaline-manganese batteries that contain mercury that was intentionally introduced (as opposed to mercury that may be incidentally present), except for button cells that contain up to 25 mg of mercury;
- Zinc-carbon batteries that contain mercury that was intentionally introduced;
- Button cell mercuric-oxide batteries; and
- Other mercuric oxide batteries, unless the manufacturer or importer does the following: identifies a collection site for recycling or proper disposal of the batteries; informs the purchasers of the collection site; and provides the purchasers with a phone number for obtaining information about sending the batteries for recycling or proper disposal.

Battery Act Enforcement

EPA may issue an order to violators of the Battery Act. The order may assess a civil penalty and/or require compliance. An order may require the violator to pay a civil penalty of not more than $10,000 for each Battery Act violation. The Agency may also impose a $10,000 penalty on a person who fails to take timely corrective action required under an order. The Agency also may bring a civil action for violations of the Act or noncompliance with an order.

For more information on the Battery Act, contact Lynn Holloway, RCRA Enforcement Division, Office of Regulatory Enforcement, (202) 564-4241;Email:holloway.lynn@.epa.gov.

For compliance assistance information, contact Gloria Lowe, Office of Compliance, at (202) 564-2181; Email: lowe.gloria@epa.gov.

'Easy Removability' Requirement

The Battery Act prohibits the sale in the United States of a rechargeable consumer product that contains a regulated battery that is not easily removable from the product. This means that consumers must be able to easily remove the regulated battery at the end of its life, by using common household tools. In 1999, EPA took an enforcement action against a company that manufactured and sold 60,000 units of an external uninterruptible power supply (UPS) device containing a small sealed-lead acid battery. The device had been distributed, offered for sale, and sold at retail without battery removal instructions and without the words ***"Contains sealed lead battery. Battery must be recycled"*** on the product or the product packaging. The User's Guide for the UPS device contained precautions that should be taken during battery removal and replacement, such as using tools with insulated handles and wearing rubber gloves and boots.

EPA determined that under Section 3(6)(A) of the Act, the UPS device was a rechargeable consumer product that was being sold in violation of the easy removability and labeling requirements in Section 103. The company agreed to provide past, present and future customers with instructions on battery removal; to edit the User's Guide to remove unnecessary provisions that would deter consumers from removing or replacing the battery; and to post information concerning the requirements of the Battery Act on its website. Since any benefit gained by these violations was minimal, and since the company eagerly complied with the Act when cited by EPA, the Agency waived the civil penalty in this case.

EPA
United States
Environmental Protection Agency
Office of Regulatory Enforcement
(2248A)
Washington, D.C. 20460
Official Business
Penalty for Private Use $300

'Enforcement Alert' newsletter

Battery Recycling and Collection Programs

The Rechargeable Battery Recycling Corporation (RBRC), a nonprofit organization representing many rechargeable battery manufacturers, developed the Charge Up to Recycle! program to help keep Ni-Cd batteries out of the solid waste stream and prevent toxins from ending up in landfills or municipal incinerators.

The Charge Up to Recycle! program offers various recycling plans for communities, retailers, businesses, and public agencies. For each group, RBRC pays or shares the cost of consolidating the batteries, shipping them to the processing facility, and recycling them. The program sends all Ni-Cd batteries to the International Metals Reclamation Company, a cadmium recovery facility in Ellwood City, Pa. At the facility, the nickel and iron are separated from the cadmium and shipped to specialty steel producers for use in stainless steel products. The recovered cadmium, at a 99.95 percent purity level, is used to produce new Ni-Cd rechargeable batteries. For more information about the Charge Up to Recycle! program, or for information about a local collection site, visit http://www.rbrc.com or call RBRC's toll-free number at 1-800-8-BATTERY.

The State of Massachusetts has worked with the RBRC to establish collection points for Ni-Cd batteries in more than 100 of the state's 351 municipalities. For more information about battery recycling efforts in Massachusetts, contact the Massachusetts Department of Environmental Protection Household Hazardous Waste Hot Line at 1-800-343-3420 (Massachusetts residents only. Out-of-state callers may call (617) 292-5704).

To encourage the recycling of commercial SSLA batteries, the manufacturers of SSLAs and products that contain them, with support from the Portable Rechargeable Battery Association (PRBA) and the Battery Council International (BCI), have established a collection program for commercial SSLA batteries in Florida, Iowa, Maryland, Minnesota and New Jersey. For more information about the commercial SSLA battery recycling program, contact the PRBA at (770) 612-8826.

Useful Compliance Assistance Resources

Office of Enforcement and Compliance Assurance:
http://www.epa.gov/compliance/

The Battery Act:
http://www.epa.gov/epaoswer/hazwaste/state/policy/pl104.txt

Implementation of the Mercury-Containing and Rechargeable Battery Management Act:
http://www.epa.gov/epaoswer/hazwaste/recycle/battery.txt

Universal Waste Rule:
http://www.epa.gov/epaoswer/hazwaste/id/univwast.htm

Audit Policy Information:
http://www.epa.gov/oeca/ore/apolguid.html

National Compliance Assistance Clearinghouse:
http://cfpub.epa.gov/clearinghouse/

Compliance Assistance Centers:
http://www.assistancecenters.net
—Automotive Service and Repair:
http://www.ccar-greenlink.org
—Transportation:
http://www.transource.org

Small Business Gateway:
http://www.epa.gov/smallbusiness/major_environmental_laws.htm

Appendix F

Hazardous Materials List

Hazardous Materials in the Electronics Lab

Appendix F

Product Name
A
Adhesive Sealant Clear RTV Silicone
B
Barrier G
Barrier J
Beryllium Copper Wrought Alloys
C-D
Cleaner for Static Control Mats 8001
Clear Insul-Spray
Cool Tool Cutting Fluid
CSM-1A Degreaser
CSM-2
E
Ecoline Cleaner/Degreaser
Ecoline Contact Cleaner
F
Flange Sealant 5900
Flux Remover TechSpray
FreeZ-IT Freezer/Refrigerant
Freon TF Solvent Tape Head Cleaner
G
Glass & Plastic Cleaner
Goo Gone
H
High Temp. Bearing Grease, Med. 44
Household Oil 3-in-1
I-K
Konform ® AR Conformal Coating
L
Lacquer Thinner
Liquid Wrench L1-04
Liquid Wrench L1-16
M
M-Bond 200 Adhesive
M-Bond 200 Catalyst C
M-Bond 610 Adhesive

Product Name Cont'd
M-Bond 610/600 curing agent
M-Bond AE Resin
M-Bond AE-10 Adhesive Kit
M-Bond Curing Agent Type 15
M-Coat A
M-Coat B
M-Coat D
M-Coat F
M-Coat W-1
Metal Conditioner SR4
M-Line 361A-20R Solder
M-Line Rosin Solvent RSK-1
M-Line RTV Primer No.1
MM- Prep Neutralizer 5A
MotorMaster Heavy Duty 30 Oil
M-Prep Conditioner A
N
Neutralizer SR4
Non-Silicone Thermal Compound
O
Omni-Pak Blend for enamels
P
Plasti Dip
Pow-R Wash Contact Cleaner (CZ)
Print Kote Solvent
Q
QA-600 Adhesive Kit Part A
QA-600 Adhesive Kit Part B
R
Rapid Tap Cutting Fluid
Rapido-EZE 3068
RTV 3140
RTV 3145
Rust Check
S
Silicone Compound Type 25

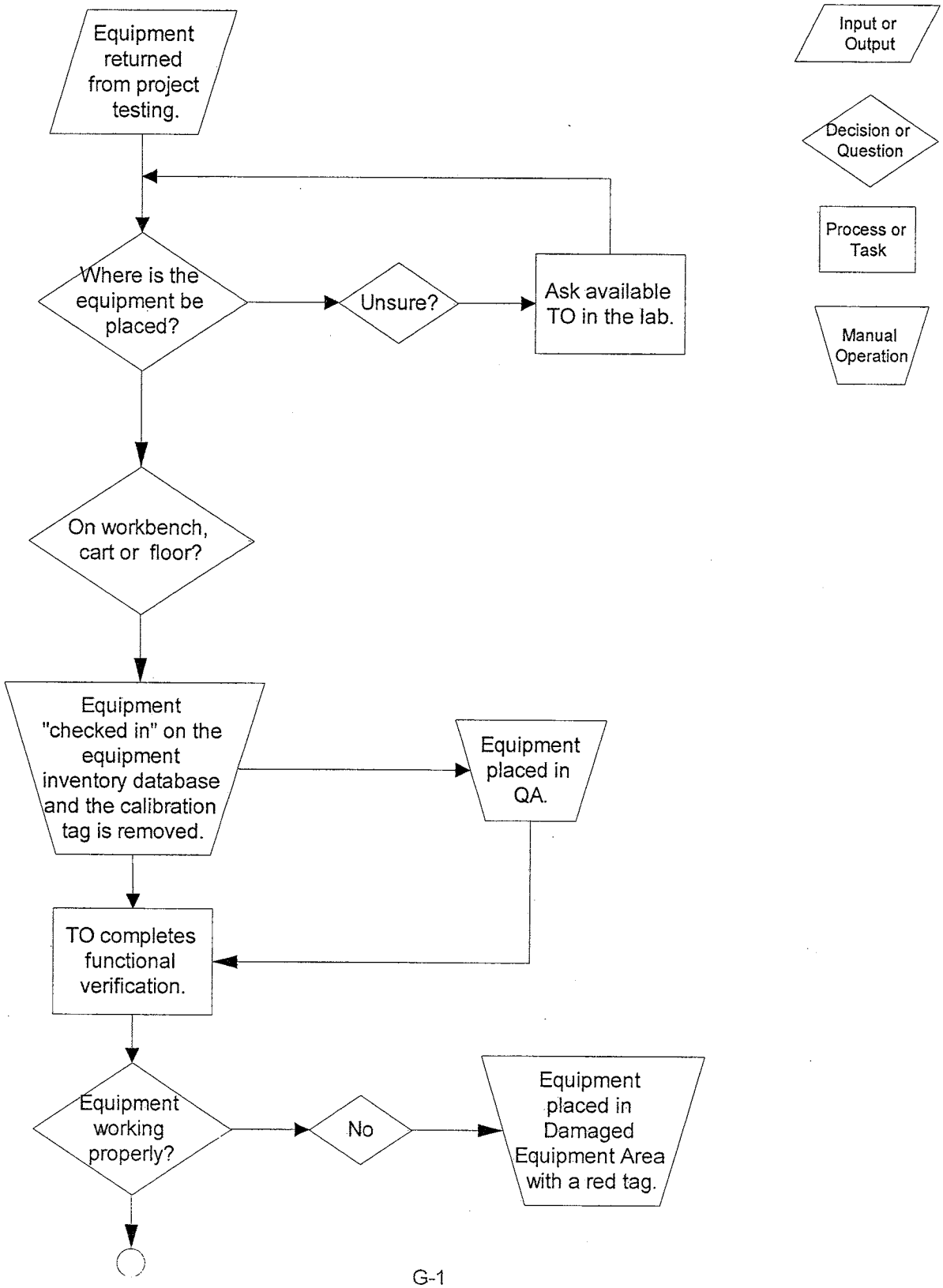
Product Name Cont'd
Silicone Lubricant Permatex
Silicone Rubber Adhesive Sealant
Spray Enamel Quick Dry
Spray Nine
SSD II Safety Solvent Degreaser
Strip X
Super Duster 134 Plus
Sylgard ® 527 Silicone Dielectric Gel Part A
Sylgard ® 527 Silicone Dielectric Gel Part B
T
Tetra-Etch
Thread Locker Loctite 262
U-V
Valvoline SAE 20W50 Oil
W-Z
WD-40
Zero-Mist Circuit Cooling Spray

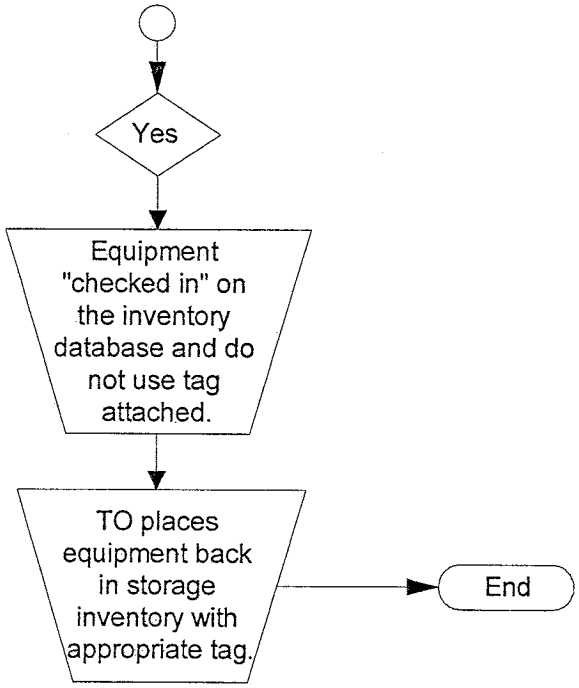
Appendix G

Equipment Flow

Appendix G

Equipment Flow




Yes
Equipment "checked in" on the inventory database and do not use tag attached.
TO places equipment back in storage inventory with appropriate tag.
End

Appendix H

Electronics Database Improvements

Electronics Database Improvements

Maintenance Log	1	Add a maintenance button in the first window of "search by barcode" as opposed to a tab (search by barcode and just click on the button to enter the maintenance information).
	2	Basic format must include the date, description of maintenance, and completed by.
	3	Each maintenance task should be categorized (pull down menu) under mechanical, electrical, etc. This should contain an "add new" button so new categories can be added.
	4	The report should be printable.
	5	There should also be a "button" to view the maintenance log.
Quarantine Report	6	Identified by project numbers
	7	Add a printable report to search by barcode or project number
Red Flag Overdue Items	8	The due date should be an unavoidable entry when equipment is signed out.
	9	Create a permanent or long-term loan option (button added to the sign out page).
	10	Instead of just flagging barcodes, maybe it would be better to flag project numbers to eliminate long lists of equipment.
	11	The issue searching equipment by # of days on loan (with very long lists) has been recognized. These changes are attempts to fix this problem.
	12	A printable report by barcode and project number is requested.
Miscellaneous	13	There is an inconsistency with the pull down menus. Under "look up equipment" window the equipment name category is not equivalent to the "add equipment" window equipment category.

Krista Byrne
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Appendix I

Equipment Database Modifications Questionnaire Feedback

Inventory Database Modifications

Appendix I

Pete has identified some issues concerning the Electronic Equipment Database located on the internal web page. As you all know, there are some discrepancies with the actual definition of the current Quarantine Area in the lab. This area consists of equipment that has been returned from a project and requires functional verification (short-term) AND equipment that has been checked and is not feasible to repair at this time (long-term). Pete is concerned that individuals using the database during project planning may mistake the long-term quarantined items for short-term quarantined items and assume that the equipment could be easily made available for a project. To avoid any confusion, I suggested that "RETURNED" be added to the inventory status categories in the database. This would provide the following equipment status options:

- Available (self explanatory)
- On Loan (self explanatory)
- Returned (equipment returned from a project and requires functional verification)
- Quarantined (equipment not working and requires repairs or troubleshooting)
- Uncertain

Pete also suggested that these categories be defined within the database to ensure all users are aware of the changes and use the system properly.

Pete also considered what equipment should be visibly available on the website database. Should the quarantined items be visible? All the Electronics equipment information, regardless of its status, is accessible through the database and Pete questioned if this was the best arrangement.

1. Do you think the "RETURNED" category would be beneficial? Do you have any other suggestions?

JF

Sure. Or, add damaged to the list instead?

JW

I believe the returning category should stay Quarantined because it meaning suggest its unknown state of the returning equipment. We should set up a new category for known not working equipment that requires repairs. This could be called "Non-functioning", "Sickbay", "Requires Service", or any other term that best describes this category.

TE

It would be beneficial to distinguish between the damaged and unchecked items in quarantine.

VB

I think that we should not change the meaning of "Quarantined" at this point in time. Should we have another category for damaged equipment? Yes! Let's called it "Damaged", or some other name.

2. With respect to all the equipment being accessible through the database, do you think this should change? Should the quarantined items be visible on the database?

JF
Sure, very few people use the database anyways. Most people come to the lab and ask for things.

JW
I think that equipment that is waiting repairs should be visible in the database as long as they are clearly marked as requiring repair.

TE
If project managers are using the database to plan their projects, I think they should have access to all the equipment. If they are aware that a piece of equipment is damaged and needs repair then they can incorporate this into their project time.

VB
Yes.

3. Do you think that withholding the quarantined items from the database could cause problems? (If an item has been placed in quarantine and a project requires that piece of equipment, it could be requested that the equipment be fixed. However, if the quarantined items are not visibly available on the web site database, this is not possible)

JF
No answer

JW
Yes it could cause problems if left out of the web database. If a project requires a particular item that needs repair they may be willing to fix the equipment under their project.

TE
See #2

VB
If an item id damaged, than it should be marked as such. If we have it waiting to be repaired, than it means that we do not have the money to do so. If someone needs it, they may have the money to get it fixed!!

4. Do you have any other suggestions regarding these issues? Do you have any questions or concerns?

JF
Nope.

JW
I feel that Quarantined should remain as is and a new category be made. This will help eliminate any confusion over the new category. Most people view Quarantined category as waiting to be check for functionality.

TE
No answer

VB
Not at this time.

Appendix J

Short-Term Solutions

A) Cable Spool Organization

Illustration 1.0 - Storage Room #1, located adjacent to the Electronics lab.

Solution:

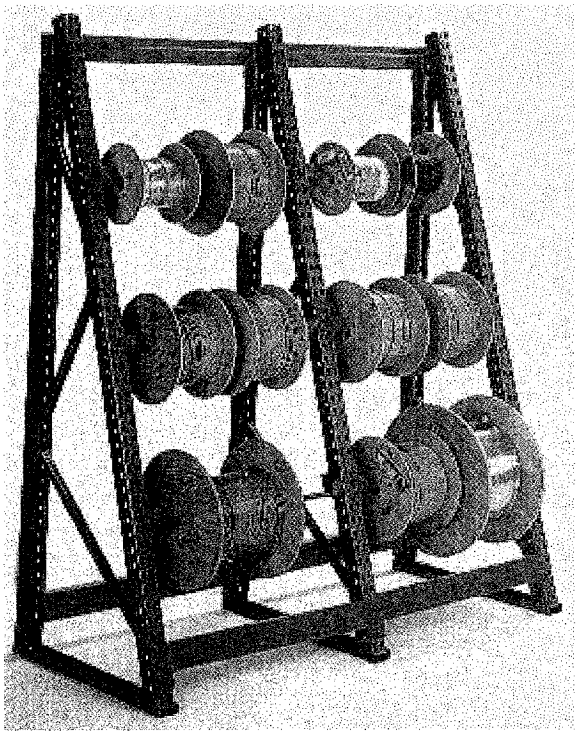


Illustration 1.1 – Cable Reel Rack

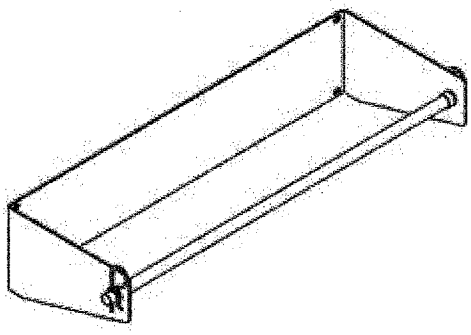


Illustration 1.2 – Cable Reel Rack (wall mounting version)

NOTE:
These cable racks can be purchased or manufactured internally.

B) Shelving Organization Problem

Illustration 2.0 - Storage Room #2, located adjacent to the Electronics lab.

Solution:

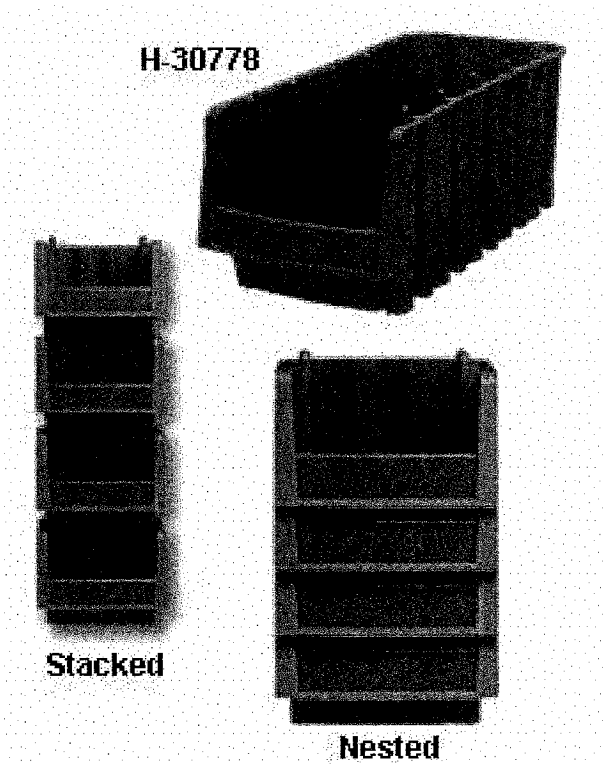


Illustration 2.1 – Small Storage Containers

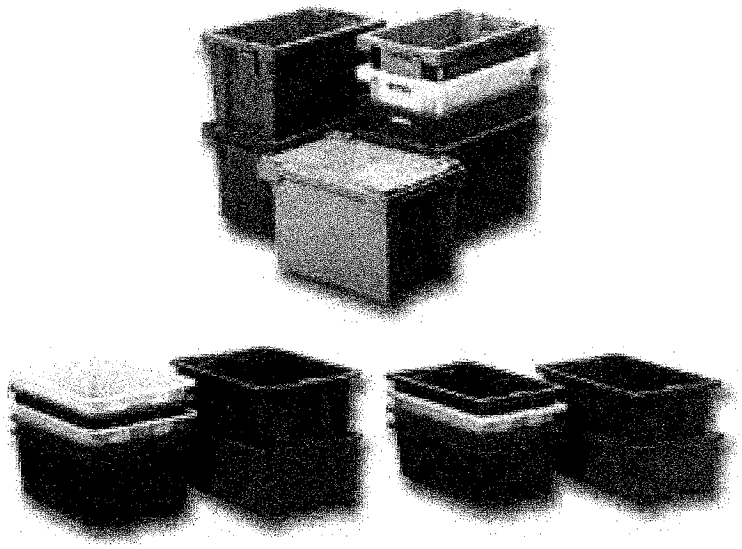


Illustration 2.2 – Large Storage Containers

C) Wasted Space

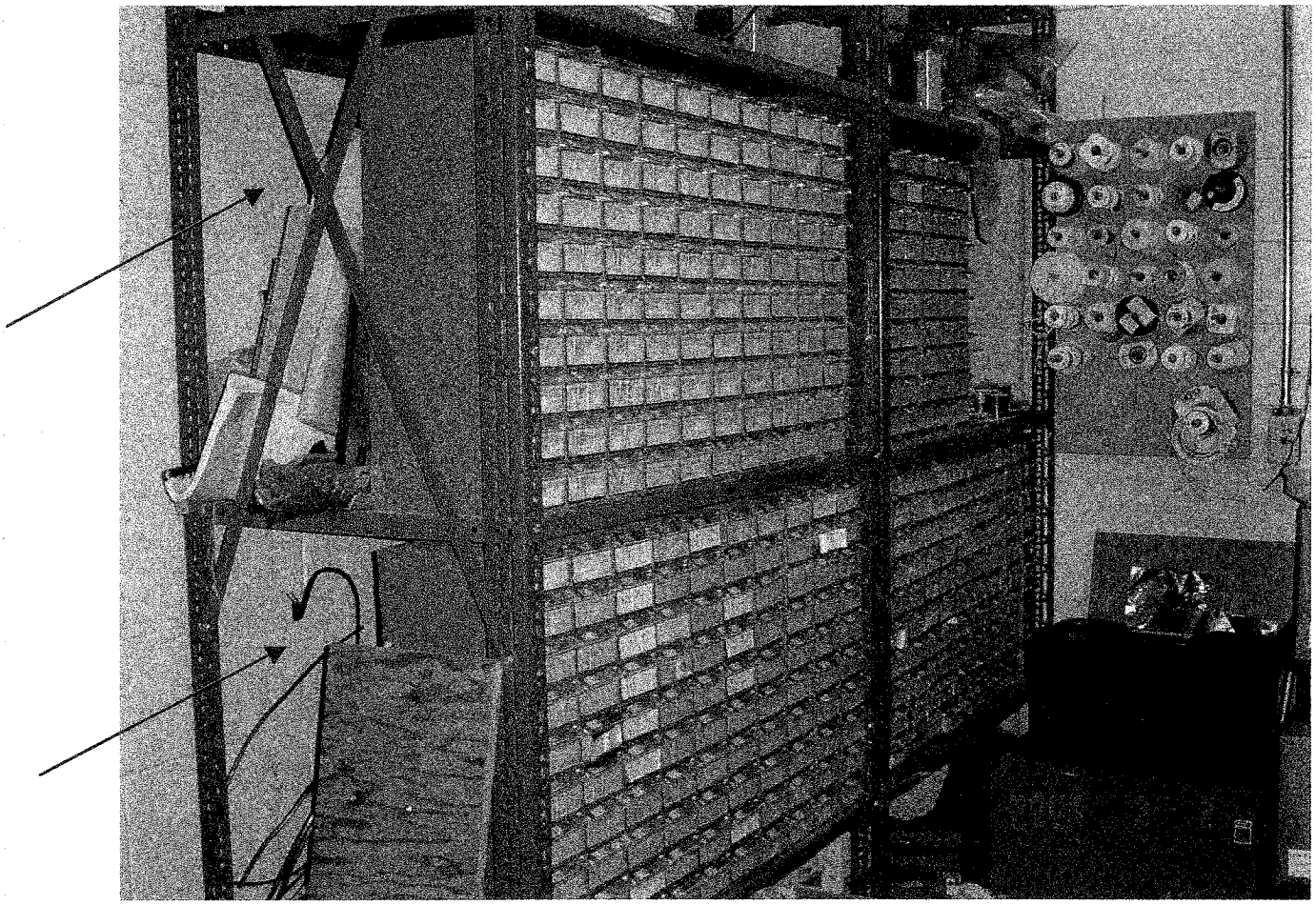


Illustration 3.0 - Storage Room #1, located adjacent to the Electronics lab.

Solution:

These four storage bins should be mounted to the wall, which would free up the space on these shelves.

D) Loose Cable Organization

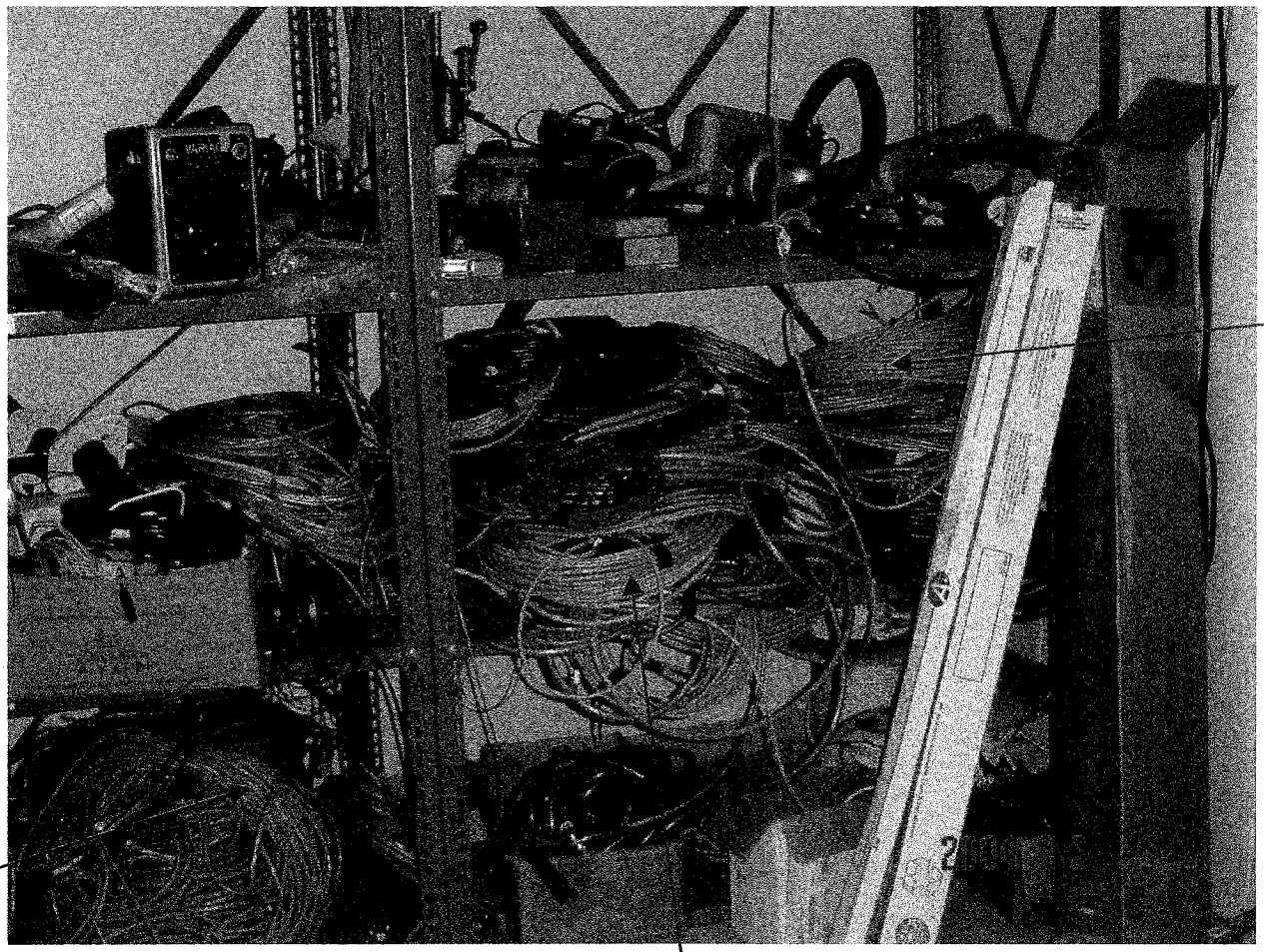


Illustration 4.0 - Storage Room #1, located adjacent to the Electronics lab.

Quick Fix:

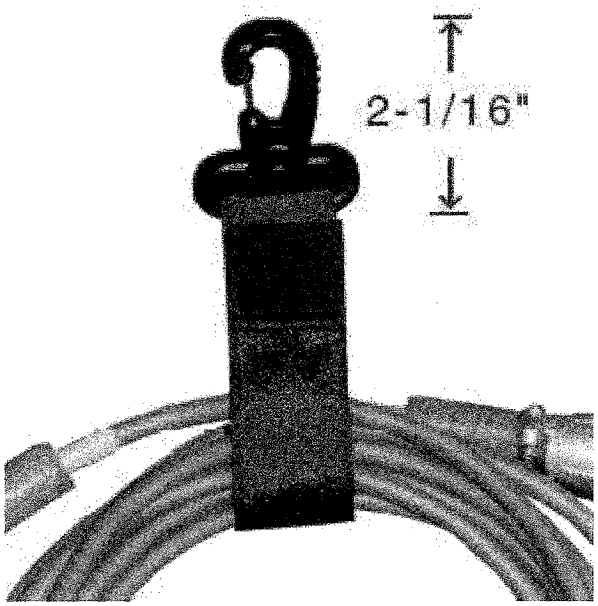


Illustration 4.1 – Cable Ties

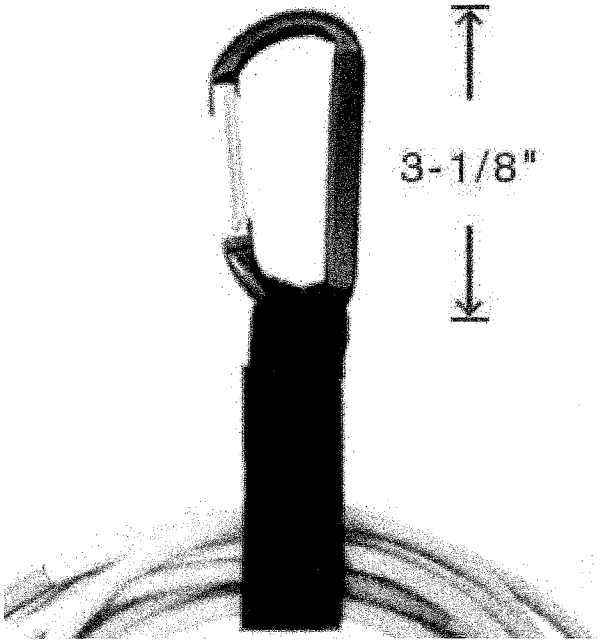
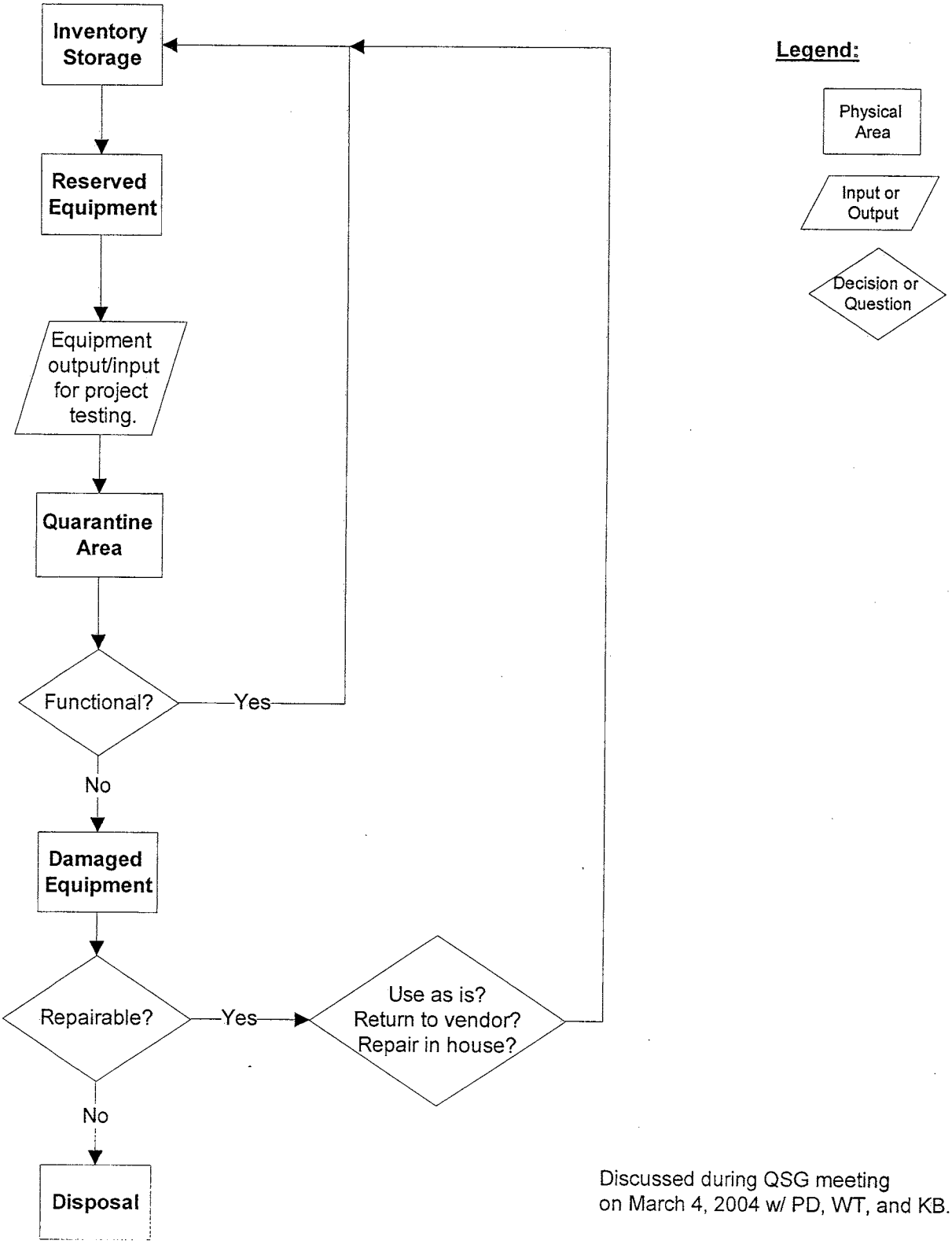


Illustration 4.2 – Cable Ties

Appendix K

Plant Layout Organization

Plant Layout Organization



Discussed during QSG meeting
on March 4, 2004 w/ PD, WT, and KB.

Appendix L

Plant Layout Drawings

REVISIONS			
REV NO	DESCRIPTION	DATE	APVD

Quarantine Area

OFFICE

ELECTRONICS LAB

Quarantine Area
Hazardous Materials
Consumables Inventory
Equipment
Damaged Equipment

STORAGE ROOM

Hazardous Materials
Consumables Inventory
Equipment

STORAGE ROOM

Hazardous Materials
Consumables Inventory
Equipment

ITEM	QTY	DESCRIPTION	MATERIAL

MATERIAL LIST

National Research Council
Institute for Ocean Technology
Electronics Department

UNLESS OTHERWISE SPECIFIED:

TOLERANCE	in.	mm
1 DECIMAL PLS	N/A	N/A
2 DECIMAL PLS	N/A	N/A
3 DECIMAL PLS	N/A	N/A
FRACTIONS	N/A	N/A
ANGLES	N/A	N/A

TITLE:

Existing Electronics Layout

DATE:	DWG BY:	APVD BY:	SCALE:
04/23/04	K. M. BYRNE	-	--

3RD ANGLE PROJECTION

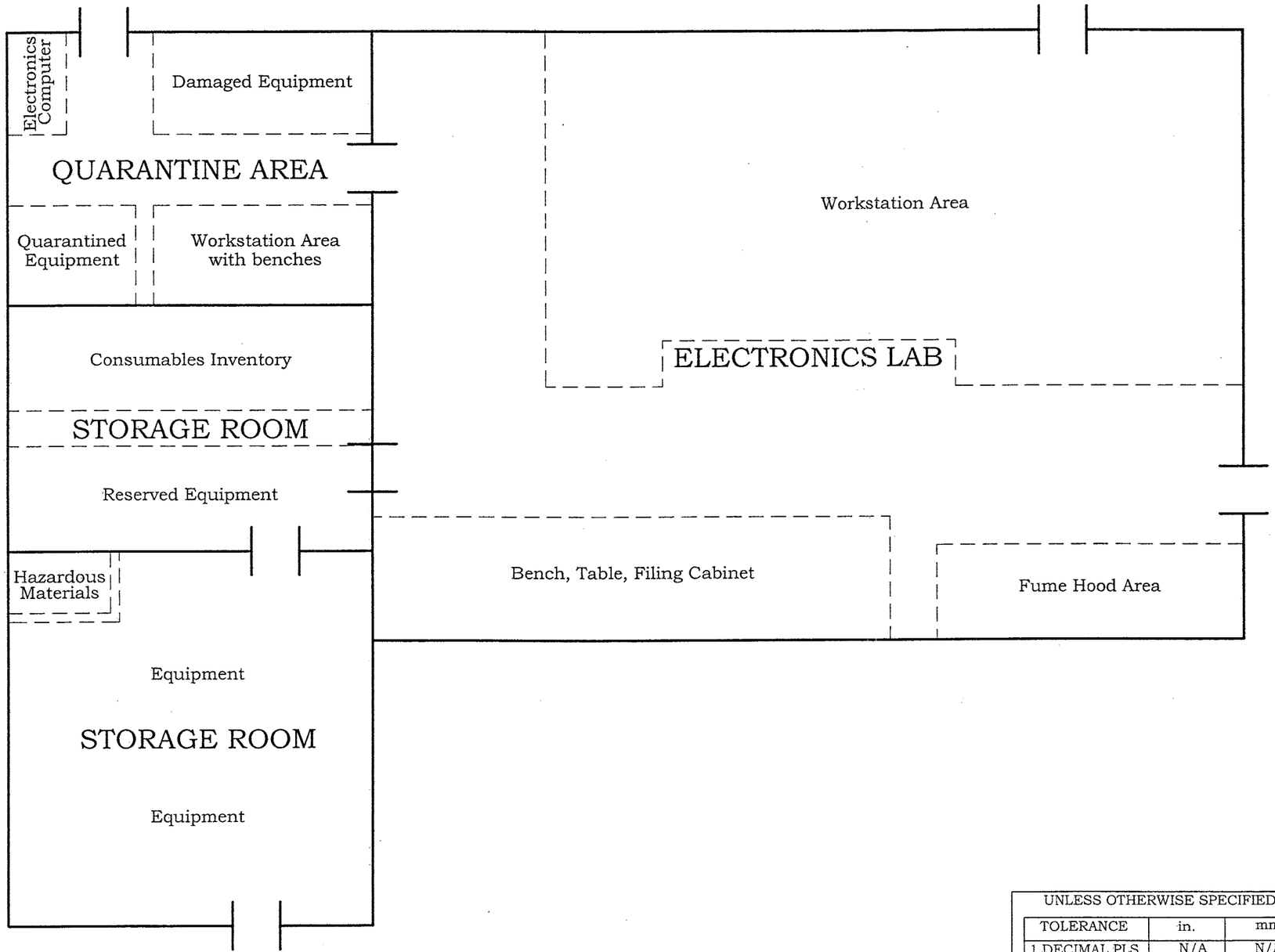
B

DWG NO: 2004-001

REV: --

SHEET: 1 OF 3

REVISIONS			
REV NO	DESCRIPTION	DATE	APVD



ITEM	QTY	DESCRIPTION	MATERIAL

MATERIAL LIST

National Research Council
Institute for Ocean Technology
Electronics Department

UNLESS OTHERWISE SPECIFIED:

TOLERANCE	in.	mm
1 DECIMAL PLS	N/A	N/A
2 DECIMAL PLS	N/A	N/A
3 DECIMAL PLS	N/A	N/A
FRACTIONS	N/A	N/A
ANGLES	N/A	N/A

TITLE: Ideal Electronics Layout

DATE:	DWG BY:	APVD BY:	SCALE:
04/23/04	K. M. BYRNE	-	--

3RD ANGLE PROJECTION

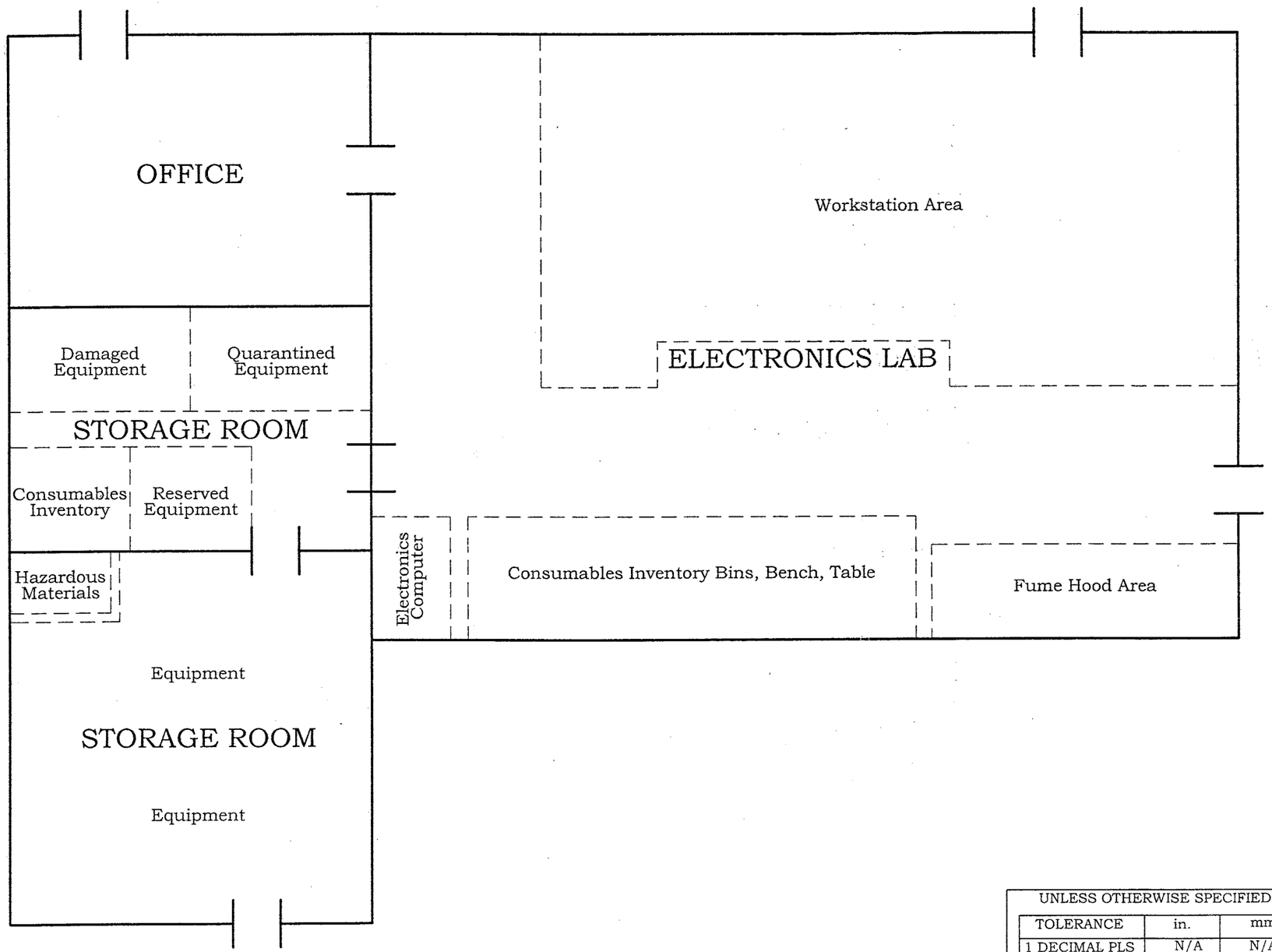
B

DWG NO: 2004-002

REV: --

SHEET: 2 OF 3

REVISIONS			
REV NO	DESCRIPTION	DATE	APVD



ITEM	QTY	DESCRIPTION	MATERIAL

MATERIAL LIST

National Research Council
Institute for Ocean Technology
Electronics Department

UNLESS OTHERWISE SPECIFIED:		
TOLERANCE	in.	mm
1 DECIMAL PLS	N/A	N/A
2 DECIMAL PLS	N/A	N/A
3 DECIMAL PLS	N/A	N/A
FRACTIONS	N/A	N/A
ANGLES	N/A	N/A

TITLE: 2nd Best Electronics Layout

DATE:	DWG BY:	APVD BY:	SCALE:
04/23/04	K. M. BYRNE	-	--

3RD ANGLE PROJECTION

B

DWG NO: 2004-003

REV: --

SHEET: 3 OF 3

Appendix M

Implementation Results

Before

Illustration 1.0 - Storage Room #1, located adjacent to the Electronics lab.

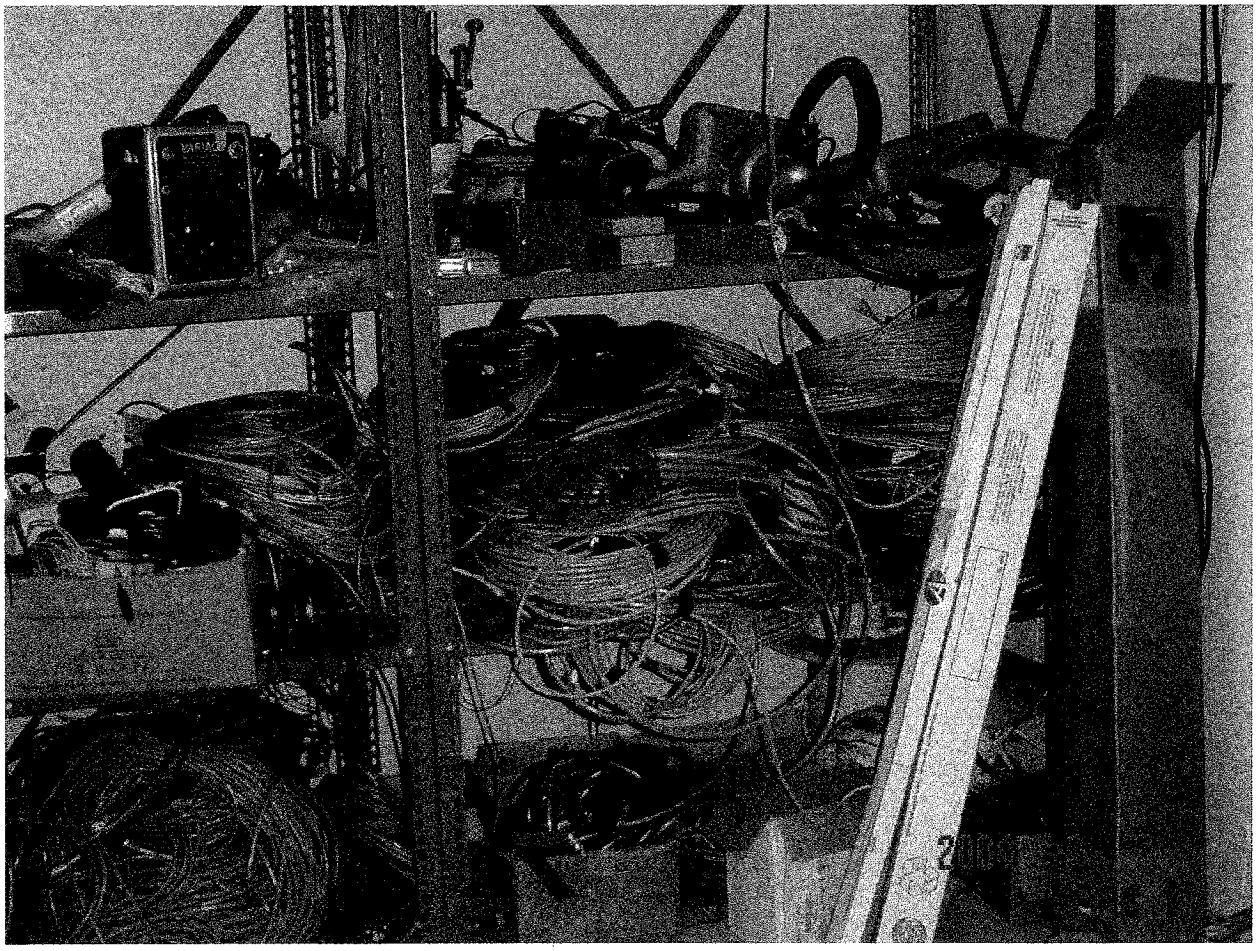


Illustration 4.0 - Storage Room #1, located adjacent to the Electronics lab.

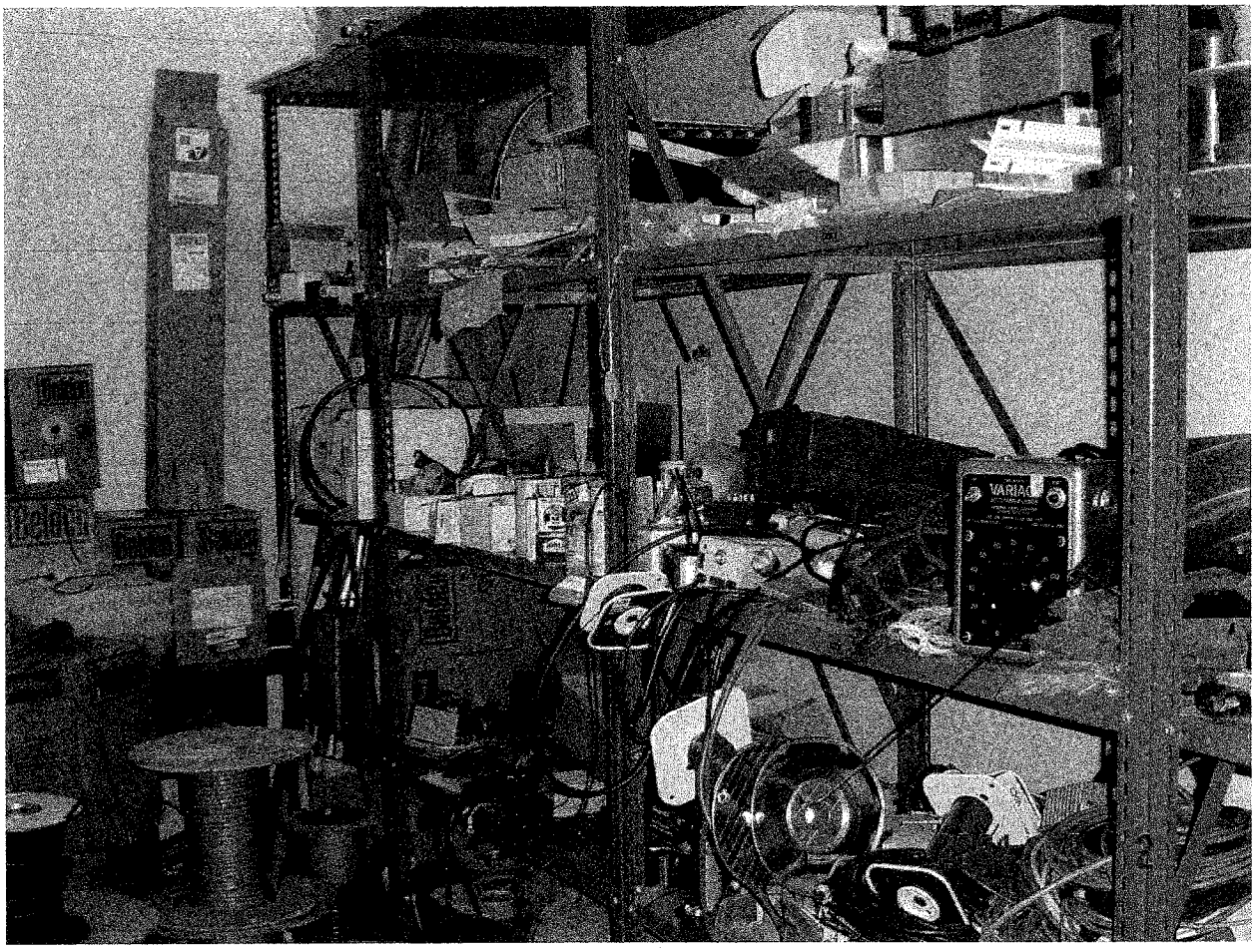


Illustration 5.0 - Storage Room #1, located adjacent to the Electronics lab.

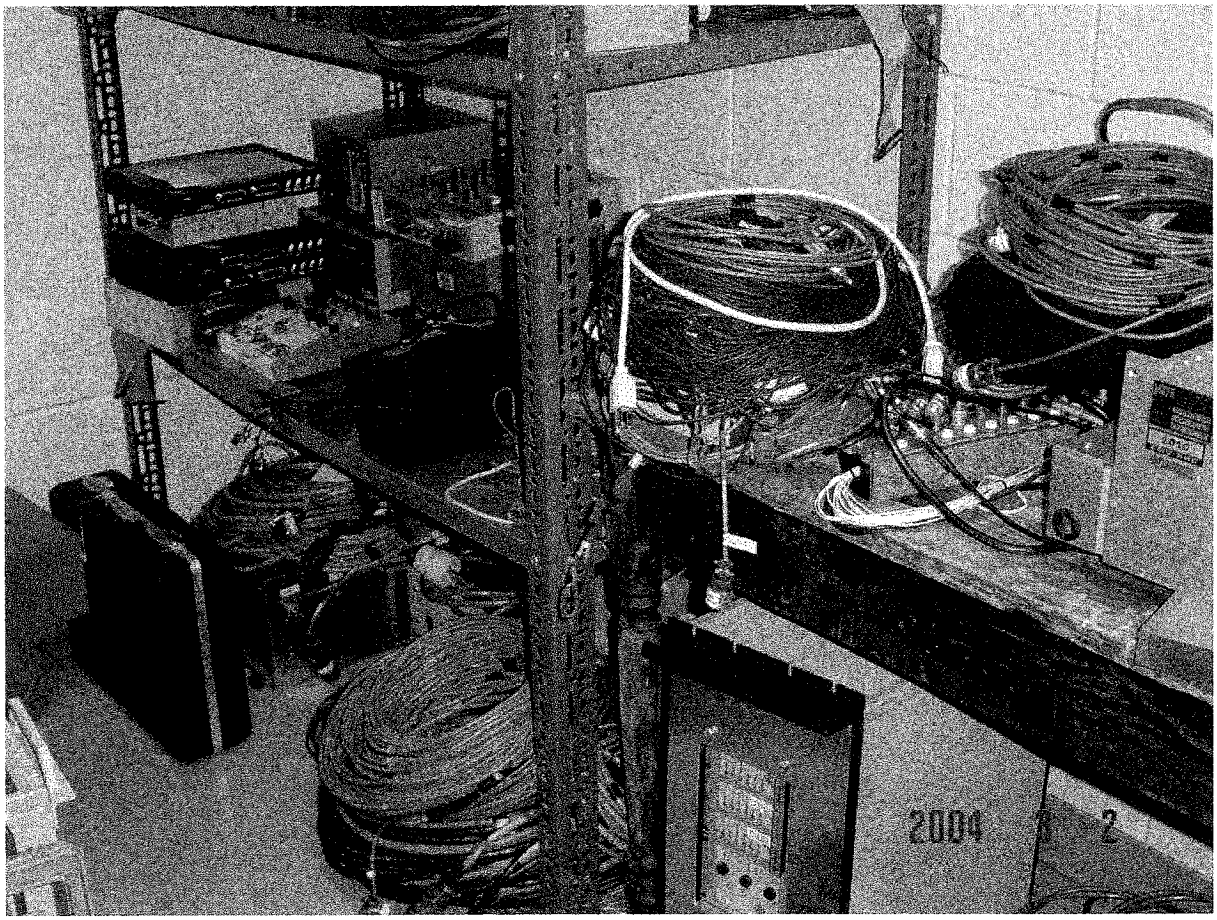


Illustration 6.0 – Quarantine Area, located in the Electronics lab.

After

Illustration 7.0 – Storage Room #2, cable spool organization.

Illustration 8.0 – Storage Room #2, cable organization.

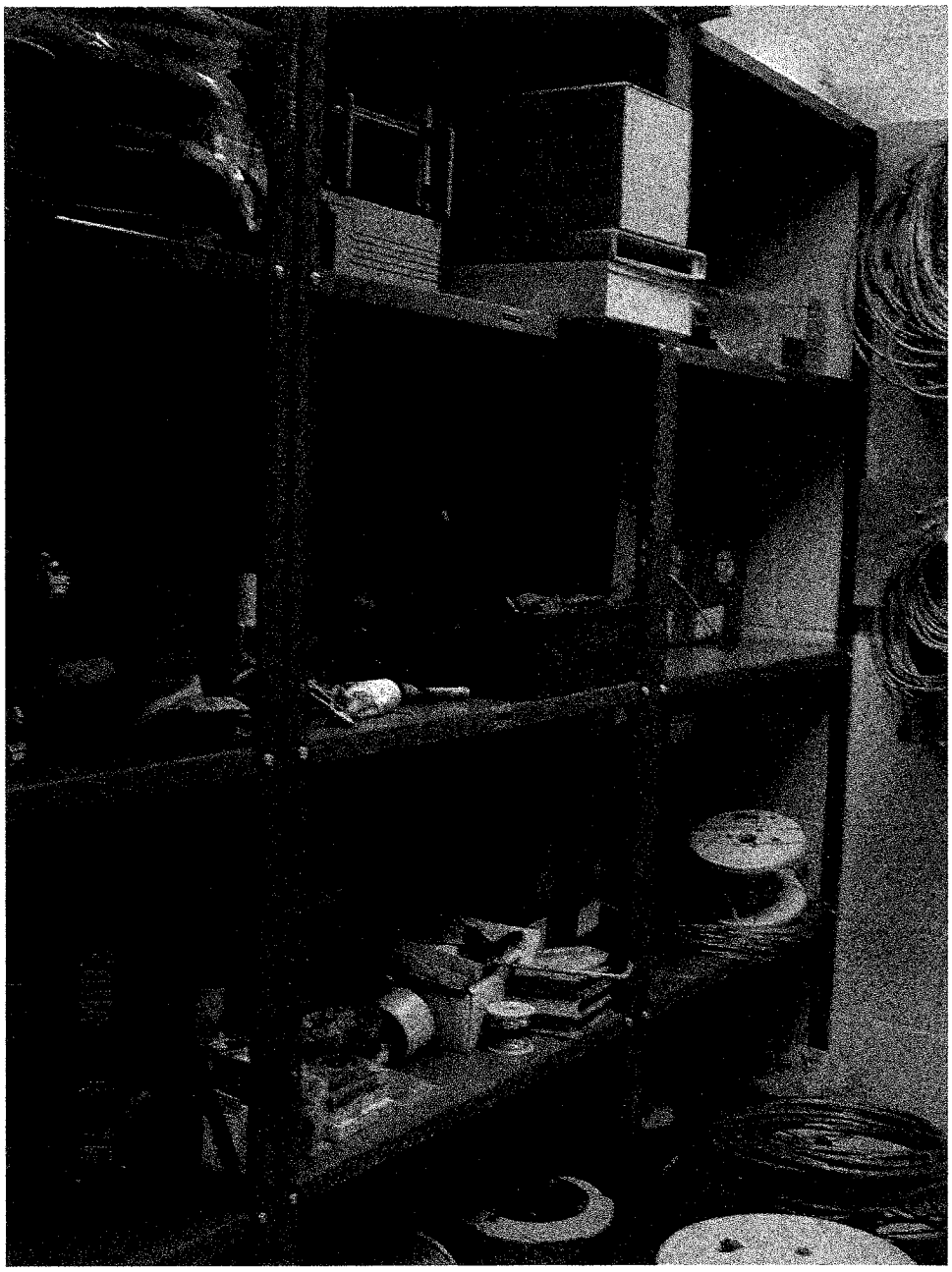


Illustration 9.0 – Storage Room #2, consumables organization.

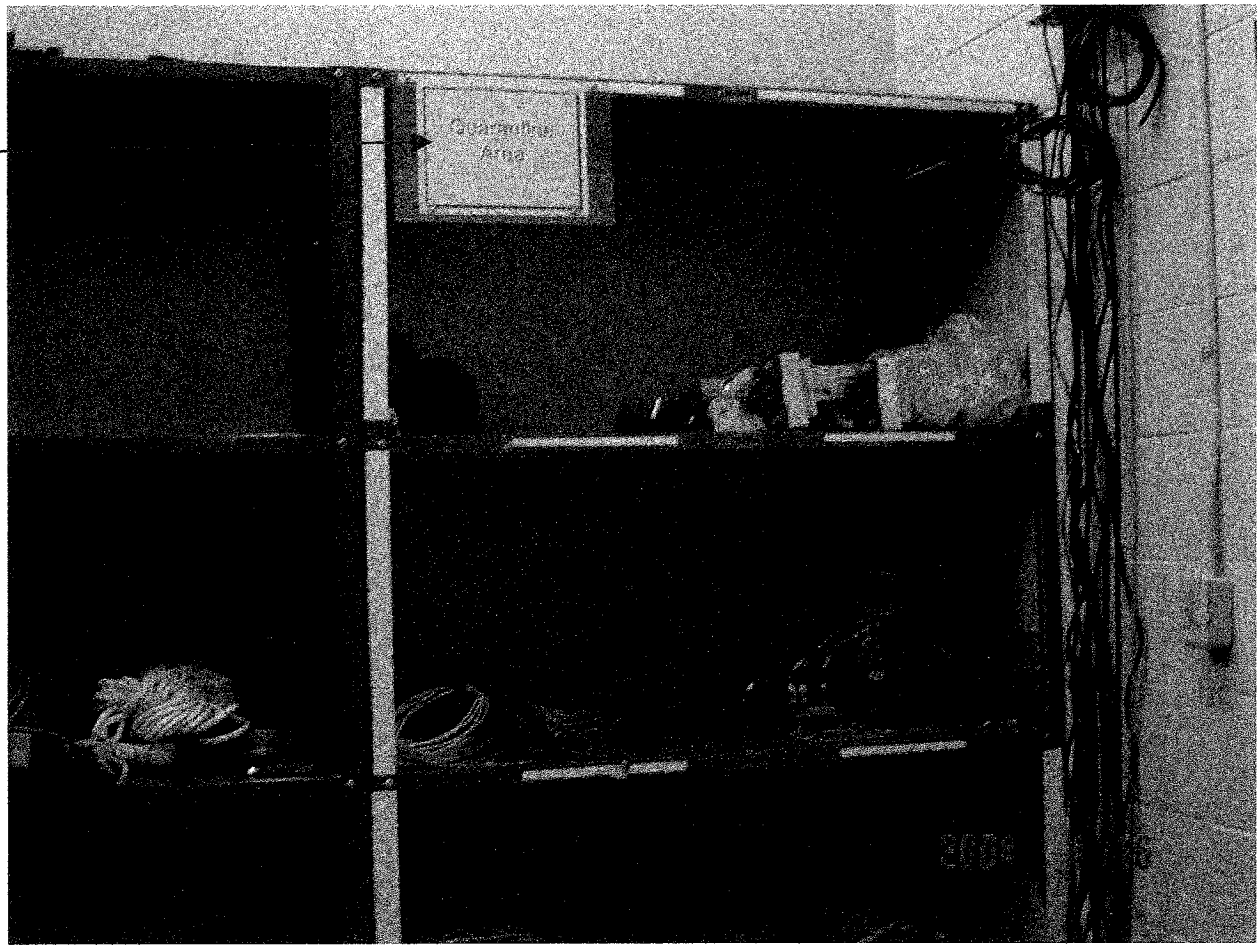


Illustration 10.0 – Storage Room #1, new Quarantine Area location.

Illustration 11.0 – Storage Room #1, new Damaged Equipment Area and Reserved Equipment Area.

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1. www.imd.nrc.ca
2. www.hc-sc.gc.ca/hecs-sesc/whmis
3. www.eng.buffalo.edu/Research/tcie/fr-plant.htm
4. Applied Production and Operations Management, Fourth Edition.
5. http://www.deming.org/theman/teachings02.html

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