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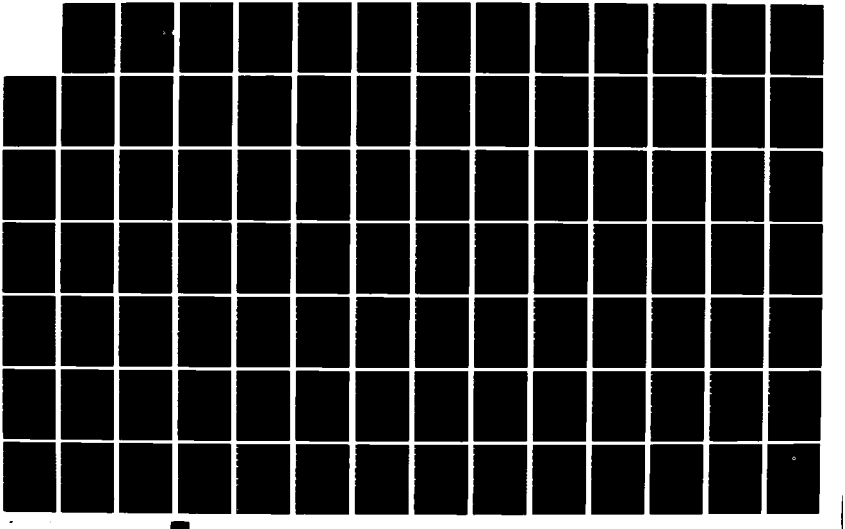

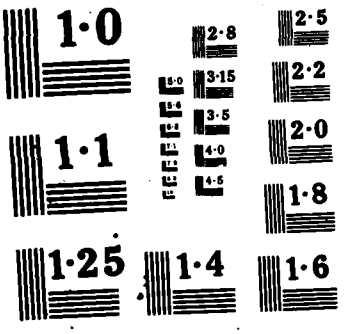

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INFORMAL TECHNICAL REPORT

Corrosion-Control (CC) Program: Pilot Powder Coating Station Service Test

Contract N66001-85-D-0015, Delivery Order 0012

Prepared for:

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In support of:

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The objective of the SIMA Pilot Powder Coating Station Service Test was to determine the feasibility of implementing a powder coating capability in Corrosion-Control Shops at the full-production level for all SIMAs under COMNAVSURFPAC. The test entailed the evaluation of facility requirements, industrial plant equipment, manning requirements, training, production procedures and quality control. A SIMA draft Process Instruction for powder coating was written and evaluated during operation of the Pilot Powder Coating Work Station. Recommendations are given in this report concerning the installation and operation of a Powder Coating Work Station in SIMA Corrosion-Control Shops, including guidance on powder resin selection and expansion of the list of authorized items to be powder coated. Site surveys for SIMA(Pearl Harbor) and SIMA(Norfolk) are also provided.

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EXECUTIVE SUMMARY

INTRODUCTION

The Naval Sea Systems Command (NAVSEA) has designated fifteen corrosion-control systems to be used to combat shipboard corrosion and thereby reduce the number of manhours spent by Ship's Force on corrosion prevention and control. The resulting increase in available productive manhours can be applied to maintenance, training, and operations in direct support of the ship's essential mission areas. One of the major designated corrosion-control systems is powder coating which is applied by intermediate or depot-level maintenance activities on steel and aluminum shipboard components.

This report documents the establishment of the Pilot Powder Coating Station in the Corrosion-Control Shop at the Shore Intermediate Maintenance Activity (SIMA), San Diego, and the Service Test conducted using the electrostatic powder spray coating process to provide corrosion-control services to units of the Naval Surface Force, U. S. Pacific Fleet. Recommendations are provided for the establishment of a powder coating production work station in the present or planned Corrosion-Control Shops in the SIMAs. This executive summary begins with a brief review of the powder-coating process; the equipment utilized during the Service Test at SIMA, San Diego, is then described; and finally recommendations for a full-production shop are presented. Included are two issues that need to be resolved in order to make full and efficient use of the powder coating capability to be established: the type of resin to be applied and the types of components to be powder coated.

BACKGROUND

Powder coating involves the coating of a clean metal object with a dry powder resin. Upon the application of heat, the powder melts and flows into a smooth film. A thermosetting resin will harden permanently while it is heated; and a thermoplastic resin will harden upon cooling and soften upon reheating.

Powder coatings are of use to the U.S. Navy as a replacement for painting because they provide less-porous coatings, require only minutes to fully cure and produce fewer pollutants while curing. Powder coatings have a proven track record in corrosion-control applications in commercial industry for pipe, reinforcing steel, storage tanks, and exterior building panels and extrusions.

A number of resins are available from manufacturers, the most common being: epoxy, polyester, epoxy-polyester hybrids and polyurethane which are all thermosetting resins. Epoxy and hybrid resins are typically used in applications where the coatings are not in direct sunlight since the colors will fade and the coating degrades. Polyesters and polyurethanes are recommended by manufacturers and commonly used for outdoor applications receiving direct sunlight due to their excellent ultraviolet (UV) resistance. Powder coating resins are typically less toxic than standard liquid paint resins because they contain no solvent. The cured state of the powder resins mentioned above have the same flammability characteristics as an analogous cured liquid paint resin.

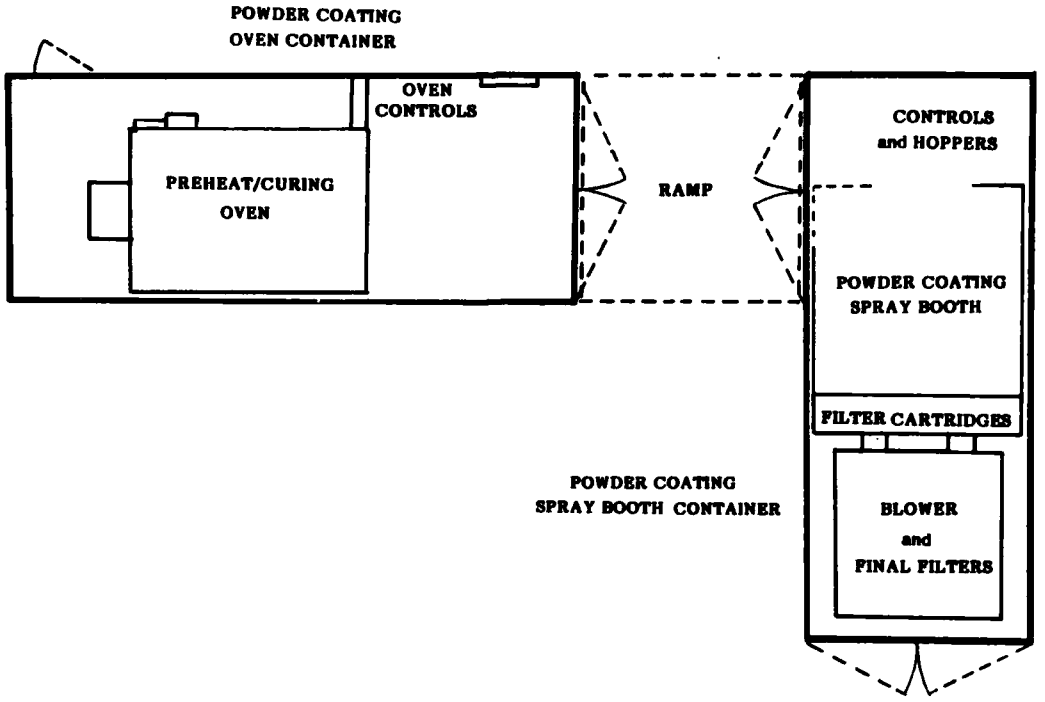
Two of the main application processes for powder coatings are fluidized bed and electrostatic spray. Fluidized-bed processes are used for the thermoplastic resins, such as nylon, polyvinyl chloride and polyethylene. The powder is fluidized in a fixed container by an upflow of air and then the item is immersed in the fluidized powder. Fluidized beds are limited in their use by the size of the container. Electrostatic spray processes are used with the thermosetting powders. The powder is applied in an open spray booth by a spray gun that electrostatically charges the powder so that it will adhere to the prepared item. The electrostatic spray process is very flexible in coating a wide range of geometrically sized and shaped items and is the process that is most applicaple in the SIMA work environment. The selection of items is dependent upon their ability to be removed from the ships, fit into a curing oven and withstand a temperature of 400°F.

The original plan developed for the Commander, Naval Surface Force, U.S. Pacific Fleet (COMNAVSURFPAC) to establish Corrosion-Control Shops at SIMAs did not include the equipment or manning to provide powder coating services. The exclusion of powder coating operations from the Pilot Corrosion-Control Shop at SIMA, San Diego, was based upon the lack of floor space and funding. Powder-coating services during the Pilot Corrosion-Control Shop Service Test were obtained through a local service contractor. Subsequently, NAVSEA 05M1/91AD provided program support and COMNAVSURFPAC tasked Integrated Systems Analysts, Inc. (ISA) to design, procure, install and service test a portable/containerized Pilot Powder Coating work station, of the electrostatic-spray application type, for the Pilot Corrosion-Control Shop at SIMA, San Diego.

SERVICE TEST

The purpose of the Service Test was to have SIMA personnel operate the powder coating equipment and gain experience in the process to provide recommendations for establishing a production powder coating capability at SIMA Corrosion-Control Shops. The Pilot Powder Coating Station operated as a work station within the Corrosion-Control Shop utilized in conjunction with the degreasing, surface preparation and masking work stations present in the Shop. Due to funding limitations and available shop floor space, the powder coating equipment was sized to fit into 8-ft by 8-ft by 20-ft containers that could be located outside existing buildings at San Diego. Types of components to be coated were reviewed and it was determined that a wide range of typical shipboard items could be processed in a containerized powder spray booth and curing oven. These items include 4-ft fog applicators, replenishment-at-sea dimmer boxes, various deck light fixtures, signal searchlight fixtures, vent screens, telephone boxes, electrical boxes, small pyrotechnic lockers and sunshields, etc. Since there were only brief guidelines available in the NAVSEA Ship Class Corrosion-Control Manuals and draft DoD standard on powder coating concerning which components could be coated, COMNAVSURFPAC directed coating of many types of components to obtain the experience needed to determine the effectiveness of powder coating as a corrosion-control system.

The equipment for the Pilot Powder Coating Station was installed in the 20-ft containers by a private contractor who had also fabricated the wire spray aluminum and anchor-tooth blast unit containers for the SIMA Pilot Corrosion-Control Shop. The equipment was guaranteed by manufacturers as conforming to Occupational Safety and Health Administration (OSHA) regulations. The diagram on the next page depicts the final layout of the Powder Coating Station.



Containerized Powder Coating Station Schematic

The Pilot Powder Coating Station used two electrostatic powder spray systems: one manufactured by Nordson and another by Ransburg-Gema. These two systems were obtained to provide experience in different types of equipment and to provide a back-up system. Both systems are designed for manual, low-volume application which is suitable for the Pilot Powder Coating Station. The Nordson system was that used by the powder coating contractor during the period powder coating services were obtained commercially during the Pilot Corrosion-Control Shop Service Test. The Ransburg-Gema system is a newer, more advanced system and proved easier to handle.

The spray booth is a dry-filter type that is self-cleaning, has final filters for the exhaust air and gages to determine when filter replacement is necessary. The oven is used to preheat the item before coating and then used to cure the item after coating. The pilot oven is electric, forced convection. This type of oven was selected since it was easier than a gas oven to install and hook up. Wheeled racks were built to suspend and transfer the product in the spray booth and oven.

The work-station manning consists of four Navy personnel assigned within the Pilot Corrosion-Control Shop. Pilot Corrosion-Control Shop personnel involved with quality control, supply, fastener support and records keeping expanded the range of their duties to include support of the powder coating process.

Training for the Navy personnel was provided by the corrosion-control support contractor. Lesson plans were developed which included generalized and specialized training directly related to the equipment in the work station. Manufacturer representatives also provided operator training to shop personnel.

A draft SIMA Process Instruction for Powder Coatings, electrostatically applied, was developed by direction of COMNAVSURFPAC for the Service Test using information gathered from NAVSEA 05M1, powder and equipment manufacturers and commercial applicators. The draft SIMA Process Instruction contains the detailed application procedures, safety requirements and quality control checks. Modifications to the draft were made during the powder coating work station start-up and as necessary during the Service Test. This draft process instruction has been submitted to SIMA for final approval.

A study was conducted to determine the standard process time data of components being powder coated in a SIMA Corrosion-Control Shop. This information will be used by the SIMA Planning Department to determine the most efficient shop loading. This information is presented in Appendix 7.

A planned maintenance system (PMS) package for SIMA Powder Coating equipments was developed and is presented in Appendix 5. The PMS package is based on equipment manufacturers' recommendations and the Corrosion-Control Shop usage rates during the Pilot. This package will be integrated by SIMA into the industrial plant PMS.

During the Service Test of the Pilot Powder Coating Station, NAVSEA 05M1 issued the current policy regarding resin selection. The policy stated that only epoxy resins meeting the standards of ASTM A775-81, and applied to a thickness of eight to 12 mils be used in coating shipboard items. The policy also stated that topcoating of the epoxy powder with TT-E-490 silicone-alkyd paint would provide sunlight resistance. The ASTM A775-81 is a test standard for epoxy powder coatings used on steel reinforcing bar (rebar). Painting over the rebar epoxy is not normally done and powder manufacturers do not recommend it. The rebar coatings are for steel which is eventually encased in concrete, thus manufacturers only produce the powder in four to five stock colors, since aesthetic appearance is not important. They do not recommend making the custom color and gloss matches to the Navy requirements for topside shipboard applications because the color and gloss of the epoxy resins will degrade within one to two months time. The impact resistance and hardness of the rebar epoxy is also low. Rebar powders are designed for high-speed mechanized application and therefore have fast gel times (25 seconds). The manual application that is used in a SIMA Corrosion-Control Shop is slow and requires a much longer gel time (90 seconds) to obtain a smooth and less-porous coating. The manufacturers recommend the use of a TGIC polyester powder resin designed for manual application. The sunlight, salt-spray and impact resistances of this resin should provide years of maintenance-free service. It is in the best interest of the Navy to work closely with the manufacturers so that the proper resin is formulated and procured. However, it should be clearly understood, that the epoxy resin meeting the requirements of ASTM-A775-81, as specified by NAVSEA, was used exclusively during the Pilot Powder Coating Station Service Test. The cured resin was then painted to provide the proper color.

RECOMMENDATIONS FOR THE IMPLEMENTATION OF POWDER COATING WORK STATIONS INTO A SIMA CORROSION-CONTROL SHOP

The recommendations concerning the implementation of Powder Coating Work Stations into Corrosion-Control Shops are dependent on a number of parameters. An important parameter is the list of generic types of components that can be powder coated. The range, or list, of component types has significant impact on industrial plant equipment sizing and shop manning; and an even greater impact on maintenance painting by Ship's Force. Eight component types are proposed to be authorized in the 20 September 1985 form of the draft DoD Standard for Powder Coating Systems for Corrosion Protection Aboard Naval Ships (i.e., vent and door screens, ventilation discharge screens, light brackets, light shock mounts, switch cover plates, fog applicators and battle helmets). A major result of the Pilot Powder Coating Station Service Test is that it has demonstrated that the application of powder coatings can be expanded to include a larger list of component types. Expanding the list of component types and utilizing powder resins formulated for corrosion control and providing sustained color retention will substantially reduce the maintenance manhours required by Ship's Force for painting and metal preservation.

This report presents an expanded list (refer to Section 5) of component types which includes items, such as pyrotechnic lockers, all shipboard light fixtures, Circle William ventilation covers, sound-powered telephone boxes, flagstaffs, jackstaffs, storage boxes and lockers. Based on this, the following recommendations are presented for establishing a Powder Coating Station at a SIMA Corrosion-Control Shop.

- The Powder Coating Station should be installed as an integral part of a Corrosion-Control Shop, sharing the use of the receipt, degreaser, masking and strip blasting stations with the Shop's wire-sprayed aluminum process.

- Industrial plant equipment dedicated to the powder coating process should include a walk-in anchor-tooth blasting unit, powder spray booth, walk-in curing oven, electrostatic powder spray guns, hoppers and control consoles and an overhead product handling monorail (refer to Section 5).

- Industrial plant equipment should be sized according to port loading, available floor space, monetary restraints, components to be coated and plant equipment presently available at the Shop.

- Manning for the Powder Coating Station should consist of a Second Class Petty Officer (preferably a Boatswain's Mate) to act as the powder coating Leading Petty Officer with two personnel to operate the coating equipment and one to perform anchor-tooth blasting (refer to Section 5).

- Familiarization with powder coating technology should be provided to personnel affiliated with its application. Operator training should be given to the Corrosion-Control Shop personnel and the SIMA Corrosion-Control Planner. Recommended lesson plans are provided in Appendix 2. Informational training should be given to Ship Work Center supervisors and 3M coordinators to provide guidance to Ship's Force.

- o The powder resin recommended by manufacturers for powder coating topside shipboard components is a TGIC polyester powder resin. TGIC polyester resin will provide good corrosion resistance and excellent resistance to degradation caused by ultraviolet radiation (sunlight). The environment the component will be subjected to and the environment in which it shall be applied should be specified to the manufacturer to allow formulation of the best powder for the application (refer to Section 3).

- o The draft SIMA Process Instruction developed and evaluated during the Service Test is contained as Appendix 1 of this report and is recommended for use in full production operations.

- o Recommended standard process times for powder coating shipboard items in a full-production Corrosion-Control Shop, developed during the Pilot, are presented in Appendix 7 for use by SIMA planning.

- o Site surveys should be conducted at all SIMAs prior to planning any corrosion-control facility. Site surveys were conducted at SIMA, Pearl Harbor, and SIMA, Norfolk, to determine equipment and facility requirements to incorporate a Corrosion-Control Shop within each SIMA (refer to Section 7).

CONCLUSION

The Pilot Powder Coating Service Test conducted at SIMA, San Diego, has provided information regarding industrial plant equipment, manning, production procedures, quality control, training and resin selection. This effort and the lessons learned during the test demonstrate conclusively that immediate and long-range value can be realized by the Navy.

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ABBREVIATIONS

AO	Oiler
ASTM	American Society for Testing and Materials
AWR	Automated Work Request
BM	Boatswain Mate
CC	Corrosion Control
CCWP	Corrosion-Control Work Package
CG	Guided-Missile Cruiser
CO	Commanding Officer
COMNAVSEASYSCOM	Commander, Naval Sea Systems Command
COMNAVSURFPAC	Commander, Naval Surface Force, U.S. Pacific Fleet
CPO	Chief Petty Officer
CSMP	Current Ship's Maintenance Project
DD	Destroyer
DDG	Guided-Missile Destroyer
DFT	Dry Film Thickness
DoD	Department of Defense
DTNSRDC	David Taylor Naval Ship Research and Development Center
EN1	Engineman, First Class Petty Officer
EPA	Environmental Protection Agency
ESP	Electrostatic Powder (Coating)
FF	Frigate
FFG	Guided Missile Frigate
FN	Fireman
ft	Foot (12 inches)

ABBREVIATIONS (Cont'd)

HT	Hull Technician
HTFN	Hull Technician Fireman
IMA	Intermediate Maintenance Activity
IPE	Industrial Plant Equipment
ISA	Integrated Systems Analysts, Inc.
kV	Kilovolts (1000 Volts)
lb	pound
LPO	Leading Petty Officer
LP	Lesson Plan
LHA	Amphibious Assault Ship
LST	Landing Ship, Tanks
mil	0.001 Inch
MM3	Machinist Mate, Third Class Petty Officer
NAVSEA	Naval Sea Systems Command
NFPA	National Fire Protection Association
NSTM	Naval Ships Technical Manual
OJT	On-the-Job Training
OSHA	Occupational Safety and Health Administration
PC	Powder Coating
PO	Petty Officer
PO2	Second Class Petty Officer
PO3	Third Class Petty Officer
psi	pounds per square inch
QA	Quality Assurance

ABBREVIATIONS (Cont'd)

QC	Quality Control
SIMA	Shore Intermediate Maintenance Activity
SIMA(SD)	Shore Intermediate Maintenance Activity, San Diego
SIMA(PH)	Shore Intermediate Maintenance Activity, Pearl Harbor
SMAF	Ship's Maintenance Action Form
SN	Seaman
sq.ft.	Square Foot (144 in^2)
SQCI	Shop Quality Control Inspector
SRA	Selected Restricted Availability
TGIC	Triglycedial Isocyanurate
TYCOM	Type Commander
UV	Ultra Violet
WSA	Wire-Sprayed Aluminum
'	foot

SECTION I

INTRODUCTION

1.0 BACKGROUND

This is the final technical report of the Shore Intermediate Maintenance Activity (SIMA) Pilot Powder Coating Station Service Test. The Service Test started 24 June 1985 with the initial phase completed on 31 December 1985 and the final phase completed on 28 February 1986. The initial phase consisted of establishing the work station in the Pilot Corrosion-Control (CC) Shop, training personnel and commencing operations. The final phase consisted of collecting a majority of the data for standard time development and determining the practicality of performing powder coating services in a SIMA environment. Additionally, this report will provide the information collected from site surveys performed at SIMA(Norfolk) and SIMA(Pearl Harbor) and will present the findings and recommendations for the proposed CC Shops.

The Navy is introducing improved shipboard CC coating systems in new construction and in the maintenance, repair and overhaul of ships in service. A Senior Navy Steering Board has proposed that Type Commanders and their Intermediate Maintenance Activities (IMAs) identify requirements and develop the capability to perform the full spectrum of CC services. The majority of the IMAs currently do not have the manning, equipment, industrial processes or shop organization to provide CC services. Some SIMAs do have a limited capability to provide CC services but may lack the training and experience to provide CC work that meets the operational and technical requirements of Type Commanders and/or Naval Sea Systems Command (NAVSEA). Development and implementation of CC programs will benefit operating units of the Fleet by:

- Reducing the excessive Ship's Force manhours spent on corrosion prevention and control,
- Extending the service life of shipboard components and structures,
- Reducing/eliminating the attendant material, labor costs and adverse schedule impacts to repair/replace failed components, and
- Reducing/eliminating requirements to paint components through the use of powder coatings.

During the initial feasibility study for the establishment of a Pilot CC Shop in SIMA, the 15 NAVSEA-designated systems were evaluated for incorporation into the shop (Ref. 1-1). The decision was made by COMNAVSURFPAC not to provide the industrial plant equipment (IPE), Training and Service Test for System 4, Powder Coating. This decision was based on lack of shop floor space and funding. It was decided to provide the required services for application of powder coating through an existing commercial source. Concurrence by COMNAVSURFPAC was received for proceeding with this approach to conserve SIMA(SD) resources and reduce initial capital expenditures.

The SIMA Pilot CC Shop Service Test Program began in September 1984. R. W. Little, Inc., a commercial powder coating applicator, was to provide these coating services. Concurrently, a SIMA draft powder coating process instruction was developed to establish a baseline for the industrial application process because there was no federal or military specification in issue applicable for this type of resin or application process. The process instruction also includes a production control record for each item processed.

NAVSEA 05M1 initiated funding action to service test a powder coating capability within the SIMA Pilot CC Shop obtaining resources from the SIMA Upgrade Program. In mid-1985, funds were made available to COMNAVSURFPAC from NAVSEA 91AD (now SEA 93F221) to procure the equipment to establish a portable/containerized powder coating capability. COMNAVSURFPAC agreed to provide funding for the technical engineering support required to implement the program.

Initial system design began to identify the IPE type, size and capacity which would be representatively scaled for a SIMA production shop capability. Equipments were procured and assembled within the funding constraints. SIMA personnel were assigned and began both classroom and on-the-job training in October 1985. Due to schedule and equipment delivery delays, the Pilot Powder Coating Station did not begin processing shipboard components until 20 November 1985.

1.1 OBJECTIVE

The objective of the Pilot Powder Coating Station Service Test was to determine the feasibility of implementing a powder coating capability within CC-Shops at the full-production level for all SIMAs under COMNAVSURFPAC. The test entailed the evaluation of facility requirements, industrial plant equipment (IPE), process instruction and manning requirements. Results of the Service Test are used to develop recommendations for the installation and operation of powder coating station in the SIMA CC Shops.

1.2 SCOPE AND APPROACH

The scope of the Pilot Powder Coating Station Service Test included:

- Design, procurement of powder coating equipments and their installation in 8' x 8' x 20' ocean cargo containers.
- Training of SIMA CC Shop personnel in the operation and maintenance of the Powder Coating Station.
- Development of an industrial process instruction for the application of powder coatings.
- Service test operation of the Powder Coating Station to collect planning and production data, e.g., labor (standard times), material and schedule costs.

The approach included:

- Technical review of the NAVSEA publications, i.e., NAVSHIPS Technical Manual, military standards and specifications, Ship Class Corrosion-Control Manuals, etc.
- Technical survey and consultation with the four major powder-resin manufacturers and coating equipment manufacturers.
- Design of a two-container Powder Coating Station.
- Equipment procurement and installation into the containers.
- Development and delivery of a training program for designated SIMA CC Shop personnel.
- Designation of customer ship and ship check to develop product load for the Powder Coating Station.
- Operation of Powder Coating Station to collect data.
- Analysis of data and its feedback during the Service Test to ensure an adequate data base for developing recommendations.

Figure 1-1 illustrates the overall logic for and scope used in developing the Pilot Powder Coating Station in the SIMA CC Shop.

The major analysis, design and production engineering phases are shown in the overhead bar in Figure 1-1: assumptions; criteria; IPE design, procurement and installation; powder coating operations; and analysis, findings and recommendations.

Block 1, Qualitative Requirements: Powder coatings are generally more durable than paint coatings but less durable than wire-sprayed-aluminum (WSA) coatings. Powder coatings are particularly effective on aluminum items and on steel items with geometries which preclude cost-effective application of WSA coatings, e.g., vent screens and electrical junction boxes. Powder coatings should be used because they will reduce Ship's Force (S/F) maintenance labor and increase the service life of the components, and there are many shipboard applications.

Block 2, Assumptions: There are many shipboard items suitable for powder coatings so it is assumed that the capital investment and cost of operation for a powder coating station in a SIMA CC-Shop will reasonably be "paid back." It is further assumed that the industrial plant equipments (IPE) exist; powder coating electrostatic spray resin materials are available and NAVSEA certifiable; and the industrial process (IPE, material, safety, quality control (QC), operator training and certification, method and reporting/feedback) and personnel training materials can be developed and implemented.

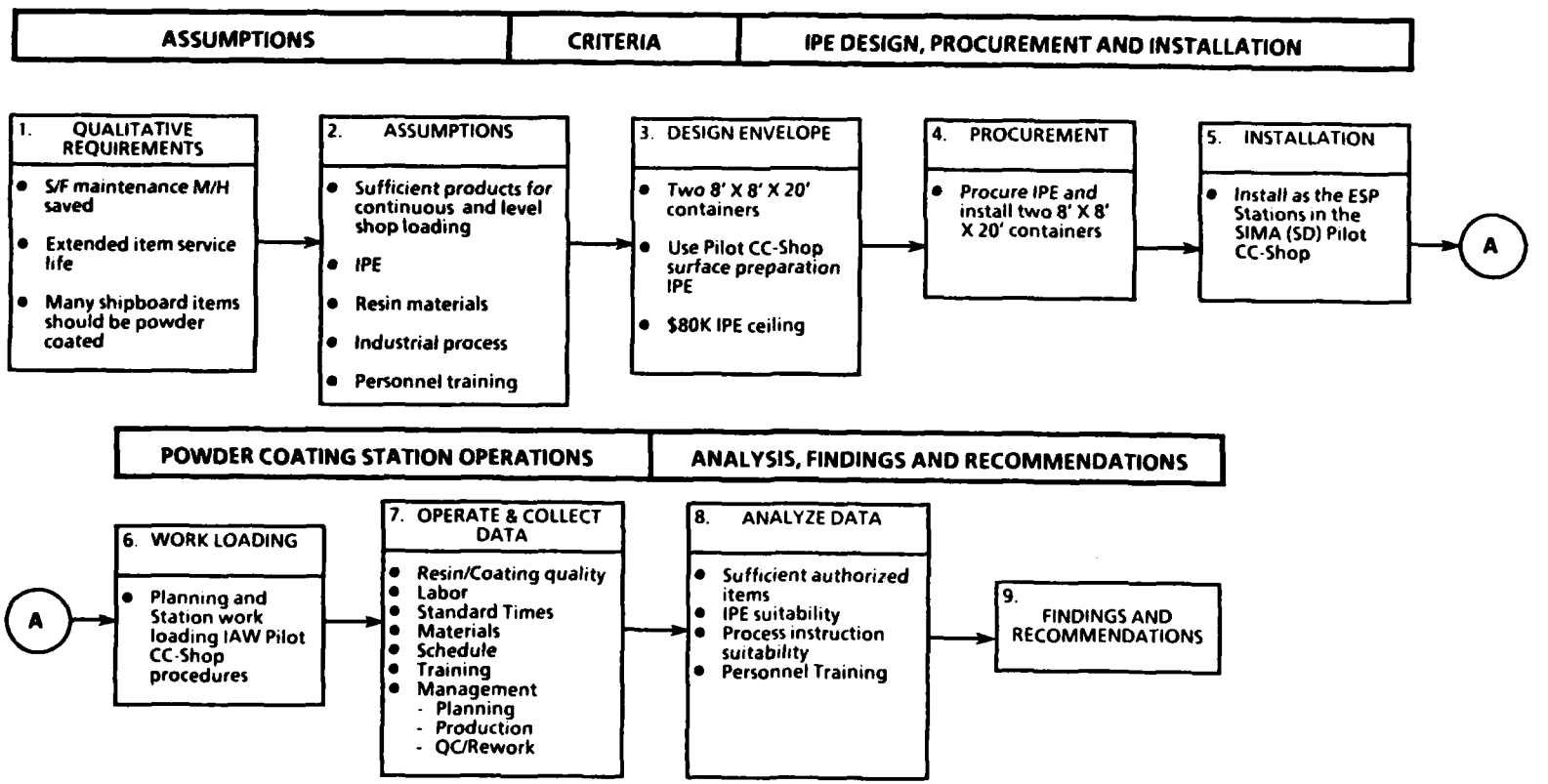


FIGURE 1-1. SCOPE AND APPROACH FOR SIMA (SD) PILOT POWDER COATING STATION

Block 3, Design Envelope: The Pilot Powder Coating Station was stipulated to be installed and operated in two weatherproofed 8' x 8' x 20' cargo containers. The procurement of the containers and the entire powder coating IPE (i.e., spray guns, spray booth and oven) had to stay within an $80K hardware cost budget. The surface preparation (i.e., degreasing, strip- and anchor-tooth blasting) equipment currently in use for the WSA process was to be shared with powder coating operations.

Block 4, Procurement and Block 5, Installation: The Powder Coating Station equipments were procured and installed in the two 8' x 8' x 20' containers and placed at the west end of Building 61 contiguous to the existing CC Shop.

Block 6, Workloading: The Pilot Powder Coating Station was initially work-loaded by the SIMA planning and screening process used for work-loading the CC Shop (e.g., ship visits to identify powder coating candidates and the ship/SIMA screening and scheduling). Later in the Service Test, selected items were obtained from the customer ships to expand the powder coating production standard times data base.

Block 7, Operate and Collect Data and Block 8, Analyze Data: The following data was collected and analyzed in the Service Test: the resin and coating quality; the labor, materials and production standard times and the in-shop schedule required for the application and quality control of the powder coatings on selected topside items; the training required and delivered for powder coating station personnel; the suitability of the IPE and draft SIMA process instruction; the sufficiency of authorized items for full-time utilization of the Powder Coating Station; and the management of CC-Shop in regards to the Powder Coating Station (planning, production, quality control and records).

Block 10, Findings and Recommendations: The findings are summarized and recommendations are made.

1.3 PLAN OF THE REPORT

Section 1 of this report presents the background of the development of the Pilot Powder Coating Station Service Test. In Section 2, a review is provided of the technology of powder coating, including types of resins. The problems of selecting a specific resin for powder coating is reviewed in Section 3. Section 4 describes the IPE and operation of the powder coating work stations during the Service Test. The recommended production powder coating facility, as part of the SIMA (SD) CC Shop, is presented in Section 5. A summary of the recommendations concerning installation, equipment manning, procedures, resin selection and types of components to be processed are contained in Section 6. The site surveys of SIMA(Pearl Harbor) and SIMA(Norfolk) are discussed in Section 7.

REFERENCES FOR SECTION 1

1-1 Sulit, R. A. and O. G. O'Brien, ASW and Support-Ship Corrosion-Control (CC) Program Pilot SIMA CC Shop, Final Report ISA(WC)-101, 14 September 1984, Contract N66001-84-D-0032, Delivery Order 0003.

SECTION 2

POWDER COATING TECHNOLOGY

2.0 INTRODUCTION

Due to powder coating being relatively new to the U.S. Navy, a general discussion concerning powder coating is given here to familiarize the reader with the technology. The purpose here is to emphasize that powder coating is a well-established technology for corrosion control in general industry, and an advanced coating system that can be beneficial in naval applications.

2.1 BACKGROUND

Powder coating involves the coating of a clean metal object with a dry resin powder, and upon heating, the powder melts and flows into a smooth film. The resin powders used may be thermosetting so that the coating will cure and harden permanently while it is heated; or thermoplastic so that the coating will harden once the part has cooled and soften when reheated.

Powder coating technology was originally developed in Europe during the late 1950's, with the introduction of thermosetting powders by the mid-1960's. Particular emphasis was placed on the development of the electrostatic powder spray process. The driving force was the need for a replacement of liquid spray painting, because of the cost of solvents, and the limited sites and costs for the disposal of toxic waste.

Electrostatic powder spray coatings are now commercially applied on items, such as: automobile parts, bicycles, marine accessories, pump housings, metal furniture, piping, light fixtures, metal toys, machinery parts, and exterior architectural panels and extrusions.

Powder coating in the U. S. did not become firmly established until the 1970's, after implementation of the Clean Air Act. Prior to this time, the bulk of powder coating performed in the U. S. was with the fluidized bed process on small parts for applications that required a higher performance coating than could be attained with plastisols (plasticized polyvinyl chloride).

After establishment of the Environmental Protection Agency (EPA), conventional spray-paint applications began to accrue higher costs, due to more stringent pollution-control measures. The EPA suggests guidelines for the regulation of reduced volatile organic compounds contained within the coating material. These restrictions are in terms of weight of volatiles per volume of coating material at the point of application. Responsibility for the specific regulations and their enforcement is that of the state and/or local pollution control board. Paints typically have volatiles ranging from 360 to 420 grams per liter or 50 to 65% by weight. Powder coatings, however, release 1-3% by weight of volatiles upon curing in the oven. An epoxy powder with a specific gravity of 1.35 releasing 3% volatiles has a grams volatiles to volume ratio of 41 grams per liter. This is well below the requirement of 275 grams per liter found in San Diego County's pollution requirements. The U.S. Navy is

currently exempt from these rules concerning coatings, but with increasingly stringent requirements, there is a probability that the Navy will also have to meet such requirements.

Due to these EPA guidelines, the use of powder coating expanded to a variety of applications through the U.S. The earliest major spray applications of powder coatings were on pipe and reinforcing bars. Most piping and reinforcing bar were coated in the factory immediately after fabrication. The technology became increasingly popular in the late seventies for above ground applications, in particular, the outdoor furniture and architectural coating industries. Applications have expanded to automotive parts, household furniture and hardware, electrical transformers and housings, and other miscellaneous items.

2.2 TYPES OF POWDER COATING PROCESSES

Coatings are applied in either a spray application or a dipping process. In both cases, the powder may be induced to cling to the part by either providing an electrostatic attraction or preheating the part above the powder's melting point. Combinations of electrostatics and preheating are often used. Most spray equipment is electrostatic, and most dipping processes require preheating. The spray process requires a gun which has an electrode that charges the powder/air mixture flowing past it. The dipping process requires a container, or bed, in which the powder is brought into a fluidized state by an upflow of air. Most thermosetting resin powders are applied with electrostatic spray equipment. Most thermoplastic resins are applied by fluidized bed equipment because of the resins' inability to accept an electrostatic charge.

2.3 TYPES OF RESINS

A number of powder coating resins are available but only a few are manufactured in great quantities. Table 2-1 provides a comparison of environmental effects on eight resin groups, with four of the most standard resins separated from the rest. There are variations within each resin type, depending on the presence of curing agents, flow agents and pigment/binder systems. Properties presented are the result of technical literature (Refs. 2-1-14) and discussions with major powder resin manufacturers (Ferro Corp., Morton Thiokol, Inc., Polymer Corp., O'Brien Corp., 3-M and Tiger Drylac, Inc.) The four standard types -- epoxy, polyester, epoxy/polyester hybrids, and polyurethanes -- were developed before the rest and have properties that are useful to more applications and are therefore the most common.

Powder coatings have been used for over 20 years in protecting metals from environmental effects. The type of environment dictates the type of resin used. Manufacturers have and will design powder coatings for specific applications and environments, i.e., indoor, outdoor, underground, above ground, and chemical.

TABLE 2-1

COMPARISON OF ENVIRONMENTAL EFFECTS ON POWDER COATING RESINS

Resin Type	Chemical Resistance	Sunlight Resistance	Salt Spray Resistance
Standard Resin Types			
Epoxy	E	P	E
Polyester	G	E	E
Hybrids	G	P	G
Polyurethanes	G	E	G
Specialized Resin Types			
Acrylic	F	E	G
Nylon	G	G	G
Polyvinyl	F	G	G
Polyethylene	E	P	G
E = Excellent; G = Good; F = Fair; P = Poor			

A large corrosion-control application of epoxy-type powders has been in coating reinforcing bar (rebar) and underground piping. High-volume powder coating lines were established because of the base material's suitability to high-speed mechanized production operations, and the requirement for low pollution levels. The resin itself allowed a thick (over eight mils) coating to be applied in one pass and is much less porous than paint because no solvent evaporation is involved. The coating's color and gloss characteristics were unimportant because the coated product was encased in concrete.

A large application of polyester and polyurethane type powders is in the architectural coating field. In this application, both corrosion protection and sunlight (in particular UV light) resistance are required. The coatings are applied to both panels and extrusions and must retain their required color and gloss for years. The earliest and most extensive architectural applications have been conducted in Europe. Polyester coated panels on buildings are still providing excellent corrosion protection and color retention after 11 years of service. The most maintenance the panels have received is a yearly washing. Architectural material coating lines are large in size and use in excess of 200,000 lbs. of powder per year.

Epoxy/polyester hybrids are used in corrosion-control applications in the form of undercoatings for automotive vehicle bodies, formulated specifically for topcoating. They are also useful for coating indoor furniture.

Of the lesser used resins shown in Table 2-1, acrylics have the best future for becoming a standard powder coating. They have excellent outdoor properties, but are still in the development stages. Nylons have good weather and abrasion resistance properties, but require special primers for adhesion and are expensive. There are nylon formulations available for fluidized bed application and formulas for electrostatic spray. Polyvinyls are most adequately applied in the hot dip fluidized bed process. Polyethelene is very specialized for chemical environments and subject to oxidation and embrittlement when exposed to sunlight.

Powder resins are inherently safer than their liquid paint analogues because they contain no solvent. However, the resin, while in its uncured powder form, can be ignited and must be considered as a potential dust hazard (Ref. 2-17, 2-18, 2-19). Electrical equipment operating within the spray area needs to only be Class II, dust-ignition-proof, rather than Class I, vapor-ignition-proof (Ref. 2-20). Personnel involved with applying the powder must wear dust masks to prevent respiratory irritation. Powder contact with the operator's skin should be kept to a minimum, but any powder residue can be removed with soap and water. All powders sold in this country have Material Safety Data Sheets (Form OSHA 20 or equivalent) which are available from the manufacturers. Cured powder resin films have the same fire properties as cured resins that were applied as liquid paint. Special fire retardancy of the cured state can be induced in powder resins the same as liquid resins i.e., halogenating the resin.

REFERENCES FOR SECTION 2

2-1 The Ferro Corp., CF 3460 Technical Data Sheet.

2-2 The Ferro Corp., VP 320 Technical Data Sheet.

2-3 The Ferro Corp., VP 332 Technical Data Sheet.

2-4 Morton Thiokol, Inc., E 194A Product Data Sheet.

2-5 Morton Thiokol, Inc., E 4000 Series Product Data Sheet.

2-6 Morton Thiokol, Inc., PE 6000 Series Product Data Sheet.

2-7 The O'Brien Corp., Technical Data Powder Coatings, Oxyplast, X21.

2-8 The Polymer Corp., ECA 155-FCH Technical Data Sheet.

2-9 The Polymer Corp., PCA 1575-GP1 Technical Data Sheet.

2-10 The Polymer Corp., PCA 1575-XW1 Technical Data Sheet.

2-11 The Polymer Corp., HCA 1585-FCA Technical Data Sheet.

2-12 3-M, Scotchkote 134 Product Data Sheet.

2-13 3-M, Scotchkote 203 Product Data Sheet.

2-14 Tiger Drylac, Inc., Series 19 Technical Data Sheet.

2-15 Tiger Drylac, Inc., Series 69 Technical Data Sheet.

2-16 Tiger Drylac, Inc., Series 79 Technical Data Sheet.

2-17 The Polymer Corp., PCA 1575-GP1-80K-24029, Material Safety Data Sheet.

2-18 The O'Brien Corp., EFH 400-S9, Material Safety Data Sheet.

2-19 The Ferro Corp., CF 3460, Material Safety Data Sheet.

2-20 National Fire Protection Association Standard 70, National Electrical Code 1984.

SECTION 3

RESIN SELECTION

3.0 GENERAL

This section summarizes the issues and investigations made for the selection of powder resin used in the Service Test. The NAVSEA Ship Class Corrosion-Control (CC) Manuals were used as the primary reference source and their recommendations, in turn, to follow resin manufacturer's recommendations for application equipment and procedures. The guidance in the Ship Class CC Manuals was insufficient to make a coating selection and to develop an industrial process instruction (IPE, QC and method) for the portable/containerized Powder Coating Station in the SIMA Pilot CC Shop. Resin manufacturer's technical information and recommendations (Refs. 3-1, -2, -3) were solicited along with advice from Materials Department of DTNSRDC, Annapolis Laboratory (Ref. 3-4) for coating topside steel and aluminum shipboard products. A high-build polyester was recommended; however, COMNAVSEASYSCOM directed that an epoxy resin conforming to ASTM A775-81 (test standard for rebar coatings) be used (Refs. 3-5, -6), topcoated with TT-E-490 silicone alkyd paint to provide ultraviolet resistance.

3.1 FUNCTIONAL REQUIREMENTS

3.1.1 Products To Be Coated and Their Environment

The Pilot Powder Coating Service Test was involved with topside shipboard components. These components are primarily exposed to sunlight and salt spray. Salt spray is very corrosive due to the elevated salt concentration from water evaporation and the abundance of oxygen at the surface. There are lesser exposures to detergents, oil and grease but no special chemical resistance is required. The components are also subject to accidental impacts and abrasion from Ship's Force.

The metal substrate is from 1-20 years old. Most powder coating applications performed in industry are on new metal. Old metal presents unique problems because of the pre-existing corrosion and absorbed moisture.

3.1.2 SIMA CC Shop Characteristics

The SIMA work environment puts limitations on the application process. Typical powder coating lines in industry have chemical pretreatment capabilities. It should be understood that priming is not necessary to achieve adhesion of epoxies and polyesters to steel or aluminum. The priming reduces the amount of disbonding that would occur in the coating surrounding a chipped or abraded area. This gives substantial life to coatings, including conventional paints, but is typically done in commercial industry with new metal. Because of limited real estate and rapid personnel turnover at SIMA installations, chemical baths and rinsing stations become impractical. Chemical pretreatment systems require daily chemical analysis and special safety and pollution requirements. Highly automated systems are significantly more expensive and their design is specific to single or a small number of geometries and a high volume of production items done. The Powder Coating Station in the CC

Shop is essentially a job shop and will receive a wide variation of component sizes and shapes but relatively small production numbers. A SIMA CC Shop has the capability to provide a white-metal finish (SSPC-SP5) to metal surfaces during abrasive blasting. Due to the lack of a conversion coating pretreatment, it is extremely important that the components to be powder coated be given a white-metal finish to assure the removal of all contamination. Powder coatings are simply barrier coatings, as are the Navy paint Formula Nos. 150 and 151. No polymeric coating is an absolute barrier to moisture; and if salt or corrosion residues are present under the coating, then corrosion reactions will eventually occur.

3.1.3 Resin Application Characteristics

The powder resin should have application parameters which are somewhat forgiving to operator error. These major parameters include over-bake stability, gel time and coating thickness.

a. Overbake Stability

Overbake stability pertains to the coating's ability to retain its integrity even though it is left at the cure temperature after complete curing has occurred. All polymeric coatings will eventually degrade when left at their cure temperatures beyond the cure time, but will do so at different rates. Epoxies degrade more quickly than polyesters. Coatings which are being overbaked first lose gloss and color then become brittle and will eventually char.

b. Gel Time

Gel time of the resin is the time necessary for it to pass through its molten state to a semisolid state; the time at which the coating no longer flows. The gel time should be long enough to allow adequate manual application of the powder to fully cure in an oven afterward. This is important for preheated parts, allowing the operator to completely cover the hot surfaces before any partial curing takes place. If the resin has partially cured before the coat has flowed smooth, an excessively orange-peeled surface may result. Preheating is used to help free the items from gas and absorbed moisture and it causes the initial powder to melt upon application allowing more powder to be applied thus giving a high build. Resin systems should have gel times from 50 to 90 seconds for SIMA application. However, it is unwise to strictly specify a powder gel time before a color and gloss match is formulated because gloss is a function of gel time and resin components.

c. Coating Thickness

Coatings which provide a high build, adaptable to either one- or two-coat applications, and give good edge coverage are required. The high-build qualities are required to provide coverage over the components rough and pitted surfaces and to fill over gaps and seams on the items. Ship components will typically be rough and pitted due to their previous exposure to the environment and from the required abrasive blasting operations that remove the corrosion. However, it should be emphasized that the coating must not be too thick because impact strength decreases as thickness increases. Thick coatings will also add unnecessary weight to items.

3.2 RESIN SELECTION

3.2.1 Initial NAVSEA Guidelines

Initial guidance for powder coatings was sought from System Four: Powdered Coatings; Fluidized Bed and Electrostatically Applied (MIL-R-46896) of the NAVSEA Corrosion-Control Manuals for classes AO-177, CG-16, DD-963, FF-1052, FFG-7, LHA-1, LPD-4 and LST-1179. All manuals listed polyvinyl chloride, polyethylene, polyester, epoxy, acrylic and nylon as applicable coatings but gave a preference to epoxies. The manuals specified that the powder be grey in color and be applied in accordance with manufacturer's specifications unless otherwise directed. The coatings were approved for application over steel surfaces above the upper limit of boot topping. The manuals also listed typical applications being vent screens, fog applicators and battle helmets.

The information given in the manuals contained inconsistencies which made following the guidelines difficult. The CC System Four section referred to MIL-R-46896 as a specification for the powder. MIL-R-46896 is a specification prepared for the U.S. Army listing the requirements for a red epoxy powder coating to be used as electrical insulation. The Army specification had no requirements for corrosion protection and the required red color was in disagreement with the grey color stated in the manual. The grey color requirement of the manuals, however, was in conflict with fog applicator, vent screen and battle helmet color requirements.

3.2.2 Manufacturer's Initial Recommendations

Due to the inconsistent guidelines of the CC Manuals, powder manufacturers (3M, The O'Brien Corp., The Polymer Corp., Ferro Corp., Morton Thiokol, Inc., and Tiger Drylac, Inc.) were consulted for their advice on proper powder selection and application. The operating and application environments of the items to be powder coated were described. Emphasis was placed on demanding that the coating reduce maintenance manhours by Ship's Force. The manufacturers were in agreement that both epoxy and polyester have had a successful history in corrosion prevention applications but polyester powders would be better suited for the topside shipboard items. Sunlight (UV light in particular) encountered in the topside environment would degrade the epoxies color and gloss within several months. Polyesters, on the other hand, would retain their designed color and gloss for years and provide similar corrosion protection (Refs. 3-1,-2,-3). The companies said that if corrosion was the only degradative parameter mentioned about the environment, then epoxies would be recommended. But when the other present degradative parameters are considered, i.e., sunlight, polyesters are the best choice. In particular, triglycedial isocyanurate (TGIC) polyesters were the best because their chemistry allowed for thick, impact-resistant and abrasion-resistant coatings.

3.2.3 Current NAVSEA Directions

The powder coating resin selected for the Pilot Powder Coating Station Service Test was specifically determined as recently as 12 September 1985 by direction from COMNAVSEASYSCOM. NAVSEA now requires that only epoxy powder meeting the requirements of ASTM A775-81 and applied at a film thickness of 8-12 mils be used in powder coating shipboard items. The ASTM A775-81 is a test standard for epoxy coatings applied to steel reinforcing bars (rebar). The policy letter also

stated that overcoating the epoxy powder coating with TT-E-490 silicone alkyd paint will give the epoxy the same ultraviolet resistance as found in polyester powders. This epoxy was utilized exclusively in the Powder Coating Station Service Test. The color and gloss of the epoxy did not meet the federal standards, thereby requiring the topcoating with paint to meet the shipboard requirements (i.e., red fog applicators or haze grey light fixtures). (Note: The epoxy, O'Brien ASA61 Grey, used on the NAVSEA test platform, USS CUSHING (DD 985), was not designed to meet the above ASTM Standard. It was, however, used to coat components manufactured from 304-Stainless Steel and received many subsequent coats of TT-E-490 by Ship's Force.)

3.2.4 Implementation of COMNAVSEASYSCOM Policy

COMNAVSURFPAC ordered the purchase of epoxy powder coatings meeting the ASTM A775-81 (Ref. 3-6) standards with high-build properties (8-12 mils) as the powder to be used exclusively in the Pilot Powder Coating Station. (The ASTM standard has been updated to ASTM A775/A775M-84). Powder manufacturers were consulted regarding the topcoating of rebar epoxies with TT-E-490 paint. None of the manufacturers had data concerning this because it is not normal to topcoat rebar coatings.

The rebar epoxies are not commercially available in the proper color and gloss to meet the Navy specifications. Color matches could be made but would require minimum orders of 3000 lbs per color, typical. During the one-year Service Test, the contracted powder coating service firm used less than 1000 lbs. of the color matched grey polyester. The powder only has a guaranteed shelf-life of one year, when stored under controlled conditions. Quantities of this size may be consumed through centralized buying and Navy-wide distribution once more Shops become operational, however, no Shops were operational during the Pilot Powder Coating Station Service Test. Therefore, as an interim solution, commercially available shades of grey rebar epoxy were ordered: 50 lbs. from Morton Thiokol and 200 lbs. from Ferro.

3.2.5 Recommendations Concerning Resin Selection

The current policy regarding powder coating resin selection needs modification. The Navy must have resins designed to meet its particular requirements and not borrow resin standards designed for another specific application, i.e., underground pipe and rebar or electrical insulation.

Powder manufacturers are willing to develop coatings for potential major customers. The manufacturers require a commitment from the customer and detailed information on the product requirements. These requirements entail information on the coated substrate (material, age and past environment); the application environment (manual or automatic equipment, powder reclaim and available pretreatment processes); and the operating environment (sunlight, salt spray, cleaners, abrasion, impact, etc.). If a coating is desired that will give five years of unattended service, then this must be specified. Coatings for indoor use should be specified separately from those used outdoors.

The rebar epoxy meeting ASTM A775-81 (now ASTM A775/A775M-84) was engineered with properties inconsistent with shipboard applications. It is a highly flexible coating in terms of the coating retaining its integrity when bent around a mandrel. This is important when installing rebar for concrete, but it serves little purpose on a shipboard item, since any item bent that severely would be probably damaged beyond use. The rebar epoxy has a low impact strength, 30-40 in-lbs. (Ref. 3-7, -8). Other resins, both epoxies and polyesters, have impact strengths over 100 in-lbs. (Ref. 3-1, -2, -3). Impact strength is extremely important for shipboard items because of the normal abuse the components receive during service. Abrasion resistance is also important, but the rebar epoxy has poor abrasion resistance. If the rebar epoxy is going to fade in color within a couple months (red fog applicators will turn pink; black vent screens gray; gray items lighter gray; and white items will bleed white film onto adjacent areas), then there is no use to go to the expense of custom color matches. A 3000 lb. minimum order of a custom color will cost approximately $3.75/lb., totaling to $11,250 per color. To have the powder certified as meeting the ASTM A775-81 will cost an additional $6,000 to $8,000 per color.

Another problem with the rebar epoxy is its gel time. This powder was designed to be applied to hot rebar in an automated high-speed coating line. The heat retained in the relatively large mass of the steel bar cures the powder. The fast gel time (25 sec.) causes the powder to cure quickly on the bar before it is quenched in a water bath and stored. Powder coating in the SIMA environment is a manual operation done much slower than a rebar coating line. Many of the items, such as lights, phone boxes and light filters, do not have enough mass to retain enough heat to cure the applied powder without being placed in an oven afterward. There is no water quench nor should there be one since it may cause the objects to bend out of shape due to rapid thermal contraction. The rapid gel time causes the powder, in this slower process done on light weight items, to have appreciable orange peel texture. Longer gel times, such as 50-90 sec., would be beneficial.

Powder manufacturers can produce epoxy resins expressly designed to be topcoated with a specific paint or powder. A number of stock epoxy powders can be successfully powder coated with a polyester but proper technique must be followed and the particular combination tested. Some manufacturers (Polymer Corp., Ferro Corp. and Tiger Drylac, Inc.) indicated that a one-resin system would be preferred since a pure TGIC polyester coating will supply similar corrosion protection as would be obtained with an epoxy undercoat. Even with the preference for a one-resin system, the manufacturers are willing to work on a two-resin system as discussed above. A one-resin system is simpler to operate because it requires only one gun and hopper and is therefore recommended.

Further coating research should be conducted. Two powder manufacturers (The Polymer Corp. and Tiger Drylac, Inc.) have performed environmental testing of epoxy and polyester coatings for the purpose of helping the Navy choose the best resin. Tests include a comparison of weatherability and salt-spray performance between epoxy and polyester resins. Results from both firms have been in agreement with each other. In the salt-spray resistance tests, done in accordance with ASTM B-117-73, both polyester and epoxy performed equally well with no discernable difference. Tiger Drylac had exposed both resins to 250 hours of salt spray, Polymer did so for 2000 hours. The UV light and condensation tests, in accordance with ASTM G53-84, showed the polyester to outperform the epoxy. For example, after 170 hours of exposure, the polyester showed no loss of color or gloss,

whereas the epoxy began to noticeably fade after 16 hours. Both firms performed the above tests on steel panels which had been grit blasted and powder coated with no chemical pretreatment. Testing of coatings on non-pretreated metal is important for the present application methods at SIMA(SD). A test comparison between coatings applied to pretreated and unpretreated metal was also performed. The pretreatments being a zinc phosphate and inorganic zinc silicate (MIL-P-23236) coatings. The pretreated samples showed no corrosion at the scribe mark, even after 2000 hours of salt spray. Pretreatment methods which could be easily applicable in SIMA environments, such as application of MIL-P-23236, should be investigated.

Ship inspections of the USS ALBERT DAVID (FF-1050), USS COPELAND (FFG-25) and USS FLETCHER (DDG-992) were conducted under the direction of COMNAVSURFPAC. These inspections revealed that aluminum components (i.e., floodlight fixtures, phone boxes, swimmer's safety line reels and bases, handrails, vent covers, 1MC speakers, pyrolockers and sunshields, and life jacket lockers) as well as round steel components (i.e., fog applicators, line reels, cable reels and helo deck edge light fixtures) are excellent components for powder coating. The majority of these components have been in service for over a year and have not required any maintenance painting by Ship's Force. Components that have shown the most coating degradation are steel pyrolockers and shields and vent screens. Pinhole rusting has been noted on sunshields as well as flange and hinge welds. These coating failures are attributed to inadequate coating thicknesses (2-4.5 mils) applied by the contracted commercial coating service firm during the Pilot CC Shop Service Test of August 1984 - November 1985. The coating service firm typically produced a surface profile of 2-3.5 mils during surface preparation, thus the thin coating did not always cover the profile. Coating failures on vent screens are due more to poor design, such as aluminum or steel mesh crimped in a mild steel frame. Better results could be obtained by applying WSA to the steel pyrolockers because of their abrasive environments and utilizing improved vent screen designs. Some pinhole failure was detected on aluminum light fixtures aboard the USS FLETCHER; however, in all cases, the coatings thickness was determined to be 1.5 mils or less.

No significant difference can be discerned between the corrosion protection obtained by components coated with epoxy and those with polyester during the August 1984 - November 1985 Pilot CC Shop Service Test. Both coatings protected aluminum objects equally well when applied thick enough to cover the surface profile. Of the 30 pyrolocker shields coated with epoxy onboard the USS ALBERT DAVID, only 4 have not required maintenance painting by Ship's Force. Coating failures are again attributed to insufficient coating thickness. The epoxy-coated fog applicators on the USS ALBERT DAVID showed more rust and coating disbonding at chipped areas than the polyester-coated applicators on the USS COPELAND, but they have been in service five months longer on the USS ALBERT DAVID. The ASA 61 grey epoxy used on the ALBERT DAVID was not a color match with the Federal Standard 595-26276 grey used onboard naval ships and there is a noticeable color difference.

COMNAVSEASYSCOM initiated the use of powder coatings for the preservation of selected shipboard components and issued technical guidelines on the approved resin and candidate ship components in the Draft DoD-STD on Powder Coatings (Ref. 3-9) and the NAVSEA Ship Class Corrosion Control Manuals. However, no detailed technical information/reports have been promulgated by the Navy concerning the test procedures and results used in determining the choice of resins and application procedures. This technical information is needed to assist in (a) better

understanding the technology; (b) controlling and expanding the applicator's industrial processes; (c) improving service and maintenance; and (d) improving training. For example, more consideration could be given to powder coating as a replacement for painting rather than being treated as a novel specialty coating. Expanding the use of powder coatings for shipboard applications could perhaps include replacing the 5-coat paint schedule in the wire-spray-aluminum system to provide increased service life and reduced in-shop time of components.

The application of powder coatings in a SIMA environment for items subjected to a marine environment is a unique one. Advanced coatings can be formulated to meet the Navy's needs and may be done at a minimal cost. The Navy should issue its own resin specifications for this application and do so by considering the shipboard environment, not previous specifications for unrelated applications. U. S. powder manufacturers are willing to supply the Navy with whichever powder is specified even though it may not be in accordance with their recommendations. The Navy should use and evaluate the knowledge held by the manufacturers. If powder coating processes are to be beneficial, the current COMNAVSEASYSCOM policy (Ref. 3-7) must be modified to permit use of weatherable coatings, polyester in particular, and designed to be applied manually in a SIMA Powder Coating Station.

REFERENCES FOR SECTION 3

3-1 The Polymer Corp., ECA-1555-FCH Technical Data Sheet.

3-2 The Polymer Corp., PCA-1575-XW1 Technical Data Sheet.

3-3 The O'Brien Corp., Technical Data Powder Coatings Oxyplast, X21.

3-4 DTNSRDC Ltr. 3900/8282, 1803M, 20 August 1985.

3-5 COMNAVSEASYSCOM Ltr. 9630, Ser. 05M1.14/374, 12 September 1985.

3-6 American Society for Testing and Materials (ASTM), A775/A775M-84,Standard Specification for Epoxy-Coated Reinforcing Steel Bars.

3-7 Morton Thiokol, Inc., E194A Product Data Sheet.

3-8 The Ferro Corp., CF 3460 Technical Data Sheet.

3-9 DoD-STD-XXXX, Powder Coating Systems for Corrosion Protection Aboard Naval Ships, Draft, Undated.

SECTION 4

PILOT POWDER COATING STATION SERVICE TEST

4.0 GENERAL

The Pilot Powder Coating Station at SIMA (SD) was established on the basis of shop space, industrial plant equipment and manning concepts approved by COMNAVSURFPAC, SIMA(SD) and NAVSEA 05M1. This led to selection of a portable/containerized electrostatic powder spray work station.

This section describes the work stations affiliated with powder coating, the industrial plant equipment, manning and operating procedures, quality control, safety, training, planning and consumables for the Service Test.

4.1 STATION DESCRIPTION

The containerized Pilot Powder Coating Station is located within the area of the SIMA (SD) CC Shop. The layout of the work stations and product flow with respect to powder coating operations are illustrated in Figure 4-1. Containers were used for the powder coating equipment due to the difficulty of obtaining shop space inside existing buildings. The containers could be placed adjacent to the existing wire sprayed aluminum (WSA) containers outside of Building 61 and, thus, co-locate all of the CC work stations for WSA and powder coating.

The containers housing the powder coating equipment were 8' x 8' x 20' ocean cargo containers modified by Flame Spray, Inc., similar to those used in shipboard WSA applications. The use of a pre-existing container design kept costs low and allowed for future modification of the containers to standard strip blast and WSA units, if desired.

Powder coating industrial plant equipment (IPE) was installed in the containers by Flame Spray, Inc. utilizing the design developed by Integrated Systems Analysts, Inc. One container houses the dry-filter spray booth and electrostatic powder spray systems. The second container houses the preheat/curing oven. A platform is placed between the containers to allow for movement of parts between the oven and spray booth by the suspension/curing racks. The plot plan of the containerized powder coating station is given in Figure 4-2. The containers were placed apart from each other to prevent the oven from heating the spray area to an uncomfortable working temperature.

Utilities readily available to the containerized facility included compressed air and electricity. The entire containerized system required approximately 70 CFM of dry compressed air at 80 PSI. Air was tapped off of the air dryer of the existing containerized WSA unit. All major electrical components of the powder coating facility (i.e., spray booth, oven blowers and oven heating element) are 440 VAC, 3-phase. Work station lights, controls and electrostatic spray systems are 110 VAC, 1-phase.

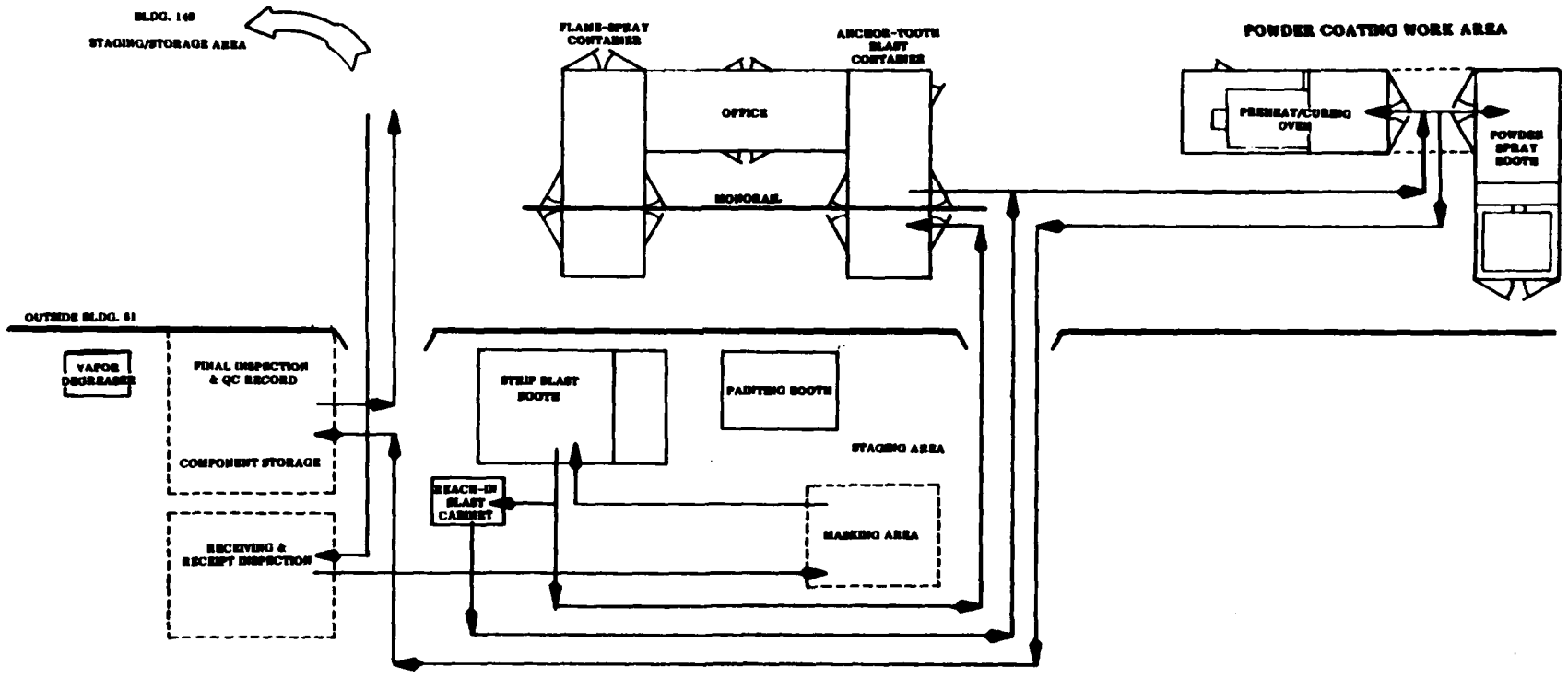


Figure 4-1 SIMA(SD) Pilot Powder Coating Work Station Layout and Product Flow

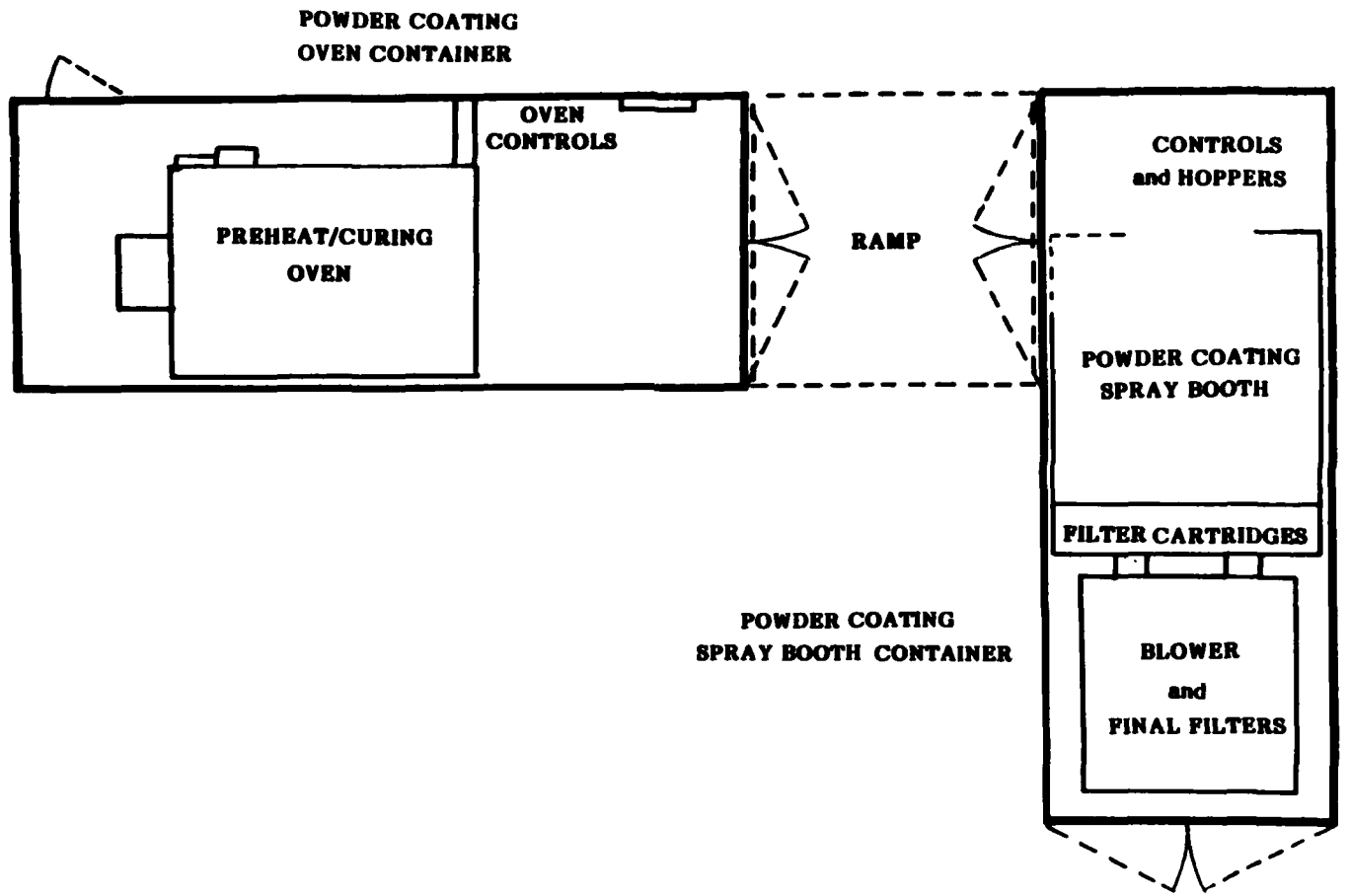


FIGURE 4-2 CONTAINERIZED POWDER COATING STATION SCHEMATIC

4.2 INDUSTRIAL PLANT EQUIPMENT

As a result of the decision to install a small Pilot Powder Coating Station within the CC Shop, the IPE selected was based on the following:

- Initiate the Service Test in the near-term and, therefore, do not purchase long-lead time equipment.
- Use available IPE for surface preparation (degreasing and abrasive blasting) currently being used for WSA coatings.
- Use of portable/containerized units that could be placed outside of existing buildings precluding requirements for shop space and building modifications.
- Procure new equipment necessary for applying and curing powder coatings, sized to fit into the 8' x 8' x 20' containers.
- Equipment to be of a design similar to what would be used in a production facility (i.e., manually operated, walk-in spray booth, forced convection oven, etc.).
- The equipment had to be nuisance (pollution) free.
- The equipment had to be inherently safe for operators and observers, conforming to OSHA requirements.

4.2.1 Existing Equipment

The concept of the Pilot Powder Coating Station Service Test was to utilize existing equipment used in the WSA process that could also be applicable to the powder coating process. The equipment is used in the WSA process (i.e., degreaser, strip blaster and paint spray booth) required proper scheduling to minimize production delays. The small reach-in blast cabinet was dedicated to anchor-tooth blasting of items for powder coating.

4.2.2 New Equipment

The pilot equipment can handle an item or batch of items that fit within the 3' x 3' x 5' volume of the suspension/curing racks. The sizes of the oven and containerized spray booth are too small for a production CC Shop; however, they are adequate for pilot operations to coat representative shipboard items mentioned in the NAVSEA CC Manuals, such as, fog applicators, replenishment-at-sea dimmer boxes, light fixtures, vent screens and electrical junction boxes, and allow for expansion of that list by COMNAVSURFPAC. Descriptions of the IPE utilized for powder coating operations during the Service Test are given in Table 4-1.

TABLE 4-1 Industrial Plant Equipment Utilized During the Pilot Powder Coating Station Service Test

EQUIPMENT	DESCRIPTION
Vapor Degreaser*	RAMCO 4' x 2' x 2', Trichloroethane
Strip-Blast Unit*	VACUBLAST 13' L x 10' W x 15' H
Anchor-Tooth Blast Unit, Reach-In	PAULI & GRIFFIN, 48" L x 32" W x 32" H
Anchor-Tooth Blast Unit,* Walk-In	FLAME SPRAY, 9'8" L x 7'2" W x 6'1" H
Containerized Preheat/ Cure Oven	BAYCO 4' x 4' x 7', Electric Oven, Installed in a Modified 8' x 8' x 20' Cargo Container
Containerized Powder Spray Booth	COMMAND 7'8" L x 7'4" W x 6'6" H Cartridge Booth Installed in a Modified 8' x 8' x 20' Cargo Container
Powder Spray Equipment	NORDSON D-1, RANSBURG-GEMA 701
Paint Spray Booth*	DEVILBUS 8' Water Wash
Paint Spray Equipment*	GRACO 700, 800 Units, Binks
Paint Drying Racks*	Manufactured by SIMA (SD)

* Equipment shared with wire sprayed aluminum process in the Pilot CC Shop

4.2.2.1 Electrostatic Powder Spray System (Gun, Hopper and Controls)

The electrostatic powder spray system consists of a powder hopper/feeder, control console and electrostatic spray gun. Flowing air conveys and dilutes the powder that is sprayed from the gun. An electrode or bank of electrodes in the gun electrostatically charges the powder. The sprayed components must be well-grounded (i.e., electrically connected to an earth ground) to attract the powder and allow for even coverage.

Powder spray systems from two manufacturers were selected for evaluation in the pilot facility. The Nordson D-1 System is a commercially used gun and was the type used by the powder coating service contractor (R. W. Little Coating, Inc.) during the one-year service test of the Pilot CC Shop reported in Reference 4-1, prior to establishment of the Pilot Powder Coating Station. The Ransburg-Gema 701 system was selected because of its advanced electronics that make it easy to handle, less likely to spark, and more uniform in charging the powder.

For coating small intricate components (light fixtures in particular), the Ransburg-Gema System performed the best. The lightweight, low-voltage power/control cable between the gun and control console made movement of the gun very simple. The gun's small nozzle allowed for coating the interior of small items. Early in the program, getting smooth consistent coatings on large flat surfaces was a problem. A primary cause for this was traced to the voltage used at application. The coatings being applied (8-12 mils as specified by NAVSEA) at SIMA are appreciably thicker than what is commonly applied in industry (1-3 mils). It was determined that simply following the manufacturer's initial advice on equipment operation would not satisfy the requirements for the Navy. The coating equipment is usually sold with the direction to apply the powder at full voltage (70 KV) because a thin coating is assumed. When coating to obtain thick coverage, the voltage actually needs to be lower because the powder, which is initially sprayed on the item, will repel the oncoming powder, thus leading to uneven coverage. For the SIMA application, the voltage on the Ransburg-Gema gun needs to be kept no higher than midscale and turned down as more powder is applied.

The coating of large parts (P-250 covers, vent covers and pyro lockers) was accomplished more easily with the Nordson System. The gun's larger nozzle allowed more powder to be deposited over a large surface. There was less of an apparent need to turn down the voltage to avoid coating inconsistencies due to powder repelling. The system's stiff power cable did inhibit gun movement.

4.2.2.2 Containerized Spray Booth

The powder spray booth is housed in a 8' x 8' x 20' cargo container (Figure 4-2). Access to the spray area is through a side double door. A 4' x 8' workspace outside of the spray booth provides room for the powder hoppers and spray system controls, as well as provide space for movement of equipment and personnel. The spray booth itself is a walk-in design with a 7'8" x 7'4" floor space and is designed specifically for powder coating. It sustains the required ventilation to provide a safe, non-polluting work area while using air flow rates low enough not to interfere with the powder transfer efficiency. Sliding door panels, when open, provide easy access for large components; and when closed, the resultant booth opening provides proper air velocity to retain powder overspray. The compartment behind the booth contains the air filters, blower and main pneumatic controls and electrical connections.

Primary air filtration for the booth occurs through six dry filter cartridges that are cyclicly purged with a three-tenths of a second pulse of clean air. The purge-type filters require less maintenance (replacement) than standard square dry filters. Booth air goes through final filters before exhausting into the atmosphere. This design was chosen to eliminate any chance of the exhaust air containing enough powder to be a nuisance that would be in violation of the local air pollution control board. Magnehelic gages are tapped into the filter cartridge and final filter plenums to indicate need for replacement of filters. Filter cartridges were estimated by the supplier to last approximately a year and final filters several years under the current usage rate of the work station.

Overall, the containerized spray booth provided a trouble-free work environment that was relatively easy to maintain. During the pilot, the filter cartridges were removed after four months of use, and the impacted powder removed from their exterior by tapping and vacuuming. This was found to help slightly but not enough to eliminate the need of replacing the filters within several more weeks of use. Because of the containerized systems open design, the moist air of the waterfront environment, as well as rainy weather, probably had significant impact on filter cartridge life. The cartridge style booth is still recommended here because of its cleanliness and would have longer filter life if installed in a complete building, away from exterior door openings. The Shop should maintain a complete replacement set of filters on hand at all times.

4.2.2.3 Containerized Preheat/Curing Oven

The preheat/curing oven is housed in a separate cargo container with main access through an end double door situated directly across from the spray booth container doors. The main electrical power disconnect panels for the entire powder coating station are located in the oven container.

The oven, used to preheat items to be powder coated and cure the applied coatings, must heat the components uniformly. Since the ship components can vary greatly in shape and weight, a forced-convection oven was selected. An infrared oven would not work with batches of components with complex geometries, and an induction oven would not work with aluminum components. An electrically-heated type was chosen due to its better applicability to the temporary nature of the pilot and relative ease of installing the necessary power lines, as opposed to a gas heated oven.

The oven performed satisfactorily without any difficulties. At the daily startup, the oven took 30-45 minutes to reach the required cure temperature of 400°F. During station operation, the oven would be opened for 30 seconds or less for the movement of product. Typically, the oven temperature would drop 25°F while the doors were open and required 5 minutes to recover to the set temperature. This much temperature change was acceptable for the Pilot. Component resident times for preheating, gelling and curing were established accordingly.

4.2.2.4 Product Suspension/Conveyance Racks

The racks utilized in the Pilot to suspend and convey the powder coated items during the process must be able to withstand the 400° F temperature of the oven and provide for good electrical grounding of the items during powder coating. The racks used roll on four steel wheels, one pair of which are the rotating type to provide maneuverability. The carts are low (3-1/2 ft.) to fit into the oven and allow the applicators to reach over the components.

There was some difficulty in moving the hot carts from the oven and into the spray booth. The technicians were prone to receiving minor burns from the racks. In addition, the parts on the racks were liable to swing into each other. To reduce these difficulties, a suspension bar was installed in the spray booth. When several small parts were to be coated, they were preheated on the cart then hand carried, by hooks and heat-resistant gloves, to the bar in the spray booth. After coating, they were again placed on the cart, which was in turn placed in the oven. A second rack was used as a cool down area for the parts. Larger components, such as P-250 covers and pyro lockers, had to be coated using the carts.

The suspension of parts from the racks or bar requires some ingenuity from the technician to satisfy two requirements. First, there must be an adequate electrical connection to earth ground. Secondly, the point of contact between suspension hook and part must be kept at a minimum because the contact point will not receive any powder during the spray process. In some instances, the melted powder did flow to cover the area of hook attachment but, often, a small holiday is left which must be touched up with paint. To reduce the chances of inadequate grounding, the wire hooks (typical diameter less than 0.13") used on the small items were disposed of after one use. Larger hooks (typical diameter greater than 0.39") were checked for adequate metallic contact and periodically grit blasted.

4.3 MANNING

The Pilot Powder Coating Station Service Test was initially assigned three enlisted personnel as powder coating technicians from the existing CC Shop. The powder coating technicians were to be involved with all aspects of the powder coating process, from surface preparation to powder application. The services of other CC shop personnel, whose assignments overlap with powder coating were made available. These services include Quality Control Inspector, Fasteners/Supply and Records/Receiving support. Most of these services fell under the lead powder coating technician's functions during the Pilot, but involvement by the existing shop personnel would assist in fully integrating the Powder Coating Work Stations into the SIMA (SD) CC Shop. An additional technician was assigned to powder coating during the second half of the Service Test due to the lead technician's increased involvement with other shop operations. Table 4-2 lists the current CC Shop manning, with those personnel directly and indirectly involved with powder coating noted. It should be noted that all powder coating technicians were also qualified WSA technicians.

TABLE 4-2 Current CC-Shop Manning

CURRENT MANNING	FEB 1986
BTC Shop Supervisor*	HT2 WSA Technician
HT1 Asst. Shop Supervisor*	HT2 WSA Technician
MM1 Quality Control Inspector*	HTFN WSA Technician
BT3 Fasteners/Supply*	HTFN WSA Technician
BT1 Records-Receiving*	EN1 PC Lead Technician**
MM2 WSA Technician	BT2 PC Technician**
HT2 WSA Technician	MM3 PC Technician **
HT2 WSA Technician	HTFN PC Technician **

* Indirectly involved with powder coating

** Directly involved with powder coating

4.4 APPLICATION PROCEDURES

A detailed description of the application procedures for applying powder coatings is given in Section IV, Method, provided in Appendix 1. Procedures given in the Draft Process Instruction were followed in the pilot operations and are applicable for full-scale production. The procedure was developed with consultation from NAVSEA 05M1, powder resin manufacturers, commercial powder applicators and experience obtained during the Pilot Powder Coating Station start-up.

4.5 QUALITY CONTROL

Quality control (QC) procedures currently followed in the Pilot Powder Coating Station Service Test are conducted on the product while it is going through the process. A detailed step-by-step procedure for in-process quality control is given in Section IV, Quality Control, in Appendix 1. The QC checkpoints are summarized in Table 4-3.

TABLE 4-3 Quality Control Checkpoints

QC CHECKPOINT	INSPECTION MEASUREMENT
Receipt	Visual inspection of cleanliness and structural integrity
Masking	Visual inspection for proper and complete masking
Strip-Blast	Visual inspection of blasted surface to ensure removal of all scale and rust
Anchor-Tooth Blast	Visual inspection to ensure surface is uniformly cleaned to white metal (SSPC-SP5) and measurement of surface profile
Powder Coat Thickness and Cure	Record of time spent at cure temperature, visual inspection of cured coating, mechanical testing for coating integrity and film thickness measurement
Paint Coating	Visual inspection and film thickness measurement
Final Assembly	Visual inspection of finished item and proper packaging

4.6 SAFETY

Safety precautions followed in the Pilot Powder Coating Station Service Test are the same as those presented in Section III, Safety, in Appendix 1. Primary topics include safety precautions for: electrical, heat, fire and respiration.

All equipment purchased for the Service Test was guaranteed by the manufacturers as conforming to Federal Occupational Safety and Health Administration (OSHA) Standards and Regulations. None of the equipment was operated until SIMA (SD) Electrical Office had conducted electrical checks on the equipment. These tests involved checking the electrical ground of equipment and resistance measurements of the system in accordance with manufacturer's specifications. The power drawn by the oven and spray booth were also checked and they did conform to their nameplate values.

4.7 TRAINING

Training of SIMA personnel was conducted in stages. First, general lessons on powder coating technology were given to familiarize CC Shop personnel. More specific lessons were then given to the personnel directly and indirectly involved with the powder coating systems.

4.7.1 Initial Training

The training of SIMA(SD) CC-Shop personnel in the field of powder coating technology was initiated in June 1985 during the weekly lesson plans on the 15 NAVSEA-designated CC systems discussed in Reference 4-1. The lesson was given in a lecture and seminar format. A more detailed version of this lesson was presented to Shop personnel in August 1985. This version was the basis used to develop Lesson 7 of Unit I of the SIMA CC-Shop Technician Training Curriculum discussed in Section 5 and presented in Appendix 2 of this report.

4.7.2 Powder Coating Technician Training

The enlisted personnel of the CC Shop assigned to the Pilot Powder Coating Station were given more detailed training once the equipment was available. The equipment operating manuals, furnished by the manufacturers, were provided to the CC Shop personnel. The assigned personnel and CC Shop Master were given a familiarization tour of the containerized powder coating system while it was being assembled, followed by a question-and-answer period.

Upon delivery of the containerized powder coating system to the SIMA (SD) CC Shop, formal training sessions were conducted. The personnel trained included the CC Shop Master, the three powder coating technicians and the SIMA (SD) CC Technical Advisor. An introductory lesson, similar to the "CC System 4: Powder Coatings" lesson (Lesson 7 of Unit I), was again given to refresh and familiarize students with general powder coating technology of interest to Naval applications. Then, lessons on Electrostatic Powder Spray Equipment and Process were given. These included Ransburg-Gema equipment, Nordson equipment, Spray Booth, Curing Ovens and Containers. The lessons entailed a total of three hours of classroom and two hours of on-the-job training. Familiarization and safety were the goal; no equipment was activated in this session.

The final training sessions were conducted at the Pilot Powder Coating Station with technical representatives from the equipment manufacturers. A two-hour session was given by Nordson Corp. on their spray gun operation and electrostatic powder spray technique. Another two-hour session was given by the Command International Systems representative on the oven, spray booth and Ransburg-Gema spray gun. The powder coating operator trainees continued their training by coating available items with various geometries for application technique development.

This training sequence proved adequate to prepare the SIMA CC Shop personnel for the operation of the Powder Coating Station. The information used in the lessons of the Pilot Powder Coating Station Service Test was the basis for development of the lessons contained in Unit III of the SIMA CC Training Curriculum discussed in Section 5 of this report.

4.8 SERVICE TEST PLANNING

The initial Service Test planning for the Pilot Powder Coating Station was conducted by the SIMA (SD) CC Shop Master assisted by the contractor, not by SIMA Planning. Ships assigned by COMNAVSURFPAC for corrosion-control availabilities were visited by personnel from the CC Shop and the contractor and briefed on the CC procedures. A shipwalk was conducted and items selected for powder coating. The ship listed the items in order of priority and the items were worked as called for by the CC Shop. Automated Work Requests were generated for the ship by contractor personnel to place the work in the SIMA (SD) repair planning and tracking system. By the end of the Powder Coating Service Test, SIMA (SD) Planning conducted all planning for powder coating work through the SIMA planning system as is done presently for the WSA CC work.

4.9 SERVICE TEST CONSUMABLES

The list of consumables required for powder coating operations has been developed by recording the quantities of supplies ordered and used for the station during the Service Test. The major item of interest is the powder used by the work station. A total of 250 pounds of epoxy powder meeting the ASTM specification for rebar was purchased, and 90% of that was used.

An estimate of the coverage of the powder was made from the Service Test data. By measuring the volume of powder used on square (easily measurable) items, such as phone boxes and oil spill boxes, the coverage found to occur in the pilot was approximately 14 square feet of product per pound of powder. Theoretically, an epoxy powder, with the specific gravity of 1.35, releasing 3% volatiles, 100% transfer efficiency and being sprayed to provide a film thickness of 8-10 mils, will result in an average coverage of 16 square feet per pound of powder.

Additional consumables include abrasive grit, facemasks, hangerwire and gloves. Fasteners for the powder coating products have been furnished by the CC Shop and are the same as reported on the Pilot CC Shop Service Test (Ref. 4-1).

Consumables required for a Production Shop will be discussed in Section 5.

4.10 PRODUCTION SUMMARY

Fifty-three types of components were powder coated during the four months (November through February) of the Pilot Station operation. The components were selected according to those listed in the NAVSEA Corrosion-Control Manuals, the Draft DoD Standard for Powder Coating (Ref. 4-2), and the list of items approved by COMNAVSURFPAC for coating by a commercial contractor during the CC Shop Service Test (Appendix 3) and additional items approved for the Pilot Powder Coating Service Test. Table 4-4 lists the major types of items that have been done in the Pilot Powder Coating Station Service Test. Time Standard analysis performed on the data collected for use in a Production Shop is discussed in Section 5.

TABLE 4-4

Types of Items Processed in the Pilot Powder Coating Station Service Test	
Applicator, Fog (4')	Ladder, Accom. - Gear Cover
Base, Twin Agent Hose Reel	Ladder, Accom. - Platform Handrail
Box, First Aid	Ladder, Accom. - Roller
Box, Fuel Oil Spill	Ladder, Three-Step - Handrail
Box, P-250	Light Fixture, Flood
Box, P-250 - Box	Light Fixture, Flood (Large)
Box, P-250 - Base	Light Fixture, Flood (Large, No Hood)
Box, P-250 - Gas Can Cover	Light Fixture, Flood (Small)
Box, RAS Dimmer	Light Fixture, Helo Deck Edge
Box, S/P Phone	Light Fixture, Running (P/S)
Box, S/P Phone Connection Junction	Light Fixture, Running (Stern)
Box, S/P Phone Handset	Light Fixture, Signal
Box, S/P Phone Single Headset	Light Fixture, Signal - Body
Box, S/P Phone Multiple Headset	Light Fixture, Signal - Arm Bracket
Bracket, Fire Exting. (PKP)	Light Fixture, Signal - Bracket
Bracket, Light Fixture	Light Fixture, Signal - Filter Cover
Bracket, Flood Light Fixture (Large)	Light Fixture, Signal - Swivel Arm
Bracket, Flood Light Fixture (Small)	Light Fixture, Signal - Yoke
Bracket, Light Fixture Shock Mount	Light Fixture, Unrep - Cover
Chair, Bridgewing	Locker, Pyrotechnic
Cover, 21MC Speaker	Locker, Man-Overboard Flare
Cover, Casualty Power	Locker, Ammunitions
Cover, FAS Receiving Nozzle	Locker, Ammunitions - Sunshields
Cover, Heater	Screen, Half-Round Vent
Cover, Vent	Screen, Vent
Duct, Vent	Socket, Portable Davit
Helmet, Battle	Speaker, 1MC
Holder, S/P Phone Handset	Stanchion, Portable
Ladder, Accommodation	Stretcher, Stokes
Ladder, Accom. - Bracket	Tray, 50 Caliber Ammunition Box

In general, items selected for powder coating are those which are not normally wire sprayed due to thin-gage construction, complicated geometry or aluminum base material. Lights and speakers are good examples of this. A number of light fixtures are absent from Table 4-4 because of their unavailability during the Pilot. In particular, most of the light fixtures used in helo operations could not be obtained from customer ships due to their inconvenient location (helo status light fixtures), or complicated construction, such as containing riveted plastic parts (helo deck flood light fixtures) which could not survive placement in the oven. Typically, powder coated items require less abrasive environments than items which receive WSA. However, some exceptions do exist, such as portable aluminum handrails, P-250 stowage covers, fog applicators and FAS receiver covers. None of these items are usually wire sprayed because of their aluminum construction but instead painted by Ship's Force. Powder coating these items provides a more durable, less porous coating requiring less corrective maintenance; and is much faster (one day shop time) than giving them the complete 4-coat paint system (four days shop time) required for aluminum.

REFERENCES FOR SECTION 4

4-1 Adkins, W., et. al., Corrosion Control (CC) Program: SIMA Pilot CC Service Test and Technical Support, ISA(WC)-107, 30 November 1985, Contract N66001-85-C-0350.

4-2 DoD-STD-XXXX, Powder Coating Systems For Corrosion Protection Aboard Naval Ships, Draft, Undated.

SECTION 5

IMPLEMENTATION OF POWDER COATING STATION IN A CC SHOP

5.0 GENERAL

The establishment of the capability to perform powder coating at a SIMA requires the integration of powder coating equipment, personnel, maintenance, supply and facility requirements, planning and training into the complete CC Shop. In order to obtain the most efficient production, the work stations affiliated with powder coating of the CC Shop must be designed and sized according to the port loading, available work space and IPE and the manpower resources. The Shop must also be able to provide an effective organization and proficient powder coating technicians and supervisors.

5.1 ADMINISTRATIVE ORGANIZATION

The powder coating station shall be an integral part of the SIMA CC Shop. Similar to the WSA process stations, both the Shop Master and the Assistant CC Shop Master shall oversee the management of the station. In order to relieve some of the Assistant CC Shop Master's duties, however, a powder coating LPO shall be responsible for the powder coating station's operation, as shown in Figure 5-1. The additional responsibilities added to the Assistant CC Shop Master may warrant the assignment of WSA coating LPO and should be evaluated upon the powder coating station's implementation. The support personnel (Installation Kit PO, Supply PO, Shop Quality Control Inspector, etc.) shall be responsible for both processes.

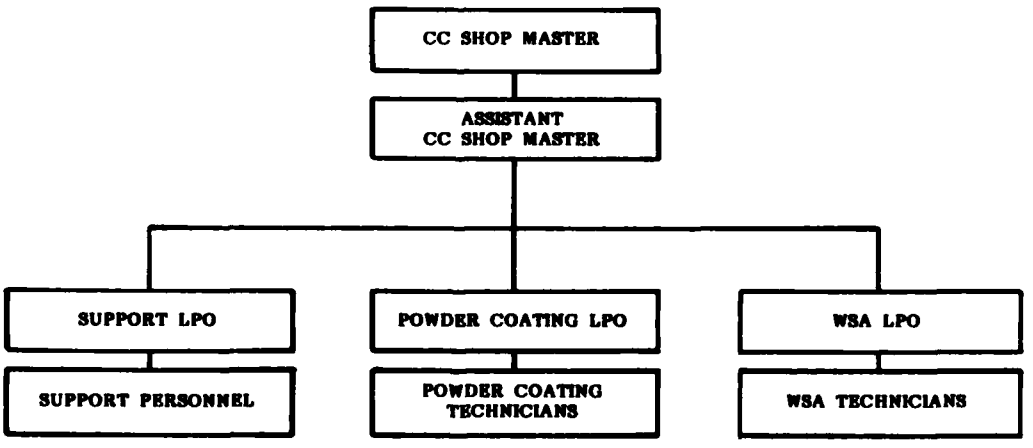


Figure 5-1 CC Shop Administrative Organization

5.2 FACILITY REQUIREMENTS

In order to achieve maximum efficiency from the powder coating work station, the work areas, as well as storage areas, should be enclosed in order to control factors, such as the wind, rain, temperature, humidity and lighting.

The utility requirements for operating a typical powder coating station, such as the proposed SIMA(Pearl Harbor) station, are listed in Table 5-1.

TABLE 5-1
POWDER COATING IPE UTILITY REQUIREMENTS

IPE	Electrical	Compressed Air	Water
Anchor-Tooth Blaster	480 VAC, 3-phase, 40 Amps, 33.33 KW 120 VAC, 1-phase, 0.5 KW (lights)	120 PSIG, 150 CFM	None
Curing Oven	480 VAC, 3-phase 117 Amps, 140 KW (includes ventilation motor)	None	None
Powder Spray Booth	480 VAC, 3-phase 5 Amps, 4.16 KW 120 VAC, 1-phase 0.5 KW (lights)	120 PSIG, 80 CFM	10 GPM Sprinkler
Powder Spray Guns	110 Volts, single-phase, 1 Amp	90 PSIG, 20 CFM	None

Actual facility sizes depend primarily on the desired production throughput, the IPE available and the usable working space. The industrial-engineered configuration for SIMA(Pearl Harbor) is illustrated in Figure 5-2. This facility is enclosed within a 52-ft by 160-ft pre-engineered building. The powder coating station occupies approximately 1100-sq.ft. within the building for the spray booth, oven and cooldown area. An additional 600-sq.ft. adjacent to the building is used for a dedicated powder coating anchor-tooth blast unit. Powder coating production shares the use of the other CC-Shop services, such as degreasing, strip blasting and installation kit make-up and issue.

Note: During the Pilot Powder Coating Station Service Test, two weatherproof containerized units were used to house the Powder Coating Station due to lack of work space in Building 61 contiguous to the CC Shop at SIMA(SD). The use of containerized powder coating IPE is not recommended for a SIMA Production CC Shop because of the inherent limitations of (a) product size, volume and numbers for simultaneous spraying and curing, (b) susceptibility to inclement weather and (c) lack of space for efficient product movement. However, the containerized system proved adequate for acquiring the necessary data during the Pilot.

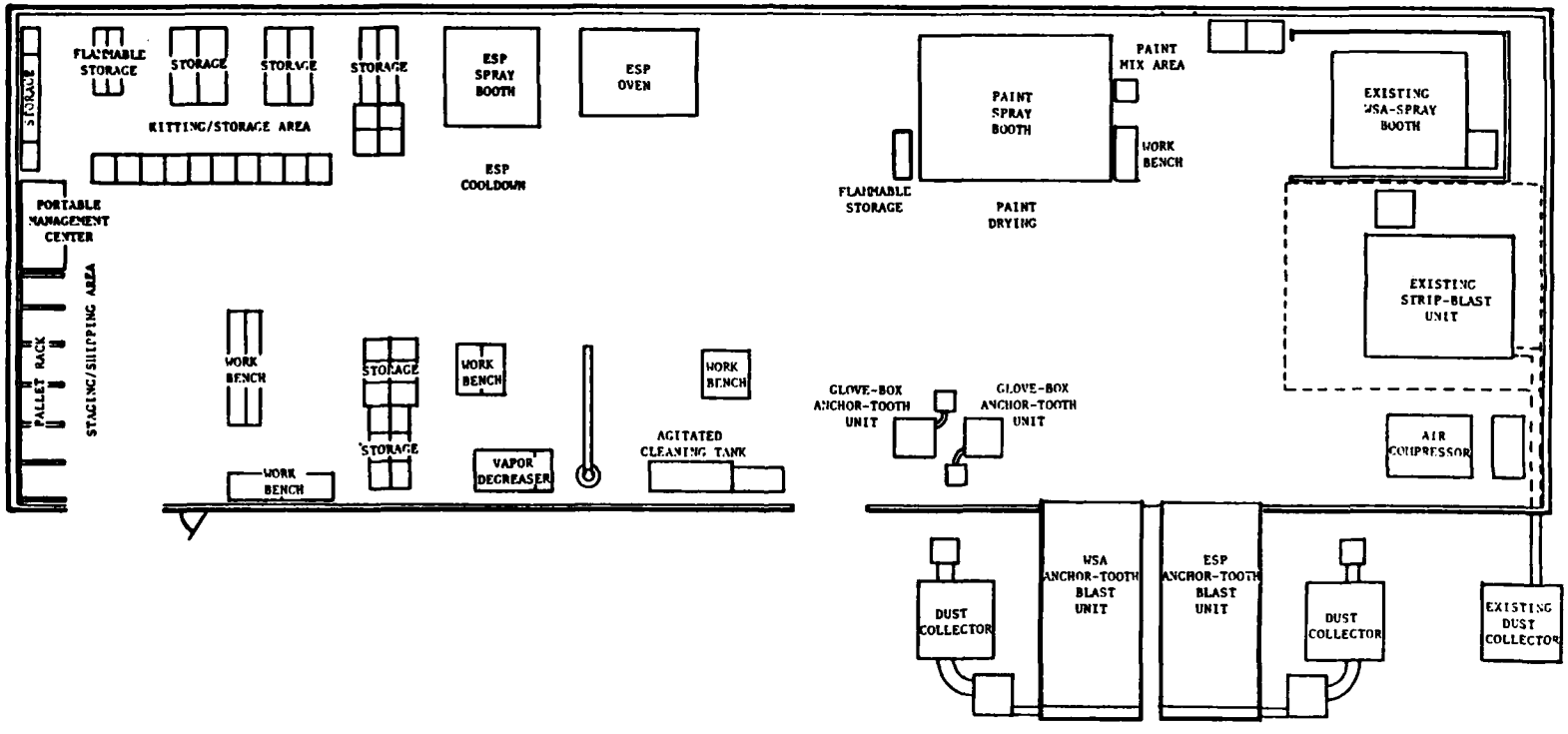


Figure 5-2 SIMA(PH) Production CC Shop Layout

5.3 INDUSTRIAL PLANT EQUIPMENT FOR A TYPICAL SIMA CC SHOP

The IPE for the powder coating station in a production SIMA CC Shop are functionally similar to that required and used in the Pilot containerized powder coating station; however, they are scaled up to meet the product size and work volume required to service the customer ships. The "production shop" sizing is primarily based on the types and quantities of components to be processed.

In order to further reduce S/F maintenance manhours, more components should be powder coated than are specified in the proposed list of eight items (i.e., vent screens, door screens, ventilation discharge screens, light brackets, light shock mounts, switch cover plates, fog applicators and battle helmets) in the current NAVSEA Draft DoD Standard "Powder Coating Systems for Corrosion Protection Aboard Naval Ships" (Ref. 5-1). However, this should only be done if a long-life resin designed for topside shipboard exposure is used. Table 5-2 presents an expanded list of candidate ship components for powder coating. This list is recommended here based on experience from the Pilot CC Shop Service Test (Ref. 5-2) and the Pilot Powder Coating Station Service Test. During the Service Test, COMNAVSURFPAC designated additional components to be powder coated. Appendix 3 is a list of components processed for customer ships by a commercial vendor during the Pilot CC Shop Service Test. The list given in Appendix 3 was utilized as an aid when selecting items to process during the Pilot Powder Coating Station Service Test. The longest item in Table 5-2 is a 12-ft fog applicator; and the item with the largest volume is a life jacket locker with the approximate dimension of 5' x 3' x 6.5'.

TABLE 5-2

CANDIDATE SHIP COMPONENTS FOR POWDER COATING

Applicator, Fog	Ladder, Accom. - Gear Cover
Base, Twin Agent Hose Reel	Ladder, Accom. - Platform Handrail
Box, First Aid	Ladder, Accom. - Roller
Box, Fuel Oil Spill	Ladder, Three-Step - Handrail
Box, General Control	Light Fixture, Deck
Box, P-250	Light Fixture, Extended Line-Up
Box, P-250 - Box	Light Fixture, Flood
Box, P-250 - Base	Light Fixture, Helo Deck Edge
Box, P-250 - Gas Can Cover	Light Fixture, Helo Deck Status
Box, RAS Dimmer	Light Fixture, Hifer
Box, J-Dial Phone	Light Fixture, Running (P/S)
Box, S/P Phone	Light Fixture, Running (Stern)
Box, S/P Phone Connection Junction	Light Fixture, Signal
Box, S/P Phone Handset	Light Fixture, Signal - Body
Box, S/P Phone Single Headset	Light Fixture, Signal - Arm Bracket
Box, S/P Phone Multiple Headset	Light Fixture, Signal - Bracket
Bracket, Fire Exting. (PKP)	Light Fixture, Signal - Filter Cover
Bracket, Light Fixture	Light Fixture, Signal - Swivel Arm
Bracket, Flood Light Fixture	Light Fixture, Signal - Yoke
Bracket, Light Fixture Shock Mount	Light Fixture, Unrep - Cover
Chair, Bridgewing	Locker, Lifejacket
Cover, 21MC Speaker	Locker, Pyrotechnic (Aluminum)
Cover, Casualty Power	Locker, Man-Overboard Flare
Cover, FAS Receiving Nozzle	Locker, Ammunitions
Cover, Heater	Locker, Ammunitions - Sunshields
Cover, VDS Guide	Locker, Chaff
Cover, Vent	Louver, Mack
Duct, Vent	Pedestal, Binocular
Flagstaff	Pole, Shore Power Cable
Flagstaff - Ensign	Pole, Wind Direction
Flagstaff - Jack Staff	Screen, Vent
Flagstaff - Supports	Socket, Portable Davit (Aluminum)
Helmet, Battle	Speaker, 1MC
Holder, S/P Phone Handset	Stanchion, Portable (Aluminum)
Ladder, Accommodation	Stretcher, Stokes
Ladder, Accom. - Bracket	Tray, 50 Caliber Ammunition Box

Based on this list, the recommended IPE, described below, was determined and sized to facilitate powder coating operations within a production SIMA CC Shop. Generic specifications for the IPE are given in Appendix 4. The recommended IPE is not dependent on the specific resin utilized, but the resin must be a thermosetting type designed for manual application.

The description and discussion of the use of the IPE utilized for powder coating operations in the CC Shop are given in the order of their use during the process.

5.3.1 Degreaser

The degreaser should be shared to satisfy all degreasing requirements of the CC Shop. Coordination by the LPO is required.

5.3.2 Strip-Blasting Unit

The strip blasting unit is used to accomplish the initial blast cleaning using a low-cost blasting media producing a near-white or commercial blast finish. The strip-blasting unit can be used interactively between the powder coating and wire sprayed aluminum processes. The strip blasting pot(s) should contain 30-36 mesh garnet sand which is suitable for blasting in both processes. The pressure regulating system must be adjustable, however, to enable personnel working on thin-gage powder coating items to reduce the pressure to avoid damaging them.

5.3.3 Anchor-Tooth Blasting Unit

The powder coating process should have its own dedicated walk-in anchor-tooth blasting unit (interior 7'2"W x 6'1"H x 9'8"D) to provide the final abrasive blast cleaning in which a white metal (SSPC-SP5) finish is produced. This is required due to the smaller anchor-tooth profile required for powder coating than for WSA-coating. Resin manufacturers recommend that the surface profile be kept below 2 mils to avoid wasting powder to fill in the voids and minimize the chance of air being trapped under the film. This is most easily accomplished by using a smaller grit size and reduced the pressure. The lower pressure is also important for processing intricate thin gauge components.

5.3.4 Preheat/Curing Oven

The oven should be an electric, forced-convection oven with a temperature range from 100 - 450° F. Its internal dimensions should be 8'W x 7'H x 12'D. It should have doors on both ends so that parts being preheated or undergoing coating gellation will not interfere with parts in their final cure or removal after cure. A system schematic is given in Figure 5-3 showing placement of oven, spray booth and conveyor for material handling. The oven dimensions allow for the placement of one or two large components (i.e. chaff lockers) on the center rail or 10 to 20 small components on the side and center rail. Ovens should be designed and loaded with at least 1.5-2 ft. clearance between parts and oven walls to allow for adequate convection of hot air.

5.3.5 Powder Spray Booth

The spray booth should be a cartridge type with cyclic purge. Final filters returning the exhaust are important for shops located in areas that have very cold or hot weather. If a CC Shop is to be air conditioned, then a final filter system returning the air to the work space is recommended to conserve energy. The spray booth should have the dimensions 10'W x 7'H x 10'D. This design will require nine filter cartridges, typical. The ventilation system shall have gage and alarm systems to indicate when the filters must be cleaned. Side openings of 6'H x 5'W will allow for easy product flow and keep the air flow requirement at a minimum.

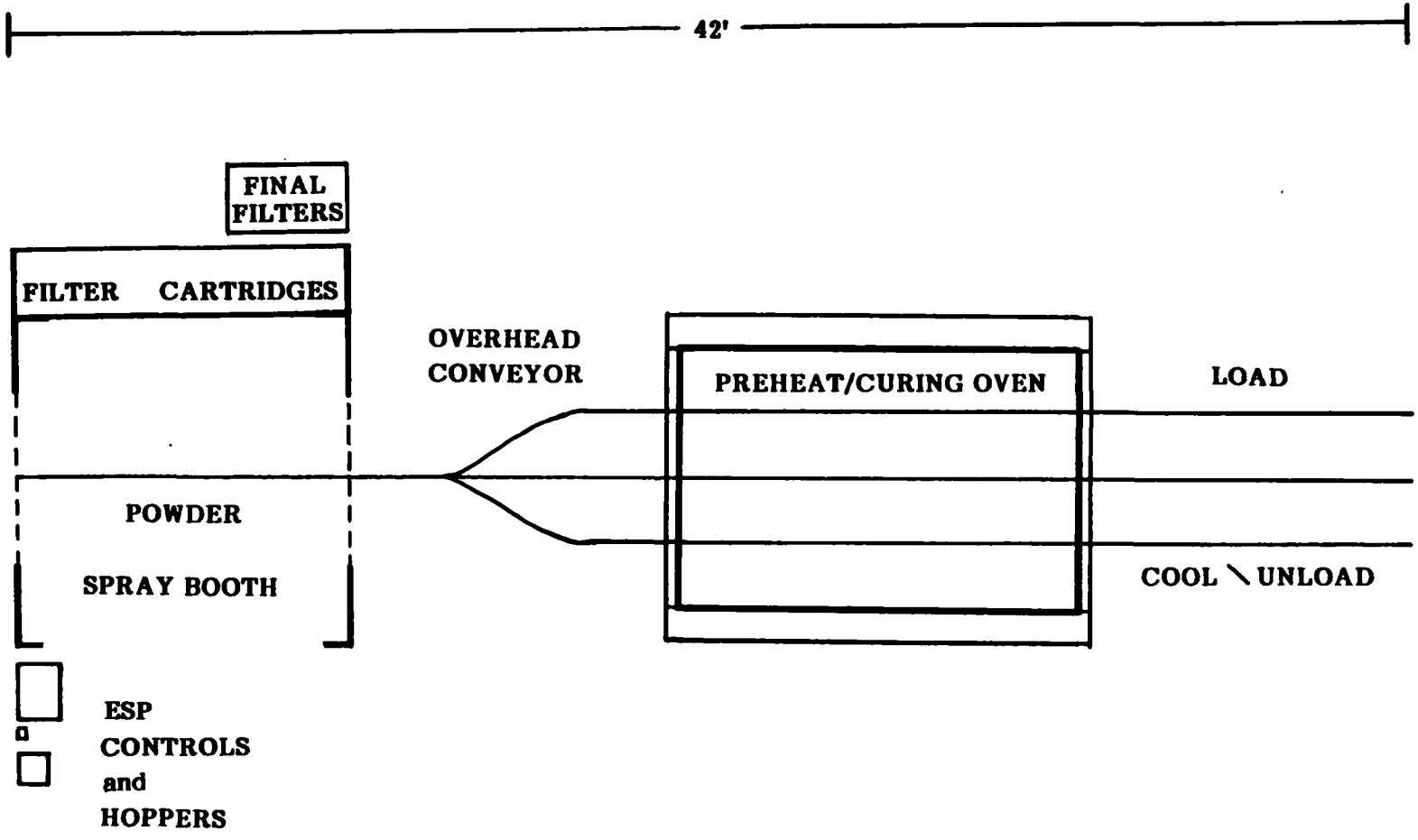


Figure 5-3 **Production Powder Coating Station Schematic**

5.3.6 Electrostatic Powder Spray Systems

The number of electrostatic-spray system components should be maintained to allow for adequate system back-up when equipment fails or is damaged. At least two control console units should be present. Four electrostatic spray powder guns, two for each console, should be available. A system that works well for large components, and a system that works well for small components should be set up and ready for operation at any time, as a variety of different sized components will be processed on any given day. There should be one large (50 lb.) and two small (5-10 lb.) hoppers for each control console. This allows for quick color change and small color batches. The control consoles and large hoppers should be on wheel-mounted carts to allow ease of movement. The Nordson and Ransburg-Gema powder coating systems were evaluated and compared in the Service Test. This comparison is given in Section 4.

5.3.7 Suspension/Conveyance System

A free-standing, overhead conveyor system should be installed for the powder coating system, as shown in Figure 5-3. The overhead conveyor system will keep the operators from burning themselves on hand pushcarts. The conveyor can operate satisfactorily in a completely manual fashion with the workers using long-handled hooks to move the parts along the rail.

The system illustrated would have 110 ft. of track, three oven expansion joints and four track end stops. Sixteen 4-wheel trolleys rated at 250 lbs. carriage capacity operable in an ambient to 450^{o}F temperature range will work safely and allow for adequate material handling.

5.4 POWDER COATING EQUIPMENT PLANNED MAINTENANCE

In order to maintain powder coating production, planned maintenance and a spare parts list is required. A planned maintenance system is given in Appendix 5 for the Pilot Powder Coating Station. This system should be used as a guide in designing a PMS Package for a production operation.

5.5 SAFETY

The equipment safety requirements for the electrostatic powder spray IPE and product processing are stipulated in the IPE manufacturers instructions and the safety requirements/procedures directed by the Federal Occupational Safety and Health Administration (OSHA) Standards and Regulations (29 CFR 1910), the National Fire Protection Association (NFPA) Standards 33 and 70 and Chapter 631 of the Naval Ships Technical Manual.

All the IPE installed in the Pilot containerized Powder Coating Station and the operating procedures detailed in the process instruction (Appendix 1) meets these requirements. The IPE recommended for the production Powder Coating Station must be procured, installed and operated to meet these safety requirements.

Each individual technician, however, is responsible for the safe operation of the equipment in the Powder Coating Station. All personnel should be aware of dangerous conditions and safety training should be provided for pre-cleaning, abrasive blasting, powder handling, powder application and curing oven operation. The safety requirements are detailed in Section III, Safety, of the SIMA Draft Process Instruction, provided in Appendix 1.

5.6 QUALITY CONTROL

Quality control checks must be accomplished during or following each major step in the process (i.e., component receipt, masking, strip and anchor-tooth blasting, powder coating and final assembly) to ensure adequate coating life. Failures due to specification non-compliance may not show up for months, and therefore, strict quality control is required to avoid poorly-coated components returning to the ships. Details for performing these quality control checks by the Shop Quality Control Inspector (SQCI) are given in Section IV of Appendix 1.

There are no suitable non-destructive tests (NDT) for measuring the total quality of the cured powder coating on the processed component, nor are there any instruments/techniques for in-process measurement of the sprayed powder thickness on the component prior to curing (needed to ensure final cured thickness of 8 to 12 mils). There are, however, NDTs that can be made during critical steps of the industrial process:

- Surface preparation
  - .. Anchor-tooth profile
  - .. Visual determination of "white metal" (SSPC-SP5)
- Preheat, gelling and curing
  - .. Contact pyrometer for component temperature after preheating and after curing
  - .. Temperature gauge on oven
  - .. A record of the time duration the component spends in the oven during gelling and curing
- Post cure
  - .. Film thickness
  - .. Visual inspection for smoothness and lack of voids
  - .. Electric holiday detection

The current draft of the SIMA Process Instruction for powder coating does not contain any methods for testing adhesion of the coating to the metal substrate. It is our recommendation here that the best destructive method for testing powder coatings for naval applications, that could be performed by SIMA personnel, would be an impact test. The impact test (ASTM D2794) would be performed on companion coupons coated at the beginning of each day. The test would only indicate the coating resin's suitability for use but not the technician's ability. The WSA process utilizes a coupon bend test, which is simple to perform, but it is not as useful for thick polymeric coatings and is therefore not recommended for powder coatings.

5.7 APPLICATION METHOD

The recommended techniques for applying powder coatings with the electrostatic spray process are presented in Section VI of Appendix 1. Most of the details presented in Appendix 1 concern the powder application itself, however, considerations for precleaning, masking and strip and anchor-tooth blasting are also given.

5.8 CONSUMABLES

In order to maintain production within the powder coating work stations, a variety of supplies are required. Fasteners and abrasive grit are furnished through other operations within the CC Shop. The primary consumable of a powder coating operation is the resin powder itself.

The amount of powder required is based on the recommended list of Powder Coating Candidate Items given in Table 5-2. The list is representative of the type of powder coating production work approved by COMNAVSURFPAC and conducted at the vendor (R. W. Little) furnishing coating services during the CC Shop Service Test (Ref. 5-1). R. W. Little used powder at the average rates of: Haze Gray, 77 lbs./mo.; White, 27 lbs./mo.; and Red, 8 lbs./mo. These usage rates should be utilized for initial stocking a powder coating facility and modified to meet actual consumption as determined by the actual production rates.

Attention must be paid to shelf life. Powders must be typically stored below $80^{o}F \pm 5^{o}$ and 50% relative humidity $\pm 10\%$ in order to receive guarantees from the manufacturer that the powder will have a minimum shelf life of one year.

Additional consumables, specific to the powder coating process, are given in Appendix 6.

5.9 MANNING

The number of personnel required to man the Powder Coating Station in a SIMA CC Shop depends upon the actual production capability and capacity of the Shop (e.g., IPE size, material handling equipment and physical layout of the production area), the planned production throughput (e.g., types, sizes and rate of items to be powder coated), the QC checkpoints and record-keeping requirements.

5.9.1 Station Manning

The typical recommended manning level is shown in Table 5-3 below. These manning requirements are again based on the recommended range of components to be powder coated given in Table 5-2.

Table 5-3 Typical Powder Coating Station Manning

POSITION	QUANTITY
Leading Petty Officer (LPO)	1
Spray Booth/Oven Operator	2
Anchor-Tooth Blaster	1

5.9.2 Duties

The position of the powder coating LPO requires a full-time Petty Officer. The LPO is responsible for the proper performance of all the personnel operating the Powder Coating Station and coordinates with:

- the Product Receipt Inspection Petty Officer to inspect and record incoming products,
- the Installation Kit Petty Officer to ensure that the proper fasteners, insulators and sealing compounds are issued for component reinstallation,
- the Shop Quality Control Inspector to ensure that all quality control checks are performed,
- the Supply Petty Officer to ensure that adequate consumables are available to maintain operation,
- the Training Supervisor to maintain a knowledgeable crew of technicians,
- the CC Shop Master to inform the Ship Superintendent that additional product may be accepted from the ships, and
- the Assistant CC Shop Supervisor to assist with the daily assignments, production scheduling and maintenance tracking.

The two spray-booth/oven operators perform the actual component powder coating. One of the technicians is responsible for placing the items in the oven to preheat them, manuevering them for powder application, placing the items back into the oven for curing and finally locating the parts in the cool-down area. The other technician is responsible for maintaining the powder systems (i.e., loading the powder hopper, setting the system controls, securing the system, etc.) and the actual powder spraying.

The anchor-tooth blast operator must be completely dedicated to blasting components to be powder coated. The anchor-tooth profile required for powder coating is less than that for wire-spraying (1-2 versus 2-3 mils) and therefore must be processed separately.

It is also the responsibility of these three technicians to perform PMS procedures as scheduled. The Powder Coating LPO should ensure that all PMS checks are performed and recorded and evaluate the adequacy of the maintenance on a periodic basis.

5.9.3 Recommended Rates

The Service Test provided a baseline from which to estimate manning requirements. It also demonstrated some of the personnel ratings capable of performing production and support work required by the Shop. Table 5-4 lists the recommended positions that need to be considered for the Powder Coating Work Station, the rate and typical duties. Support personnel, additionally, are required to keep the blast units, powder spray booths and powder curing oven in full operation and to move product, set-up equipment, perform minor maintenance, obtain blast grit, etc., allowing the operators to work full-time.

The Powder Coating LPO should be a Boatswain's Mate because preservation and corrosion control are in the career path of the Boatswain. Boatswain Mates are trained in corrosion prevention and control, in the effective and safe use of surface-preparation and coating-application equipments and are cognizant of the quality-control requirements of the various coating systems.

TABLE 5-4

RECOMMENDED RATES

POSITION	QTY	RECOMMENDED RATES
Powder Coating Leading Petty Officer	1	PO2
Spray Booth/Oven Operators	2	PO3/FN/SN
Anchor-Tooth Blaster	1	PO3/FN/SN

The Powder Coating LPO must be technically competent in corrosion control. The Powder Coating LPO must be able to recognize and correct potential problems with a component to be powder coated, such as a steel hinge or hasp riveted to an aluminum box, items not completely disassembled, damaged components requiring repair prior to powder coating or removal of identification tags prior to powder coating, to name just a few potential problems. Powder coating work requires attention to substrate preparation and application of a coating system in specified time intervals and environments. There are three non-destructive examination methods for end-item inspection and acceptance: visually inspecting for coating continuity; tapping with a metallic instrument to determine if coating is completely cured; and measuring the final dry film thickness. None of these methods measure coating adhesion to substrate; therefore, the exact process controls must be followed. The industrial plant equipment must be set up and operated properly, and the industrial process instruction must be followed explicitly.

5.10 TRAINING POWDER COATING TECHNICIANS

5.10.1 Generalized Training for the CC-Shop

All personnel assigned to the CC Shop should be required to complete the three-unit 18-day SIMA CC-Shop Technician Training Course. Table 5-5 lists the three units and the lesson plans in each unit of the curriculum. Lesson 7 in Unit I (classroom training) and the three lessons in Unit III (classroom and OJT) are the lessons directed to powder coating.

CC-Shop technicians should be cross-trained to man any station in the Shop. They should be assigned to the various stations for a period of time to become knowledgeable in the subject matter and proficient in applying quality coatings and operating and maintaining the IPE. The career development of CC-Shop technicians must include knowledge of and proficiency in manning the various work stations (i.e., receipt inspection, degreasing, masking, strip blasting, anchor-tooth blasting, wire spraying, powder coating, painting, installation kit and CC Shop management (work scheduling/progressing, preventive and corrective maintenance and training/certification). In this regard, CC-Shop technicians will cycle through the various work stations in the Shop.

The 18-day training curriculum will provide the basic knowledge and "apprentice" skills for the CC-Shop technicians. The apprentice, under the guidance of a journeyman CC technician for several months working on a representative range of shipboard products, should develop rapidly into a journeyman CC technician. Apprentice to journeyman skills and proficiency should be acquired in 2 to 4 months for electrostatic powder spraying; 4-6 months for WSA spraying and 1 to 3 months for paint spraying.

5.10.2 Specific Training for the Powder Coating Station

CC-Shop personnel assigned to the Powder Coating Station should have "refresher training" in the powder coating training material from the CC-Shop Technician Training Curriculum (Table 5-5) if they completed the course greater than 4 to 6 months prior to assignment to the Powder Coating Station. This refresher training should include Lesson 7 in Unit I (CC System 4: Powder Coating, 3 hours) and the three lessons in Unit III Electrostatic Powder coating (ESP) Equipment and Application Process, 6 hours plus 18 hours OJT).

Table 5-5 SIMA CC-Shop Technician Training Curriculum

UNIT	LESSON	TITLE	SHOP TECH CLASS (hr)	SHOP TECH OJT (hr)
I		MARINE CORROSION, CAUSES, PREVENTION AND CONTROL		
	1	Introduction and Corrosion Discussion	2	—
	2	Corrosion; Causes and Control	2	—
	3	Corrosion Evaluation and Control	2	—
	4	CC Systems 1 and 2: WSA	2	—
	5	CC Systems 3: Paints	3	14
	6	CC System 5: Non-Skid Deck Coating	1	—
	7	CC System 4: Powder Coating	3	—
	8	CC Systems 6-9: Fasteners and Preservation Materials	1	—
	9	CC Systems 10-15: Sealing and Coating Compounds	1	—
	10	Installation Kits	1	7
	11	Shop Modus Operandi*	(1)	—
	12	Shop Organization and Management, Planning and Scheduling*	(1)	—
		UNIT TOTAL	17 (2)	21
II		WSA: EQUIPMENT AND APPLICATION PROCESS		
	1	Introduction to Corrosion for WSA Technicians	4	—
	2	CC Using WSA, Part I - Surface Preparation	4	20
	3	CC Using WSA, Part II - Wire Spraying	4	28
	4	CC Using WSA, Part III - PMS	4	8
	5	CC Using WSA - Certification Tests	2	6
		UNIT TOTAL	18	62
III		ESP EQUIPMENT AND APPLICATION PROCESS		
	1	ESP-Coating Review and GEMA ESP Equipment	2	6
	2	NORDSON ESP Equipment	2	6
	3	ESP Spray Booth, Curing Oven and Containers	2	6
		UNIT TOTAL	6	18
		COURSE TOTAL (141 hrs ≈ 18 days)	38 (2)	101

The Unit III lesson plans, taken from Reference 5-2, are presented in Appendix 2. Two hours of classroom training plus 6-hours OJT are allocated for each of the three lessons for a total of 6-hours classroom and 18-hours OJT or 3 days for Unit III.

5.10.3 Recommendations for Powder Coating Training

The quality of powder coatings is dependent upon process control. The technician must be trained to strictly follow the industrial process instruction, i.e., the equipment setup and operation; the resin materials specified and their application requirements; the safety requirements; the quality control checkpoints and any corrective actions necessary; and the step-by-step method or application process with the specific CC-Shop equipment and QC checkpoints. The Powder Coating Station technician must also be able to evaluate the suitability of powder coatings for shipboard items, the relationships of the powder coating application and process-control elements to the quality of the coating, production efficiencies to maximize shop throughput, customer feedback on the service life and use of powder coatings.

It is recommended that the :

- Training for the powder coating technician be centered on the powder coating industrial process instruction (see Appendix 1).

- First lesson (Electrostatic Powder Coating (ESP) Review and Gema ESP equipment) in Unit III of the CC-Shop Technician Training Curriculum (Appendix 2) be expanded to include the powder-coating industrial process instruction of Appendix 1.

- Qualification for a powder coating technician should be based on passing the written test for the CC-Shop Technician and demonstrate his skill and proficiency for electrostatic powder spraying. The examination questions and proficiency tests should be included in the Unit III curriculum. Certification of powder coating technicians is not considered necessary because of the similarity of the process to painting and the process' inherent ability to provide uniform coatings due to the electrostatic attraction.

- The Powder Coating Station should always be manned with at least one person who has been continuously involved with powder coating for a minimum of six months to help provide experienced guidance on application technique.

5.11 PLANNING

The recommended procedures for the planning and accomplishment of CC work are based on the current conventions and procedures for work definition and management specified in the Ship's Maintenance and Material Management (3-M) Manual (Ref. 5-3). Section Two of Reference 5-1, Corrosion-Control Work Package Planning and Execution, presents an overview of the relevant 3-M information and describes the customer ship and their supporting SIMA's action for CC work. Figure 5-4, (Ref. 5-2), summarizes the CC planning and work accomplishment.

Planning, scheduling and progressing powder-coating services should follow the same procedures by the same ship Work Center's CC Coordinator and SIMA organizations used in planning and accomplishing other CC work. The information base will have to be expanded, however, to:

- Provide customer ships with candidate items suitable for powder coating and the powder coating production capabilities and capacity of their supporting SIMA.

- Provide the SIMA CC-Shop Planner with the necessary technical training on the:

  .. Powder coating characteristics and limitations, recommended shipboard applications, the industrial process and QC procedures, installation procedures and coating maintenance procedures to properly advise customer ships and to knowledgeably select items for powder coating over the other coating/preservation options.

  .. Powder Coating Station production capabilities (resin materials used and maximum size of item that can be powder coated) and capacities (standard times and allowance factors). The standard times for powder coating representative shipboard items in a production CC Shop are presented in Appendix 7.

  .. Installation-Kit Technical Data Sheets for the powder coated items.

  Note: The fastener requirements for candidate powder coated items are already included in the overall ship-class fastener inventory requirements given in Appendix A6-1 of Reference 5-2 for the following ship classes: FF-1052, FFG-7, DD-963, CG-16, CGN-38, ARS, DDG-2, FF-1040, FFG-1, LPD-1 and LSD-36. Individual component fastener requirement data sheets, such as these shown in Appendix A6-2 of Reference 5-2, are being developed to provide fastener reordering information in order to maintain the fastener pre-expended bin stocking level.

- Provide the customer ship and SIMA with the listing of powder-coated items to be added to the "CC-Work Accomplished Book" (see Section 3.3.2.4 of Reference 5-2) or an equivalent record for that given availability.

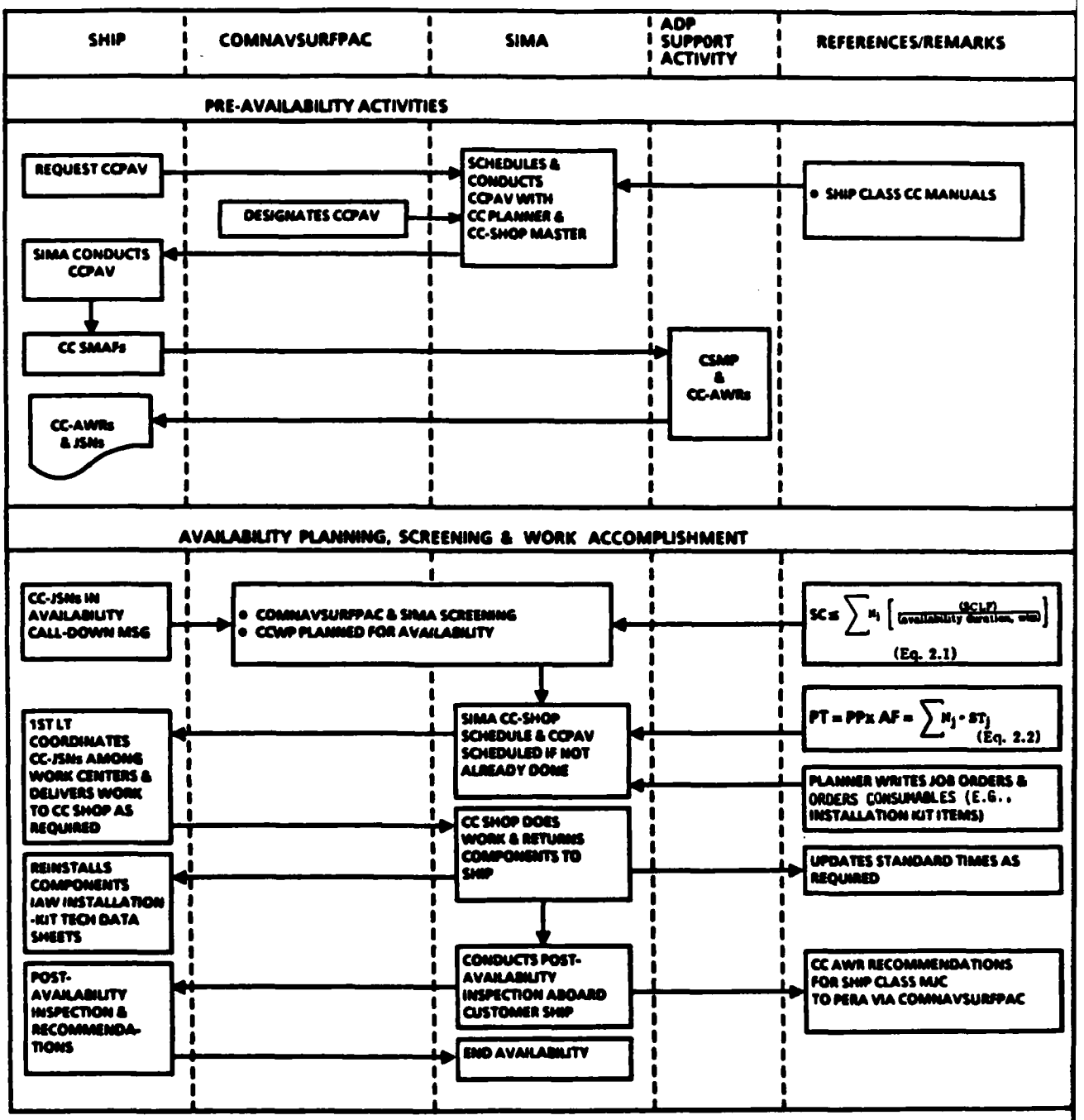


Figure 5-4 Corrosion-Control Planning and Work Accomplishment

The required knowledge base for the CC-Shop Planner is a basic knowledge of the causes shipboard corrosion, the NAVSEA corrosion prevention and control systems and a detailed knowledge of the capabilities and capacity of the SIMA's CC Shop, especially the standard times and shop allowances for production. This breadth of knowledge is required for evaluating and screening ship CC work packages and scheduling work to the CC Shop. Common practice is for shop personnel to have future tours/assignments in the Planning Department. If, however, the CC Shop Planner has not formally been a CC-Shop Technician, he should complete the 18-day CC-Shop Technician Training Curriculum.

5.12 COMPONENT IDENTIFICATION

During the early phases of the Pilot CC Shop implementation, it became obvious that one of the major problems confronting the topside CC Program was "corporate memory" onboard the ships regarding which items on the ship had received CC treatment. This problem became evident on a review inspection of USS CUSHING (DD 985) which was the test ship for a NAVSEA CC project. During the tour of the USS CUSHING, it was noted that powder-coated items had been painted over with standard haze-gray topcoat. Discussion with Ship's Force revealed that there was no current source available that identified the preserved items and their proper maintenance and repair procedures.

This lack of identification became even more evident during the operation of the Pilot CC Shop. Previously-preserved components were being received from ships by the CC Shop because the components were not clearly identified as being preserved. These items required additional processing and, thereby, reduced the shop output. Therefore, in order to ensure the success and efficient operation of the CC Program at the SIMAs and onboard ship, the following knowledge and information is essential for SIMA and ship's force personnel:

- Identification of corrosion and its causes.
- Familiarity with the 15 NAVSEA-designated corrosion prevention and control systems and their applications.
- Instructions to use, maintain and repair the corrosion prevention and control systems.
- Capability to identify preserved items to avoid reprocessing these items during future CC availabilities.
- Information for all personnel about the program and how it affects them.

These five requirements can be divided into two major categories:

- Information Resource, and
- Identification Method.

5.12.1 Information Resource

The first step to ensure the success of the CC Program is to provide an explanation of corrosion, its cause and prevention. The SIMA, San Diego, Corrosion-Control Work Accomplished Information Book was developed to supplement the information contained in the NAVSEA ship class CC manuals.

Through simplified corrosion theory and prevention, the majority of shipboard corrosion problems can be identified and resolved with the assistance of the CC Shop. This knowledge and the proper maintenance of preserved components can then be conveyed to Ship's Force through the ship's CC Coordinator to maintain the integrity of the preservation systems.

5.12.2 Identification Method

The identification of preserved components is the second step to the success of the program. Ship's Commanding Officers have been consulted on various alternatives and their suggestions have been carefully considered.

The first solution to this problem was to provide the ship's CC Coordinator and the Commanding Officer with the SIMA, San Diego, Corrosion-Control Work Accomplished Information Book. The book provided ease of preserved component identification through an alphabetized Corrosion-Control Work Package listing and topside plot plans with locations indicated. This book provides a complete centralized history of the preservation services received; however, the need for CC identification on each component is still required.

This local component identification systems must be easily identified by ship personnel, relatively easy to apply, permanent, non-corrosive and capable of sustaining several coats of paint. Discussions with Commanding Officers of COMNAVSURFPAC ships have indicated that the use of color-coded markings, tags or stickers is not desirable in that they detract from the uniform appearance of the ships.

A complete description of the book and a copy of the CC Work Accomplished Information Book for the USS COPELAND (FFG 25) was provided in Appendix A4-5 of Ref. 5-2.

5.13 CONCLUSION

The establishment and operation of a Powder Coating Station in a SIMA CC Shop requires:

- Definition of interfaces within the entire CC Shop,
- designation of items approved for powder coating,
- allocation of work space and installation of IPE,
- stocking of consumables and maintenance of fasteners pre-expanded bins (PEB),

- manning adequate for production and definition of personnel duties,
- technician and planner training on process instruction and production, application production standard times and shop allowances and equipment operation,
- specification of all required planning data, i.e., standard times, candidate components to be powder coated and fastener requirements to reorder and maintain the PEB,
- identification methods for tracking preserved components, and
- maintain Ship's Force awareness of powder coated components through "I" Division Lesson Plans and POD Notes.

REFERENCES FOR SECTION 5

5-1 DoD-STD-XXXX, Powder Coating Systems for Corrosion Protection Aboard Naval Ships, SEA 05M1 Draft, circa October 1985.

5-2 Adkins, W. et. al., Corrosion-Control (CC) Program: SIMA Pilot CC Shop Service Test and Technical Support. ISA(WC)-107, 30 November 1985, Contract N66001-85-C-0350.

5-3 OPNAVINST 4790.4A, Ship's Maintenance and Material Management (3-M) Manual, Op-434, 27 August 1984.

SECTION 6

POWDER COATING RECOMMENDATIONS

6.0 GENERAL

The recommendations for effectively implementing powder coating services at SIMA CC Shops that have been discussed in the preceding sections are summarized here. These recommendations are based on lessons learned during the Pilot Powder Coating Station Service Test and will have the greatest impact on the viability of future powder coating operations within the U.S. Navy.

6.1 POWDER COATING STATION ORGANIZATION

The Powder Coating Station should be installed as an integral part of the SIMA CC Shop. Work stations utilized for product receipt, degreasing, masking and strip blasting operations should be shared with the Shop's WSA process. The station operations should be under the control of the CC Shop Master and Assistant Shop Master and receive services from the Petty Officers assigned to the shop duties of supplies, installation kits, quality control, training and PMS.

6.2 INDUSTRIAL PLANT EQUIPMENT DEDICATED TO POWDER COATING

The industrial plant equipment (IPE) dedicated to the powder coating process should include:

- A walk-in anchor-tooth blasting unit utilizing finer meshed grit and lower air pressures than used in the WSA process.
- One walk-in, dry filter cartridge powder spray booth, with a final absolute filter bank.
- One walk-in, forced convection preheat/curing oven.
- Two electrostatic powder spray systems (guns, hoppers and control consoles) to provide adequate backup and to enable one system to be set up for coating small components and one system for large components.
- An overhead product handling monorail for the safe transport of hot components between oven and spray booth.

The IPE should be sized according to component types approved for powder coating, port loading, available floor space, monetary restraints and IPE presently available at the Shop.

6.3 MANNING

Manning for the Powder Coating Station should consist of four personnel: a Second Class Petty Officer (preferably a Boatswain's Mate) to act as the powder coating Leading Petty Officer with; two personnel to operate the coating equipment; and one to perform anchor-tooth blasting. The station should always have at least one member who has been working at the station over six months to help provide proper application procedure guidance.

6.4 SIMA PROCESS INSTRUCTION

The SIMA Draft Process Instruction developed and evaluated during the Service Test is contained as Appendix 1 of this report and is recommended for use in full-production operations. The draft process instruction presently has only nondestructive tests for determining coating integrity during coating operations. It is recommended that a test (which is simple to perform) be instituted that significantly tests a coating adhesion to the substrate and cohesion to itself. The test we recommend most strongly for powder coatings for naval applications is an impact test in accordance with ASTM-D2794. This test should be conducted on a companion coupon with the first batch of items processed each day. It is primarily an indication that the resin has not gone bad while in storage.

6.5 TRAINING

Training concerning the application of powder coatings for naval applications should be provided for all personnel affiliated with the technology. As a minimum, this shall include the CC Shop personnel and the SIMA CC Planner. Ship Work Center Supervisors and 3M coordinators should also be trained to provide guidance to Ship's Force. Lesson plans developed for this purpose are provided in Appendix 2.

6.6 POWDER RESIN

The powder resin recommended for powder coating topside shipboard components is a TGIC polyester. A TGIC polyester resin will provide good corrosion resistance and excellent color and gloss retention for components receiving direct sunlight. Epoxy powders can provide good corrosion resistance but will fade and chalk relatively quickly under sunlight, thus requiring maintenance painting by Ship's Force and, therefore, are not recommended. The environment the component will be subjected to and the environment in which the coating is applied should always be specified to the manufacturer to allow for the best powder formulation.

6.7 LIST OF COMPONENTS TO BE POWDER COATED

The proposed list of components authorized for powder coating, given in the draft DoD-STD-XXXX "Powder Coating Systems for Corrosion Protection Aboard Naval Ships," should be expanded. The recommended powder resin will provide a less porous, more durable, and longer lasting coating than conventional painting. It would be in the best interest of the Navy to apply this advanced coating, in place of paint, on as many components as possible. The Pilot Powder Coating Station Service Test has demonstrated that powder coatings can be applied to a wide range of items. The standard process times for powder coating items in a production shop are given in Appendix 7 for use by SIMA Planning to determine efficient shop loading.

6.8 CONCLUSION

By following the above recommendations, the U.S. Navy will be able to provide effective powder coating services through its SIMA CC Shops. A Powder Coating Station will enable SIMA CC Shops to deliver state-of-the-art coating systems to customer ships.

SECTION 7

SITE ANALYSIS

7.0 GENERAL

The Senior Navy Steering Board (SNSB) has proposed that Type Commanders identify IMA requirements and associated costs to fully outfit IMAs to perform the full spectrum of CC services. In order to establish production CC shops in Navy SIMAs, the contractor was required to conduct site surveys of SIMA (Pearl Harbor) and SIMA (Norfolk), the two SIMAs designated by the Naval Surface Force Type Commanders to be the first two SIMAs to participate in a Corrosion-Control Upgrade Program.

7.1 SCOPE

The site surveys were conducted to identify the IPE, facility requirements and a plot plan for a production CC Shop and to recommend a Plan of Action and Milestones (POA&M) for a FY1986 installation and Initial Operating Capability (IOC) for a CC Shop. The site survey included the review and evaluation of:

- Existing IPE and facilities suitable for CC services.
- Programmed and planned IPE acquisitions/modernization and MILCON in the SIMA Upgrade Program, the SIMA's Master Plan and Basic Facility Requirements.
- Current and forecasted port loading to determine the CC Shop workload potential and consequent CC Shop IPE, facility and manning requirements.
- Current and projected SIMA manning.
- Training and supply support requirements.

The site surveys for SIMA(Pearl Harbor) and SIMA(Norfolk) are included as Appendices 8 and 9. The SIMA (Pearl Harbor) Production CC-Shop layout, proposed POA&M and utility line diagrams are included in Reference 7-1.

REFERENCES FOR SECTION 7

7-1 Adkins, W., et.al., Corrosion-Control (CC) Program: SIMA Pilot CC Shop Service Test and Technical Support, ISA(WC)-107, 30 November 1985, Contract No. N66001-85-C-0350.

APPENDIX 1

DRAFT PROCESS INSTRUCTION for POWDER COATINGS, ELECTROSTATICALLY APPLIED: NAVSEA CORROSION CONTROL (CC) SYSTEM 4

No.: 7100-19-84

Effective: _____

Cancels: Original Issue

D R A F T

PROCESS INSTRUCTION

Shore Intermediate Maintenance Activity

San Diego, Naval Station, Box 106

San Diego, California 92136

TITLE: POWDER COATINGS, ELECTROSTATICALLY APPLIED: NAVSEA CORROSION-CONTROL (CC) SYSTEM 4

SECTION:

I	EQUIPMENT	V	OPERATOR TRAINING
II	MATERIAL	VI	METHOD
III	SAFETY	VII	FEEDBACK
IV	QUALITY CONTROL		

ORIGINATOR: 8100 and SHOP 061

APPLICABLE SHIP TYPES: ALL

REASON FOR REVISION: ORIGINAL ISSUE

APPROVALS:

		DATE
ORIGINATOR:	(7100/8100/Shop 061)	
PLANNING:	(2000)	
REPAIR OFFICER:	(3090)	
PRODUCTION:	(3000)	
SAFETY:	(0140)	
QUALITY ASSURANCE:	(5000)	
ENGINEERING:	(7000)	

REVIEW: ANNUALLY

LEAD SHOP: PILOT CORROSION-CONTROL SHOP
SHOP 061

ASSIST SHOPS: 72A 72C
11A 26A
17A

REFERENCES

A. NAVSEA Corrosion-Control Manual for AO-177, DD-963, FF-1052, FFG-7, CG-16, LHA-1, LST-1179, LPH-2 and LPD-4 Class.

B. NORDSON, Manufacturer of Electrostatic Powder Coating Equipment, Finishing Equipment Division, D-1 and D-1A Powder Spray Systems.

C. RANSBURG-GEMA Electrostatic Powder Coating System, Type 701 and 702.

D. BAYCO Industries of Ca., Custom Curing Ovens.

E. American Society for Testing and Materials (ASTM) D-2794, Impact Resistance.

F. ASTM B-117, Saltspray Resistance Test.

G. ASTM D-2247-68, Humidity Resistance.

H. ASTM D-822, Weatherability

I. ASTM A775/A775M-84, Epoxy-Coated Reinforcing Steel Bars.

J. ASTM D-3363, Pencil Hardness.

K. ASTM D-3359, Cross Hatch Adhesion.

L. NAVSEA S9086-VD-STM-000/CH-631, Preservation of Ships in Service (Surface Preparation and Painting), 15 Apr 81.

M. Federal Occupational Safety and Health Administration (OSHA) Standards and Regulations, (29 CFR 1910) Rev. 11 March 83.

N. National Fire Protection Association (NFPA) Standard 33, Spray Application Using Flammable and Combustible Materials, 1985.

O. NFPA Standard 70, National Electrical Code, 1984.

STANDARD DISTRIBUTION: (1 copy unless noted otherwise)

Code:	0140	3300	**Shop:**	11A	67A
	2000	3600		17A	38D 67E
	2160	3700		67H	
	2161 (3)	3800		51A	
	2162 (3)	5000		51B	
	2163 (3)	7000			72E
	3090	7100			
	3100	7200		06I (12)	
	3200	7300			

Shore Intermediate Maintenance Activity		NAVSHIPYD CHASN	(Code 380)	(1)
		NAVSHIPYD LBEACH	(Code 380)	(1)
		NAVSHIPYD MARE	(Code 380)	(1)
Pearl Harbor	(2)	NAVSHIPYD PEARL	(Code 380)	(1)
Alameda	(2)	NAVSHIPYD PHILA	(Code 380)	(1)
Long Beach	(2)	NAVSHIPYD NORFOLK	(Code 380)	(1)
Charleston	(2)	NAVSHIPYD PUGET	(Code 380)	(1)
NAVAIRLANT	(2)	NAVSHIPYD Ports	(Code 380)	(1)
Little Creek	(2)	SUPSHIP Charleston		(1)
Mayport	(2)	NAVSSES PHILA	(Code 053B)	(1)
Norfolk	(2)	DTNSRDC/ANNA	(Code 2803M)	(1)
NAVSURFLANT Readiness Support Group	(2)			

ADDITIONAL DISTRIBUTION: COMNAVSEASYSCOM (SEA 05M1, 91AD121, 0704, 075) (1 copy each)

SCOPE: The scope of this process instruction covers the required equipment, method or industrial process, safety and quality control required for applying the NAVSEA Corrosion-Control (CC) Coating, System 4 (Powder Coatings, Electrostaticaly Applied) (Ref. A) to ferrous and aluminum-alloy substrates in accordance with the manufacturer's recommendations.

COORDINATION:

VALIDATION:

SECTION I

EQUIPMENT

1.1 GENERAL

The equipments specified in this Process Instruction are typical for application of powder coating systems electrostatically applied in an industrial activity. The equipments consists of an electrostatic spray gun, power supply, resin hoppers, (Refs. B and C); dry filter spray booth, resin recovery system (optional), conveyor system (optional) curing oven, (Ref. D); grit-blast booth, grit-blast nozzle and hoses, pressure pots, grit-recovery system (optional), air-purification system, air-dryer system and quality control and safety equipment. A typical equipment layout and production flow diagram is presented in Figure A1-1.

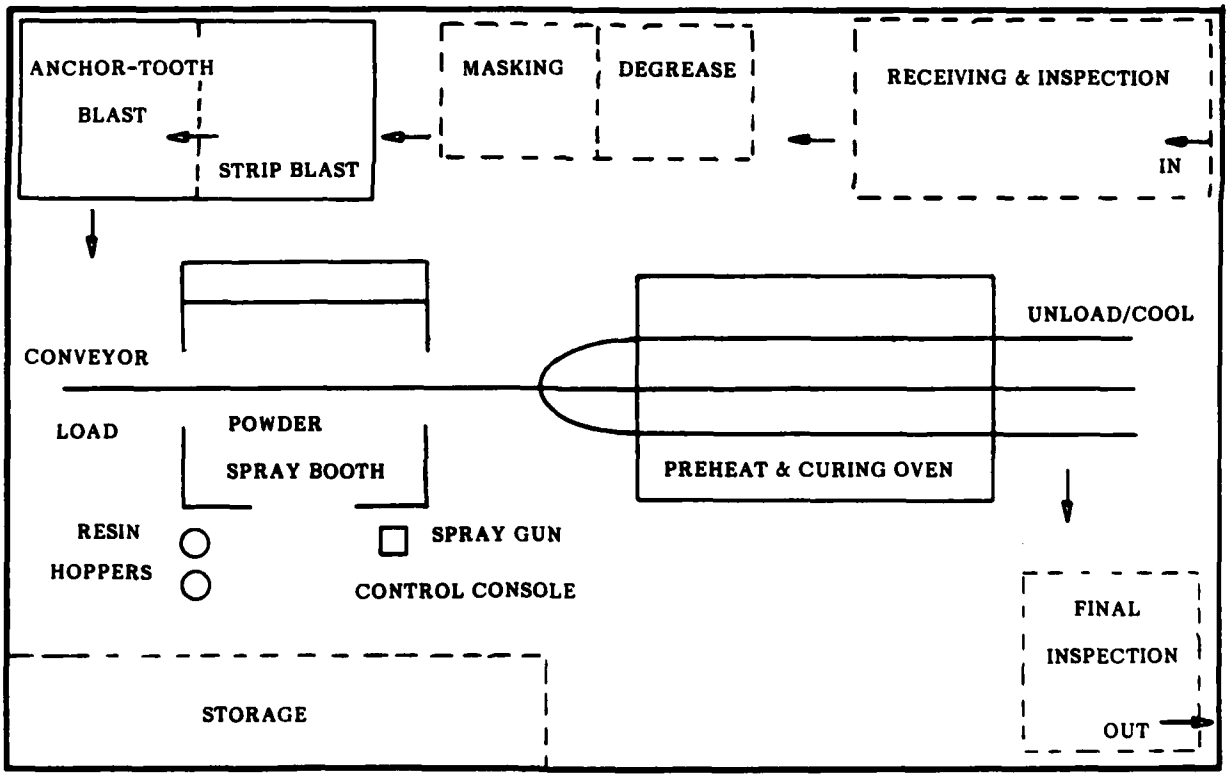


Figure A1-1 Powder Coating Station, Idealized Equipment Layout

SECTION II

MATERIAL

2.1 RESIN

2.1.1 Powdered Epoxy Meeting ASTM A775/775M-84

The powdered epoxy shall consist of a finely divided powder, grey in color, that shall require no blending, mixing or addition of other compounds to effect a cure. The resin shall be thermosetting (oven cured) when applied in film thicknesses from 8 to 12 mils. The cure temperatures and oven time will depend on the component or item weight. Cure temperatures and cure time will also be effected by preheating of the component.

2.1.1.1 Impact Strength

The cured resin, at a thickness of 8-mils, shall be capable of withstanding a mechanical shock load of not less than 30 in/lb, on direct impact, when tested in accordance with ASTM-D-2794 (Ref. E).

2.1.1.2 Salt Spray Resistance

The cured resin applied to cold rolled steel and given 500 hours minimum exposure in the salt-spray booth shall have less than 1/16 inch creepage from scribe when tested in accordance with ASTM-B-117 (Ref. F).

2.1.1.3 Humidity Resistance

The cured resin shall show no blisters and no change in gloss when tested in accordance with ASTM-D-2247-68 (Ref. G).

2.1.1.4 Weatherability

The cured resin shall sustain 500 hours of exposure in an Atlas Weatherometer without exhibiting chalking, loss of gloss or film deterioration when tested in accordance with ASTM D-822 (Ref. H).

2.1.1.5 Chemical Resistance, Cathodic Disbonding, Chloride Permeability, Flexibility, Abrasion Resistance and Hardness Test

The cured resin shall meet the standards of ASTM A775/A775M-84 (Ref. I) (formerly ASTM A775-81).

2.1.1.6 Shelf Life

The shelf life of the uncured resin shall not be less than one-year from the date of manufacture when stored in original unopened containers below 80°F and 50% ± 10% relative humidity.

Note: Storage requires environmental control.

2.2 ABRASIVE BLASTING MEDIA

2.2.1 Rough Blasting for Cleaning

Any clean and dry blasting media other than silica sand, a mesh size from 30 to 60, may be used to clean painted, rusted/oxidized metallic surface.

2.2.2 Anchor-Tooth Blasting

Abrasive blasting media used to provide the anchor tooth of 1 to 2 mils maximum measured with profile tape (Testex, Inc.) during final surface preparation of the substrate shall be one of the following:

TYPE ABRASIVE	MESH SIZE	SURFACE to be BLASTED
Aluminum Oxide	30 - 80	Steel or Aluminum
Crushed Garnet	30 - 80	Steel or Aluminum

2.2.3 Restrictions

(A) Abrasive particles shall be clean, dry, sharp and free of rust and excessive fines.

(B) Abrasive particles shall not contain any feldspar or other mineral constituents that tend to break down and remain on the surface. Abrasive particles that have been used for cleaning contaminated surfaces shall not be used for final surface preparation, even if the abrasive has been rescreened.

(C) Abrasive blasting pots and hoses must be clean and uncontaminated. It is advisable to "dedicate" blasting pots and hoses to the anchor-tooth blasting operation.

2.3 PROCESS AIR

The air equipment used in the abrasive blasting process and the powder coating process shall furnish air which is free of oil and moisture (maximum of 5 mg/m^3 of hycrocarbons) and maximum of 35°F dew point at the maximum flow rate (CFM) and maximum pressure (lb/ft^2). The air supply shall be adequate to maintain a minimum pressure of 75 lbs. per square inch (lb/in^2) at the blast generator.

2.4 MASKING MATERIALS

Any masking material that provides adequate protection of the substrate through both the abrasive blasting and curing operations without causing substrate corrosion or contamination may be used. Acceptable masking materials include various high temperature tapes, plastic caps or plugs. The preferred masking tape is:

Hi-Temp Al Foil Tape (0.007" thick, 3/4" wide x
36 yd. per roll, Stock No. 06004)
T&F Division of SHR Industries
3660 Edison Place
Rolling Meadows, IL 60008
(312) 392-8090

2.5 CLEANING MATERIALS

2.5.1 Solvents

Ethyl Alcohol (denatured) conforming to O-E-760, toluene conforming to TT-T-548, and trichloroethane conforming to O-T-620C are approved cleaning solvents.

WARNING:
Toluene and ethyl alcohol are flammable. Ethanol, toluene and trichloroethane are toxic. Use only in well-ventilated spaces. DO NOT use near open flames, blasting, thermal spraying work or sources of sparks. DO NOT allow prolonged contact with bare skin. Read and follow precautions on container shipping labels before using contents.

2.5.2 Alkaline

The alkaline cleaning agent is made up of three chemicals: tribasic sodium phosphate dedocahydrate; pentahydrate sodium metasilicate, technical grade; and detergent, nonionic, Type II, water soluble (MIL-D-016791, Type I). The solution shall consist of 8 lbs. sodium phosphate tribasic, 3 lbs sodium metasilicate and 3 pts. water soluble nonionic detergent (MIL-D-016791, Type I) in 50 gallons of fresh water. Refer to NSTM Chp. 631, Section 2 for health and safety requirements (Ref. K). In 0.1N concentrations, these materials are extremely caustic and can be harmful to skin, eyes and any body contact. **USE CAUTION!** Read and follow precautions on container shipping labels before using contents.

SECTION III

SAFETY

3.1 GENERAL

The primary responsibility for safety rests with the individual, non-supervisory personnel who have been assigned to perform the work. The individual's skill level and knowledge of potential hazards is the first guard against unsafe conditions.

The operator's responsibility for safety is shared by his supervisor and all higher levels of management who must ensure that the operator has had the requisite training, is provided sufficient guidance and direction and maintains the required proficiency. In addition, periodic monitoring of all safety requirements should be made to assure they conform to the applicable Federal Occupational Safety and Health Administration (OSHA) Standards and Regulations, (29 CFR 1910) (Ref. M). Particular attention should be paid to sections 1910.94, 1910.106 and 1910.107. Detailed safety information is given in National Fire Protection Association (NFPA) Standards 33 and 70 (Refs. N and O).

3.2 PRECLEANING

When using solvents or alkaline cleaners, all applicable sections of NSTM, Ch. 631 Section 2 and the applicable NAVOSH Manual apply when performed by Naval personnel. All applicable OSHA rules and regulations shall apply to other industrial activities and manufacturer's safety instructions.

3.3 ABRASIVE BLASTING

When performing abrasive blasting, the current NAVOSH Manual and Sections 631-2.272 through 631-2.288 of NSTM Ch. 631 apply for SIMA(SD) personnel. All applicable OSHA rules and regulations apply to other industrial activities.

3.4 ELECTROSTATIC SPRAY POWDER

3.4.1 Spray Booth

Powder-in-air concentration of greater than 0.05-0.07 oz per cubic foot can be ignited by hot flame or strong electrical discharge. Proper application equipment shall be used to keep powder-in-air concentrations below 0.01 oz/ft. Spray booths are designed for single gun or multi-gun operation. The use of more guns than as specified for the booth will create a dangerous powder-in-air concentration and so must never be done. The spray equipment shall be interlocked with the booth blower so that no powder may be sprayed when the ventilation is shut off. The work floor of the coating area must be electrically conductive. All metal objects within 15 ft. of spray gun must be grounded. **DO NOT spray near any source of ignition.**

3.4.2 Component Suspension Devices

Hangers shall be clean to assure good electrical ground of component and to avoid static electrical discharge. The component shall be well-grounded (0-300 ohms) when the electrostatic voltage is maintained at 50-100 Kv.

3.4.3 Personnel Precautions

3.4.3.1 Respiration - Personnel operating the spray equipment shall wear respiration masks approved by OSHA. These powders are classified as "nuisance dust" and are not toxic. However, if powder gets on skin, it should be removed with soap and water.

3.4.3.2 Electrical - Personnel in the spray area must wear electrically conductive shoes (e.g., leather soles), or leg stats so that there is less than 50 megohms resistance between themself and earth ground. The operator should hold spray gun in bare hand. If gloves are worn, the palm should be out to assure skin-to-metal contact.

3.4.3.3 Heat - The sprayed component is heat cured to complete coating polymerization. The oven temperatures used are from 325 to 450°F. Personnel handling these components after the cure cycle shall wear heat resistant gloves and use extreme care to avoid contact with exposed skin areas.

3.4.4 Powder Resin

The Material Safety Data Sheet, Form OSHA-20 or equivalent, must be kept on file for each powder product in shop files and SIMA safety office.

SECTION IV

QUALITY CONTROL

4.1 PRODUCTION QUALITY CONTROL

The following inspection procedures shall be followed by the Shop Quality Control Inspector for all powder coating work accomplished by the Corrosion Control Shop.

4.2 RECEIPT INSPECTION - A receipt inspection shall be accomplished as follows:

(A) Conduct a visual inspection to determine if welding, structural repairs, removal of prior coatings or further disassembly is required. If repairs are required, notify shop supervisor so item can be routed to applicable shop. If further disassembly is required, advise shop supervisor that further disassembly is required before shop acceptance.

(B) Inspect Ship-to-Shop Tag (Enclosure A1-1), attached to the item for completeness and give Part 3 to the ship's representative.

(C) Complete a Production Control Record (Enclosure A1-2) and assign a Production Control Number from the Production Control Work Log. Enter this number in the serial number block of the Ship-to-Shop Tag. The Production Control Number will consist of:

- The letter designation of the IMA.
- A sequential four-digit number beginning with 0001.

Example: For an item that was coated at SIMA, San Diego, a typical production control number would be S-0001.

(D) Attach a metal tag with the Production Control Number stamped on it. After the metal tag is attached, remove the Ship-to-Shop Tag and staple it to the Production Control Record.

(E) Release item for precleaning. Free from oil, grease and other contamination. Visual inspection.

(F) Sign the Production Control Record in Section 1 for Receipt and Degreasing Inspection and release item to masking area.

4.3 MASKING INSPECTION - A masking inspection shall be conducted as follows:

(A) Ensure that only masking materials and plugs designed to withstand up to 450°F temperature exposure are used.

(B) Visually inspect items to ensure that all areas not to be coated ("fit and function" surfaces and openings) are either masked off or plugged. Ensure masking is tightly adherent to the substrate and to itself when applied in multiple layers.

(C) Sign Production Control Record in Section 2 for Masking Inspection and release item to strip blasting area.

4.4 STRIP-BLASTING INSPECTION - A strip-blasting inspection will be conducted after strip blasting as follows:

(A) Ensure that all scale, rust and paint has been removed.

(B) Ensure that all masked areas are still intact. Remask as required.

(C) Inspect for warpage, cracks, bad welds or over blast. Take corrective action as necessary to correct any discrepancies.

(D) Random profile measurements are to be taken on the first item strip blasted each morning and each afternoon.

(E) Random grit-mesh-size measurements shall be taken prior to the first daily production run and at the end of the daily production run.

(F) Sign Production Control Record in Section 3 for Strip-Blasting Inspection and release to anchor-tooth blast area.

4.5 ANCHOR-TOOTH-BLAST INSPECTION - An anchor-tooth-blast inspection will be conducted after anchor-tooth blasting as follows:

(A) Visually inspect and ensure that all masked areas are still intact. Remask as required.

(B) Visually inspect and ensure that all areas are uniformly blasted to white metal (SSPC-5).

(C) Measure the anchor-tooth profile using Press-O-Film (x-coarse) and calibrated dial micrometer thickness gage (MITUTOYD #7326 or equivalent).

(D) Ensure that anchor-tooth profile is 1 to 2 mils.

(E) Enter measurement, date and sign Press-O-Film Tab and attach the tab to Production Control Record. Record the anchor-tooth profile measurement, date and time.

(F) Sign Production Control Record in Section 4 for the Anchor-Tooth Blast Inspection.

(G) Release to powder coat ensuring that powder coating operation is started within four hours after anchor tooth surface preparation. If more than 15 minutes is expected to lapse between the surface preparation and the start of the powder coating process, the prepared anchor-tooth surface shall be protected from moisture, contamination and fingermarks. Wrapping with clean paper will normally provide adequate protection.

4.6 POWDER COAT INSPECTION - A post powder coating inspection will be conducted as follows:

(A) Ensure that the powder application was started within four hours after the anchor-tooth surface preparation.

(B) Visually inspect all components processed with a 10X power magnifying glass. The coating shall be uniform, have no blisters, pinholes, cracks or chips.

(C) The coating's cure shall be checked by lightly tapping the coating with a metal object, such as a putty knife or screw driver. A properly cured coating will be resilient to the metal object. If the coating is brittle and breaks at the point of contact, the coating fails and must be completely removed. Over-cured coatings are typically dull and brittle. If the coating is soft and permanently indented, the object shall be placed in the oven at the curing temperature for another five minutes and again inspected afterwards.

(D) Calibrate thickness gages for ferrous substrates and aluminum substrates at first measurement in the morning and the afternoon. A magnetic flux measurement device is used for non-conductive coatings over mild steel. An eddy-current measurement device is used on non-conductive coatings over aluminum.

(E) Measure each item ensuring that the required coating thickness was attained, 8 to 12 mils. Thickness measurements will be taken in at least five random locations. If the coating thickness is unacceptable, the item shall be rejected.

(F) Sign Production Control Record in Section 10 for Proper Cure Check and Cured Coating Thickness. Record the high and low thickness measurements taken, the date and time.

(G) Release to silicone alkyd paint topcoating process. The powder coated surface shall be protected from moisture, contamination, fingermarks and chipping.

4.7 FINAL ASSEMBLY INSPECTION - A final assembly inspection will be conducted as follows:

(A) Ensure that all masking and plugging material is removed.

(B) Ensure that, if required, installation kit and instructions are complete and are attached.

(C) Ensure that item is properly protected and stowed in such a manner as to protect all coated surfaces for the transport from the CC Shop to installation on the customer ship.

(D) Remove metal identification tag, discard and re-attach Ship-to-Shop Tag.

(E) Sign Production Control Record in Section 13 for Final Assembly Inspection a. Packaging.

(F) Remove Part 2 of Ship-to-Shop Tag and notify Shop Supervisor that item is ready for pickup.

(G) When Ship's Force picks up item, complete and attach Parts 1 and 3 of Ship-to-Shop Tag to Production Control Record.

SECTION V

OPERATOR TRAINING

5.1 TRAINING

SIMA CC Shop personnel shall be trained for applying the NAVSEA CC System 4 by completing the 3-day "CC Shop Electrostatic Spray Powder: Equipment and Application Process Course." The course covers the theory and practical aspects of powder coating systems; the production process of the powder coating system (receipt inspection/item identification, surface preparation, masking, anchor-tooth blasting, powder spraying and curing; quality control; record keeping; DoD-STD-XXXX; this SIMA Process Instruction; and CC Shop operations (work stations and product flow, productivity and standard times, QC, consumables and supply support.) Approximately 1/3 of the time will be classroom training; 2/3 hand-on shop training in the SIMA CC Shop.

The major training source documents are:

- NAVSEA Ship Class Corrosion-Control Manuals (Reference A).
- DoD-STD-XXXX, Powder Coating Systems for Corrosion Protection Aboard Naval Ships.
- NAVSEA S9086-VD-STM-000/CH-631 (Reference L).
- NFPA Standard 33, Spray Application Using Flammable and Combustible Materials (Reference N).
- Equipment Manufacture Operator and Field/Factory Maintenance Instructions.
- This Process Instruction.

SECTION VI

METHOD

6.1 POWDER COATING PROCESS

The method for applying electrostatic spray powder coatings is given as follows:

6.2 RECEIPT INSPECTION

Refer to paragraph 4.2.

6.3 PRECLEANING

The item shall have any oils or grease removed by solvent or alkaline cleaning agents as stated in paragraph 2.5. Porous items that are contaminated with oil should be baked free of oil in the oven for two hours at 400 degree F. No components other than those being baked free of oil shall be in the oven at the same time.

6.4 MASKING

Refer to paragraph 2.4.

(A) All threaded areas must be masked. Only high-temperature tape and plugs designed to withstand up to 450°F shall be used.

(B) As little masking as possible should be used on items to be powder coated so that as much of the item's surface as possible will be protected by the powder coat.

(C) Inspection if item, reference paragraph 4.3.

6.5 STRIP BLASTING

Refer to paragraph 2.2.1. Items shall be strip blasted to remove all old paint and corrosion products.

(A) Care must be exercised where stripping thin gage metals to prevent product warping or any other damage.

(B) Grit sizes of 30-60 mesh shall be used to prevent too large of an anchor pattern from being made on the surface.

(C) Strip blasting inspection shall be conducted as stated in paragraph 4.4.

6.6 ANCHOR-TOOTH BLASTING

Refer to paragraph 2.2.2. Anchor-tooth blasting is conducted to guarantee the presence of a surface profile for mechanical bonding by the coating and to clean the surface of contamination left by the strip blasting operation.

(A) Items shall be anchor-tooth blasted to a white metal finish (SSPC-SP5) using clean grit to ensure that the proper anchor tooth of 1 to 2 mils is provided and that any contamination left from the strip blasting grit is removed. The anchor-tooth profile is measured using Press-O-Film (coarse) and calibrated dial micrometer.

(B) Care must be exercised to prevent damaging thin-gage items. Anchor-tooth blasting should be conducted as a quick sweep of the surface, not as a metal removal procedure.

(C) After the item has been blasted, it shall be cleaned of all grit and dust by using an air gun and lint-free rags. Additional cleaning can be accomplished with denatured alcohol.

(D) The cleaned item shall be protected from moisture, contamination and fingermarks.

(E) Anchor-tooth blast inspection shall be conducted as stated in paragraph 4.5.

6.7 PREHEAT

Component preheating is required to both free the object of moisture and provide a hot surface for the powder to build up thickly when applied. Once preheated, the component should be transferred to spray area as quickly and safely as possible.

6.7.1 Thin-Gage Steel and Aluminum. These components shall be preheated for at least 15 minutes at the cure temperature, unless otherwise specified by powder manufacturers.

6.7.2 Steel Castings. Steel castings shall be preheated for one hour 25°F above the cure temperature.

6.7.3 Aluminum Castings. Aluminum castings shall be preheated for half an hour at the cure temperature.

6.8 ELECTROSTATIC SPRAY POWDER APPLICATION

Refer to paragraph 2.1. Powder coating can be done in a one-coat or two-coat process depending on the type of resin and/or the coating equipment operator. Only personnel familiar with applying the resin correctly should be permitted to coat actual production items.

6.8.1 Receipt. Coating equipment and booth should be immediately operational upon receipt of preheated item.

6.8.2 Grounding. The components conveying/suspension system must be electrically grounded before electrostatic spray gun is operated.

6.8.3 Powder Coating in a Single Coat Operation. If conditions are such that the part can be coated with 8 to 12 mils of the desired resin in one coat, than this is the preferred operation. Conditions allowing this include: components mass (heat retention), powder formulation, grain size, time between preheat and spraying and operator skill.

(A) Interior areas sharp corners and edges shall be coated first.

(B) Surfaces should be coated over slowly and completely three times. The most powder shall be delivered on the first pass, due to a lessening of electrostatic attraction as thickness increases. If powder begins to fall off of object, immediately cease coating that object and check for clumps.

(C) Powder clumps should be removed by blowing them off with an air gun. The area should then be carefully recoated.

(D) When coating a surface, the gun shall remain on. By continually releasing the trigger, an uneven stream of powder is blown towards the part. Whenever first depressing the spray gun trigger, the gun must be pointed away from the component to keep from depositing clumps of powder.

(E) Once all components are sprayed, they shall be returned to the oven immediately for complete curing (refer to Section 6.9).

6.8.4 Powder Coating in a Two-Coat Operation. If conditions are such that the part must be coated with 8 to 12 mils of the desired resin in two coats, then perform the following:

(A) Interior areas sharp corners and edges shall be coated first.

(B) Surfaces should be coated over slowly and completely three times. The most powder shall be delivered on the first pass, due to a lessening of electrostatic attraction as thickness increases. If powder begins to fall off of object, immediately cease coating that object and check for clumps.

(C) Powder clumps should be removed by blowing them off with an air gun. The area should then be carefully recoated.

(D) When coating a surface, the gun shall remain on. By continually releasing the trigger, an uneven stream of powder is blown towards the part. Whenever depressing the spray gun trigger, the gun must be pointed away from the component to keep from depositing clumps of powder.

(E) Return sprayed parts to curing oven for 5 minutes to gel the coating.

(F) Repeat 6.8.4.A-E.

(G) Return components to oven for complete cure (refer to section 6.9).

6.9 CURING

The coating is cured at the temperature specified by the resin manufacturer. Manufacturers provide a range of temperatures and time schedules. The operators should choose one that provides a complete cure in 10-20 minutes.

6.9.1 Cure Time. The parts should remain in the oven for the complete cure time if they are to be single coated or are in the second coat of a two-coat operation.

6.9.2 Cool Down and Coating Inspection. Upon curing, the parts are removed from the oven. The coating should be checked for brittleness or completeness of cure while still hot by tapping it with a metal object, such as a screw driver or putty knife. Allow the component to cool, then check coating thickness as specified in paragraph 4.6.

6.10 SILICONE ALKYD PAINT TOPCOAT

The application of a topcoat of silicone alkyd paint shall be applied in accordance with reference P.

6.10.1 Receipt - The powder coated component shall be checked for cleanliness upon receipt in paint spray area.

6.10.2 Paint - The paint, TT-E-490, shall be applied in accordance with NSTM Chapter 631.

6.10.3 Coating Thickness - The topcoat and total coating thickness shall be inspected as stated in paragraph 4.7.

6.11 FINAL INSPECTION AND PACKAGING

Refer to paragraph 4.7 for final inspection and packaging.

SECTION VII

FEEDBACK

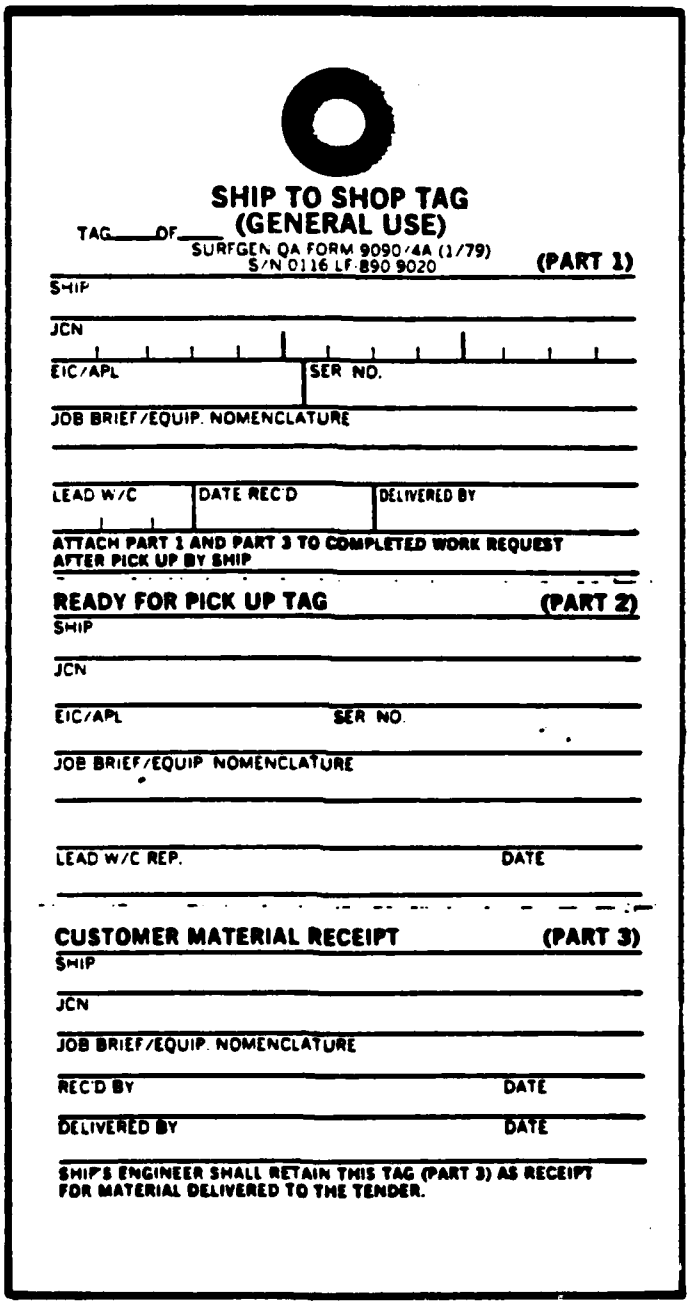
7.1 FEEDBACK INDICATIONS

In addition to the daily supervision of production and quality control, the following "feedback" indications will be used to monitor and maintain/improve the quality and productivity of the CC Shop:

(A) Verbal and written reports from customer ships and shops.

(B) Weekly analysis of the CC Shop's:

- Production input to output
- Labor and materials consumed
- PM/CM activity
- QC activity and results
- Product degradation/failure reports



SHIP TO SHOP TAG
(GENERAL USE)

TAG ____ OF ____
SURFGEN QA FORM 9090/4A (1/79)
S/N 0116 LF-890 9020

(PART 1)

SHIP

JCN

EIC/APL | SER NO.

JOB BRIEF/EQUIP. NOMENCLATURE

LEAD W/C | DATE REC'D | DELIVERED BY

ATTACH PART 1 AND PART 3 TO COMPLETED WORK REQUEST AFTER PICK UP BY SHIP

READY FOR PICK UP TAG **(PART 2)**

SHIP

JCN

EIC/APL SER NO.

JOB BRIEF/EQUIP NOMENCLATURE

LEAD W/C REP. DATE

CUSTOMER MATERIAL RECEIPT **(PART 3)**

SHIP

JCN

JOB BRIEF/EQUIP. NOMENCLATURE

REC'D BY DATE

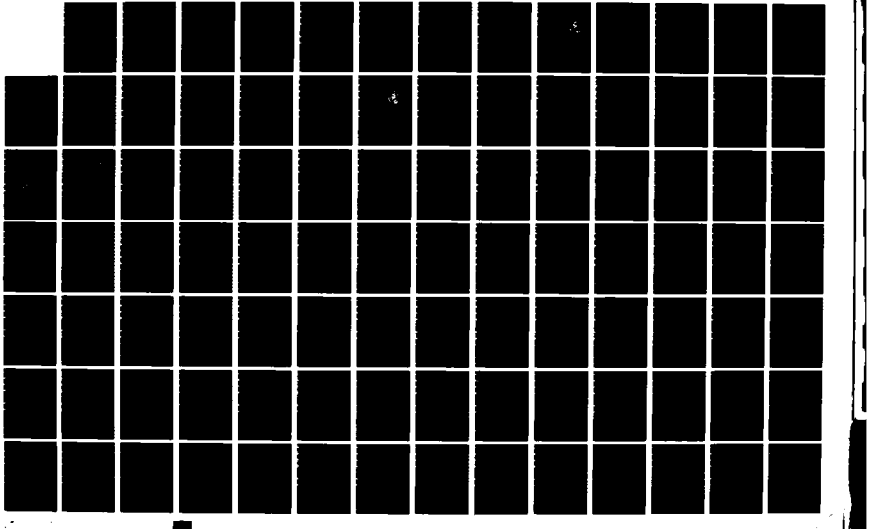
DELIVERED BY DATE

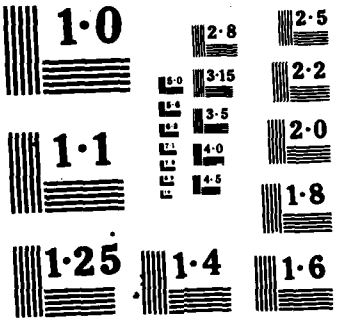
SHIP'S ENGINEER SHALL RETAIN THIS TAG (PART 3) AS RECEIPT FOR MATERIAL DELIVERED TO THE TENDER.

Enclosure A1-1

AD-A167 694 CORROSION-CONTROL (CC) PROGRAM:PPILOT POWDER COATING STATION SERVICE TEST.. (U) INTEGRATED SYSTEMS ANALYSTS INC NATIONAL CITY CA S KULLERD ET AL. 14 MAR 86 2/3

UNCLASSIFIED ISA(WC)-ITR-108 N66001-85-D-0015 F/G 13/9 NL





CORROSION CONTROL SHOP

POWDER COATING

PRODUCTION CONTROL RECORD

USS _____
Ship Hull Number

_____ _____
Job Control Number (JCN) Production Control Number

_____ _____
Item Description Location Deck Frame Side

TYPE COATING:

_____ Epoxy
(Meeting ASTM A775)

FINISH COLOR:

_____ Haze Gray TT-E-490

_____ White TT-E-490

_____ Other _____

SECTION	PROCESS SEQUENCE INSPECTIONS		DATE	TIME	SHOP QCI SIGNATURE
1.	Receipt, Degrease				
2.	Masking	Plug Tape			
3.	Strip				
4.	Anchor Tooth 1-2 mils	mils			
5.	Start Preheat Oven at 400°F	Temp			
6.	End Preheat 0.5 to 1.0 hr				
7.	Powder Spray	1. 2.			
8.	Begin Curing Oven at 400°F	Temp			
9.	End Curing 10-15 min				
10.	Proper Cure Check and Cured Coating Thickness - 8-12 mils	mils			
	TOPCOAT				ATTACH PROFILE TAPE HERE
	Type/DFT Rqmt	Measured DFT	Date	Time	
11.	TC/1.5 mils				
12.	Final Thickness				
13.	Final Assembly Inspection, Packaging				

Enclosure A1-2

APPENDIX 2

LESSON PLANS
for
POWDER COATING

APPENDIX 2

LESSON PLANS for POWDER COATING

1.0 Training of SIMA planning and CC shop personnel will be required in order for a SIMA to provide the powder coating services to the best of its ability. Training should have a generalized portion for the entire CC Shop and a specific portion for those involved directly and indirectly with the powder coating process.

2.0 Initial training should be given to the CC planner and all shop personnel to acquaint them with PC technology. The CC System 4, Powder Coatings, lesson plan is satisfactory for this.

3.0 Specific training on the powder coating process, centered on the Process Instruction for Powder Coatings, Electrostatically Applied, should be given to the SIMA CC Planner, Powder Coating Technicians and the shop personnel indirectly involved with powder coating. Lessons on the specific Electrostatic Powder (ESP) Spray systems and the oven and spray booth should have both classroom and on-the-job (OJT) training sessions. Powder Coating Technicians shall be involved with all aspects of classroom and OJT. The Shop Master, Assistant Shop master, and Shop Quality Control Inspector shall be present during classroom and OJT. The supply and records personnel should be present in the classroom instructions. Lesson plans 1-3 of Unit 2 of SIMA CC Training Curriculum given are satisfactory for classroom training of the equipment.

UNIT	LESSON	TITLE	SHOP TECH CLASS (hr)	SHOP TECH OJT (hr)	PAGE NO.
I		MARINE CORROSION, CAUSES, PREVENTION AND CONTROL			
	7	CC System 4: Powder Coating	3	—	A2-2
III		ESP EQUIPMENT AND APPLICATION PROCESS			
	1	ESP-Coating Review and GEMA ESP Equipment	2	6	A2-12
	2	NORDSON ESP Equipment	2	6	A2-24
	3	ESP Spray Booth, Curing Oven and Containers	2	6	A2-58
		UNIT TOTAL	6	18	

INSTRUCTOR PREPARATION

SIMA CC-SHOP
Lesson Plan

TITLE CC System 4: Powder Coatings COURSE CC-Shop Technician UNIT 1* LESSON NO. 7

LEARNING OBJECTIVES

Trainees will understand or be able to identify:

1. The differences between thermoplastic and thermoset plastics.
2. Crosslinking.
3. Why powder coating is used.
4. Environmental concerns utilizing powder coatings.
5. Shipboard items to be powder coated.
6. Powder coating process.

TRAINING AIDS/MATERIALS

Materials:

- Examples of powder-coated items.
- Examples of thermoset and thermoplastic items.

  Note: Examples of powder coated and plastic must be procured from local sources.
- Transparencies T:I-7-1 through T:I-7-3.
- Overhead projector.
- Chalk or dry erase markers for board.

References:

1. NAVSEA S9630-AG-MAN-010/FFG-7CL, Manual, Corrosion Control for FFG-7 Class, 30 November 1983.
2. DoD-STD-XXXX, Powder Coating Systems for Corrosion Protection Aboard Naval Ships, SEA 05M1 draft circa August 1985.

Handouts:

1. Section 4.3.4, Powder Coating (MIL-R-46896) from Reference 1.
2. Paper copies of T:I-7-1 through T:I-7-3.

* Marine Corrosion, Causes, Prevention and Control.

INSTRUCTOR PRESENTATION

TITLE CC System 4: Powder Coatings COURSE CC-Shop Technician UNIT I LESSON NO. 7

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
I. GENERAL A. Powder Coating: the covering of a surface with a finish or protective layer of "resin" in a dry powder form that when heated will melt and flow into a smooth finish. B. Types of Powder Coating 1. Sprayed (a) preheated object (b) electrostatic (c) combination of "a" and "b". 2. Fluidized Bed (a) preheated object (b) electrostatic (c) combination of "a" and "b".	• Write instructor's name, number of lesson and title on board.	1. Take notes. 2. Participate in class discussion.

TITLE CC System 4: Powder Coating COURSE CC-Shop Technician UNIT I LESSON NO. 7

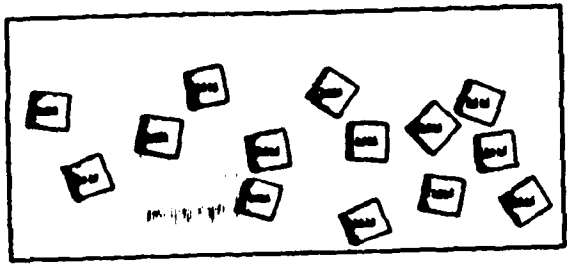
KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
C. **Primary Concern** 1. Electrostatic sprayed powder coating (a) covers large variety of differently sized and shaped objects. D. **Application** - Electrostatic Sprayed Powder coating is applied: 1. Onto a clean, pretreated object: (a) white metal surface finish with a 1-2 mil anchor tooth. (b) priming required on some surfaces. 2. Preheated at or above curing temperature. 3. In powdered resin form. 4. With an electrostatic spray gun inside a filtered spray booth. E. **Curing** 1. Item is placed in a 200-450°F oven. 2. Powder melts and begins to cure: (a) If two coats are desired, the item is removed from oven during the partial cure (gel state), coated again and returned to oven. (b) Complete cure in oven occurs in 5-20 minutes. 3. Item may be handled immediately after cooling.	• Pass out examples of powder coated items to trainees. • Define "near-white" and "white" metal surface preparation.	• Examine powder coated items and pass on.

INSTRUCTOR PRESENTATION

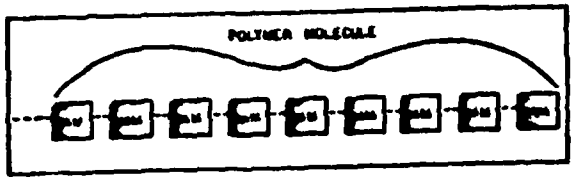
TITLE CC Systems 4: Powder Coatings COURSE CC-Shop Technician UNIT 1 LESSON NO. 7

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
II. TYPES OF POWDER		
The coating powders are plastics.	• Show transparency T:I-7-1.	
A. <u>Basically, two types of coating powders</u>	• Explain and discuss.	
1. Thermoplastics		
(a) Can be melted, formed, cooled and hardened separately.		
2. *Thermosetting*		
(a) Heated, cured (set) into permanent state.		
(b) When reheated at high enough temperature will burn or char.		
B. <u>Thermosetting Resins in Particular</u>		
1. They are the only type we will use because of their durability, flexural strength and chemical resistance.	• Show transparency T:I-7-2.	
2. *Chemical difference between a thermoset resin and a typical plastic.*		
(a) A plastic is made up of long molecules called polymers.		
(b) *In cross-linking (curing), the polymers become chemically attached to each other.*		
(c) Cross-linking is a chemical reaction that results in a permanent change.		

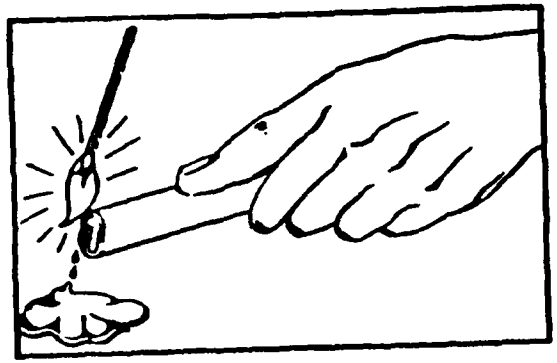
TRAINING AID



Monomer molecules.
Monomer molecules are small molecules. They are not connected to each other.



Polymer molecule.
A polymer molecule is composed of hundreds to thousands of monomer molecules joined in a chain.



Thermoplastics act like candle wax when heated or cooled.

TWO TYPES OF PLASTICS

All Plastics are either

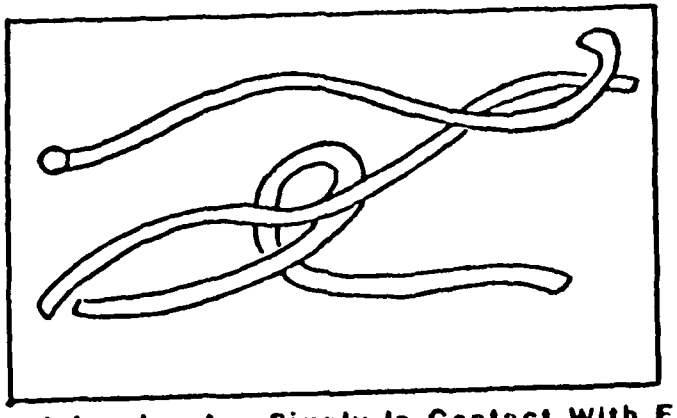
1. Thermoplastic (heat softening)
2. Thermosetting (heat curing)

. Thermosetting plastics act like concrete when set.

TRAINING AID

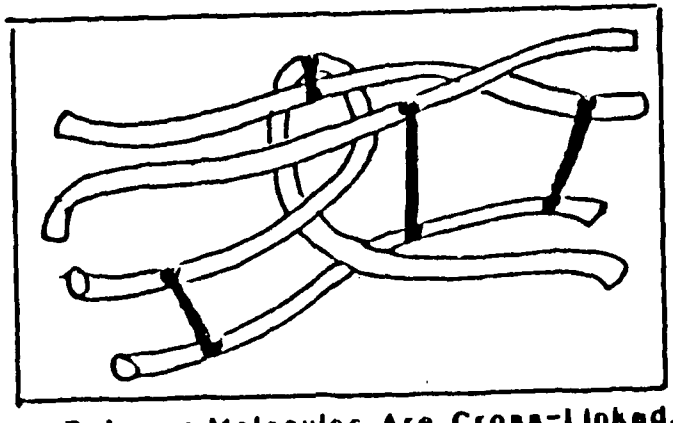
POLYMERS

Regular Plastic



Molecules Are Simply In Contact With Each Other.

Cross-Linked Plastic



Polymer Molecules Are Cross-Linked.

TITLE CC Systems 4: Powder Coatings COURSE CC-Shop Technician UNIT I LESSON NO. 7

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
3. Powdered resins are formulated to allow enough time between powder melting and polymer cross-linking so that a good, smooth coating results. C. **Thermosetting Powders** Powdered epoxy coatings are approved for interior and exterior application on steel surfaces above the upper limit of boot topping. There are several coatings which can be applied by this process, including polyvinyl chloride, polyethylene, polyester, epoxy, acrylic and nylon. Only the epoxy systems are authorized for shipboard CC applications by COMNAVSEASYSCOM. Current NAVSEA policy requires that only an epoxy meeting the standards of ASTM A775-81, and providing a total film thickness of 8-12 mils, shall be used for topside shipboard application. Chalking of the epoxy coating is to be prevented by the application of silicone alkyd paint. Polyesters are less affected by sunlight (ultraviolet light, in particular) retaining their color and gloss longer. **III. WHY POWDER COAT INSTEAD OF PAINT?** A. **More durable.** Powder coatings resist physical abrasion better than paint. Also, the powder coating will retain color and gloss longer. Saves maintenance time and money. B. **A more complete barrier coating.** Because there is no solvent evaporating from the coating during the cure, there are very few pores. C. **EPA - 85% reduction of VOC.** In other words, of all the solvent in your wet paint, only 15% may be released into the atmosphere. The 85% must be captured and safely disposed as hazardous waste.		

INSTRUCTOR PRESENTATION

TITLE CC System 4: Powder Coatings COURSE CC-Shop Technician UNIT 1 LESSON NO. 7

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
1. Solvent recovery systems are expensive. 2. Alternate paint systems have problems with poor curing or inadequate adhesion. D. <u>OSHA - Safety.</u> Coating powders are classified as a "nuisance dust" and are non-toxic. Proper respirators must be worn. E. <u>Clean-Up</u> 1. No hazardous waste. 2. No solvents to clean up spills. 3. Washes off skin and clothing with soap and water. **IV. WHERE SHOULD POWDER COATING BE USED ON SHIP COMPONENTS?** A. It may be used in low abrasion environments. WSA is to be used in high abrasion environments. B. Powder coatings supply corrosion protection as barrier coatings only. They supply no cathodic protection. C. Reference (a) lists proposed components for powder coating.	• Show/discuss T:I-7-3.	• Copy list of approved application items from board.

TRAINING AID

Topside Shipboard Components Authorized by NAVSEA to receive Powder Coatings*

1. Vent screens
2. Door screens
3. Ventilation discharge screens
4. Light brackets
5. Light shock mounts
6. Switch cover plates
7. Fog applicators
8. Battle helmets

*Powder Coating Systems for Corrosion Protection Aboard Naval Ships, DoD-STD-XXXX, SEA 05M1 Draft circa Oct 85.

INSTRUCTOR FOLLOW-THROUGH

TITLE CC System 4: Powder Coatings COURSE CC-Shop Technician UNIT 1 LESSON NO. 7

PRACTICAL APPLICATIONS	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
• Summarize Lesson. • Question students on key points; repeat and amplify the instruction as required.		• Answer questions and explain issues asked by the instructor. • Demonstrate knowledge of: -characteristics of powder coating. -surface preparation requirements. -industrial process requirements. -NAVSEA proposed items.

INSTRUCTOR PREPARATION

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

LEARNING OBJECTIVES

Trainees will learn:

1. The differences between thermoplastic and thermoset plastics.
2. Crosslinking.
3. Why powder coating is used.
4. Environmental concerns.
5. Shipboard items to be powder coated.
6. Powder coating processes.

The Trainees will be able to:

1. Follow proper safety rules.
2. Start up and operate equipment.
3. How to change colors.
4. Perform proper PMS.
5. Disassemble, clean and reassemble gun.
6. Replace insert sleeve and clean injector.
7. Troubleshoot equipment problems.

TRAINING AIDS/MATERIALS

Materials:

1. GEMA Manual ESP Gun.
2. GEMA 701 ESP Unit.
3. Examples of powder-coated items of various shapes and sizes.
   (Note: Items must be procured from local sources.)
4. 35mm slides of GEMA Equipments and use.
5. Transparencies T:III-1-1 through T:III-1-8.
6. 35mm slide projector.
7. Overhead projector.

References:

1. NAVSEA S9630-AG-MAN-010/FFG-7CL, Manual, Corrosion Control for FFG-7 Class, 30 November 1983.
2. Dod-STD-XXXX, Powder Coating Systems for Corrosion Protection Aboard Naval Ships, SEA 05M draft circa August 1985.
3. GEMA Electrostatic Spray Technical Manual.

INSTRUCTOR PREPARATION

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

LEARNING OBJECTIVES	TRAINING AIDS/MATERIALS
	Handouts: 1. Paper copies of T:III-1-1 through T:III-1-8. **CC Shop:** 1. Tour of ESP Stations. 2. OJT with GEMA Equipments (6 hours).

INSTRUCTOR PRESENTATION

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
REVIEW OF ELECTROSTATIC POWDER COATING	• Write instructor's name, lesson number and title on board.	• Take notes. • Participate in class discussion and activities.
I. GENERAL		
A. **Powder Coating:** the covering of a surface with a finish or protective layer of "resin" in a dry powder form that when heated will melt and flow into a smooth finish.	• Write definition on board. Explain and discuss.	• Copy definition from board.
B. **Types of Powder Coating**		
1. Sprayed		
(a) preheated object		
(b) electrostatic		
(c) combination of "a" and "b".		
2. Fluidized Bed		
(a) preheated object		
(b) electrostatic		
(c) combination of "a" and "b".	• Describe and pass around ESP samples.	• Examine samples and pass on.

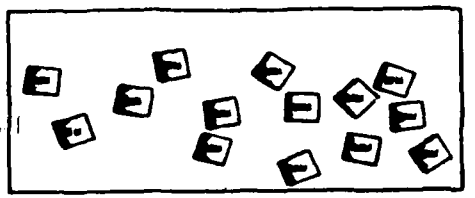
TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
C. **Attributes** 1. Dry powder; no solvents; no "VOC" concerns. 2. Uniformly covers large variety of differently sized and shaped objects. 3. More wear resistant than paints. D. **Application** - Electrostatic Sprayed Powder coating is applied: 1. onto a clean, pretreated object, (a) white metal blast (b) priming required on some surfaces 2. preheated at or above curing temperature, 3. in powdered resin form, 4. with an electrostatic spray gun. E. **Curing** 1. Item is placed in a 200-450°F oven, exact temperature and curing time are functions of resin type. 2. Powder melts and begins to cure: (a) If two coats are desired, the item is removed from oven during the partial cure (gel state), coated again and returned to oven. (b) Complete cure in oven occurs in 5-20 minutes.	• Show slides. Explain and discuss.	

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

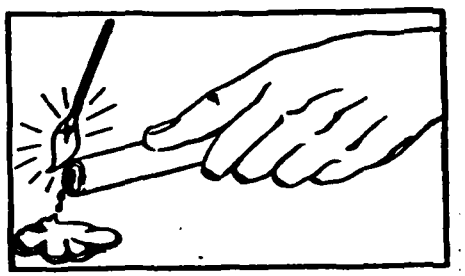
KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
3. Item may be handled immediately after cooling. **II. TYPES OF POWDER** The coating powders are plastics. **A. <u>Basically, two types of coating powders</u>** 1. Thermoplastics (a) Can be melted, formed, cooled and hardened separately. 2. Thermosetting (a) heated, cured (set) into permanent state. (b) when reheated at high enough temperature will burn or char. **B. <u>Thermosetting Resins</u>** 1. They are the only type we will use because of their durability, flexural strength and chemical resistance. 2. Chemical difference between a thermoset resin and a typical plastic. (a) a plastic is made up of long molecules called polymers. (b) in cross-linking (curing), the polymers become chemically attached to each other.	• T:III-1-1	

TRAINING AID



Monomer molecules.
Monomer molecules are small molecules. They are not connected to each other.

Polymer molecule.
A polymer molecule is composed of hundreds to thousands of monomer molecules joined in a chain.



Thermoplastics act like candle wax when heated or cooled.

TWO TYPES OF PLASTICS

All Plastics are either

1. Thermoplastic (heat softening)
2. Thermosetting (heat curing)

Thermosetting plastics act like concrete when set.

A2-17

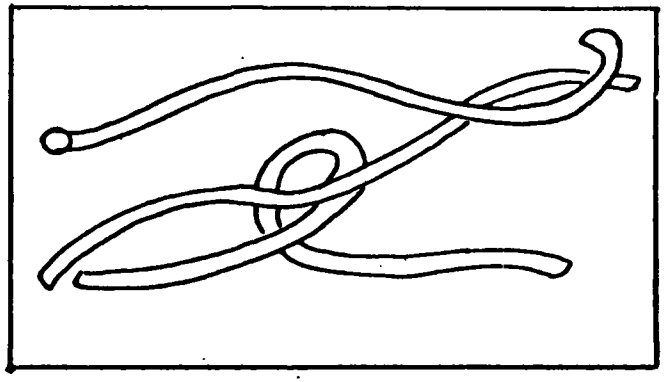
T: III-1-1

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
(c) Cross-linking is a chemical reaction that results in a permanent change. 3. Powdered resins are formulated to allow enough time between powder melting and polymer cross-linking so that a good, smooth coating results. C. **Thermosetting Powders:** Powdered epoxy coatings are approved for interior and exterior application on steel surfaces above the upper limit of boot topping. There are several coatings which can be applied by this process, including polyvinyl chloride, polyethylene, polyester, epoxy, acrylic, and nylon. The epoxy systems are preferred. Current NAVSEA policy requires than only an epoxy meeting the standards of ASTM A775-81, and providing a total film thickness of 8-12 mils, shall be used for topside shipboard application. Chalking of the epoxy coating is to be prevented by the application of silicone alkyd paint. Polyesters are less affected by sunlight (ultraviolet, in particular), retaining their color and gloss longer.	• T:III-1-2	

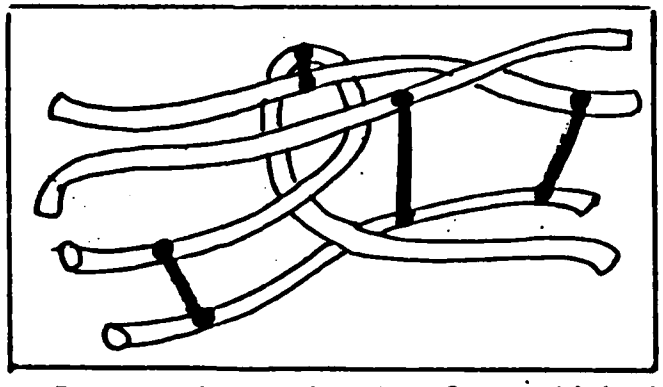
POLYMERS

Regular Plastic



Molecules Are Simply In Contact With Each Other.

Cross-Linked Plastic



Polymer Molecules Are Cross-Linked.

INSTRUCTOR PRESENTATION

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
III. WHY POWDER COAT INSTEAD OF PAINT? A. **More durable.** Powder coatings resist physical abrasion better than paint. Also the P.C. will retain color and gloss longer. Saves maintenance time and money. B. **A more complete barrier coating.** Because there is no solvent evaporating from the coating during the cure, there are very few pores. C. **EPA - 85% reduction of VOC.** In other words, of all the solvent in your wet paint, only 15% may be released into the atmosphere. The 85% must be captured and safely disposed as hazardous waste. 1. Solvent recovery systems are expensive. 2. Alternate paint systems have problems with poor curing or inadequate adhesion. D. **OSHA - Safety.** Coating powders are classified as a "nuisance dust" and are non-toxic. Proper respirators must be worn. E. **Clean-up.** 1. No hazardous waste. 2. No solvents to clean up spills. 3. Washes off skin and clothing with soap and water.	• List on board: 1. More durable. 2. More complete barrier coating. 3. 85% reduction in VOC. Explain and discuss • Explain OSHA.	

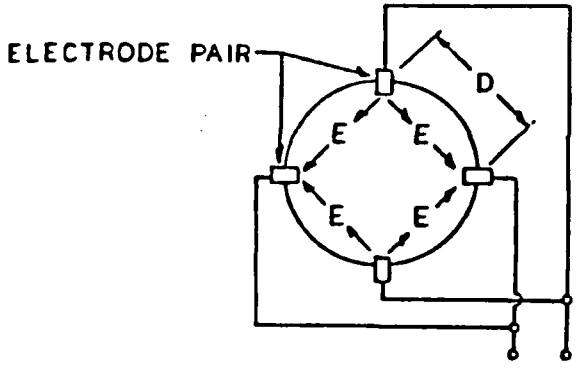
TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
IV. WHERE SHOULD POWDER COATING BE USED ON SHIP COMPONENTS? **A.** It may be used in low-abrasion environments. WSA is to be used in high abrasion environments. **B.** Powder coatings supply corrosion protection as barrier coatings only. They supply no cathodic protection. **C.** List of approved ship components that may be powder coated: • Vent Screens • Door Screens • Ventilation Discharge Screens • Light Brackets • Light Shock Mounts • Switch Cover Plates • Fog Applicators • Battle Helmets	• List items for approved application on board.	• Copy list of approved application items from board.

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

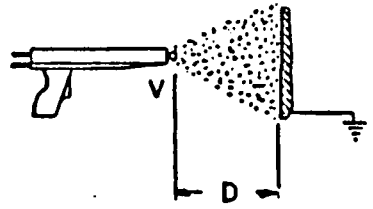
KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
V. GEMA TYPE 701 ESP UNIT **A. <u>Description and Operations.</u>** 1. Functional description: The fluidized powder in the powder hopper is sucked up in the injector by the conveying air (red hose). Through the powder hose, the powder/air mixture reaches the gun. The powder is electrostatically charged immediately before it reaches the gun muzzle. An intense electrostatic field also exists between the gun muzzle and the grounded workpiece. The electrostatically charged powder sprayed onto the workpiece adheres to the latter's surfaces. The line voltage is converted in the control module to a high-frequency current. This current is then stepped up by the high-voltage transformer (1) and the HV-cascade (2) in the gun to 70 to 100kV and applied to the electrodes (3). The conveying air and the dosing air is to be regulated on the control module, the fluidizing air on the pneumatic unit. The function of the injector is explained in the description EPM-228. The powder is fluidized by forcing air from below through a porous plastic plate. The fluidized powder gets liquid-like properties.	• T:III-1-3	

WHAT MAKES ELECTROSTATICS WORK



GEMA GUN
DISTANCE IS FIXED, FIELD STRENGTH IS CONSTANT

$$E = \frac{6000V}{.6CM} = \underline{7500V/CM\ CONSTANT}$$



CONVENTIONAL GUN
FIELD STRENGTH VARIES WITH DISTANCE

$$E = \frac{75,000V}{10\,CM\,(4")} = \underline{7500\,V/CM\ VARIABLE}$$

$$\underline{\text{FIELD STRENGTH (E)}} = \frac{(V)\,\text{VOLTAGE}}{(D)\,\text{DISTANCE}}$$

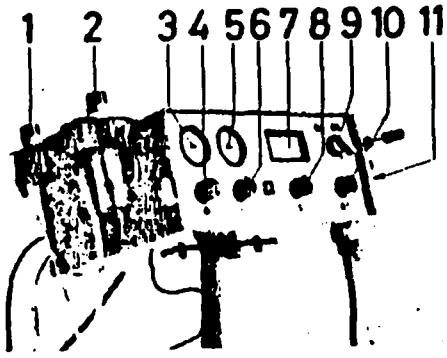
$$\underline{\text{CHARGE ON POWDER}}$$
$$Q = KEf(t)$$

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
2. Operator Controls: 3. Spray Gun: (a) Hand Gun 70kV (b) Maximum output current 0.12mA (c) Short circuit current 0mA 4. Pneumatic Data: (a) Maximum input pressure 176 psi (b) Minimum input pressure 88 psi (c) Maximum compressed air consumption is 13.2Nm^3/hr. (*Newton meters-cubed per hour; standard cubic feet per second*) 5. Working method of the injector and the influence of the dosing air: When air flows out of a jet into a hollow which contains an exit opening placed in the continuation of the air flow, a vacuum arises in the cavity, see T:III-1-6. This effect is utilized to draw powder through an aspiration hole - a powder-air mixture arises. This gets to the powder hose and to the gun. The concentration of the powder-air mixture and therefore of the powder output depends on the conveying-air pressure, the quality of the powder, the length of the powder hose, the difference of the height between gun and injector and the type of the gun (manual or automatic gun). The manometer indicates the dynamical pressure.	• T:III-1-4 • T:III-1-5 • Explain use of metric units. • T:III-1-6	

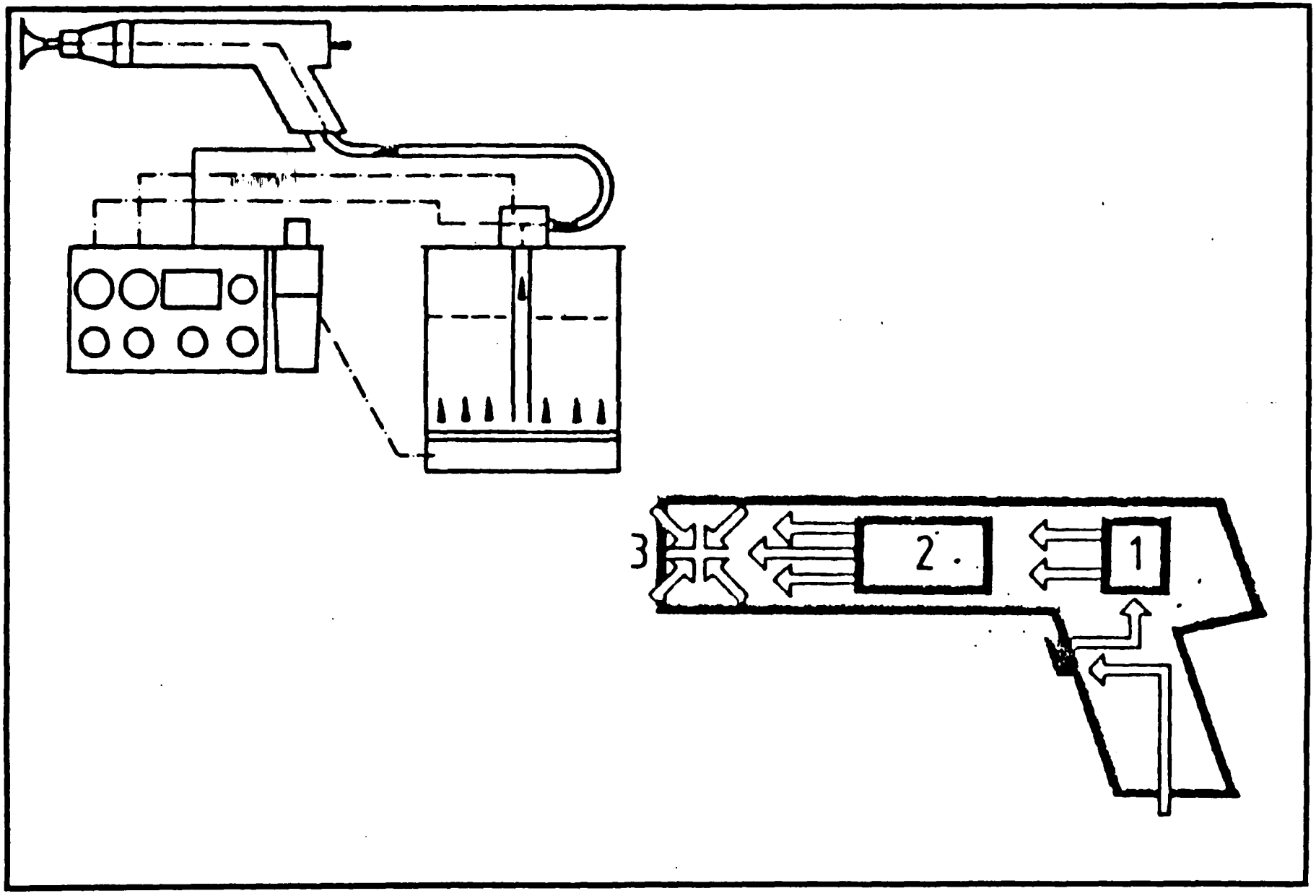
TRAINING AID

Operator controls

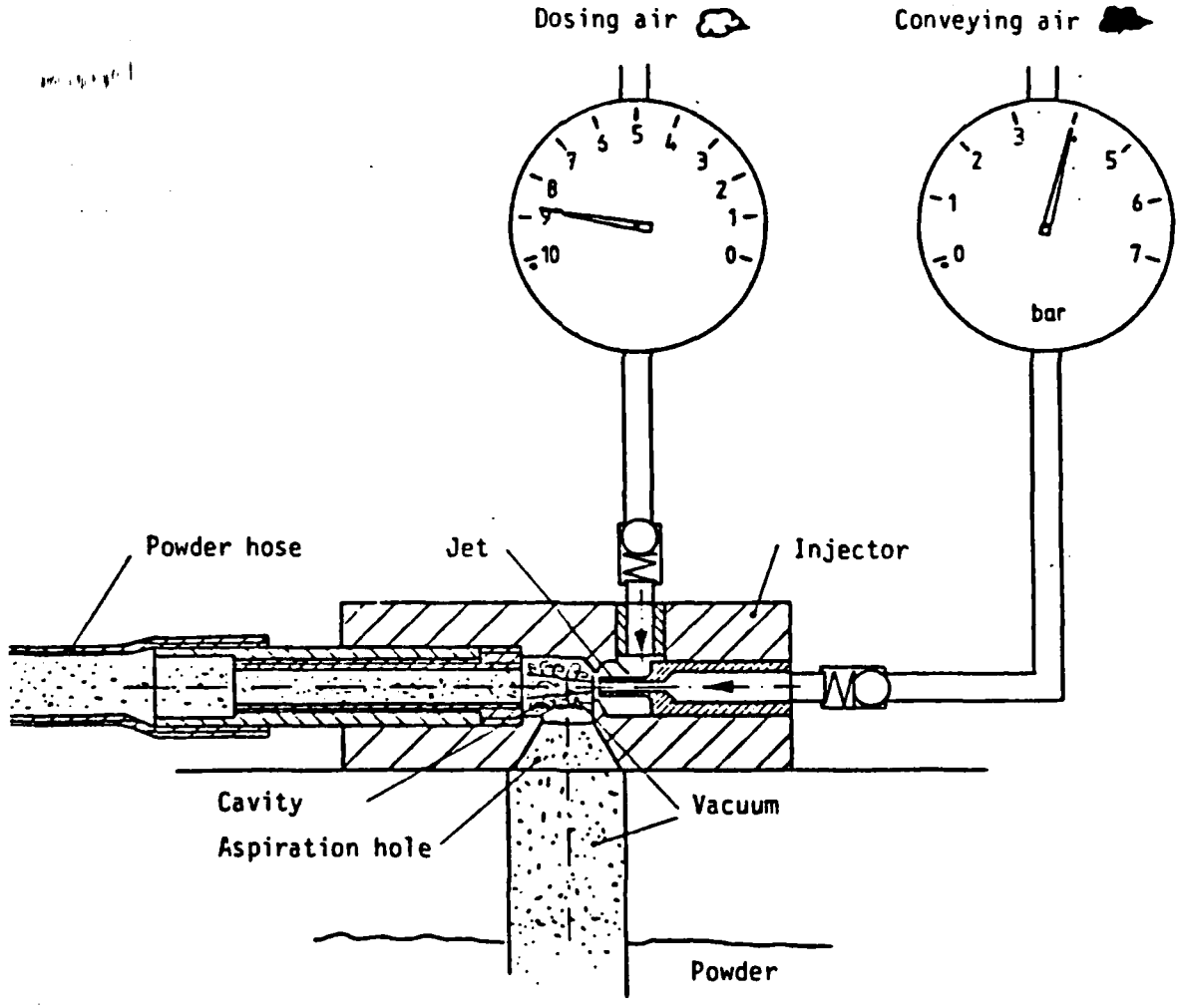


1. Pressure reducing valve for regulating the fluidizing air
2. Inlet pressure reducing valve with water separator
3. Manometer for monitoring conveying-air pressure
4. Pressure reducing valve for regulating the conveying-air pressure
5. Manometer for monitoring the dosing air
6. Pressure reducing valve for regulating the dosing air
7. High-voltage meter
8. Control knob for regulating the high voltage
9. Power switch
10. Green illuminated push button. The discharge current can be read on dial gauge 7 by pressing this button.
11. Gun switch

TRAINING AID



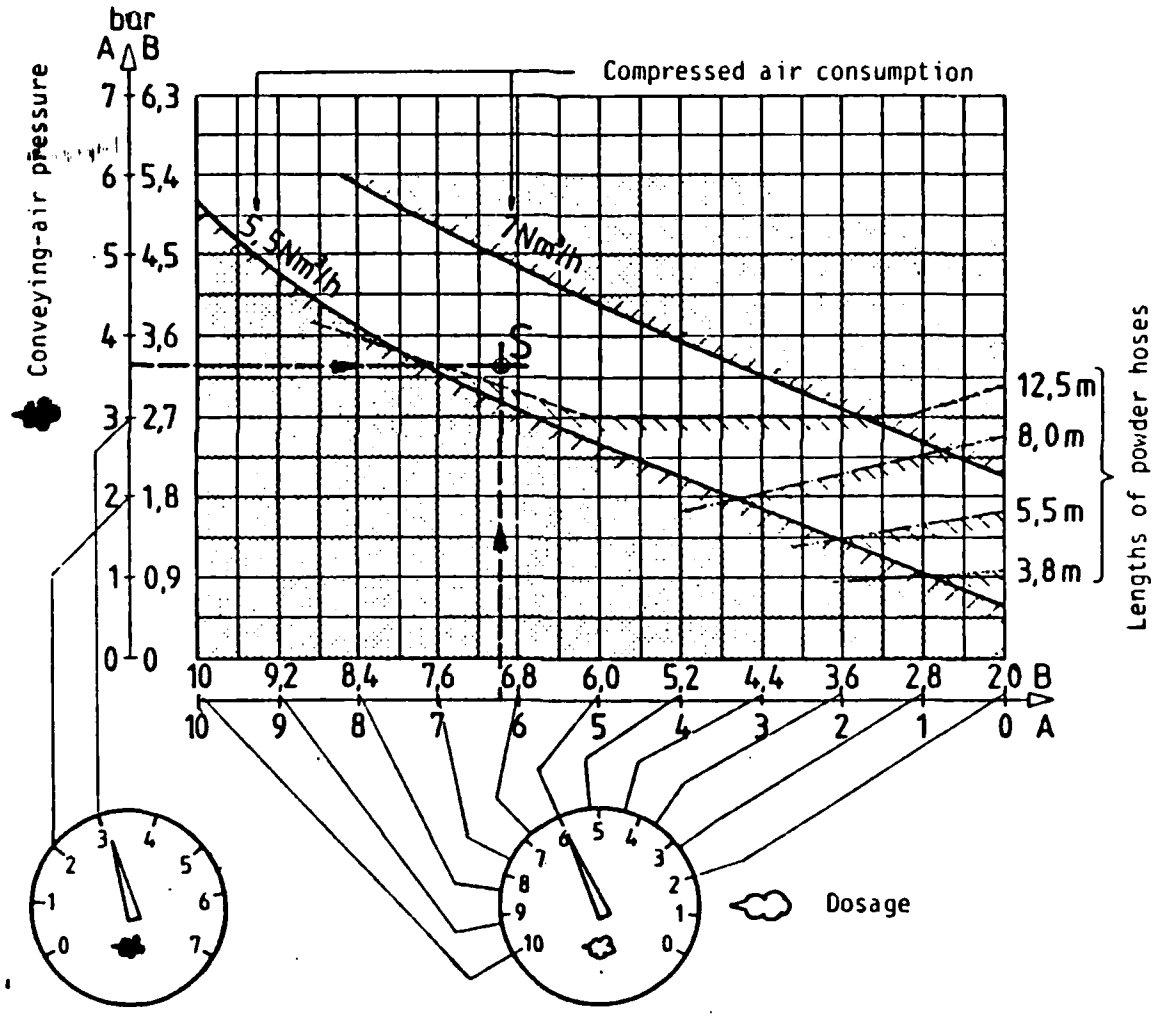
T: III-1-5


Dosing air
Conveying air
bar
Powder hose
Jet
Injector
Cavity
Aspiration hole
Vacuum
Powder

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
5. (Cont'd) To decrease the powder output without reducing the conveying speed, the vacuum in the hollow has to be decreased. For that purpose, the dosing air is blown into the cavity as secondary air. By raising the dosing air, the powder output decreases. The scale of the dosing-air manometer does not indicate the pressure but an index which proceeds corresponding to the conveying-air pressure. The zero on the scale of the dosing air does not correspond with the zero of the effective powder output. It is dependent on the conveying-air pressure: the higher the conveying-air pressure, the lower the scale value of the dosing air for the effective zero point of the powder output. Thus the scale does not indicate an absolute value, but one which depends on the conveying-air. The division on the dosing-air manometer does not indicate constant output values but serves as adjusting help for better reproducibility of the coating values.		
6. Graphics for the Determination of Adjustment for Perfect Powder Output: To obtain a regular pulsating free powder output, the adjusting of conveying-air and dosage have to be chosen in such a way that the whole compressed air consumption per gun does not fall below 5.5 Nm^3/h, see example. To avoid an eventual blow-off, the consumption should not exceed 7 Nm^3/h.	• T:III-1-7	
A regular and pulsating free powder output depends also on the length of the powder hose. The intersecting point (S) of the adjustment of conveying-air and dosage thus have to be set above the line which corresponds with the length of the powder hose. The determination of the graphics is based upon epoxide powder IG EP 149P (density: 1.55 g/m^3).	• Point out intersection on T:III-1-7. • Show use of graph of powders used by the CC Shop.	

TRAINING AID



TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
7. Installation of ES Powder Sprayer: Type 701 The ES powder sprayer is preassembled at the factory to the point where only the individual subassemblies must be connected. The gun support can be mounted either on the left-hand or the right-hand side of the control housing. The pneumatic unit is mounted on the opposite side. Connect conveying-air (red hose) to the angular fitting of the injector. Connect dosing-air (blue hose) to the straight fitting of the injector. Connect fluidizing air (white 6mm hose) to the angular fitting of the pressure reducing valve (No. 1, refer to operator controls) of the pneumatic unit and to the angular fitting of the powder hopper bed.	• Show slides of the Type 701 ES Powder Sprayer.	
B. **Safety Rules for Electrostatic Powder Coating** 1. All electrostatically conductive parts located within 5m of the coating equipment must be properly grounded. 2. The work floor of the coating area must be electrostatically conductive. 3. The operating staff must wear electrostatically conductive shoes (e.g., leather soles).	• T:III-1-8.	• Trainees discuss reasons for these safety rules.

Safety Rules for Electrostatic Powder Coating

1. All electrostatically conductive parts located within 5m of the coating equipment must be properly grounded.

2. The work floor of the coating area must be electrostatically conductive.

3. The operating staff must wear electrostatically conductive shoes (e.g., leather soles).

4. The operating staff should hold the gun in the bare hand. If gloves are worn, they must be electrostatically conductive.

5. The ground cable supplied with the equipment (yellow/green) must be connected to the ground terminal of the electrostatic sprayer. This cable must have proper metallic connection with the coating booth, the recovery unit and the conveyor chain or the suspension devices of the workpieces to be coated.

6. The electric and the powder feed lines to the guns must be routed in such a manner that they are suitably protected against mechanical damage.

7. Power to the powder sprayer should only be available after the booth has been switched on. If the booth is switched off, the powder sprayer must also shut off.

8. The ground connection of all conductive parts must be checked at least weekly.

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
4. The operating staff should hold the gun in the bare hand. If gloves are worn, they must be electrostatically conductive. 5. The ground cable supplied with the equipment (yellow/green) must be connected to the ground terminal of the electrostatic sprayer. This cable must have proper metallic connection with the coating booth, the recovery unit and the conveyor chain or the suspension devices of the workpieces to be coated. 6. The electric and the powder feed lines to the guns must be routed in such a manner that they are suitably protected against mechanical damage. 7. Power to the powder sprayer should only be available after the booth has been switched on. If the booth is switched off, the powder sprayer must also shut off. 8. The ground connection of all conductive parts must be checked at least weekly. **VI. CC SHOP OJT AT ESP STATION (6 hours)**	• Point out all these items during tour of the ESP Station in the CC Shop. • Equipment safety, operation and maintenance, and QC.	• Operate equipments and spray parts.

INSTRUCTOR FOLLOW-THROUGH

TITLE GEMA ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 1

PRACTICAL APPLICATIONS	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
• Summarize lesson. • Question trainees on key points; repeat and amplify the instruction as required. • Have trainees demonstrate the proper use and maintenance of equipments.		• Answer questions and explain issues asked by the instructor. • Demonstrate knowledge of practical skills.

INSTRUCTOR PREPARATION

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

LEARNING OBJECTIVES

Trainees will be able to:

1. Set up,
2. Operate,
3. Maintain, and
4. Troubleshoot

the Nordson ESP gun, hopper/feeder and console.

TRAINING AIDS/MATERIALS

Materials:

1. 35mm slides of set up, operation, PMS and troubleshooting of:
   - Nordson ESP Console,
   - Nordson ESP Hopper/Feeder, and
   - Nordson ESP Hand Gun.

   (Make up slides comparable to the photographs in Ref. 2,3 and 4 and number similarly. Tape/slide training programs for Ref. 2,3 and 4 may be purchased from Nordson Corporation, Finishing Equipment Division, Technical Training Department, 555 Jackson Street, P.O. Box 151, Amherst, OH 44001.)
2. Transparencies T:III-2-1 through T:III-2-3.
3. 35mm slide projector.
4. Overhead projector.
5. Nordson Control Console in the CC Shop.
6. Nordson Feeder/Hopper in the CC Shop.
7. Nordson ESP Gun in the CC Shop.

INSTRUCTOR PREPARATION

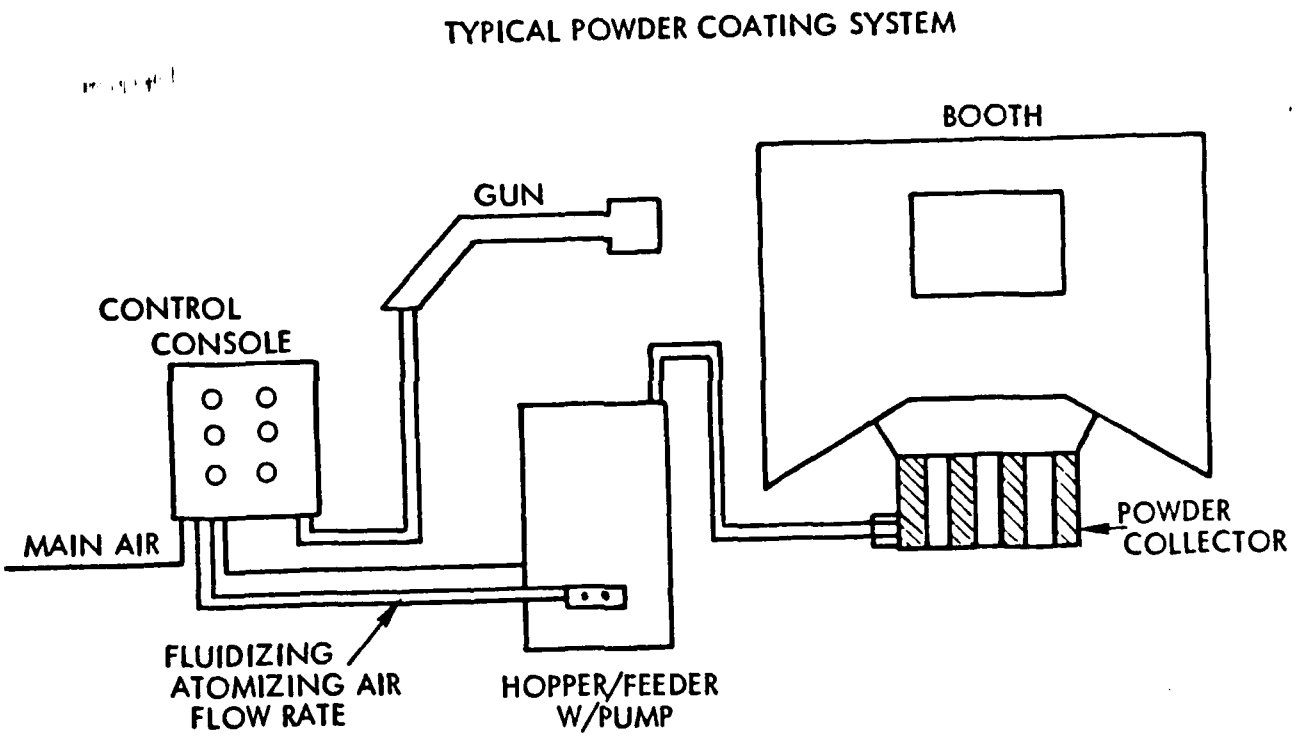
TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

LEARNING OBJECTIVES	TRAINING AIDS/MATERIALS
	References: 1. DoD-STD-XXXX, Powder Coating Systems for Corrosion Protection Aboard Naval Ships, SEA 05M draft circa August 1985. 2. Nordson Training Module "Y", NPE-2M Gun, Resource Guide Y-O, 1980. 3. Nordson Training Module "O", H2,3,4 & 5 Hoppers, Resource Guide O-O, July 1980. 4. Nordson Training Module "X", NPE-CC8, Resource Guide X-O, November 1980. **Handouts:** 1. Paper copy of transparencies. 2. Copy of Ref. 2,3 and 4. **CC Shop:** 1. OJT with Nordson Equipments (6 hours).

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
I. INTRODUCTION **Typical Powder-Coating System.**	• Write instructor's name, lesson number and title on board. • T:III-2-1 (also Slide 1)	• Take notes. • Participate in class discussion and activities.
II. NPE-2M ESP HAND GUN **A. Description:** A manually-operated Powder Spray Gun that incorporates electrostatic features. • Lightweight, balanced • Magnetic reed switch trigger • Positive and adjustable control of spray pattern • Central external antenna for maximum charge efficiency • Positive governing of powder velocity and volume • Equipped with 25' (7.62m) feed tubinhg • Resistor in gun limits current • Short internal powder passage Specifications: (a) Height — USA: 8.25" — METRIC: 226mm (b) Length — USA: 13.25" — METRIC: 325mm (c) Powder Tubing Length — USA: 25.0' — METRIC: 7.62m	• Show gun to class. • Explain function and use. • Slide 2	
The Nordson Powder Electrostatic gun NPE-2M is a simple powder hand gun easy to use and maintain. However, it does require some maintenance if it is expected to operate at high efficiency. This training module pertains to the few procedures necessary to clean and repair the gun.	• Slide 3	

TRAINING AID



T: III-2-1

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
B. Functions Most people who work with tools and have to maintain them find it easier if they understand the operation of the NPE-2M gun. Let's look at the different functions that occur wtihin the gun, starting with the flow of powder from the hose into the gun, through the nozzle, the deflector, sleeve and out the front of the gun in an evenly-shaped pattern.	• Slide 4	
An electrostatic charge is fed to the gun through a special cable (1) then through a resistor (2) in an insulated extension (3) and finally to a charging electrode at the front of the gun.	• Slide 5	
The third function in the gun, the trigger, controls the other two. In this function, a permanent magnet in the trigger is moved close to a switch as the trigger is pulled. The magnet pulls one contact in the switch against another making a circuit allowing a low-voltage current to pass to the control counsel turning on the powder flow and electrostatic charge.	• Slide 6	
C. Maintenance Because a static electric charge will always seek out a path to ground, cleanliness of the gun becomes very important.	• Slide 7	
1. Wipe all powder and foreign matter from the gun so all the charge intended to move from the electrode to the powder cloud will do so. This procedure will prevent leaking back through the contaminants to the grounded gun handle..		

INSTRUCTOR PRESENTATION

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
2. Powder allowed to accumulate on the inner parts of the gun will cause an uneven distribution of powder in the cloud and also the same lack of efficiency that dirt on the outside of the gun will cause.	• Slide 8	
3. Never use solvent or soap and water to clean the gun. These liquids may cause the flow of harmful efficiency-robbing particles to accumulate in pores and small voids in the gun.	• Slide 9	
D. ***Disassembly***		
As we proceed with the disassembly steps of this module, you will see that some clean, dry, compressed air and a fiber brush or course cloth is al that is needed to clean the gun.		
1. Lift the sleeve adjuster up off the extension. You may encounter some resistance caused by friction between the rear of the adjuster and the extension. Don't be afraid to lift or even pry upward with a screwdriver.	• Slide 10 & 11	
2. Slide the sleeve forward off the front of the extension.		
3. Carefully pull the deflector from the front of the extension, making sure not to damage the electrode.	• Slide 12	
4. If the deflector fits too losely, the O-ring inside the deflector must be replaced.	• Slide 13	
5. An uneven or narrowing powder cloud are the most common symptoms of a worm deflector. Inspect the deflector. If it has grooves in it or if its outside diameter has diminished, it should be replaced. Remember, new deflectors measure 38 or 16mm in diameter.	• Slide 14	

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
6. Pull the nozzle with a twisting motion from the front of the gun. Sometimes when this is done the sleeve around the deflector mount may slide off. Be careful not to lose it.	• Slide 15	
7. Slide the sleeve from the deflector mount. On guns used to spray porcelain enamel, the sleeve and deflector mount are one part and are disassembled from the rear of the extension. We will see this a little later in the program when we remove the deflector mount.	• Slide 16	
8. Remove the two slotted screws from each side of the extension and pull the extension forward away from the handle until it clears the insulation tube.	• Slide 17	
9. The resistor which has the electrode attached to it also has dielectric grease on it. The grease may cause the resistor to stick in either the extension or the insulating tube. Shake the resistor out of the part it is in. Any further disassembly steps would result in replacng the resistor and grease. To overcome the cohesion of the grease, shake the part vigorously to get the resistor out.	• Slide 18	
10. Hold the extension front-end down and tap the front tip of the deflector mount on the work bench. This will force the mount out the back of the extension. On guns used for porcelain enamel, the part being removed is made of ceramic and is equivalent to the mount and the sleeve used in organic powder guns.	• Slide 19	
11. Disconnect the control wire leads by pulling the plug on the cable away from the switch plug attached to the handle.	• Slide 20	
12. Unscrew the cable nut and pull the cable from the adaptor in the base of the handle.	• Slide 21	

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
13. Pull the switch and plug from the gun handle. This part fits in very tightly and may require a hard pull to remove it.	• Slide 22	
14. Pull the insulating tube from the gun handle.	• Slide 23	
15. If the trigger or spring requires replacement, hold the trigger pivot with one screwdriver and remove the screw with another.	• Slide 24	
This completes disassembly of the gun.	• On completion of showing and explaining slides of gun disassembly, demonstrate "hands on" gun step by step gun disassembly to trainees.	
E. Reassembly		
Reassembly of the NPE-2M gun is basically the reverse of disassembly except for a few steps.	• Demonstrate reassembly of the gun.	• Trainees working in groups will reassemble the gun.
When replacing the deflector mount, it is important for it to be fully inserted. To do this, line it up so it is started straight into the extension and then hand press it in with a round dowel until it protrudes about 13mm or 1/2 inch from the front of the extension.	• Slide 25	
Place the spring of the resistor assembly on the end of a pencil. Gently slide the electrode, resistor and spring into the extension and align the electrode so it passes through the deflector mount. Hold the electrode and pull out the pencil.	• Slide 26	

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
Push the insulating tube into the gun handle. When it is seated against the cable adapter, fill the end protruding from the front of the handle with dielectric grease. It is important to put all the grease from the applicator into the tube. This will fill all the voids in the resistor-spring and cable contact areas and will prevent electrical breakdown due to arching.	• Slide 27	
F. Troubleshooting		
1. Mechanical		
(a) Puffing (b) Uneven Pattern (c) Inadequate Powder (d) Poor Efficiency or Poor Wrap. (e) Powder does not flow (f) Too much film.	• T:III-2-2a • T:III-2-2b	
2. Electrostatic	• T:III-2-2c	
(a) Loss of Wrap • Red light ON, Feeder/Power Unit ON		
(b) Loss of Wrap • Red light ON, Feeder/Power Unit OFF		
(c) Electrical sparks between workpiece and conveyor rack.	• DANGER - SHUT DOWN	

TRAINING AID

TROUBLESHOOTING THE NPE-2M GUN

Mechanical:

PROBLEM	PROBABLE CAUSE	SUGGESTED CORRECTION
Poor efficiency or poor wrap	Output voltage is not sufficient.	Increase the output voltage.
Electrode bent of broken off	Rough handling during use or in cleaning.	Remove and replace the Resistor Assembly.
Powder does not flow	Air supply to the system is "OFF" or below minimum required.	Check air supply to the system to insure it is "ON". Also check for kinked air lines.
	Interlock malfunction.	Check and replace if necessary.
	Faulty solenoid.	Check solenoids and replace if necessary.
Too much film build	Improper placement of gun.	Relocate gun and trial-and-error until proper thickness is achieved.

TRAINING AID

TROUBLESHOOTING THE NPE-2M GUN (CONT.)

Mechanical:

PROBLEM	PROBABLE CAUSE	SUGGESTED CORRECTION
Puffing	Ejector pressure and/or Diffuser flow are not adequate.	Increase the Ejector pressure, or increase the Diffuser flow, or both.
	Hopper vent hose kinked or too long.	Straighten or shorten hose.
	Powder feed hose too long.	Move hopper closer to booth and shorten feed hose.
Uneven pattern (heavy spots)	Diffuser flow is not adequate.	Increase the Diffuser flow.
	Deflector is not press fit into the mounting deflector correctly.	Properly press fit the deflector into the mounting deflector.
	Deflector is worn or damaged.	Remove and replace the deflector.
Inadequate powder	Wet or damp powder is causing the metering orifice in the Venturi Assembly of the Feeder/ Power Unit or in the powder pump to clog.	Clean the metering orifice in the Venturi Assembly of the Feeder/ Power Unit or in the powder pump.
	Venturi throat worn out or is distorted.	Replace the Venturi throat in the Venturi Assembly of the Feeder/ Power Unit or in the powder pump.
	Venturi Nozzle is partially blocked.	Clean or replace the Venturi Nozzle in the Venturi Assembly of the Feeder/Power Unit or in the powder pump.
	Excessive Diffuser pressure.	Decrease the Diffuser pressure.

TRAINING AID

Electrostatic: TROUBLESHOOTING THE NPE-2M GUN (CONT.)

PROBLEM	PROBABLE CAUSE	SUGGESTED CORRECTION
Loss of wrap (red light on Feeder/ Power Unit "ON")	Poorly grounded workpieces.	Clean hooks, conveyor rollers, and channels.
	Dirt on the outside of gun, inside extension resistor, and/or cable end at Feeder/Power Unit.	Clean using a clean cloth or brush.
	Damaged resistor.	Check resistivity with megohm-meter. Replace if necessary.
	Defective cable.	Check voltage output with Nordson hand KV meter.** Replace if necessary.
	Defective Power Unit package in the Feeder/Power Unit.	Check output with Nordson hand KV meter.**
Loss of wrap (red light on Feeder/ Power Unit "OFF")	Power Unit package in the Feeder/ Power Unit or Control Console.	Check Power Unit using instructions provided with that unit.
Electrical sparks between workpiece and conveyor or rack.	Poor ground contact for workpiece or rack.	Danger! Shut down operation and correct ground deficiency. Fire may result if not corrected.

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
III. NORDSON ESP HOPPER/FEEDER This training module will deal with the theory of operation, troubleshooting and repair of the hopper and the pumps. **A. Description** The H2, H3, H4 and H5 Hopper Feeders are designed to hold and fluidize a supply of powder to be transmitted via an attached powder pump to a single Electrostatic Powder Spray Gun. The H2, H3, H4 or H5 Hopper Feeder, in conjunction with an NPE-F3 or CC-1 (high-voltage and control) module, regulates the amount of powder and the ratio of air and powder being eminated in the form of a cloud from the electrostatic Powder Spray Gun. **B. Specifications**	• Hopper/Feeder Slide Set - Slide 1. Point out hopper/feeder. • Slide 2	

	U.S.A. (in.)				METRIC (mm)			
	H2	H3	H4	H5	H2	H3	H4	H5
Dimensions:								
Height	42.50	31.12	15.38	10.88	1078	791	390	276
Width	21.31	14.5	9.0	7.0	541	368	229	178
Depth	23.00	14.5	7.0	5.0	584	368	178	127
Capacity:								
Powder (Static 2/3 full)	130 lb.	50 lb.	6 lb.	2 lb.	59 kg	23 kg	2.7 kg	.91 kg
Air Requirements (SCFM/liter/sec)								
Air to plenum (Fluidizing)	10	3	1	1	5.7	1.41	.47	.47
Air to pump								
Diffuser	5	5	5	5	2.3	2.3	2.3	2.3
Ejector	5	5	5	5	2.3	2.3	2.3	2.3
Average operating PSI/kg/cm^2								
Fluidizing	5-15	5-15	5-15	5-15	.35-1	.35-1	.35-1	.35-1
Ejector	60	60	60	60	4.2	4.2	4.2	4.2
Diffuser	40	40	40	40	2.8	2.8	2.8	2.8

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
C. Nomenclature		
1. There are no controls or electronics in the hopper or in the pump. These are contained in the control console(3) which can be mounted away from the spray area adding a great safety factor to the system.	• Slide 7	
2. The control console contains the on-off switch and the electric voltage selector. It also contain the "Flow Rate" regulator and the "Atomizing Air" regulator which controls air to the pump.	• Slide 8	
3. Some consoles, such as the CC8, also contain a third regulator and gage feeding the proper amount of fluidized air to the hopper plenum.	• Slide 9	
4. Automatic and hand guns operate identically except for turn on and turn off. On automatic units all functions turn on when the on-off switch is moved to the on position.	• Slide 10	
5. On hand guns only the hopper is fluidized when the switch is turned on. All other functions are activated when the operator pulls the trigger.		
D. Operation		
1. In operation, air passes through the: (a) Fluidizing regulator, and (b) into the plenum of the hopper (c) where it is distributed across the surface of a porous membrane.	• Slide 11	

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
2. Air then passes through the membrane and into the powder where it is mixed with it and elevates it to a fluid-like consistency.	• Slide 12	
3. When a hand gun is triggered or an automatic gun is turned on, two streams of air pass through tubes from the control console to each pump. One of these streams is the "Flow Rate" stream. This stream passes through a venturi in the pump where it pulls the fluidized mixture of powder and air from the hopper and propels it along with itself to the gun. The greater the air pressure applied on the venture nozzle, the more powder the venturi propels to the gun.	• Slide 13	
4. Working in conjunction with the Flow Rate control is the Atomizing Control. This control passes a stream of air from the control console to the metering orifice of the pump, which is between the hopper and the venturi. Here air is mixed with the fluidized powder passing into the venturi and eventually to the gun. It controls the ratio of powder particles to air in the cloud being emitted from the gun.	• Slide 14	
5. At this point, you would like to see a magical set of numbers appear before you telling just exactly at which pressure to set each regulator. This is not possible because there is no one combination of pressure regulator settings for all possible part configurations, powder formulas, and desired fill thickness combination. Without tests or experience, the most magical thing that can be said is to spray at the lowest possible pressure setting that still gives good results. This will give you maximum efficiency.	• Slide 15	

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
6. Hoppers require little or no maintenance. However, if the membrane should become broken by a heavy object falling into the hopper or if it should become plugged by dirty or oily air, it would have to be replaced. When it is replaced, clean all the metal surfaces that contact the membrane and apply silicone rubber sealant to them before putting the new membrane in place. The sealant will assure you of a leakproof joint at the membrane.	• Slide 16	
7. The single gun pump is attached to the side of the hopper with two socket heat screws passing through the sheet metal of the hopper and into the pump.	• Slide 17	
8. Once it has been attached to the hopper, it would rarely be removed. Our disassembly procedure will deal with only those parts of the pump that would be removed.		
E. **Disassembly**		
1. Before beginning disassembly, notice the words "up" stamped on both the flow valve retainer and the pump body.	• Slide 18	
2. It is important that thes two parts are always assembled in this position. If they were not assembled in this position, let's say the pump body was turned 180°, the center of the metering orifice of the pump body would not line up with the flow valve opening. This would cause lack of proper powder flow and possibly puffing at the gun.		
3. Pull the powder feed hose from the pump and remove the barbed venturi fitting from it.	• Slide 19	

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
4. Disconnect the two air tubes from the pump at their quick-disconnect fittings.	• Slide 20	
5. Remove the two thumb screws and lift the pump off the powder flow valve retainer.	• Slide 21	
6. Turn the valve 90° and pull out the metering orifice and O-ring.	• Slide 22	
7. Turn the male half of the quick-disconnect coupling counter-clockwise and remove it from the pump.	• Slide 23	
8. Turn the pump over and shake out the venturi nozzle. If it does not fall out, place the eraser end of a pencil in the opposite side of the pump and push it out.	• Slide 24	
9. If the flow valve is worn, unscrew the two socket head screws and replace the valve.	• Slide 25	
10. Examine the (a) metering valve orifice, (b) barbed venturi throat, (c) venturi nozzle, and (d) powder flow valve for wear. Also make sure powder is not clinging in a hard mass to any part. If either condition exists after a short time in production, an optinal part ma be used to prevent the problem.	• Slide 26	
F. **Troubleshooting**		
1. Puffing	• T:III-2-3	
2. Uneven pattern (heavy spots)		
3. Inadequate powder flow		

TRAINING AID

TROUBLESHOOTING THE HOPPER FEEDER

CONDITION	PROBABLE CAUSE	SUGGESTED CORRECTION
Puffing	Flow Rate pressure and/or Atomizing pressure are not adequate.	Increase the Flow Rate pressure, or increase the Atomizing pressure, or both.
	Vent hose too long or kinked.	Straighten or shorten vent hose.
Uneven pattern (heavy spots)	Atomizing pressure is not adequate.	Increase the Atomizing pressure.
Inadequate powder flow	Wet or damp powder is causing the metering orifice in the powder pump to clog.	Clean the metering orifice in the powder pump.
	Venturi throat is worn out and distorted.	Replace the venturi throat in the powder pump.
	Venturi nozzle is partially blocked.	Clean or replace the venturi nozzle.
	Excessive Atomizing pressure.	Decrease the Atomizing pressure.
Powder does not flow	Air supply to the system is OFF or below minimum required.	Check the air supply to the system and insure it is ON.
	Faulty solenoid.	Check solenoids and replace if necessary.
Uneven fluidization in hopper; "rat holing"	Too high Fluidizing Air pressure.	Decrease Fluidizing Air pressure.
	Wet powder in hopper.	Change to dry powder.
	Dirty or wet air has clogged membrane.	Try blowing dry air back through membrane. May require membrane replacement.

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
4. Powder does not flow 5. Uneven fluidity in hopper; "rat holing"		
G. **OJT in the ESP Station of the CC Shop**	• Take trainees to the CC Shop and physically demonstrate disassembly and reassembly of the hopper/feeder.	• Trainees disassemble and reassemble citing nomenclature of parts and cautions required.

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
IV. THE NORDSON NPE-CC8 CONTROL CONSOLE **A. Definition** The CC8 is the electrostatic and pneumatic control console for a single gun manual or automatic powder coating system. Continunous high-voltage control from 30 to 90 kV. Gages, regulators and controls conveniently located. Solid state, regulated voltage supply. **B. Specifications** USA / METRIC Dimensions: Height 15.5" 392mm Width 13.0" 330mm Depth 6.0" 152mm Electrical: Input 120/240 VAC +/- 15% @ 50/60 Hz Output 30-90 kV DC +/- 3 kV (continuous) Short Circuit Current (Gun,cable and power unit) 150 Microamperes (maximum) Air (Dry): Input 60psi (min) 4.2kg/cm^2 (min) 100psi (max) 7.0kg/cm^2 (max)	• NPE-CC8 Console Slide Set • Slide 1	

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
C. Description and Operation		
1. Understanding how to properly operate and maintain the NPE-CC8 will result in long service life and high efficiency for your Nordson powder coating system.		
2. The NPE-CC8 is a 30 to 90 kV DC output, low current, electrostatic power unit. Its purpose is to charge the powder coating, producing an attraction of the powder to the workpiece.	• Slide 3 (There is no Slide 2)	
3. The CC8 is also a pneumatic console for controlling the fluidizing flow and atomization of the powder coating.	• Slide 4	
4. The CC8 is used with any Nordson feeder hopper and may be used for manual or automatic gun operation.	• Slide 5	
5. The CC8 has a variable output voltage of between 30 kV and 90 kV. The lowest setting is appropriate for overcoming Faraday caging and thus for penetrating into recesses. Maximum wrap and efficiency are produced at the 90 kV setting.	• Slide 6	
6. In the pneumatic section, fluidizing, atomizing and flow rate are regulated and monitored by the CC8.	• Slide 7	
7. Fluidizing air is then sent to the feed hopper. Atomizing and flow rate air are sent to the powder pump.	• Slide 8	
D. External Troubleshooting		
1. If you are experiencing powder problems, such as puffing, uneven pattern on the workpiece or an inability to control the powder flow, chances are the problem is in the powder pump (1), hose (2) or gun (3); not in the CC8.	• Slide 9	

INSTRUCTOR PRESENTATION

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
2. A simple test to find out if the CC8 is at fault is to disconnect the output air tubes. Turn the unit on. Then adjust each regulator control to see the effect on each air output. No air from any output means that the 3-way air valve is not working. Call for an electrician. Work is needed inside the unit.	• Slide 10	
3. If the regulator controls and gages are acting erratically, this is usually an indication that powder has gotten into these components.	• Slide 11	
4. Do not clean the tip of the gun with compressed air while the gun is attached to its hose.	• Slide 12	
5. That procedure forces powder back through the system and into the regulator and gages of the CC8.	• Slide 13	
6. To properly clean the system, disconnect the fluidizing, flow rate and atomizing tubing from the CC8, or the output hose from the powder pump. Then go ahead and use compressed air to force material toward the gun end of the system.	• Slide 14	
7. As stated earlier, the NPE-CC8 produces an electrostatic charge that assists atomization, producing a more even distribution of powder on the workpiece. In addition, the electrostatics permit the powder to actually wrap around to the backside of the workpiece. If trouble occurs with the electrostatics, usually the first indication is the loss of wrap. However, before calling in an electrician, look at the following.	• Slide 15	

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
8. The front panel lamps are good indictors of the CC8's operating condition, that is as long as they haven't burned out or loosened.	• Slide 16	
9. In fact, it's a good idea to check the condition of the bulbs frequently.	• Slide 17	
10. Assuming the lamps are okay, both lamps out indicate that a circuit breaker or other fused device has tripped, cutting off power to the unit.	• Slide 18	
11. Or the one amp fuse has blown. Take the fuse out and inspect it.	• Slide 19	
12. If it looks blackened or burned, replace the fuse and try the unit again. If the fuse continues to blow, call for an electrician.	• Slide 20	
13. If both lamps are on, the problem may not be in the control console. Check out the following:	• Slide 21	
(a) Is the workpiece in good contact with its hanger? Does the hanger have good metal-to-metal contact with the conveyor? Cured powder on these parts can interrupt a good electrical path to ground, reducing or stopping electrical attraction of powder to the workpiece.	• Slide 22	
(b) Check your spray gun. A bent, broken or dirty electrode or even powder on the extension can decrease or stop the wrap effect.	• Slide 23	
(c) Likewise, the electrostatic cable must not be cut or nicked. If it is, the electrostatic charge will leak out before reaching the electrode on the gun.	• Slide 24	

INSTRUCTOR PRESENTATION

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
(d) If the amber lamp is on, but the red one is not, work is needed inside the unit. All internal repairs must be performed by qualified service technicians in accordance with all applicable safety codes.	• Slide 25	
E. OJT in the ESP Station of the CC Shop		
1. Console Operations and Troubleshooting	• Take trainees to the CC Shop and physically demonstrate operation and external troubleshooting of the console.	• Trainees check out and operate console.
2. Training Shapes and Production OJT	• Powder spray training shape emphasizing safety issues and demonstrating proper spraying techniques.	• Trainees spray training shapes followed by production spraying under direct supervision of a "journeyman" powder coating sprayer.

INSTRUCTOR FOLLOW-THROUGH

TITLE NORDSON ESP EQUIPMENT COURSE CC-Shop Technician UNIT III LESSON NO. 2

PRACTICAL APPLICATIONS	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
• Summarize Lesson. • Question trainees on key points; repeat and amplify the instruction as required. • Have trainees demonstrate proper use and maintenance of equipments.		• Answer questions and explain issues asked by the instructor. • Demonstrate knowledge of practical skills.

INSTRUCTOR PREPARATION

SIMA CC-SHOP
Lesson Plan

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

LEARNING OBJECTIVES

The trainees will be able to:

1. Start-up, operate, shut down and perform the PMS for the containerized ESP Spray Booth and Curing Oven, and
2. Apply ESP Coatings to production products.

The trainees will learn the:

1. Principles of operation of and the PMS requirements for the ESP Spray Booth and Curing Oven,
2. Safety requirements and procedures, and
3. Major elements of the industrial process instruction for applying ESP coatings at the ESP Station of the CC Shop.

TRAINING AIDS/MATERIALS

Materials:

1. 35mm slide of spray booth, oven and containers. (Note: Slides must be procured from local sources.)
2. Transparency T:III-3-1.
3. 35mm slide projector.
4. Overhead projector.
5. Chalk or dry erase markers for board.

References:

1. SIMA(SD) Process Instruction No. 7100-19-84, Powder Coatings, Electrostatically Applied: NAVSEA Corrosion-Control System 4, draft 30 December 1985.
2. "Installation and Operating Instructions for BAYCO Curing Ovens," BAYCO Industries of California, 1982.
3. Standard #33, National Fire Protection Association, 1985.

Handouts:

1. Copy of Ref. 1 above.

INSTRUCTOR PREPARATION

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

LEARNING OBJECTIVES	TRAINING AIDS/MATERIALS
	CC Shop: 1. OJT in ESP Coating of production products and equipment PMS (6 hours).

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
I. **SPRAY BOOTH** The spray booth container is designed for the electrostatic spray application of powder coatings. The spray booth is a cyclic purge cartridge type, with two modules having 3 filter cartridges each. The purge air cleans the filters with a reverse flow 0.3 pulse every 20 seconds. The powder over-spray that is purged from the filters falls into collection troughs for disposal. The filter booth was designed with openings to allow access by applicator but also maintaining a high enough air velocity to keep the powder in the booth. The booth is designed as a one gun booth; the use of two guns at once is both impractical and dangerous. The area outside of the spray booth is where the electrostatic spray guns control consoles must be kept during the applicating process. It is the location of all power and pneumatic outlets and booth control switches. The electrical outlet for the spray unit is interlocked with the booth blower to prohibit powder spraying without ventilation. The area located behind the filter modules houses the blower, final filter, purge valves and utilities. A. **Operation** 1. Procedures (a) Connect umbilical (b) Throw main power (c) Lights (d) Check electrical connections (e) Check outside and inside of booth for powder. Clean up if necessary. (f) Turn on blower (g) Open sliding doors by first raising dead bolt (h) Move spraying/curing cart into booth (i) Connect ground	o Write instructor's name, lesson number and title on board. o Show/discuss slides of the spray booth mounted in the 8'x8'x20' container. o Show/explain slide series.	o Take notes. o Participate in class discussion and activities.

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
(j) Close doors and lower dead bolts (k) Spray (l) Open doors (m) Disconnect (n) Remove cart B. **Maintenance** 1. Daily (a) Clean floor and collect troughs by vacuum cleaner (wet/dry type). (b) Clean hoppers, powder tubing and guns of all powder. 2. Weekly (a) Check filter cartridge to make sure powder is being cleared from them. (b) Check magnehelic gages in rear of container. (c) Cartridge plenum should read 8" of water (adjust dampers, both dampers equally, to maintain 8". If the gage is still not reading 8", remove filters and tap out loose powder. Return filters to modules and check gage reading. If pressure is still not correct, replace filters with new ones. 3. Gage Inspection (Note: Sliding doors on booth must be closed.) Gage on final filter should be around 0" to 2" water. If gage is reading outside of this range, remove filters and tap loose powder from them. Reinstall filters and check gage. If readings are still outside of this range, replace filters.	o Write maintenance schedule on board. o Explain and discuss.	o Copy maintenance schedule from board.

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
4. Final Filter Maintenance: (a) Remove first the back and top filter. (b) The third filter can only be removed by first removing the plenum by loosening the 12 attachment bolts.		
C. **Safety** 1. Be certain all metal items in spray area are grounded. 2. Be certain all personnel are grounded. 3. The containerized system is designed so that one gun can only be used during booth operation. o Modifying the electrical system to override the interlock or allow more than one gun in use at one time will cause the operator to be working in a hazardous environment.	o Write safety precautions on board. o Explain and discuss.	o Copy safety precautions from board.
D. **Tour of the ESP Station in the CC Shop**	o Demonstrate operation and maintenance of spray booth. Emphasize the safety and quality control issues. o Ask trainees questions to test their knowledge.	

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
II. CURING OVEN CONTAINER **A. Description** 1. This container houses the powder cooling systems curing oven and electrical main. 2. The oven has an interior work space of 4w x 4h x 7d and is heated electrically. 3. A recirculation blower maintains an even distribution of heat and an exhaust blower helps assure adequate venting of accummulated volatiles. 4. Oven controls include: (a) System operation timer (b) Temperature control (c) Purge timer 5. The system's electrical controls include: (a) The 440v system main (b) A step down transformer for 110v with disconnect (c) The 440v oven main, and	o Show/discuss slides of the curing oven mounted in the 8'x8'x20' container.	

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
(d) an auxiliary trailer main. B. **System Start Up Procedure** 1. Open the oven container end doors and the spray booth container side doors. 2. Slide ramp into place and bring up to level using the four screw jacks. 3. Connect umbilical between containers. 4. Throw main power on. 5. Throw transformer on. 6. Throw oven power on. 7. Throw auxiliary trailer power on. 8. Turn oven system on, located on oven control panel, system light should go on. 9. Set oven timer to 8 hours or another applicable work time. The blowers will start operation. 10. Open right oven door and hold all the way open so that the interlock light comes on. Hold the door in this position for approximately 110 seconds until the purged light comes on.	o Show/discuss slides showing step-by-step operating procedures.	

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
11. Close door. 12. Set temperature to desired setting. 13. Allow oven to come up to temperature (a half hour should be sufficient). 14. Safety check spray booth. 15. Refer to Powder Coating Application Process Instruction. C. System Shut Down 1. If time has not run out, then return it to zero. 2. Turn system off on oven control panel. 3. Throw oven main off. 4. Throw auxiliary trailer power off after first deactivating all equipment in powder spray booth container. 5. Throw step down transformer off. 6. Throw main power off. 7. Disconnect umbilical.	o Show/discuss slides.	

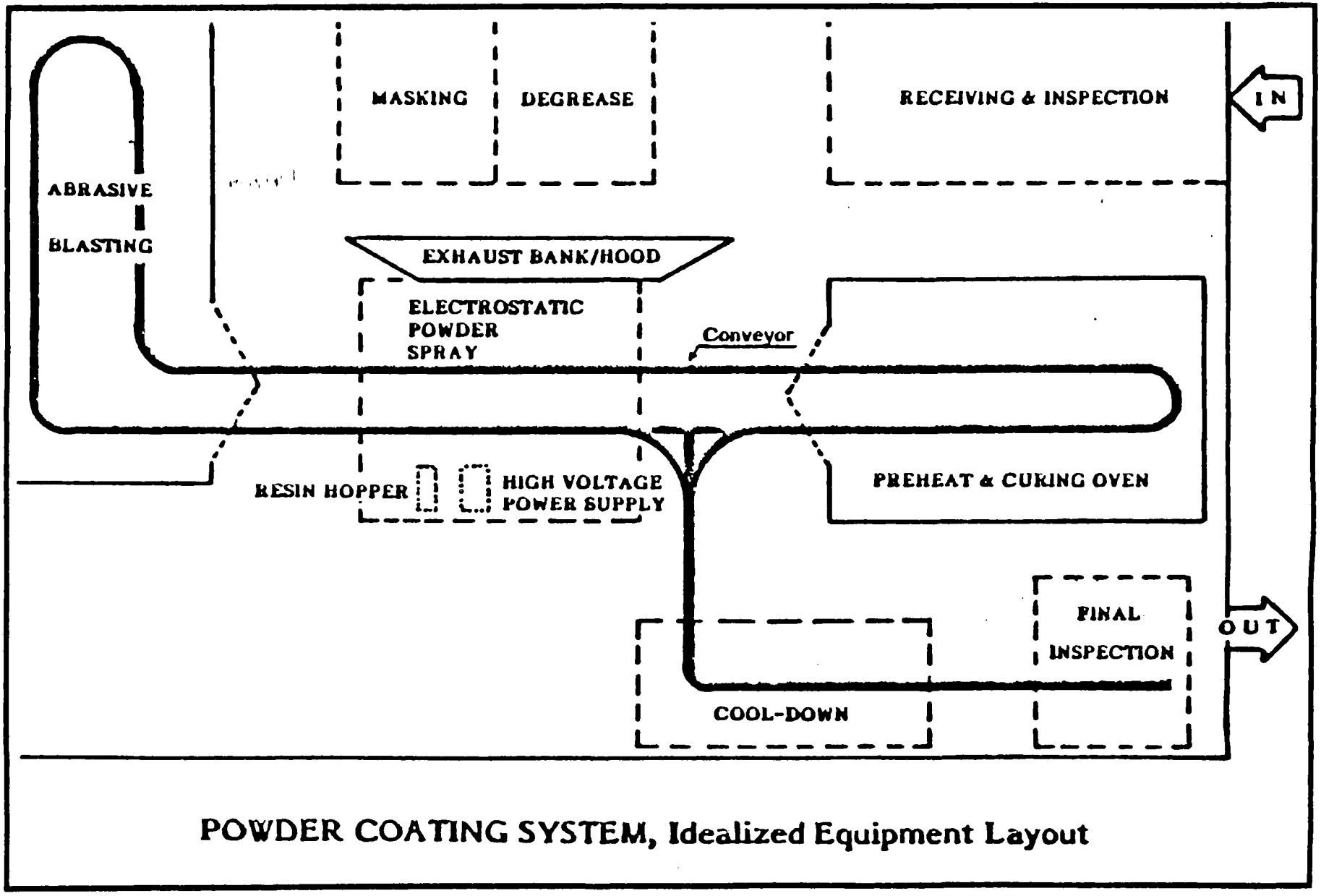
TITLE *ESP Spray Booth, Curing Oven and Container* COURSE *CC-Shop Technician* UNIT *III* LESSON NO. *3*

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
D. Maintenance o Check oven operating instructions for BAYCO Model CB112.		
E. Safety 1. Do not cook food in a curing oven. o Volatiles released during curing could contaminate food and poison recipient. 2. Do not sit, rest or sleep in oven. 3. Do not override interlock on purge system. 4. Do not readjust any vents or purge timer settings not authorized by equipment manufacturer. 5. Wear protective gloves when moving curing racks/carts in and out of oven.	o Write safety precautions on board. o Explain/discuss.	o Copy safety instructions from board.
F. Tour of ESP Station in the CC Shop	o Demonstrate operation and maintenance of the oven. Emphasize safety and quality control issues.	

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
III. ESP COATING PROCESS INSTRUCTION This is the integration of all the elements for the actual shop operations. **A. Equipment** 1. Surface Preparation (a) Degreaser (b) Strip Blaster (c) Anchor-Tooth Blaster with media for 1- to 2-mil anchor tooth 2. ESP Spraying and Curing (a) Spray Gun (b) Power Supply (c) Resin Hopper/Feeder (d) Dry-Filter Booth (e) Dry Air and Air Purification (f) Oven (g) Oven Racks and Hangers for Products 3. Quality Control (a) Pyrometer (100°-600°F Range) (b) Surface Profile Gage (Testex Profile Tape) (c) Elcometer (0-25 mil Range) (d) Color Standards (e) Impact Tester (being designed) (f) 10x Magnification Glass	o T:III-3-1. o Handout SIMA Process Instruction No. 7100-19-84 (draft, 30 December 1985). o Discuss/explain the various sections.	o Follow and make notes in copy of Process Instruction.

TRAINING AID



POWDER COATING SYSTEM, Idealized Equipment Layout

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
B. Materials 1. Powdered Epoxy meeting ASTM A775/755M-84 2. Abrasive Blasting Media 3. Process Air 4. Masking Materials 5. Cleaning Materials **C. Safety** 1. Solvents 2. Abrasive Blasting 3. ESP Spray Equipments (a) Powder Concentrations (b) Electrical Grounding 4. Personnel (a) Respirator (b) Electrical (c) Heat	o Ask trainees to summarize the safety issues and procedures.	

INSTRUCTOR PRESENTATION

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
D. **Quality Control** 1. Receipt Inspection 2. Masking 3. Strip Blasting 4. Anchor-Tooth Blasting 5. Powder Coating 6. Silicone-Alkyd Topcoating 7. Final Assembly Inspection E. **Method** 1. Receipt Inspection 2. Precleaning 3. Masking 4. Strip Blasting 5. Anchor-Tooth Blasting 6. Preheat	o Have trainees summarize the QC items and measurement procedures.	

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
7. ESP Powder Application (a) Single Coat (b) Two Coat 8. Curing 9. Silicone-Alkyd Topcoating 10. Final Inspection and Packaging		
F. Feedback	o Have trainees summarize the methods and all of the QC checkpoints.	
G. OJT in the ESP Station of the CC Shop	o Trainees man and operate all equipments directly supervised by the Instructor and/or ESP Station Supervisor.	o Complete all ESP spraying/curing operations and equipment PMS.

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
D. Maintenance		
o Check oven operating instructions for BAYCO Model CB112.		
E. Safety	o Write safety precautions on board.	o Copy safety instructions from board.
1. Do not cook food in a curing oven.	o Explain/discuss.	
o Volatiles released during curing could contaminate food and poison recipient.		
2. Do not sit, rest or sleep in oven.		
3. Do not override interlock on purge system.		
4. Do not readjust any vents or purge timer settings not authorized by equipment manufacturer.		
5. Wear protective gloves when moving curing racks/carts in and out of oven.		
F. Tour of ESP Station in the CC Shop	o Demonstrate operation and maintenance of the oven. Emphasize safety and quality control issues.	

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
III. ESP COATING PROCESS INSTRUCTION This is the integration of all the elements for the actual shop operations. **A. Equipment** 1. Surface Preparation (a) Degreaser (b) Strip Blaster (c) Anchor-Tooth Blaster with media for 1- to 2-mil anchor tooth 2. ESP Spraying and Curing (a) Spray Gun (b) Power Supply (c) Resin Hopper/Feeder (d) Dry-Filter Booth (e) Dry Air and Air Purification (f) Oven (g) Oven Racks and Hangers for Products 3. Quality Control (a) Pyrometer (100°-600°F Range) (b) Surface Profile Gage (Testex Profile Tape) (c) Elcometer (0-25 mil Range) (d) Color Standards (e) Impact Tester (being designed) (f) 10x Magnification Glass	o T:III-3-1. o Handout SIMA Process Instruction No. 7100-19-84 (draft, 30 December 1985). o Discuss/explain the various sections.	o Follow and make notes in copy of Process Instruction.

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
B. Materials 1. Powdered Epoxy meeting ASTM A775/755M-84 2. Abrasive Blasting Media 3. Process Air 4. Masking Materials 5. Cleaning Materials **C. Safety** 1. Solvents 2. Abrasive Blasting 3. ESP Spray Equipments (a) Powder Concentrations (b) Electrical Grounding 4. Personnel (a) Respirator (b) Electrical (c) Heat	o Ask trainees to summarize the safety issues and procedures.	

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
D. **Quality Control** 1. Receipt Inspection 2. Masking 3. Strip Blasting 4. Anchor-Tooth Blasting 5. Powder Coating 6. Silicone-Alkyd Topcoating 7. Final Assembly Inspection E. **Method** 1. Receipt Inspection 2. Precleaning 3. Masking 4. Strip Blasting 5. Anchor-Tooth Blasting 6. Preheat	o Have trainees summarize the QC items and measurement procedures.	

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

KEY POINTS/ACTIVITIES	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
7. ESP Powder Application (a) Single Coat (b) Two Coat 8. Curing 9. Silicone-Alkyd Topcoating 10. Final Inspection and Packaging	o Have trainees summarize the methods and all of the QC checkpoints.	
F. **Feedback**		
G. **OJT in the ESP Station of the CC Shop**	o Trainees man and operate all equipments directly supervised by the Instructor and/or ESP Station Supervisor.	o Complete all ESP spraying/curing operations and equipment PMS.

INSTRUCTOR FOLLOW-THROUGH

TITLE ESP Spray Booth, Curing Oven and Container COURSE CC-Shop Technician UNIT III LESSON NO. 3

PRACTICAL APPLICATIONS	TRAINING AID/ DEMONSTRATION	TRAINEE RESPONSE
o Summarize Lesson. o Question trainees on key points; repeat and amplify the instruction as required. o Have trainees demonstrate proper use and maintenance of equipments.		o Answer questions and explain issues asked by the instructor. o Demonstrate knowledge of practical skills.

APPENDIX 3

CONTRACTOR POWDER COATING PRODUCTION SUMMARY

APPENDIX 3

CONTRACTOR POWDER COATING PRODUCTION SUMMARY

1.0 INTRODUCTION

In order to maintain a detailed listing of components preserved by the powder coating contractor, all powder coating application contractor's invoices were summarized.

2.0 CONTRACTOR POWDER COATING PRODUCTION SUMMARY

The application contractor's invoices were the data bank that the powder coating summary was created from. The Pilot CC Shop did not maintain complete powder coating records due to the limited involvement required of the shop, however, records were maintained for components powder coated by the Pilot CC Shop in the newly-installed powder coating work station.

CONTRACTOR POWDER COATING PRODUCTION SUMMARY

COMPONENT	COMPONENT
ALBERT DAVID (FF-1050) Fog Applicators (10') Speaker Covers Handrails Smoke Float Racks Stern Light Fixtures Exhaust Screen Signal Searchlight Fixture Line Reels Cable Reels Pyro Locker Shields Vent Screens Riser Guards Electric Box Covers Electrical Power Tray Gun Mount Platforms **Total Components Powder Coated = 131**	**BRONSTEIN (DD-1037)** Electrical Boxes Fog Applicators (4') Light Fixtures Vent Screens First Aid Box **Total Components Powder Coated = 33** **COPELAND (FFG-25)** Pyro Lockers Speaker Covers Fog Applicators (10') MWB Cable Screen Boat Davit Screens Phone Boxes/Holders Speaker Horns Speaker Box Life Jacket Lockers Light Fixtures Signal Searchlight Fixtures Deck Edge Light Covers Captain's Chair (4 pcs.) Safety Reels Capstan Controllers Storage Boxes **Total Components Powder Coated = 151**
BERKELEY (DDG-15) Signal Light Filters Fog Applicator Phone Boxes Jackstaff/Supports Vent Screens Electrical Boxes Signal Searchlight Fixtures Light Fixtures **Total Components Powder Coated = 112**	**FLETCHER (DD 992)** Pyro Lockers w/Shields Light Fixtures Vent Screens Signal Light Filters Fog Applicators Deck Edge Light Covers Boxes Storage Boxes
BRISTOL COUNTY (LST-1198) Pyro Locker Shields (2' x 3') **Total Components Powder Coated = 12**	

CONTRACTOR POWDER COATING PRODUCTION SUMMARY (Cont'd)

COMPONENT
FLETCHER (DD-992) (Cont'd) P-250 Boxes/Covers Hose Boxes/Lids **Total Components Powder Coated = 216**
FRESNO (LST-1182) Vent Screens **Total Components Powder Coated = 5**
HENRY B. WILSON (DDG-7) Signal Searchlights Miscellaneous **Total Components Powder Coated = 68**
HORNE (CG-30) Vent Screens **Total Components Powder Coated = 25**
ROURKE (FF-1053) P-250 Boxes Jackstaff Wind-Direction Pole Davits (7") Davit Socket (7") Pyro Lockers Binocular Pedestals Unrep Boxes **Total Components Powder Coated = 32**

COMPONENT
SCHENECTADY (LST-1185) Pyro Lockers Storage Lockers File Holder Davits S/P Phone Boxes Life Jacket Locker First Aid Boxes Hose Lockers Fire Alarm Box (5 pcs.) Fog Applicator (4') Shelves Electrical Boxes Vent Covers Vent Ducting P-250 Boxes Phone Cradles Panel Vent Screens Oil Spill Control Boxes Control Box **Total Components Powder Coated = 138**
TRUXTUN (CGN-35) Garbage Chute P-250 Boxes **Total Components Powder Coated = 5**

CONTRACTOR POWDER COATING PRODUCTION SUMMARY (Cont'd)

COMPONENT
WADSWORTH (FFG-9)
Pyro Lockers
Capstan Controllers
Signal Searchlights
Light Fixtures
Phone Boxes
Phone Holders
Deck Edge Light Covers
Total Components Powder Coated = 88

APPENDIX 4

POWDER COATING WORK STATION
INDUSTRIAL PLANT EQUIPMENT

APPENDIX 4

POWDER COATING WORK STATION
INDUSTRIAL PLANT EQUIPMENT

1. Abrasive Blast Unit (Walk-In)
2. Powder Spray Booth
3. Oven Curing Type, Walk-In
4. Powder Spray Gun/Hopper/Feeder/Control Console
5. Overhead Conveyor System

ABRASIVE-BLAST UNIT (WALK-IN, ANCHOR-TOOTH)

1. **Intended Use:**

   The intended use of this system is to provide a containerized walk-in SSPC-5 white-metal blast capability using aluminum oxide.

2. **Design**

   - Inside working dimensions shall be 6'1" high x 9'8" deep x 7'2" wide.

3. **Operational Requirements**

   - 480 VAC, 3 phase, 60 Hz, 40 amps, 33.3 kW
   - **Air** - 200 CFM, 100 PSI

4. **Estimated Cost**

   First Alternate $90,000

SPRAY BOOTH; ELECTROSTATIC POWDER SPRAY (CARTRIDGE TYPE)

1. **Intended Use:**

   To provide a safe and nuisance-free area for the application of electrostatically-sprayed powder.

2. **Design**

   a. Overall work area shall be 10'x10'x10'.

   b. Plenum shall have a cartridge bank face of 10'x10'.

3. **Operational Requirements**

   a. Face velocity - refer to NFPA No. 33

   b. Utilities

   - Blower - 3 phase, 440V, 60 Hz, 7.5 Amps
   - Lights (total) - 110V, 60 Hz, 3.5 Amps

4. **Estimated Cost**

First Alternate	$15,000-$20,000
Second Alternate	$15,000-$20,000

OVEN; CURING TYPE, WALK-IN

1. **Intended Use:**

   To provide uniform heating to parts that have to be electrostatically powder coated so that the coating will flow and cure to a smooth hard finish. The oven shall also be used for preheating parts.

2. **Design**

   a. Interior dimensions of oven shall be 7' high, 12' deep, 8' wide.

3. **Operational Requirements**

   a. Oven shall have the operational range of 100-450°F.

   b. With the 450°F limit, the oven shall be set on a concrete floor.

   c. Utilities:

      Heat Source:

Electric Oven	3 phase, 440V, 140 KW, Maximum
Recirculation System:	3 phase, 440v, 12 Amps, Maximum

4. **Estimated Cost**

   First Alternate

Gas Fired	$19,000
Electric	$19,000

   Second Alternate

Gas Fired	$22,800
Electric	$23,800

CONTROL CONSOLE/POWER SUPPLY - ELECTROSTATIC POWDER SPRAY SYSTEM

1. **Intended Use:**

Houses all electrical and air inputs, powder feed and high voltage controls, gauges and switches for a complete single gun Electrostatic Spray System.

2. **Design**

a. Chassis size, 18"x18"x10", typical

b. Console shall be wall or cart mounted

3. **Operational Requirements**

a. Electrical, typical

Input	120/240 VAC, 60 Hz
Output	30-90 KV
Current (short circuit)	150 MicroAmperes

b. Pneumatic, typical

Input Air	60-100 psi
Total Air Consumption	15 SCFM

c. Can only be used with same manufacturer's spray guns and powder hoppers

POWDER SPRAY GUN - ELECTROSTATIC POWDER SPRAY SYSTEM

1. **Intended Use:**

   For the manual application of electrostatically-sprayed powder coatings.

2. **Design**

   a. The spray gun shall be less than 2 lbs. in weight

   b. The gun barrel shall be designed for ease of cleaning

   c. The gun shall have lance extensions of 6' and 12' for coating interior areas.

3. **Operational Requirements**

   The gun manufacturer shall be the same for the control console and powder hopper. Interchangeability is not acceptable.

POWDER HOPPER/FEEDER - ELECTROSTATIC POWDER SPRAY SYSTEM

1. **Intended Use:**

   As a portable container to hold and feed powders for the powder spray gun.

2. **Design**

   a. Powder capacity of 50 lb.

   b. The hopper/feeder shall be equipped with a venturi system to transfer powder to spray gun.

   c. Two additional hopper/feeders of 6-8 lb capacity shall be provided.

   d. The 6-8 lb. hopper feeders shall have a size of 35"x15"x15", typical.

3. **Operational Requirements**

   a. The pneumatic requirements of the hopper/feeder shall be in the ranges of:

Hopper Fluidizing Air	3-4 SCFM	5-15 psi
Ejection Air	4-6 SCFM	40-100 psi
Dilution Air	4-6 SCFM	40-100 psi

4. **Estimated Cost**

POWDER SPRAY SYSTEM

(Control Console/Power Supply, Spray Gun, Hopper/Feeder)

First Alternate	$3,500
Second Alternate	$3,700

ACCESSORIES

(Extra Hopper, Lance Extensions)

First Alternate	$700
Second Alternate	$700

OVERHEAD CONVEYOR SYSTEM

1. **Intended Use:**

   To convey and suspend items undergoing the powder coating process.

2. **Design**

   a. Overhead free conveyor system.

   b. 110 feet of enclosed track.

   c. Floor mounted support steel.

   d. 16 trolleys, four wheel design.

   e. Three over expansion joints.

   f. Four track end stops.

3. **Operational Requirements**

   a. Trolleys shall be rated at 250 lbs carriage capacity.

   b. Operating temperature 100 to 550 degree F.

4. **Estimated Cost**

   First Alternate $5,700

APPENDIX 5

RECOMMENDED PMS PROCEDURES

APPENDIX 5

RECOMMENDED PMS PROCEDURES

1.0 GENERAL.

The enclosed maintenance procedure package is presented here to serve as a basis to develop a standard SIMA PMS program. The exact equipment installed at each SIMA CC Shop will have some bearing on the PMS procedure details.

2.0 PMS PACKAGE DEVELOPMENT

The maintenance procedures specified for each piece of equipment were derived from the equipment-manufacturer's recommendations and shop experience. Standard SIMA maintenance and safety procedures, codes and format are still required to develop maintenance requirement cards. List of effective pages, maintenance index pages, equipment guide lists, tag guide lists and cycle, quarterly and weekly planned maintenance schedules must be developed to implement the PMS recommended in this Appendix.

AD-A167 694 CORROSION-CONTROL (CC) PROGRAM:PPILOT POWDER COATING STATION SERVICE TEST.. (U) INTEGRATED SYSTEMS ANALYSTS INC NATIONAL CITY CA S KULLERD ET AL. 14 MAR 86 3/3

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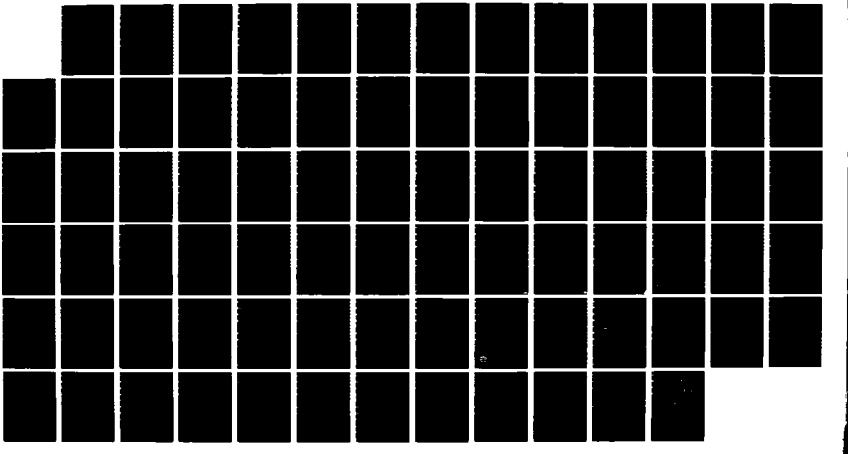
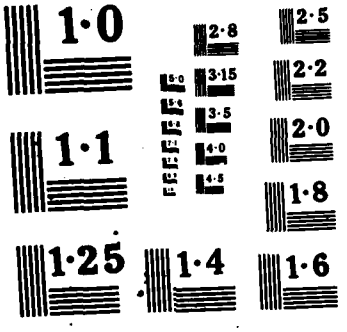




PMS REQUIREMENTS

Shipsystem, System, Subsystem or Equipment

Powder Spray Booth, Containerized

Configuration

Reference Publication

NORDSON Corporation, Technical Publications for the NPE D-1 System
RANSBURG-GEMA, Operating Instructions for the Electrostatic Powder Coating Equipment, Type 701

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION
Daily	A. **Visual Inspection of Electrical and Pneumatic Systems.**

Safety Equipment: None
Tools: Wire Brush and Wrench
Tag Out: Only if corrective action required

1. Inspect ground rod connection outside of container for soundness of connection and lack of corrosion. If connection is loose, tighten with wrench. If corrosion is present, tag out container at power source, disconnect ground wire from ground rod, wire brush away corrosion products, reconnect ground wire to ground rod and clear danger tags.

2. Inspect ground wires to all powder hoppers and control consoles for soundness of connection and lack of corrosion. If connection is loose, tighten with wrench. If corrosion is present, tag out container at power source, disconnect ground wire from ground rod, wire brush away corrosion products, reconnect ground wire to ground rod and clear danger tags.

Powder Spray Booth, Containerized

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION

A. **Visual Inspection of Electrical and Pneumatic Systems** (cont'd).

3. While booth is operating, check magnehelic gages on filter plenums. Filter cartridge plenum should read 6"-10" H_2O (8" H_2O ideal.) Final filterplenum should read 0"-3" H_2O.

4. If pressures registered on gages are outside of this range, danger tag out the container and then the filters affiliated with the out-of-specification reading must be changed.

Daily

B. **Cleaning Interior Walls and Floor of Spray Booth.**

Safety Equipment:	**Surgical Gloves and Face Masks**
Tools:	**Compressed Air Hose with Blow Down Nozzle, Vacuum Cleaner and Dust Rag**
Tag Out:	**Spray Booth must be in operation to perform this check**

1. Sweep residual powder on floor and walls towards filter bank using dry compressed air (40-80 PSIG).

   WARNING: Always perform cleaning procedures while the spray booth is operating. Avoid prolonged contact with or inhalation of powder resin. Use surgical gloves and face masks when performing cleaning operations.

2. Remaining powder must be removed by dust rag and vacuum.

Powder Spray Booth, Containerized

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION
Daily	C. **Product Suspension Bar(s) and Suspension Hooks.**

Safety Equipment: Surgical Gloves and Face Masks

Tools: 80 Grit Sandpaper, Abrasive Blast Glove Box or Facility

Tag Out: None

1. Inspect suspension hooks for accumulation of powder which prevents metal-to-metal contact between the hook, cart or suspension bar and product. Remove all suspension hooks from the work area that do not provide metal-to-metal contact with suspension bar or product and abrasively blast to remove the accumulation of resin.

2. Clean powder booth suspension bar of any residual powder by hand sanding with 80 grit sandpaper.

3. Inspect the curing cart wheels and suspension bars for accumulation of powder which prevents metal-to-metal contact between the floor and product hooks. Remove all suspension bars from work area that do not provide metal-to-metal contact and abrasively blast to remove the accumulation of resin. Remove all accumulated resin from the wheels by hand sanding with 80 mesh sandpaper.

4. Reinstall all suspension hooks and bars.

Powder Spray Booth, Containerized

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION

Weekly

D. Spray Booth Container Floor.

Safety Equipment: Surgical Gloves and Face Masks
Tools: Vacuum Cleaner
Tag Out: None

1. The entire floor of the container shall be cleaned by vacuum.

Monthly

E. Lubricate Blower.

Safety Equipment: None
Tools: Grease Gun containing Electric Motor Bearing Grease

1. Perform tag out procedures.
2. Wipe the grease fittings on the drive shaft. There are two fittings.
3. Inject grease through the fittings.
4. Remove safety tag and energize circuit.

Monthly

F. Inspect Drive Belts.

Safety Equipment: None
Tools: Wrench

1. Perform tag out procedures.
2. Depress belt halfway between pulleys. Belts should depress 1/2" to 3/4". If belt does not depress between 1/2" to 3/4", loosen the motor bracket bolts with wrench and adjust motor position to adjust belt tension between 1/2" to 3/4". Retighten motor bracket bolts with wrench.

Powder Spray Booth, Containerized

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION
	F. **Inspect Drive Belts** (cont'd).
	3. Inspect belts for wear.
	4. Remove safety tag and energize circuit.
Monthly	**G.** **Clean Ceiling, Walls, Equipment and Space Above Spray Booth.**
	Safety Equipment: Face Shield and Surgical Gloves **Tools:** Dust Rag and Vacuum Cleaner **Tag Out:** None
	1. The container's ceiling should be cleaned by dust rag and vacuum.
	2. The space above the spray booth, including container ceiling, top of booth ceiling and plexiglass light panels shall be cleaned by dust rag and vacuum.
	3. Walls and all mounted equipment shall be cleaned with dust rag.
Every Two Months	**H.** **Electrical Ground Checks.**
	Safety Equipment: None **Tools:** 500 or 1000 Volt Megohm Meter **Tag Out:** None
	Note: Operator must be wearing leg stat or leather sole shoes.

Powder Spray Booth, Containerized

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION

H. Electrical Ground Checks (cont'd).

1. Check the resistance measured from the bare hand of operator to earth ground as he/she stands on the usual work surface in spray area. Measurement should be less than 50 megohms. If the measurement is greater than or equal to 50 megohm, perform containerized powder spray booth maintenance check A-1, B and D then reperform this check.

2. Measure resistance from powder hopper to earth ground. Resistance should be zero ohms. If not zero, perform containerized powder spray booth check A-1 and A-2 then reperform this check.

3. Measure resistance between a component to be coated and earth ground while it is suspended in the booth. Resistance should be under 300 ohms. Resistance greater than 300 ohms require that containerized powder spray booth PMS checks A-1 and C be performed then reperform this check.

4. Measure resistance from floor of booth to earth ground. Resistance shall be less than 50 megohms, ideally zero ohms for metal floors. If greater than or equal to 50 megohms, perform containerized powder spray booth PMS checks A-1, B and D then reperform this check.

PMS REQUIREMENTS

Shipsystem, System, Subsystem or Equipment

Electrostatic Spray Powder System (Gun, Hopper, Control Console)

Configuration

Reference Publication

NORDSON Corporation, Technical Publications for NPE D-1 System

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION
Daily	A. **Clean Gun Nozzle.**

WARNING: Always perform cleaning procedures in an operating spray booth. Avoid prolonged contact with or inhalation of powder resin.

Safety Requirements: **Surgical Gloves and Face Masks**

Tools: **Compressed Air Hose with Blow Down Nozzle, Tool Cleaning Brush and flat tip Screwdriver**

1. Disconnect powder hose from powder inlet of gun.
2. Clean nozzle with dry compressed air.
3. Remove deflector plate and clean the interior areas of the nozzle and powder inlet.
4. Reinstall deflector plate.
5. Reconnect powder hose.

Electrostatic Spray Powder System

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION

Daily

B. Clean Venturi Powder Pump.

Safety Requirements: Surgical Gloves and Face Masks

Tools: Compressed Air Hose with Blow Down Nozzle, Tool Cleaning Brush and flat tip Screwdriver

1. Disconnect powder hose from outlet of pump.
2. Remove pump body from mounting plate by loosening the two thumb screws.
3. Remove metering orifice.
4. Clean interior of pump body and metering orifice with dry compressed air.
5. Reinstall metering orifice.
6. Reinstall pump body.
7. Connect powder house to pump outlet.

Weekly

C. Clean Powder Hopper.

WARNING: Always perform cleaning procedures in an operating spray booth. Avoid prolonged contact or inhalation of powder resin.

Safety Equipment: Surgical Gloves and Face Masks

Tools: Compressed Air Hose with Blow Down Nozzle and Vacuum Cleaner

Electrostatic Spray Powder System

PERIODICITY CODE	MAINTENANCE REQUIREMENT DESCRIPTION

D. Electrical Checks (cont'd).

11. Check power unit indication on analyzer.

12. Turn off control console, tag control console off and remove probe.

13. Using a 500 or 1000 megohm meter, measure the resistance between the tip of the gun electrode and the tip of the cable. Resistance shall be 375 megohms ± 10%. If the measured resistance is outside of this range, then refer to Part E, Corrective Action.

14. Measure resistance from top of gun electrode to gun handle. The resistance must be infinity. If it is not, then the gun must be disassembled and cleaned.

15. Using a 0-1000 ohm meter, measure resistance from gun handle to earth ground. The measurement should be zero ohms; check all connections if greater than zero.

16. If measurements were within specifications, then the electrostatic cable may be reinstalled.

17. The end of the electrostatic cable that is inserted into the control console must be freed of all foreign matter by using a lint-free rag.

18. The cable well of the control console must have enough insulating oil in it so that the oil level is to the top when the cable is fully installed.

19. Add oil as necessary and wipe away any overflow after cable is installed, clear danger tags and reperform the check.

Electrostatic Spray Powder System

PERIODICITY	**MAINTENANCE REQUIREMENT DESCRIPTION**
When the Resistance measured in Electrostatic Spray Powder System PMS D.13 is not within 375 Megohm ± 10%.	**E. Electrical Corrective Action.**

Safety Equipment: None
Tools: 500 or 1000 Megohm Meter, Dielectric Grease, 0-1000 ohm Meter
Tag Out: Tag out control console before performing check

1. Remove cable from gun so that the cable is completely free from gun and control console.

2. Measure resistance from connecting nut on end of cable to the center conductor (brass tip) with megohm meter. Resistance must be infinity; if less than infinity, than replace cable.

3. Measure resistance from the brass tips at opposite ends of cable with megohm meter. Resistance must be 200 megohms ± 10%; if outside of range than replace the cable.

4. Using a 0-1000 ohm meter, measure resistance from cable well housing of control console to earth ground. The required resistance is zero ohms. If resistance is above zero ohms, than provide better grounding to control console.

5. Remove resistor from gun.

6. Using the megohm meter, measure resistance from end to end of resistor. The required resistance is 175 megohms ± 10%; if measurement is outside of this range, replace resistor.

Electrostatic Spray Powder System

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION

E. Electrical Corrective Action (cont'd).

7. Reinstall resistor with adequate dielectric grease.

8. Reinstall power cable to gun making certain cable end is clean.

9. Reinstall cable to control console, making certain cable end is clean and well is full of insulating oil.

10. Clear danger tag.

PMS REQUIREMENTS

Shipsystem, System, Subsystem or Equipment

Electrostatic Spray Powder System (Gun, Hopper, Control Console)

Configuration

Reference Publication

RANSBURG-GEMA, Operating Instructions for the Electrostatic Powder Coating Equipment, Type 701

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION
Daily	A. Clean Gun.

Safety Equipment: Surgical Gloves and Face Masks

Tools: Compressed Air Hose with Blow Down Nozzle and Gun Brush

Tag Out: Tag out control console

1. Disconnect powder hose from powder inlet of gun.
2. Clean deflector plate with dry compressed air.
3. Unscrew deflector plate and union nut.
4. Pull out nozzle.

   CAUTION: Do not twist when pulling out.

5. Pull out deflector rod.
6. Unscrew gland bolt and remove gasket.
7. Clean gun and accessories with gun brush and compressed air.

   CAUTION: Do not damage electrodes when cleaning the nozzle.

Electrostatic Spray Powder System

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION

A. **Clean Gun** (cont'd).

8. Reinstall gasket, gland bolt and deflector rod.

9. Reinstall nozzle.

10. Reinstall deflector plate and connect powder hose.

Daily

B. **Clean Venturi Powder Pump.**

Safety Equipment:	**Surgical Gloves and Face Mask**
Tools:	**Wrench, Compressed Air Hose with Blow Down Nozzle**
Tag Out:	**Danger Tag Hopper/ Feeder**

1. Pull off powder hose from its fitting and disconnect air hoses.

2. Remove fitting and clamping nut from pump body.

3. Clean hose fitting with gun brush.

4. Remove pump from hopper by first loosening the two knurled nuts.

5. Clean pump with dry compressed air.

6. Clean contact surfaces and gaskets.

7. Reinstall pump, tightening knurled nuts uniformly.

8. Reinsert hose fitting.

9. Clear danger tags.

Electrostatic Spray Powder System

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION
Weekly	**C. Clean Powder Hopper.**

Safety Equipment: **Surgical Gloves and Face Mask**

Tools: **Lint-Free Rags, Compressed Air Hose with Blow Down Nozzle Vacuum Cleaner**

Tag Out: **Danger Tag Hopper/ Feeder**

1. Disconnect air hoses and exhaust hose.
2. Remove venturi powder pump.
3. Pull out suction tube.
4. Disconnect ground cable.
5. Remove lid and wipe with a clean dry brush or rag.
6. Clean suction tube and seals with dry compressed air.
7. Empty remaining powder into a plastic bag.
8. Examine powder. If it clumps, than it must be disposed of. If it is dry and loose, close bag and store for later use.
9. Vacuum out powder hopper and porous membrane.
10. Reassemble powder hopper.
11. Reconnect ground cable.
12. Do not load hopper with powder until it is to be used again.
13. Clear danger tags.

PMS REQUIREMENTS

Shipsystem, System, Subsystem or Equipment

Curing Oven, Containerized

Configuration

Reference Publication

BAYCO Industries of California, Operating Instructions for Model CB-112E.

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION

Weekly

A. Lubrication of Cart Wheel Bearings.

Safety Equipment: None
Tools: Grease Gun with High Temperature Grease (Dow Corning #41 or Equivalent)
Tag Out: None

1. Cart wheel bearings should be greased with high-temperature lubricant.

Weekly

B. Clean Container Floor Including Oven Ramps.

Safety Equipment: None
Tools: Vacuum Cleaner
Tag Out: None

1. Vacuum floor clean.

Monthly

C. Clean Oven Interior and Exterior.

Safety Equipment: None
Tools: Dust Rags and Vacuum Cleaner
Tag Out: None

1. Oven interior should be wiped clean with dust rags and vacuumed.

2. Oven exterior, especially the top of the oven, should be freed of all dust and similar contamination.

Curing Oven, Containerized

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION
Every Two Months	**D. Inspect Door Gaskets and Hinges**

Safety Equipment: None
Tools: Grease Gun with High Temperature Grease (Dow Corning #41 or Equivalent)
Tag Out: None

1. Check door gaskets for good closing contact.
2. Wipe the grease fittings on the door hinges - 4 fittings total.
3. Inject grease through the fittings.

Monthly — **E. Lubrication of Recirculation Motor.**

Safety Equipment: None
Tools: Grease Gun
Tag Out: Danger Tag Oven Circuit

1. Perform tag out procedures.
2. Wipe grease fittings.

Note: 2 grease fittings on motor.
2 grease fittings on drive shaft.

3. Inject grease through fittings.
4. Remove safety tags and energize circuit.

Curing Oven, Containerized

PERIODICITY	MAINTENANCE REQUIREMENT DESCRIPTION
Monthly	F. **Inspect Exhaust Motor Drive Belt.**

Safety Equipment: None
Tools: Wrench

1. Perform tagout procedures.
2. Depress belt halfway between pulleys. Belts should depress 1/2" to 3/4". If belt does not depress between 1/2" to 3/4", loosen the motor bracket bolts with wrench and adjust motor position to adjust belt tension between 1/2" to 3/4". Retighten motor bracket bolts with wrench.
3. Inspect belts for wear.
4. Clear danger tags.

RECOMMENDED SPARE PARTS

The following is a list of spare parts recommended to be kept on hand by the Corrosion Control Shop for the powder coating work station. Parts listed are those which wear out under normal use or are easily susceptible to damage.

NORDSON

	PART NUMBER	QUANTITY
Gun:		
Resistor and Insulating Tube	106-275	1
O-ring 1-1/8 x 1-3/8	942-161	1
Nozzle	245-408	1
Deflector Mount	245-744	1
Deflector with O-ring	245-855	1
Sleeve	245-742	1
Dielectric Grease	245-733	1
Powder Inlet Connector	246-865	1
Hopper:		
Powder Metering Orifice	243-840	1
Venturi Throat, Barbed	244-868	1
Venturi Nozzle	245-991	1
Nozzle Retainer	245-373	1
O-ring 1 x 1-1/4	942-193	1
O-ring 5/8 x 1/2	940-126	1
Thumb Screw 10-24 x 2"	245-471	2
Gasket	246-979	1
O-ring 1/2 x 3/4	942-060	1
Standard Repair Kit for one (1) Gun Pump (includes all the above)	106-366	1
Control Console:		
Incandescent Lamp (output)	939-142	1
Neon Lamp (input)	939-003	1
Fuse 1A	939-016	1
Insulating Oil, High Voltage, 7.5ml	247-312	2

RECOMMENDED SPARE PARTS (Cont'd)

RANSBURG-GEMA

	PART NUMBER	QUANTITY
Gun:		
Deflector Rod Gasket	3017	1
Deflector Plate		
20mm	3314	1
24mm	3315	1
32mm	3317	1
Gun Cable (5.5m)	3028	1
Gun Muzzle (Nozzle) (87.5mm)	3302	1
Hopper:		
Teflon Insert Sleeve	305	1
Injector Nozzle	317	1
Check Valve	321	1
Control Console:		
Fine Wire Fuse (Slow Blow)	002	1
Fine Wire Fuse (Slow Blow)	062	1

Powder Spray Booth:

The cylindrical filter cartridges should be replaced when the filter cartridge plenum gage begins to indicate over 10" H_2O of vacuum or less than 6" H_2O. The unit will require six new filter cartridges.

APPENDIX 6

PRODUCTION CC-SHOP POWDER COATING CONSUMABLES LISTING

APPENDIX 7

TIME STANDARD DEVELOPMENT
for
THE APPLICATION OF ELECTROSTATIC SPRAY POWDER COATINGS
ON TOPSIDE SHIPBOARD COMPONENTS

APPENDIX 7

TIME STANDARD DEVELOPMENT
for
THE APPLICATION OF ELECTROSTATIC SPRAY POWDER COATINGS ON TOPSIDE SHIPBOARD COMPONENTS

1.0 INTRODUCTION

Standard times are required by the Planning Department to correctly schedule CC work and load the shop based upon what the operator can reasonably perform. Standard times are defined as the times required by an average operator, who has been fully trained to handle the work assignment and who is working at a normal pace, to perform the operation. It is essential that these allowed times are realistic for full-time production. Realistic allowances for personal needs, unavoidable delays and general slowdown of performance because of fatigue, etc., must be included in the development of these standard times. A detailed description of time standard development is given in the final report on the CC-Shop Service Test, Reference A7-1.

The collection of standard times was a major concern of the Pilot CC-Shop Service Test since the beginning of production. It was desired to measure standard times on all representative items that would be serviced by a SIMA CC Shop. Forms used to record element times were developed and modified as improvements became apparent. Due to the nature of work performed by the CC Shop, it was necessary to determine the process element times for each type and size of component.

2.0 METHODOLOGY

2.1 Process Chart and Record System

Figure A7-1 shows the operation and inspection elements considered in powder coating operations. One step left out of the Flow Chart that was performed in the pilot is the topcoating of the items with the proper color of paint. This step will no longer occur once color-matched powders are obtained. If the paint step, as done in the pilot, is preferred in future operations, then add an increment of time equivalent to the single powder coat.

2.2 Samples, Sample Size and Data Collection

Time-standards were developed for representative items that would be serviced by a SIMA CC Shop, i.e., actual work load from customer ships, specific items pulled from ships that were not in the Pilot Shop routine work package and items cited in the ship-class CC manuals. Fifty-three item class samples were measured with sample size ranging from one to 15. Items were chosen that would be generic to any ship class.

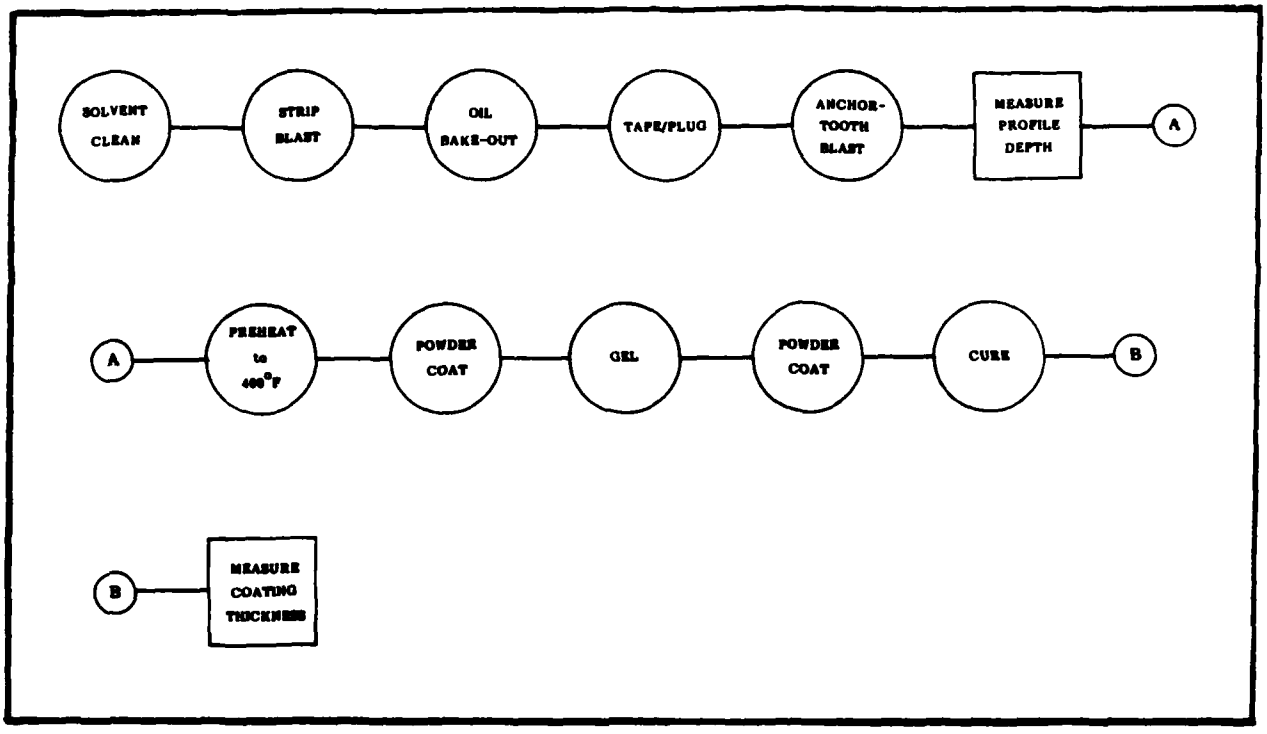


Figure A7-1 Standard-Time-Measurement Powder Coating-Process Chart

Utilizing the Production-Control Record and a stopwatch, times to complete each operation process element were recorded by a designated Shop Petty Officer on the Production Record (Figure A7-2). This collection commenced with the start of production and was performed for every component processed by the shop. This method had its shortcomings. Due to the Petty Officer's colateral duties, it was often impossible to time each element of each component's production. The forms were found to be completed by the Petty Officer's best guess or the operator's estimate of the time expended. An ISA representative was assigned to record product times to provide a second source for data collection on the Manpower/Supply Summary (Figure A7-3).

This data is compilated in Table A7-1. The process element times marked with an asterisk (i.e., preheat, gel and cure) must be considered differently from the rest. The preheat, gel and cure times are required for each component, but may be accomplished concurrently with other components. For example, four fog applicators can be preheated at the same time; however, they are powder coated one by one. This will be considered in the standard times given in Section 2.5 of this Appendix. The mean process element times are summarized in Table A7-2.

Figure A7-2 Powder Coating Production Control Record

CORROSION CONTROL SHOP

POWDER COATING

PRODUCTION CONTROL RECORD

USS _____
Ship Hull Number

_____ _____
Job Control Number (JCN) Production Control Number

_____ _____
Item Description Location Deck Frame Side

TYPE COATING:

_____ Epoxy
(Meeting ASTM A775)

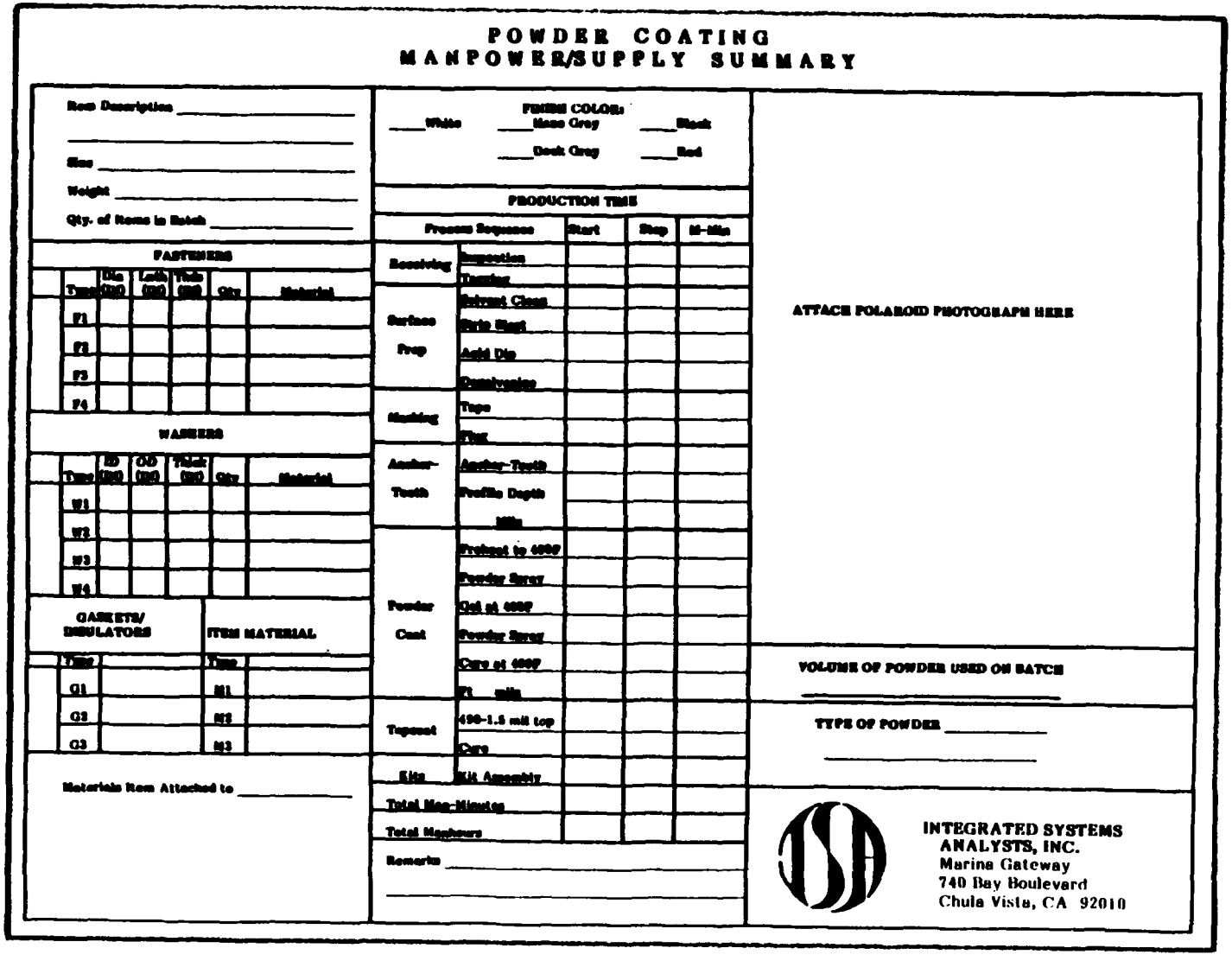
FINISH COLOR:

_____ Haze Gray TT-E-490

_____ White TT-E-490

_____ Other _____

SECTION	PROCESS SEQUENCE INSPECTIONS		DATE	TIME	SHOP QCI SIGNATURE
1.	Receipt, Degrease				
2.	Masking	Plug / Tape			
3.	Strip				
4.	Anchor Tooth 1-2 mils	mils			
5.	Start Preheat Oven at 400°F	Temp			
6.	End Preheat 0.5 to 1.0 hr				
7.	Powder Spray	1. / 2.			
8.	Begin Curing Oven at 400°F	Temp			
9.	End Curing 10-15 min				
10.	Proper Cure Check and Cured Coating Thickness - 8-12 mils	mils			
	TOPCOAT				ATTACH PROFILE TAPE HERE
	Type/DFT Rqmt	Measured DFT	Date	Time	
11.	TC/1.5 mils				
12.	Final Thickness				
13.	Final Assembly Inspection, Packaging				



POWDER COATING
MANPOWER/SUPPLY SUMMARY

Item Description _____

Size _____

Weight _____

Qty. of Items in Batch _____

FINISH COLOR:
____White ____Mono Grey ____Black
____Dark Grey ____Red

ATTACH POLAROID PHOTOGRAPH HERE

FASTENERS

Type	Dia (in)	Leads (no)	Width (in)	Qty	Material
F1					
F2					
F3					
F4					

WASHERS

Type	ID (in)	OD (in)	Thick (in)	Qty	Material
W1					
W2					
W3					
W4					

GASKETS/ INSULATORS		ITEM MATERIAL	
Type		Type	
G1		M1	
G2		M2	
G3		M3	

Materials Item Attached to _____

PRODUCTION TIME

Process Sequence		Start	Stop	M-Min
Receiving	Inspection			
	Tracking			
Surface Prep	Solvent Clean			
	Parts Blast			
	Acid Dip			
	Deoxidize			
Masking	Tape			
	Plug			
Anchor-Tooth	Anchor-Tooth			
	Profile Depth			
	Mils			
Powder Coat	Preheat to 400F			
	Powder Spray			
	Cure at 400F			
	Powder Spray			
	Cure at 400F			
	Ft mils			
Topcoat	450-1.5 mil top			
	Cure			
Kits	Kit Assembly			
Total Man-Minutes				
Total Manhours				

Remarks _____

VOLUME OF POWDER USED ON BATCH _____

TYPE OF POWDER _____

INTEGRATED SYSTEMS ANALYSTS, INC.
Marina Gateway
740 Bay Boulevard
Chula Vista, CA 92010

Figure A7-3 Powder Coating Manpower/Supply Summary

Table A7-1 Process-Element Times (Man-Minutes)

APPLICATOR, FOG (4")

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6013	0.0	0.0	2.5	2.5	1.3	1.0	15.0	0.5	5.0	0.5	15.0	0.5	43.8
FF-1076	6013	0.0	0.0	2.5	2.5	1.3	1.0	15.0	0.5	5.0	0.5	15.0	0.5	43.8
FF-1076	6013	0.0	0.0	2.5	2.5	1.3	1.0	15.0	0.5	5.0	0.5	15.0	0.5	43.8
FF-1076	6013	0.0	0.0	2.5	2.5	1.3	1.0	15.0	0.5	5.0	0.5	15.0	0.5	43.8
AVERAGE		0.0	0.0	2.5	2.5	1.3	1.0	15.0	0.5	5.0	0.5	15.0	0.5	43.8

BASE, TWIN AGENT HOSE REEL

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
DDG-996	6056	0.0	0.0	20.0	0.0	13.0	1.0	15.0	5.0	5.0	5.0	15.0	1.0	80.0
DDG-996	6056	0.0	0.0	25.0	0.0	15.0	1.0	15.0	5.0	5.0	5.0	15.0	1.0	87.0
DDG-996	6056	0.0	0.0	15.0	0.0	10.0	1.0	15.0	5.0	5.0	4.0	15.0	1.0	71.0
AVERAGE		0.0	0.0	20.0	0.0	12.7	1.0	15.0	5.0	5.0	4.7	15.0	1.0	79.3

BOX, FIRST AID

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
	6017	0.0	0.0	30.0	0.0	15.0	2.0	15.0	6.0	5.0	4.0	15.0	2.0	94.0
AVERAGE		0.0	0.0	30.0	0.0	15.0	2.0	15.0	6.0	5.0	4.0	15.0	2.0	94.0

BOX, FUEL OIL SPILL

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1053	6043	0.0	0.0	30.0	0.0	15.0	2.0	15.0	13.0	5.0	10.0	15.0	2.0	107.0
AVERAGE		0.0	0.0	30.0	0.0	15.0	2.0	15.0	13.0	5.0	10.0	15.0	2.0	107.0

BOX, P-250

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6006	0.0	0.0	26.0	0.0	15.0	1.0	15.0	16.0	5.0	13.0	15.0	0.7	106.7
FF-1076	6006	0.0	0.0	26.0	0.0	15.0	1.0	15.0	16.0	5.0	13.0	15.0	0.7	106.7
FF-1076	6006	0.0	0.0	26.0	0.0	15.0	1.0	15.0	16.0	5.0	13.0	15.0	0.7	106.7
AVERAGE		0.0	0.0	26.0	0.0	15.0	1.0	15.0	16.0	5.0	13.0	15.0	0.7	106.7

BOX, P-250 - BASE

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6002	0.0	0.0	45.0	30.0	10.0	2.0	15.0	7.0	5.0	8.0	15.0	2.0	139.0
FF-1076	6002	0.0	0.0	15.0	30.0	7.0	2.0	15.0	7.0	5.0	8.0	15.0	2.0	106.0
FF-1076	6002	0.0	0.0	45.0	5.0	20.0	2.0	15.0	10.0	5.0	6.0	15.0	2.0	125.0
AVERAGE		0.0	0.0	35.0	21.7	12.3	2.0	15.0	8.0	5.0	7.3	15.0	2.0	123.3

Table A7-1 Process-Element Times (Cont'd) (Man-Minutes)

BOX, P-250 - GAS CAN COVER

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDERR COAT #2	CURE*	QA	TOTAL
FF-1075	6002	0.0	0.0	8.0	0.0	4.0	1.0	15.0	6.0	5.0	2.0	15.0	0.7	56.7
FF-1076	6002	0.0	0.0	8.0	0.0	4.0	1.0	15.0	6.0	5.0	2.0	15.0	0.7	56.7
FF-1076	6002	0.0	0.0	8.0	0.0	4.0	1.0	15.0	6.0	5.0	2.0	15.0	0.7	56.7
AVERAGE		0.0	0.0	8.0	0.0	4.0	1.0	15.0	6.0	5.0	2.0	15.0	0.7	56.7

BOX, RAS DIMMER

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1050	5360	0.0	0.0	10.0	0.0	5.0	2.0	15.0	6.0	5.0	6.0	15.0	2.0	66.0
AVERAGE		0.0	0.0	10.0	0.0	5.0	2.0	15.0	6.0	5.0	6.0	15.0	2.0	66.0

BOX, SOUND-POWERED TELEPHONE CONNECTION JUNCTION

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1050	5360	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	1.0	15.0	0.7	41.7
FF-1050	5360	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	1.0	15.0	0.7	41.7
FF-1050	5360	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	1.0	15.0	0.7	41.7
AVERAGE		0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	1.0	15.0	0.7	41.7

BOX, SOUND-POWERED TELEPHONE HANDSET

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
	6013	0.0	0.0	10.5	1.0	5.5	1.5	15.0	9.0	5.0	9.0	15.0	3.0	74.5
	6013	0.0	0.0	10.5	1.0	5.5	1.5	15.0	9.0	5.0	9.0	15.0	3.0	74.5
AVERAGE		0.0	0.0	10.5	1.0	5.5	1.5	15.0	9.0	5.0	9.0	15.0	3.0	74.5

BOX, SOUND-POWERED TELEPHONE SINGLE HEADSET

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6016	0.0	0.0	5.0	0.0	4.0	1.0	15.0	3.0	5.0	3.0	15.0	1.0	52.0
FF-1076	6016	0.0	0.0	4.0	0.0	4.0	1.0	15.0	3.0	5.0	2.0	15.0	1.0	50.0
FF-1076	6016	0.0	0.0	6.0	0.0	5.0	1.0	15.0	3.0	5.0	2.0	15.0	1.0	53.0
AVERAGE		0.0	0.0	5.0	0.0	4.3	1.0	15.0	3.0	5.0	2.3	15.0	1.0	51.7

BOX, SOUND-POWERED TELEPHONE MULTIPLE HEADSET

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6013	6.0	0.0	15.0	0.0	10.0	2.0	15.0	4.0	5.0	3.0	15.0	0.5	75.5
AVERAGE		6.0	0.0	15.0	0.0	10.0	2.0	15.0	4.0	5.0	3.0	15.0	0.5	75.5

Table A7-1 Process-Element Times (Cont'd) (Man-Minutes)

BRACKET, FIRE EXTINGUISHER (PKP)

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
LSD-40	6043	0.0	0.0	10.0	0.0	7.0	0.5	15.0	2.0	5.0	1.0	15.0	0.5	56.0
LSD-40	6043	0.0	0.0	9.0	0.0	7.0	0.5	15.0	2.0	5.0	1.5	15.0	0.5	55.5
LSD-40	6043	0.0	0.0	10.0	0.0	6.0	0.5	15.0	2.0	5.0	1.5	15.0	0.5	55.5
LSD-40	6043	0.0	0.0	11.0	0.0	8.0	0.5	15.0	2.0	5.0	1.0	15.0	0.5	58.0
LSD-40	6043	0.0	0.0	10.0	0.0	7.0	0.5	15.0	2.0	5.0	1.0	15.0	0.5	56.0
LSD-40	6043	0.0	0.0	10.0	0.0	7.0	0.5	15.0	2.0	5.0	1.0	15.0	0.5	56.0
AVERAGE		0.0	0.0	10.0	0.0	7.0	0.5	15.0	2.0	5.0	1.2	15.0	0.5	56.2

BRACKET, FLOOD LIGHT (LARGE)

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076		0.0	0.0	4.0	0.0	1.0	0.4	15.0	0.6	5.0	0.6	15.0	0.4	42.0
FF-1076		0.0	0.0	4.0	0.0	1.0	0.4	15.0	0.6	5.0	0.6	15.0	0.4	42.0
FF-1076		0.0	0.0	4.0	0.0	1.0	0.4	15.0	0.6	5.0	0.6	15.0	0.4	42.0
FF-1076		0.0	0.0	4.0	0.0	1.0	0.4	15.0	0.6	5.0	0.6	15.0	0.4	42.0
FF-1076		0.0	0.0	4.0	0.0	1.0	0.4	15.0	0.6	5.0	0.6	15.0	0.4	42.0
AVERAGE		0.0	0.0	4.0	0.0	1.0	0.4	15.0	0.6	5.0	0.6	15.0	0.4	42.0

BRACKET, FLOOD LIGHT (SMALL)

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1053	5350	0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2
FF-1053	5350	0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2
FF-1053	5350	0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2
FF-1053	5350	0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2
FF-1053	5350	0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2
FF-1053	5350	0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2
FF-1053	5350	0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2
FF-1053	5350	0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2
FF-1053	5350	0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2
AVERAGE		0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2

BRACKET, LIGHT SHOCK MOUNT

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
LSD-40	6043	0.0	0.0	0.2	0.0	0.1	1.0	15.0	0.1	5.0	0.1	15.0	1.0	37.5
LSD-40	6043	0.0	0.0	0.2	0.0	0.1	1.0	15.0	0.1	5.0	0.1	15.0	1.0	37.5
AVERAGE		0.0	0.0	0.2	0.0	0.1	1.0	15.0	0.1	5.0	0.1	15.0	1.0	37.5

CHAIR, BRIDGEWING

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6024	15.0	0.0	11.0	0.0	5.0	1.0	30.0	2.5	5.0	2.5	15.0	1.0	88.0
FF-1076	6024	15.0	0.0	9.0	0.0	4.0	1.0	30.0	2.0	5.0	2.0	15.0	1.0	84.0
AVERAGE		15.0	0.0	10.0	0.0	4.5	1.0	30.0	2.3	5.0	2.3	15.0	1.0	86.0

Table A7-1 Process-Element Times (Cont'd) (Man-Minutes)

COVER, 21MC SPEAKER

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	5342	0.0	0.0	10.0	0.0	4.0	2.0	30.0	8.0	5.0	4.0	15.0	2.0	80.0
AVERAGE		0.0	0.0	10.0	0.0	4.0	2.0	30.0	8.0	5.0	4.0	15.0	2.0	80.0

COVER, CASUALTY POWER

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	5350	0.0	0.0	6.0	0.0	4.0	2.0	15.0	1.5	5.0	1.0	15.0	0.5	50.0
AVERAGE		0.0	0.0	6.0	0.0	4.0	2.0	15.0	1.5	5.0	1.0	15.0	0.5	50.0

COVER, FAB RECEIVING NOZZLE

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6037	0.0	0.0	10.0	7.5	7.0	2.0	15.0	4.0	5.0	3.5	15.0	1.0	70.0
FF-1076	6037	0.0	0.0	10.0	7.5	7.0	2.0	15.0	4.0	5.0	3.5	15.0	1.0	70.0
AVERAGE		0.0	0.0	10.0	7.5	7.0	2.0	15.0	4.0	5.0	3.5	15.0	1.0	70.0

COVER, HEATER

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6013	15.0	0.0	8.0	0.0	3.0	1.7	15.0	1.8	5.0	2.0	15.0	0.6	67.1
FF-1076	6013	15.0	0.0	8.0	0.0	3.0	1.7	15.0	1.8	5.0	2.0	15.0	0.6	67.1
FF-1076	6013	15.0	0.0	8.0	0.0	3.0	1.7	15.0	1.8	5.0	2.0	15.0	0.6	67.1
FF-1076	6013	15.0	0.0	8.0	0.0	3.0	1.7	15.0	1.8	5.0	2.0	15.0	0.6	67.1
FF-1076	6013	15.0	0.0	8.0	0.0	3.0	1.7	15.0	1.8	5.0	2.0	15.0	0.6	67.1
AVERAGE		15.0	0.0	8.0	0.0	3.0	1.7	15.0	1.8	5.0	2.0	15.0	0.6	67.1

DUCT, VENT (7"OD X 18")

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1053	6034	0.0	0.0	15.0	0.0	10.0	1.0	15.0	4.0	5.0	5.0	15.0	1.0	71.0
AVERAGE		0.0	0.0	15.0	0.0	10.0	1.0	15.0	4.0	5.0	5.0	15.0	1.0	71.0

COVER, VENT

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1050	5351	0.0	0.0	20.0	0.0	15.0	2.0	15.0	7.5	5.0	7.5	15.0	1.5	88.5
FF-1050	5351	0.0	0.0	20.0	0.0	15.0	2.0	15.0	7.5	5.0	7.5	15.0	1.5	88.5
FF-1050	5351	0.0	0.0	20.0	0.0	15.0	2.0	15.0	7.5	5.0	7.5	15.0	1.5	88.5
FF-1050	5351	0.0	0.0	20.0	0.0	15.0	2.0	15.0	7.5	5.0	7.5	15.0	1.5	88.5
AVERAGE		0.0	0.0	20.0	0.0	15.0	2.0	15.0	7.5	5.0	7.5	15.0	1.5	88.5

Table A7-1 **Process-Element Times** (Cont'd)
(Man-Minutes)

HELMET, BATTLE														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	5351	0.0	0.0	5.0	0.0	2.0	1.3	15.0	0.9	5.0	0.8	15.0	0.5	45.5
FF-1076	5351	0.0	0.0	5.0	0.0	2.0	1.3	15.0	0.9	5.0	0.8	15.0	0.5	45.5
FF-1076	5351	0.0	0.0	5.0	0.0	2.0	1.3	15.0	0.9	5.0	0.8	15.0	0.5	45.5
FF-1076	5351	0.0	0.0	5.0	0.0	2.0	1.3	15.0	0.9	5.0	0.8	15.0	0.5	45.5
FF-1076	5351	0.0	0.0	5.0	0.0	2.0	1.3	15.0	0.9	5.0	0.8	15.0	0.5	45.5
FF-1076	5351	0.0	0.0	5.0	0.0	2.0	1.3	15.0	0.9	5.0	0.8	15.0	0.5	45.5
FF-1076	5351	0.0	0.0	5.0	0.0	2.0	1.3	15.0	0.9	5.0	0.8	15.0	0.5	45.5
FF-1076	5351	0.0	0.0	5.0	0.0	2.0	1.3	15.0	0.9	5.0	0.8	15.0	0.5	45.5
AVERAGE		0.0	0.0	5.0	0.0	2.0	1.3	15.0	0.9	5.0	0.8	15.0	0.5	45.5

HOLDER, S/P TELEPHONE														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF1053	6036	0.0	0.0	10.0	0.0	5.0	0.5	15.0	1.0	5.0	1.0	15.0	0.5	53.0
FF1053	6036	0.0	0.0	9.0	0.0	5.0	0.5	15.0	0.5	5.0	1.0	15.0	0.5	51.5
FF1053	6036	0.0	0.0	9.0	0.0	5.0	0.5	15.0	0.5	5.0	1.5	15.0	0.5	52.0
FF1053	6036	0.0	0.0	11.0	0.0	5.0	0.5	15.0	1.0	5.0	1.5	15.0	0.5	54.5
AVERAGE		0.0	0.0	9.8	0.0	5.0	0.5	15.0	0.8	5.0	1.3	15.0	0.5	52.8

LADDER, ACCOMODATION - BRACKET														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
DDG-996	6043	0.0	0.0	4.0	0.0	3.0	1.0	15.0	1.5	5.0	2.0	15.0	1.0	47.5
DDG-996	6043	0.0	0.0	4.0	0.0	3.0	1.0	15.0	1.5	5.0	1.0	15.0	1.0	46.5
AVERAGE		0.0	0.0	4.0	0.0	3.0	1.0	15.0	1.5	5.0	1.5	15.0	1.0	47.0

LADDER, ACCOMODATION - GEAR COVER														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	5348	0.0	0.0	0.0	0.0	2.0	1.0	30.0	1.0	5.0	1.0	15.0	0.5	55.5
FF-1076	5348	0.0	0.0	0.0	0.0	2.0	1.0	30.0	1.0	5.0	1.0	15.0	0.5	55.5
AVERAGE		0.0	0.0	0.0	0.0	2.0	1.0	30.0	1.0	5.0	1.0	15.0	0.5	55.5

LADDER, ACCOMODATION - PLATFORM HANDRAIL														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6010	0.0	0.0	6.0	0.0	3.0	0.0	15.0	5.0	5.0	4.0	15.0	0.0	53.0
FF-1076	6010	0.0	0.0	6.0	0.0	3.0	0.0	15.0	5.0	5.0	4.0	15.0	0.0	53.0
FF-1076	6010	0.0	0.0	6.0	0.0	3.0	0.0	15.0	5.0	5.0	4.0	15.0	0.0	53.0
FF-1076	6010	0.0	0.0	6.0	0.0	3.0	0.0	15.0	7.0	5.0	6.0	15.0	0.0	57.0
FF-1076	6010	0.0	0.0	6.0	0.0	3.0	0.0	15.0	7.0	5.0	6.0	15.0	0.0	57.0
FF-1076	6010	0.0	0.0	6.0	0.0	3.0	0.0	15.0	5.0	5.0	4.0	15.0	0.0	53.0 *
FF-1076	6010	0.0	0.0	6.0	0.0	3.0	0.0	15.0	5.0	5.0	4.0	15.0	0.0	53.0 *
AVERAGE		0.0	0.0	6.0	0.0	3.0	0.0	15.0	5.6	5.0	4.6	15.0	0.0	54.1

Table A7-1 Process-Element Times (Cont'd) (Man-Minutes)

LADDER, ACCOMODATION - ROPE ROLLER

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT 01	GEL*	POWDER COAT 02	CURE*	QA	TOTAL
FF-1053	5324	10.0	60.0	2.0	0.0	1.0	1.0	30.0	0.7	5.0	0.7	15.0	0.7	126.1
FF-1053	5324	10.0	60.0	2.0	0.0	1.0	1.0	30.0	0.7	5.0	0.7	15.0	0.7	126.1
FF-1053	5324	10.0	60.0	2.0	0.0	1.0	1.0	30.0	0.7	5.0	0.7	15.0	0.7	126.1
AVERAGE		10.0	60.0	2.0	0.0	1.0	1.0	30.0	0.7	5.0	0.7	15.0	0.7	126.1

LADDER, THREE-STEP - HANDRAIL

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT 01	GEL*	POWDER COAT 02	CURE*	QA	TOTAL
FF-1053	6036	0.0	0.0	12.0	0.0	10.0	2.0	15.0	10.0	5.0	7.0	15.0	2.0	86.0
FF-1053	6036	0.0	0.0	30.0	0.0	20.0	4.0	15.0	7.5	5.0	6.0	15.0	4.0	106.5
AVERAGE		0.0	0.0	21.0	0.0	15.0	3.0	15.0	8.8	5.0	6.5	15.0	3.0	96.3

LIGHT FIXTURE, FLOOD (LARGE)

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT 01	GEL*	POWDER COAT 02	CURE*	QA	TOTAL
FF-1076		0.0	0.0	12.4	1.0	6.0	0.4	15.0	3.0	5.0	3.0	15.0	0.6	61.4
FF-1076		0.0	0.0	12.4	1.0	6.0	0.4	15.0	3.0	5.0	3.0	15.0	0.6	61.4
FF-1076		0.0	0.0	12.4	1.0	6.0	0.4	15.0	3.0	5.0	3.0	15.0	0.6	61.4
FF-1076		0.0	0.0	12.4	1.0	6.0	0.4	15.0	3.0	5.0	3.0	15.0	0.6	61.4
FF-1076		0.0	0.0	12.4	1.0	6.0	0.4	15.0	3.0	5.0	3.0	15.0	0.6	61.4
AVERAGE		0.0	0.0	12.4	1.0	6.0	0.4	15.0	3.0	5.0	3.0	15.0	0.6	61.4

LIGHT FIXTURE, FLOOD (LARGE, NO HOOD)

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT 01	GEL*	POWDER COAT 02	CURE*	QA	TOTAL
FF-1076		0.0	0.0	5.7	0.0	2.9	1.4	15.0	2.0	5.0	2.0	15.0	0.6	49.6
FF-1076		0.0	0.0	5.7	0.0	2.9	1.4	15.0	2.0	5.0	2.0	15.0	0.6	49.6
FF-1076		0.0	0.0	5.7	0.0	2.9	1.4	15.0	2.0	5.0	2.0	15.0	0.6	49.6
FF-1076		0.0	0.0	5.7	0.0	2.9	1.4	15.0	2.0	5.0	2.0	15.0	0.6	49.6
FF-1076		0.0	0.0	5.7	0.0	2.9	1.4	15.0	2.0	5.0	2.0	15.0	0.6	49.6
FF-1076		0.0	0.0	5.7	0.0	2.9	1.4	15.0	2.0	5.0	2.0	15.0	0.6	49.6
FF-1076		0.0	0.0	5.7	0.0	2.9	1.4	15.0	2.0	5.0	2.0	15.0	0.6	49.6
AVERAGE		0.0	0.0	5.7	0.0	2.9	1.4	15.0	2.0	5.0	2.0	15.0	0.6	49.6

LIGHT FIXTURE, FLOOD (SMALL)

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT 01	GEL*	POWDER COAT 02	CURE*	QA	TOTAL
FF-1053	5343	0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5
FF-1053	5343	0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5
FF-1053	5343	0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5
FF-1053	5343	0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5
FF-1053	5343	0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5
FF-1053	5343	0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5
FF-1053	5343	0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5
FF-1053	5343	0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5
FF-1053	5343	0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5
AVERAGE		0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5

Table A7-1 Process-Element Times (Cont'd) (Man-Minutes)

LIGHT FIXTURE, HELO DECK EDGE														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
DDG-396	5056	0.0	0.0	3.0	0.0	2.0	1.3	15.0	0.7	5.0	1.0	15.0	0.3	43.3
DDG-396	6056	0.0	0.0	4.0	0.0	2.0	1.3	15.0	0.6	5.0	1.0	15.0	0.3	44.2
DDG-396	6056	0.0	0.0	3.0	0.0	2.0	1.3	15.0	0.7	5.0	1.0	15.0	0.3	43.3
AVERAGE		0.0	0.0	3.3	0.0	2.0	1.3	15.0	0.7	5.0	1.0	15.0	0.3	43.6

LIGHT FIXTURE, RUNNING (P/S)														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6024	0.0	0.0	10.0	0.0	5.0	2.0	15.0	4.0	5.0	6.0	15.0	2.0	64.0
AVERAGE		0.0	0.0	10.0	0.0	5.0	2.0	15.0	4.0	5.0	6.0	15.0	2.0	64.0

LIGHT FIXTURE, RUNNING (STERN)														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6024	0.0	0.0	5.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	2.5	49.5
FF-1076	6024	0.0	0.0	5.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	2.5	49.5
AVERAGE		0.0	0.0	5.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	2.5	49.5

LIGHT FIXTURE, SIGNAL														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6017	0.0	0.0	9.0	0.0	6.3	7.3	15.0	15.8	5.0	5.5	15.0	2.0	80.9
FF-1076	6017	0.0	0.0	9.0	0.0	6.3	7.3	15.0	15.8	5.0	5.5	15.0	2.0	80.9
FF-1076	6017	0.0	0.0	9.0	0.0	6.3	7.3	15.0	15.8	5.0	5.5	15.0	2.0	80.9
FF-1076	6017	0.0	0.0	9.0	0.0	6.3	7.3	15.0	15.8	5.0	5.5	15.0	2.0	80.9
AVERAGE		0.0	0.0	9.0	0.0	6.3	7.3	15.0	15.8	5.0	5.5	15.0	2.0	80.9

LIGHT FIXTURE, SIGNAL - ARM BRACKET														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	5325	0.0	0.0	7.0	2.0	3.5	1.0	30.0	1.5	5.0	1.5	15.0	1.0	67.5
FF-1076	5325	0.0	0.0	7.0	2.0	3.5	1.0	30.0	1.5	5.0	1.5	15.0	1.0	67.5
AVERAGE		0.0	0.0	7.0	2.0	3.5	1.0	30.0	1.5	5.0	1.5	15.0	1.0	67.5

LIGHT FIXTURE, SIGNAL - BRACKET														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6014	0.0	0.0	1.0	0.0	1.0	1.0	15.0	0.8	5.0	0.5	15.0	0.7	40.0
FF-1076	6014	0.0	0.0	1.0	0.0	1.0	1.0	15.0	0.8	5.0	0.5	15.0	0.7	40.0
FF-1076	6014	0.0	0.0	1.0	0.0	1.0	1.0	15.0	0.8	5.0	0.5	15.0	0.7	40.0
FF-1076	6014	0.0	0.0	1.0	0.0	1.0	1.0	15.0	0.8	5.0	0.5	15.0	0.7	40.0
FF-1076	6014	0.0	0.0	1.0	0.0	1.0	1.0	15.0	0.8	5.0	0.5	15.0	0.7	40.0
FF-1076	6014	0.0	0.0	1.0	0.0	1.0	1.0	15.0	0.8	5.0	0.5	15.0	0.7	40.0
AVERAGE		0.0	0.0	1.0	0.0	1.0	1.0	15.0	0.8	5.0	0.5	15.0	0.7	40.0

Table A7-1 Process-Element Times (Cont'd) (Man-Minutes)

LIGHT FIXTURE, SIGNAL - FILTER COVER

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDERR COAT #2	CURE*	QA	TOTAL
FF-1053	5324	0.0	0.0	2.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	0.5	42.5
FF-1053	5324	0.0	0.0	2.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	0.5	42.5
FF-1053	5324	0.0	0.0	2.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	0.5	42.5
FF-1053	5324	0.0	0.0	2.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	0.5	42.5
FF-1053	5324	0.0	0.0	2.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	0.5	42.5
FF-1053	5324	0.0	0.0	2.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	0.5	42.5
AVERAGE		0.0	0.0	2.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	0.5	42.5

LIGHT FIXTURE, SIGNAL - SWIVEL ARM

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6017	10.0	0.0	4.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	1.0	55.0
FF-1076	6017	10.0	0.0	4.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	1.0	55.0
AVERAGE		10.0	0.0	4.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	1.0	55.0

LIGHT FIXTURE, SIGNAL - YOKE

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6016	0.0	0.0	2.0	1.7	1.0	0.3	15.0	0.7	5.0	1.0	15.0	0.7	42.4
FF-1076	6016	0.0	0.0	2.0	1.7	1.0	0.3	15.0	0.7	5.0	1.0	15.0	0.7	42.4
FF-1076	6016	0.0	0.0	2.0	1.7	1.0	0.3	15.0	0.7	5.0	1.0	15.0	0.7	42.4
AVERAGE		0.0	0.0	2.0	1.7	1.0	0.3	15.0	0.7	5.0	1.0	15.0	0.7	42.4

LIGHT FIXTURE, UNREP - COVER

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
DDG-996	6056	0.0	0.0	5.0	0.0	3.0	1.0	15.0	1.5	5.0	1.5	15.0	1.0	48.0
DDG-996	6056	0.0	0.0	5.0	0.0	2.0	1.0	15.0	1.5	5.0	1.5	15.0	1.0	47.0
AVERAGE		0.0	0.0	5.0	0.0	2.5	1.0	15.0	1.5	5.0	1.5	15.0	1.0	47.5

LOCKER, MAN-OVERBOARD FLARE PYROTECHNIC

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6017	0.0	0.0	17.5	0.5	5.0	1.0	30.0	8.0	5.0	6.0	15.0	1.5	89.5
FF-1076	6017	0.0	0.0	17.5	0.5	5.0	1.0	30.0	8.0	5.0	6.0	15.0	1.5	89.5
FF-1076	6021	0.0	0.0	15.0	0.0	4.5	1.0	30.0	6.0	5.0	5.0	15.0	1.0	82.5
FF-1076	6021	0.0	0.0	15.0	0.0	4.5	1.0	30.0	6.0	5.0	5.0	15.0	1.0	82.5
AVERAGE		0.0	0.0	16.3	0.3	4.8	1.0	30.0	7.0	5.0	5.5	15.0	1.3	86.0

LOCKER, PYROTECHNIC (28"X27"X30")

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6021	0.0	0.0	70.0	0.0	34.0	4.0	30.0	13.0	5.0	12.0	15.0	2.0	185.0
FF-1076	6021	0.0	0.0	76.0	0.0	30.0	4.0	30.0	15.0	5.0	14.0	15.0	2.0	191.0
AVERAGE		0.0	0.0	73.0	0.0	32.0	4.0	30.0	14.0	5.0	13.0	15.0	2.0	188.0

Table A7-1 Process-Element Times (Cont'd)
(Man-Minutes)

LOCKER, PYROTEC-NIC - SUNSHIELDS (28"X27"X38") (SET OF 4)

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6021	0.0	0.0	38.0	0.0	30.0	3.0	15.0	15.0	5.0	15.0	15.0	3.0	139.0
FF-1076	6021	0.0	0.0	42.0	0.0	30.0	3.0	15.0	17.0	5.0	15.0	15.0	2.0	144.0
AVERAGE		0.0	0.0	40.0	0.0	30.0	3.0	15.0	16.0	5.0	15.0	15.0	2.5	141.5

SCREEN, HALF-ROUND VENT

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1053	6037	0.0	0.0	5.0	0.0	2.5	1.0	15.0	2.5	5.0	2.0	15.0	1.0	49.0
FF-1053	6037	0.0	0.0	5.0	0.0	2.5	1.0	15.0	2.5	5.0	2.0	15.0	1.0	49.0
AVERAGE		0.0	0.0	5.0	0.0	2.5	1.0	15.0	2.5	5.0	2.0	15.0	1.0	49.0

SCREEN, VENT

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL	SIZE
FF-1053	6034	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	1.0	15.0	2.0	43.0	7"OD
FF-1053	6035	0.0	0.0	5.0	0.0	3.0	2.0	15.0	1.2	5.0	1.0	15.0	2.0	49.2	15"OD
FF-1053	6035	0.0	0.0	10.0	0.0	4.0	2.0	15.0	5.0	5.0	4.0	15.0	2.0	62.0	32 1/2"OD
FF-1053	6036	0.0	0.0	15.0	0.0	3.0	2.0	15.0	3.0	5.0	3.0	15.0	2.0	63.0	30 X 33 X 1 1/2
FF-1053	6035	0.0	0.0	5.0	0.0	5.0	2.0	15.0	1.8	5.0	1.8	15.0	2.0	52.6	37 1/2 X 17 1/2 X 1
FF-1053	6035	0.0	0.0	6.0	0.0	6.0	2.0	15.0	1.8	5.0	1.8	15.0	2.0	54.6	23 X 23 X 1
FF-1053	6035	0.0	0.0	5.0	0.0	5.5	2.0	15.0	1.5	5.0	1.8	15.0	2.0	52.8	31 1/2 X 11 1/4 X 1
FF-1053	6035	0.0	0.0	4.0	0.0	1.0	2.0	15.0	0.5	5.0	0.5	15.0	2.0	45.0	12 1/2 X 5 X 1
FF-1053	6035	0.0	0.0	5.0	0.0	4.0	2.0	15.0	1.4	5.0	1.4	15.0	2.0	50.8	18 X 15 1/2 X 1
FF-1053	6035	0.0	0.0	10.0	0.0	4.0	2.0	15.0	2.5	5.0	2.0	15.0	2.0	65.5	12 1/2 X 11 1/2 X 1
AVERAGE		0.0	0.0	7.5	0.0	3.7	1.9	15.0	2.0	5.0	1.8	15.0	2.0	53.9	

SOCKET, PORTABLE DAVIT

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1076	6037	10.0	120.0	10.0	0.0	10.0	1.0	30.0	3.0	5.0	3.0	15.0	1.0	208.0
FF-1076	6037	10.0	120.0	10.0	0.0	10.0	1.0	30.0	3.0	5.0	3.0	15.0	1.0	208.0
AVERAGE		10.0	120.0	10.0	0.0	10.0	1.0	30.0	3.0	5.0	3.0	15.0	1.0	208.0

SPEAKER, IMC

SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1053	6031	0.0	0.0	8.0	0.0	1.0	1.0	15.0	2.0	5.0	2.0	15.0	2.0	51.0
FF-1053	6037	0.0	0.0	15.0	0.0	5.0	1.0	15.0	2.0	5.0	1.5	15.0	2.0	61.5
FF-1053	6037	0.0	0.0	15.0	0.0	5.0	1.0	15.0	3.0	5.0	1.5	15.0	2.0	62.5
FF-1053	6037	0.0	0.0	14.0	0.0	5.0	1.0	15.0	2.0	5.0	1.5	15.0	2.0	60.5
FF-1053	6037	0.0	0.0	15.0	0.0	5.0	1.0	15.0	1.5	5.0	1.5	15.0	2.0	61.0
FF-1053	6037	0.0	0.0	16.0	0.0	5.0	1.0	15.0	1.5	5.0	1.5	15.0	2.0	62.0
AVERAGE		0.0	0.0	13.8	0.0	4.3	1.0	15.0	2.0	5.0	1.6	15.0	2.0	59.8

Table A7-1 Process-Element Times (Cont'd) (Man-Minutes)

STANCHION, PORTABLE														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
FF-1053	6031	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	0.6	15.0	0.3	40.9
FF-1053	6031	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	0.6	15.0	0.3	40.9
FF-1053	6031	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	0.6	15.0	0.3	40.9
FF-1053	6031	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	0.6	15.0	0.3	40.9
FF-1053	6031	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	0.6	15.0	0.3	40.9
FF-1053	6031	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	0.6	15.0	0.3	40.9
FF-1053	6031	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	0.6	15.0	0.3	40.9
FF-1053	6031	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	0.6	15.0	0.3	40.9
FF-1053	6031	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	0.6	15.0	0.3	40.9
DDG-996	6045	0.0	0.0	3.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	0.5	45.5
DDG-996	6045	0.0	0.0	3.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	0.5	45.5
DDG-996	6045	0.0	0.0	3.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	0.5	45.5
DDG-996	6045	0.0	0.0	3.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	0.5	45.5
DDG-996	6045	0.0	0.0	3.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	0.5	45.5
DDG-996	6045	0.0	0.0	3.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	0.5	45.5
AVERAGE		0.0	0.0	2.4	0.0	1.4	1.0	15.0	1.4	5.0	1.2	15.0	0.4	42.7

STRETCHER, STOKES														
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL
DDG-996	6059	0.0	0.0	12.0	0.0	7.0	1.0	15.0	9.0	5.0	6.0	15.0	1.0	71.0
DDG-996	6059	0.0	0.0	13.0	0.0	8.0	1.0	15.0	7.0	5.0	6.0	15.0	1.0	71.0
AVERAGE		0.0	0.0	12.5	0.0	7.5	1.0	15.0	8.0	5.0	6.0	15.0	1.0	71.0

TRAY, 50 CALIBER AMMUNITION BOX															
SHIP	JULIAN DATE	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL	STYLE
FF-1076		0.0	0.0	4.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	1.0	47.0	SIDE HINGED
FF-1076		0.0	0.0	4.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	1.0	47.0	SIDE HINGED
FF-1076		0.0	0.0	30.0	0.0	20.0	1.0	15.0	1.8	5.0	1.3	15.0	1.0	90.1	FRONT HINGED
FF-1076		0.0	0.0	30.0	0.0	20.0	1.0	15.0	1.8	5.0	1.3	15.0	1.0	90.1	FRONT HINGED
FF-1076		0.0	0.0	30.0	0.0	20.0	1.0	15.0	1.8	5.0	1.3	15.0	1.0	90.1	FRONT HINGED
FF-1076		0.0	0.0	30.0	0.0	20.0	1.0	15.0	1.8	5.0	1.3	15.0	1.0	90.1	FRONT HINGED
AVERAGE		0.0	0.0	21.3	0.0	14.0	1.0	15.0	1.9	5.0	1.5	15.0	1.0	75.7	

Table A7-2 Process-Element Time Summary

COMPONENT	SOLVENT CLEAN	OIL BAKE-OUT	STRIP BLAST	TAPE/ PLUG	ANCHOR TOOTH	QA	PREHEAT*	POWDER COAT #1	GEL*	POWDER COAT #2	CURE*	QA	TOTAL M-MIN	TOTAL M-HR
APPLICATOR, FOG (4')	0.0	0.0	2.5	2.5	1.3	1.0	15.0	0.5	5.0	0.5	15.0	0.5	43.8	0.7
BASE, TWIN AGENT HOSE REEL	0.0	0.0	20.0	0.0	12.7	1.0	15.0	5.0	5.0	4.7	15.0	1.0	79.4	1.3
BOX, FIRST AID	0.0	0.0	30.0	0.0	15.0	2.0	15.0	6.0	5.0	4.0	15.0	2.0	94.0	1.6
BOX, FUEL OIL SPILL	0.0	0.0	30.0	0.0	15.0	2.0	15.0	13.0	5.0	10.0	15.0	2.0	107.0	1.8
BOX, P-250	0.0	0.0	26.0	0.0	15.0	1.0	15.0	16.0	5.0	13.0	15.0	0.7	106.7	1.8
BOX, P-250 - BASE	0.0	0.0	35.0	21.7	12.3	2.0	15.0	8.0	5.0	7.3	15.0	2.0	123.3	2.1
BOX, P-250 - GAS CAN COVER	0.0	0.0	8.0	0.0	4.0	1.0	15.0	6.0	5.0	2.0	15.0	0.7	56.7	0.9
BOX, RAS DIMMER	0.0	0.0	10.0	0.0	5.0	2.0	15.0	6.0	5.0	6.0	15.0	2.0	66.0	1.1
BOX, S/P TELEPHONE CONNECTION JUNCT.	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	1.0	15.0	0.7	41.7	0.7
BOX, S/P TELEPHONE HANDSET	0.0	0.0	10.5	1.0	5.5	1.5	15.0	9.0	5.0	9.0	15.0	3.0	74.5	1.2
BOX, S/P TELEPHONE SINGLE HEADSET	0.0	0.0	5.0	0.0	4.3	1.0	15.0	3.0	5.0	2.3	15.0	1.0	51.6	0.9
BOX, S/P TELEPHONE MULTIPLE HEADSET	6.0	0.0	15.0	0.0	10.0	2.0	15.0	4.0	5.0	3.0	15.0	0.5	75.5	1.3
BRACKET, FIRE EXTINGUISHER (PKP)	0.0	0.0	10.0	0.0	7.0	0.5	15.0	2.0	5.0	1.2	15.0	0.5	56.2	0.9
BRACKET, FLOOD LIGHT (LARGE)	0.0	0.0	4.0	0.0	1.0	0.4	15.0	0.6	5.0	0.6	15.0	0.4	42.0	0.7
BRACKET, FLOOD LIGHT (SMALL)	0.0	0.0	3.0	0.0	2.0	1.0	15.0	0.7	5.0	0.3	15.0	0.2	42.2	0.7
BRACKET, LIGHT SHOCK MOUNT	0.0	0.0	0.2	0.0	0.1	1.0	15.0	0.1	5.0	0.1	15.0	1.0	37.5	0.6
CHAIR, BRIDGEWING	15.0	0.0	10.0	0.0	4.5	1.0	30.0	2.3	5.0	2.3	15.0	1.0	86.1	1.4
COVER, 21MC SPEAKER	0.0	0.0	10.0	0.0	4.0	2.0	30.0	8.0	5.0	4.0	15.0	2.0	80.0	1.3
COVER, CASUALTY POWER	0.0	0.0	6.0	0.0	4.0	2.0	15.0	1.5	5.0	1.0	15.0	0.5	50.0	0.8
COVER, FAS RECEIVING NOZZLE	0.0	0.0	10.0	7.5	7.0	2.0	15.0	4.0	5.0	3.5	15.0	1.0	70.0	1.2
COVER, HEATER	15.0	0.0	8.0	0.0	3.0	1.7	15.0	1.8	5.0	2.0	15.0	0.6	67.1	1.1
COVER, VENT	0.0	0.0	20.0	0.0	15.0	2.0	15.0	7.5	5.0	7.5	15.0	1.5	88.5	1.5
DUCT, VENT (7"OD X 18")	0.0	0.0	15.0	0.0	10.0	1.0	15.0	4.0	5.0	5.0	15.0	1.0	71.0	1.2
HELMET, BATTLE	0.0	0.0	5.0	0.0	2.0	1.3	15.0	0.9	5.0	0.8	15.0	0.5	45.5	0.8
BRACKET, S/P TELEPHONE HANDSET	0.0	0.0	9.0	0.0	5.0	0.5	15.0	0.8	5.0	1.3	15.0	0.5	52.9	0.9
LADDER, ACCOMMODATION - BRACKET	0.0	0.0	4.0	0.0	3.0	1.0	15.0	1.5	5.0	1.5	15.0	1.0	47.0	0.8
LADDER, ACCOMMODATION - GEAR COVER	0.0	0.0	0.0	0.0	2.0	1.0	30.0	1.0	5.0	1.0	15.0	0.5	55.5	0.9
LADDER, ACCOM. - PLATFORM HANDRAIL	0.0	0.0	6.0	0.0	3.0	0.0	15.0	5.6	5.0	4.6	15.0	0.0	54.2	0.9
LADDER, ACCOMMODATION - ROLLER	10.0	60.0	2.0	0.0	1.0	1.0	30.0	0.7	5.0	0.7	15.0	0.7	126.1	2.1
LADDER, THREE-STEP - HANDRAIL	0.0	0.0	21.0	0.0	19.0	3.0	15.0	8.0	5.0	6.5	15.0	3.0	96.3	1.6
LIGHT FIXTURE, FLOOD (LARGE)	0.0	0.0	12.4	1.0	6.0	0.4	15.0	3.0	5.0	3.0	15.0	0.6	61.4	1.0
LIGHT FIXTURE, FLOOD (LARGE, NO HOOD	0.0	0.0	5.7	0.0	2.9	1.4	15.0	2.0	5.0	2.0	15.0	0.6	49.6	0.8
LIGHT FIXTURE, FLOOD (SMALL)	0.0	0.0	10.0	0.0	5.0	1.1	15.0	1.0	5.0	1.0	15.0	0.4	53.5	0.9
LIGHT FIXTURE, HELO DECK EDGE	0.0	0.0	3.3	0.0	2.0	1.3	15.0	0.7	5.0	1.0	15.0	0.3	43.6	0.7
LIGHT FIXTURE, RUNNING (P/S)	0.0	0.0	10.0	0.0	5.0	2.0	15.0	4.0	5.0	6.0	15.0	2.0	64.0	1.1
LIGHT FIXTURE, RUNNING (STERN)	0.0	0.0	5.0	0.0	2.0	1.0	15.0	2.0	5.0	2.0	15.0	2.5	49.5	0.8
LIGHT FIXTURE, SIGNAL	0.0	0.0	9.0	0.0	6.3	7.3	15.0	15.0	5.0	5.5	15.0	2.0	80.9	1.3
LIGHT FIXTURE, SIGNAL - ARM BRACKET	0.0	0.0	7.0	2.0	3.5	1.0	30.0	1.5	5.0	1.5	15.0	1.0	67.5	1.1
LIGHT FIXTURE, SIGNAL - BRACKET	0.0	0.0	1.0	0.0	1.0	1.0	15.0	0.8	5.0	0.5	15.0	0.7	40.0	0.7
LIGHT FIXTURE, SIGNAL - FILTER COVER	0.0	0.0	2.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	0.5	42.5	0.7
LIGHT FIXTURE, SIGNAL - SWIVEL ARM	10.0	0.0	4.0	0.0	2.0	1.0	15.0	1.0	5.0	1.0	15.0	1.0	55.0	0.9
LIGHT FIXTURE, SIGNAL - YOKE	0.0	0.0	2.0	1.7	1.0	0.3	15.0	0.7	5.0	1.0	15.0	0.7	42.4	0.7
LIGHT FIXTURE, UNREP - COVER	0.0	0.0	5.0	0.0	2.5	1.0	15.0	1.5	5.0	1.5	15.0	1.0	47.5	0.8
LOCKER, MAN-OVERBOARD FLARE PYROTECH	0.0	0.0	16.3	0.3	4.8	1.0	30.0	7.0	5.0	5.5	15.0	1.3	86.2	1.4
LOCKER, PYROTECHNIC (28"X27"X38")	0.0	0.0	73.0	0.0	32.0	4.0	30.0	14.0	5.0	13.0	15.0	2.0	188.0	3.1
LOCKER - SUNSHIELDS (28"X27"X38", 4)	0.0	0.0	40.0	0.0	30.0	3.0	15.0	16.0	5.0	15.0	15.0	2.5	141.5	2.4
SCREEN, HALF-ROUND VENT	0.0	0.0	5.0	0.0	2.5	1.0	15.0	2.5	5.0	2.0	15.0	1.0	49.0	0.8
VENT, SCREEN	0.0	0.0	7.5	0.0	3.7	1.9	15.0	2.0	5.0	1.8	15.0	2.0	53.9	0.9
SOCKET, PORTABLE DAVIT	10.0	120.0	10.0	0.0	10.0	1.0	30.0	3.0	5.0	3.0	15.0	1.0	208.0	3.5
SPEAKER, 1MC	0.0	0.0	13.8	0.0	4.3	1.0	15.0	2.0	5.0	1.6	15.0	2.0	59.7	1.0
STANCHION, PORTABLE	0.0	0.0	2.0	0.0	1.0	1.0	15.0	1.0	5.0	0.6	15.0	0.3	40.9	0.7
STRETCHER, STOKES	0.0	0.0	12.5	0.0	7.5	1.0	15.0	8.0	5.0	6.0	15.0	1.0	71.0	1.2
TRAY, 50 CALIBER AMMUNITION BOX	0.0	0.0	21.3	0.0	14.0	1.0	15.0	1.9	5.0	1.5	15.0	1.0	75.7	1.3

2.3 Data Adjustment

In order to create realistic process times, adjustments for the following factors were considered:

- transportation between stations
- operator performance
- personal allowances
- basic-fatigue allowance
- abnormal-position allowance
- muscular energy required
- lighting allowances
- atmospheric allowances
- noise level
- station preparation and set-up
- pilot-shop allowance
- planning requirements

The above factors are considered the same for the Pilot Powder Coating Operations as they were for the WSA process reported in Reference A7-1. In the Pilot CC Shop, both powder coating and WSA items are received and inspected, solvent cleaned, grit blasted and transported between stations in the same manner. During the Pilot operations, the powder coating technicians were often envolved with WSA process when not enough items were present.

The same average Pilot-Production-Allowance Factor (PPAF) of 5.00 presented in Reference A7-1 is used here. This factor is the sum of all allowances, i.e., transportation, personal allowances, station preparation and set-up and pilot-shop allowance.

2.4 Shop Adjustments to the PPAF

Due to the non-production requirements imposed during the Service Test, an allowance other than the PPAF will be required once the Pilot CC Shop is absorbed into the normal SIMA(SD) system. This factor will adjust for the decrease in data collection, contractor interference and increased emphasis in production.

Utilizing the given equipment and shop layout, the only source that would influence the productivity of the shop would be the effect of SIMA Planning. Based upon exposure to the shop operation, it is reasonable to expect that the decrease in paperwork and the emphasis on output could result in a 25% increase in production or a production allowance factor only 75% of the PPAF as shown in Table A7-3. Once the production shop becomes operational, additional factors increasing production would be expected due to the improved shop layout and equipment. Estimating these factors contributing 15 and 20% increases in production, a total adjustment of 0.51 and a production allowance factor of 2.55 are predicted.

Table A7-3 Shop Production Allowance Factor Estimate

	EQUIPMENT	LAYOUT	PLANNING	MULTIPLE	PRODUCTION ALLOWANCE FACTOR
Existing Shop	1.00	1.00	0.75	0.75	3.75
Production Shop	0.85	0.80	0.75	0.51	2.55

2.5 Planning Time Standards

Time standards need to be in a form that permits quick and easy reference by the planner enabling a realistic estimate of shop loading. Due to the powder coating process containing several steps in which batch processing can occur, a table of average standard times for one of each item would not be adequate. Simply multiplying the standard time by the number of items available for processing would provide incorrect estimates. The time shared by several components concurrently heating in the oven must be considered.

A useful estimate can be made when quantities of the same component are assumed to be processed together. It is understood that multiple types of components are often heated at the same time, but for estimation purposes, the assumption of batches of the same type of component will be adequate.

Table A7-4 presents the total process element times in man-hours for batches of similar components with respect to oven loading. The values were computed by the following formula:

Batch Component Time = Q (PE – OT) + OT

Q = quantity of items in batch
PE = total process element time for component (M-HR)
OT = oven time = preheat + gel + cure (M-HR)

The oven time is considered in man-hours because there should always be someone monitoring the process.

The time standards for use at a production shop are given in Table A7-5. These values were generated by multiplying the element time values in Table A7-4 by the production allowance factor for a production shop. Use of these values require some knowledge of the powder coating station's oven. For example, four floodlights could be done at once in the Pilot Shop's oven which had a 3' x 3' x 5' oven rack, whereas, eight floodlights could fit in the 7'x 8' x 12' production oven proposed for SIMA, Pearl Harbor. The values in Table A7-5 are given only up to batch quantities that would be realistic for the large production oven. For instance, it may be possible to process a batch of three pyro lockers at a time but batches of four or above are highly unlikely and, therefore, no times are given.

Table A7-4 Process Element Times in Batch Quantities for Powder Coating

COMPONENT	ONE ITEM	TWO ITEMS	THREE ITEMS	FOUR ITEMS	FIVE ITEMS	SIX ITEMS	SEVEN ITEMS	EIGHT ITEMS
APPLICATOR, FOG (4')	0.7	0.9	1.0	1.2	1.3	1.5	1.6	1.9
BASE, TWIN AGENT HOSE REEL	1.3	2.1	2.8	3.5	4.3	5.0	5.8	6.5
BOX, FIRST AID	1.6	2.6	3.5	4.5	5.5	6.5	7.5	8.5
BOX, FUEL OIL SPILL	1.8	3.0	4.2	5.4	6.6	7.8	9.0	10.2
BOX, P-250	1.8	3.0	4.2	5.4	6.6	7.8	8.9	10.1
BOX, P-250 - BASE	2.1	3.5	5.0	6.5	7.9	9.4	10.9	12.4
BOX, P-250 - GAS CAN COVER	0.9	1.3	1.7	2.0	2.4	2.8	3.1	3.5
BOX, RAS DIMMER	1.1	1.6	2.1	2.7	3.2	3.7	4.2	4.7
BOX, S/P TELEPHONE CONNECTION JUNCT.	0.7	0.8	0.9	1.0	1.1	1.3	1.4	1.5
BOX, S/P TELEPHONE HANDSET	1.2	1.9	2.6	3.2	3.9	4.5	5.2	5.9
BOX, S/P TELEPHONE SINGLE HEADSET	0.9	1.1	1.4	1.7	2.0	2.2	2.5	2.8
BOX, S/P TELEPHONE MULTIPLE HEADSET	1.3	1.9	2.6	3.3	4.0	4.6	5.3	6.0
BRACKET, FIRE EXTINGUISHER (PKP)	0.9	1.3	1.6	2.0	2.4	2.7	3.1	3.4
BRACKET, FLOOD LIGHT (LARGE)	0.7	0.8	0.9	1.1	1.2	1.3	1.4	1.5
BRACKET, FLOOD LIGHT (SMALL)	0.7	0.8	0.9	1.1	1.2	1.3	1.4	1.5
BRACKET, LIGHT SHOCK MOUNT	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9
CHAIR, BRIDGEWING	1.4	2.0	2.6	3.2	3.8	4.4	5.0	5.6
COVER, 21MC SPEAKER	1.3	1.8	2.3	2.8	3.3	3.8	4.3	4.8
COVER, CASUALTY POWER	0.8	1.1	1.3	1.6	1.8	2.1	2.3	2.6
COVER, FAS RECEIVING NOZZLE	1.2	1.8	2.3	2.9	3.5	4.1	4.7	5.3
COVER, HEATER	1.1	1.7	2.2	2.7	3.3	3.8	4.3	4.9
COVER, VENT	1.5	2.4	3.3	4.2	5.0	5.9	6.8	7.7
DUCT, VENT (7"OD X 18")	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4
HELMET, BATTLE	0.8	0.9	1.1	1.3	1.5	1.6	1.8	2.0
BRACKET, S/P TELEPHONE HANDSET	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
LADDER, ACCOMMODATION - BRACKET	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
LADDER, ACCOMMODATION - GEAR COVER	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6
LADDER, ACCOM. - PLATFORM HANDRAIL	0.9	1.2	1.5	1.9	2.2	2.5	2.8	3.1
LADDER, ACCOMMODATION - ROLLER	2.1	3.4	4.6	5.9	7.2	8.4	9.7	11.0
LADDER, THREE-STEP - HANDRAIL	1.6	2.6	3.6	4.7	5.7	6.7	7.7	8.8
LIGHT FIXTURE, FLOOD (LARGE)	1.0	1.5	1.9	2.3	2.8	3.2	3.7	4.1
LIGHT FIXTURE, FLOOD (LARGE, NO HOOD	0.8	1.1	1.3	1.6	1.8	2.0	2.3	2.5
LIGHT FIXTURE, FLOOD (SMALL)	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.1
LIGHT FIXTURE, HELO DECK EDGE	0.7	0.9	1.0	1.2	1.3	1.4	1.6	1.7
LIGHT FIXTURE, RUNNING (P/S)	1.1	1.6	2.0	2.5	3.0	3.5	4.0	4.5
LIGHT FIXTURE, RUNNING (STERN)	0.8	1.1	1.3	1.6	1.8	2.0	2.3	2.5
LIGHT FIXTURE, SIGNAL	1.3	2.1	2.9	3.6	4.4	5.2	5.9	6.7
LIGHT FIXTURE, SIGNAL - ARM BRACKET	1.1	1.4	1.7	2.0	2.3	2.6	2.9	3.2
LIGHT FIXTURE, SIGNAL - BRACKET	0.7	0.8	0.8	0.9	1.0	1.1	1.2	1.2
LIGHT FIXTURE, SIGNAL - FILTER COVER	0.7	0.8	1.0	1.1	1.2	1.3	1.5	1.6
LIGHT FIXTURE, SIGNAL - SWIVEL ARM	0.9	1.3	1.6	1.9	2.3	2.6	2.9	3.3
LIGHT FIXTURE, SIGNAL - YOKE	0.7	0.8	1.0	1.1	1.2	1.3	1.4	1.6
LIGHT FIXTURE, UNREP - COVER	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
LOCKER, MAN-OVERBOARD FLARE PYROTECH	1.4	2.0	2.6	3.2	3.9	4.5	5.1	5.7
LOCKER, PYROTECHNIC (28"X27"X38")	3.1	5.4	7.7	10.0	12.3	14.6	16.9	19.2
LOCKER - SUNSHIELDS (28"X27"X38", 4)	2.4	4.1	5.9	7.7	9.5	11.2	13.0	14.8
SCREEN, HALF-ROUND VENT	0.8	1.1	1.3	1.5	1.8	2.0	2.2	2.5
SCREEN, VENT	0.9	1.2	1.5	1.8	2.2	2.5	2.8	3.1
SOCKET, PORTABLE DAVIT	3.5	6.1	8.7	11.4	14.0	16.6	19.3	21.9
SPEAKER, 1MC	1.0	1.4	1.8	2.2	2.6	3.1	3.5	3.9
STANCHION, PORTABLE	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4
STRETCHER, STOKES	1.2	1.8	2.4	3.1	3.7	4.3	4.9	5.5
TRAY, 50 CALIBER AMMUNITION BOX	1.3	1.9	2.6	3.3	4.0	4.7	5.3	6.0

Table A7-5 Production Shop* - Loading Standard Times for Powder Coating

COMPONENT	ONE ITEM	TWO ITEMS	THREE ITEMS	FOUR ITEMS	FIVE ITEMS	SIX ITEMS	SEVEN ITEMS	EIGHT ITEMS
APPLICATOR, FOG (4')	1.9	2.2	2.6	3.0	3.4	3.7	4.1	4.5
BASE, TWIN AGENT HOSE REEL	3.4	5.3	7.1	9.0				
BOX, FIRST AID	4.0	6.5	9.0	11.5	14.0	16.5	19.0	21.5
BOX, FUEL OIL SPILL	4.5	7.6						
BOX, P-250	4.5	7.6	10.6					
BOX, P-250 - BASE	5.2	9.0	12.7	16.5				
BOX, P-250 - GAS CAN COVER	2.4	3.3	4.3	5.2				
BOX, RAS DIMMER	2.8	4.1	5.4	6.8	8.1	9.4	10.7	12.0
BOX, S/P TELEPHONE CONNECTION JUNCT.	1.8	2.1	2.3	2.6	2.9	3.2	3.5	3.8
BOX, S/P TELEPHONE HANDSET	3.2	4.8	6.5	8.2	9.9	11.6	13.2	14.9
BOX, S/P TELEPHONE SINGLE HEADSET	2.2	2.9	3.6	4.3	5.0	5.7	6.4	7.1
BOX, S/P TELEPHONE MULTIPLE HEADSET	3.2	4.9	6.7	8.4	10.1	11.8	13.5	15.3
BRACKET, FIRE EXTINGUISHER (PKP)	2.4	3.3	4.2	5.1	6.0	6.9	7.8	8.7
BRACKET, FLOOD LIGHT (LARGE)	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9
BRACKET, FLOOD LIGHT (SMALL)	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9
BRACKET, LIGHT SHOCK MOUNT	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3
CHAIR, BRIDGEWING	3.7	5.2	6.7	8.3				
COVER, 21MC SPEAKER	3.4	4.7	5.9	7.2	8.5	9.8	11.1	12.3
COVER, CASUALTY POWER	2.1	2.8	3.4	4.0	4.7	5.3	6.0	6.6
COVER, FAS RECEIVING NOZZLE	3.0	4.5	6.0	7.4	8.9	10.4	11.9	13.4
COVER, HEATER	2.9	4.2	5.6	6.9	8.3	9.7	11.0	12.4
COVER, VENT	3.8	6.0	8.3	10.6	12.9	15.1	17.4	19.7
DUCT, VENT (7"OD X 18")	3.0	4.5	6.1	7.6	9.1	10.7	12.2	13.7
HELMET, BATTLE	1.9	2.4	2.8	3.3	3.7	4.2	4.6	5.1
BRACKET, S/P TELEPHONE HANDSET	2.2	3.0	3.8	4.5	5.3	6.1	6.8	7.6
LADDER, ACCOMMODATION - BRACKET	2.0	2.5	3.0	3.5				
LADDER, ACCOMMODATION - GEAR COVER	2.4	2.6	2.8	3.1	3.3	3.5	3.8	4.0
LADDER, ACCOM. - PLATFORM HANDRAIL	2.3	3.1	3.9	4.8				
LADDER, ACCOMMODATION - ROLLER	5.4	8.6	11.8	15.1	18.3	21.5	24.8	28.0
LADDER, THREE-STEP - HANDRAIL	4.1	6.7	9.3	11.9				
LIGHT FIXTURE, FLOOD (LARGE)	2.6	3.7	4.9	6.0	7.1	8.2	9.3	10.5
LIGHT FIXTURE, FLOOD (LARGE, NO HOOD	2.1	2.7	3.3	4.0	4.6	5.2	5.8	6.5
LIGHT FIXTURE, FLOOD (SMALL)	2.3	3.1	3.8	4.6	5.4	6.2	7.0	7.8
LIGHT FIXTURE, HELO DECK EDGE	1.9	2.2	2.6	2.9	3.3	3.7	4.0	4.4
LIGHT FIXTURE, RUNNING (P/S)	2.7	4.0	5.2	6.4	7.7	8.9	10.1	11.3
LIGHT FIXTURE, RUNNING (STERN)	2.1	2.7	3.3	4.0	4.6	5.2	5.8	6.4
LIGHT FIXTURE, SIGNAL	3.4	5.4	7.3	9.3	11.2	13.2	15.1	17.1
LIGHT FIXTURE, SIGNAL - ARM BRACKET	2.9	3.6	4.4	5.1	5.8	6.6	7.3	8.1
LIGHT FIXTURE, SIGNAL - BRACKET	1.7	1.9	2.1	2.3	2.5	2.8	3.0	3.2
LIGHT FIXTURE, SIGNAL - FILTER COVER	1.8	2.1	2.4	2.8	3.1	3.4	3.7	4.0
LIGHT FIXTURE, SIGNAL - SWIVEL ARM	2.3	3.2	4.0	4.9	5.7	6.6	7.4	8.3
LIGHT FIXTURE, SIGNAL - YOKE	1.8	2.1	2.4	2.7	3.1	3.4	3.7	4.0
LIGHT FIXTURE, UNREP - COVER	2.0	2.6	3.1	3.6	4.1	4.7	5.2	5.7
LOCKER, MAN-OVERBOARD FLARE PYROTECH	3.7	5.2	6.7	8.3	9.8	11.4	12.9	14.4
LOCKER, PYROTECHNIC (28"X27"X38")	8.0	13.9	19.7					
LOCKER - SUNSHIELDS (28"X27"X38", 4)	6.0	10.5	15.1					
SCREEN, HALF-ROUND VENT	2.1	2.7	3.3	3.9	4.5	5.1	5.7	6.2
SCREEN, VENT	2.3	3.1	3.9	4.7	5.5	6.3	7.1	7.9
SOCKET, PORTABLE DAVIT	8.8	15.6	22.3	29.0	35.7	42.4	49.1	55.8
SPEAKER, 1MC	2.5	3.6	4.6	5.7	6.7	7.8	8.8	9.9
STANCHION, PORTABLE	1.7	2.0	2.2	2.5	2.7	3.0	3.2	3.5
STRETCHER, STOKES	3.1	4.6						
TRAY, 50 CALIBER AMMUNITION BOX	3.2	4.9	6.7	8.4	10.1	11.9	13.6	15.3

* Utilizing a Production Shop Allowance Factor of 2.55.

Standard times given for vent screens and covers are for average size vent openings ranging from 38-1/2 to 656 square inches. Times given for pyro lockers are for relatively small ones and are significantly shorter than what would be expected for larger lockers.

The shop-loading standard times given in Table A7-5 are only estimates, however, the values are recommended to provide the baseline for SIMA(SD) Planning and should be included in the next edition of the Repair Time Standards Manual.

REFERENCES FOR APPENDIX 7

A7-1 Adkins, W., et.al., Corrosion-Control (CC) Program: SIMA Pilot CC Shop Service Test and Technical Support, ISA(WC)-107, 30 November 1985, Contract N66001-85-C-0350.

APPENDIX 8

SIMA(PEARL HARBOR) SITE SURVEY

MEMORANDUM

From: O. G. O'Brien 30 May 1985

To: CDR J. Schuhl, COMNAVSURFPAC N-81

Subject: Site Survey at SIMA Pearl Harbor to Establish a SIMA Corrosion Control (CC) Shop

Encl: (1) CC Shop Consumables
(2) Shop Personnel Alternatives
(3) Preliminary Shop Layout
(4) POA&M

1. SUMMARY

CC Shop location assigned and types of equipment defined. Workload was established for shop loading and required personnel were agreed upon. Coordination meetings were held with Facilities, Planning, Production, Safety, Quality Assurance and Personnel. CO, SIMA and CNSP N81 concurred with POA&M developed at end of the 10-day site visit.

2. PURPOSE OF SITE SURVEY

To establish the shop workload (port loading and shop-to-shop) that would be performed by a Corrosion Control Shop at SIMA Pearl Harbor. Establish the geographic location, facility and equipment requirements to satisfy the projected workload and assess the personnel requirements for efficient shop operation. Develop a Plan of Action and Milestone (POA&M) to implement a full production shop capability operating in compliance with TYCOM and NAVSEA requirements in FY86, namely 1 June 86.

3. BRIEF SUMMATION OF EACH DAYS EVENTS

3.1 21-04-85

Provided brief overview of program and required information to the CO, SIMA Pearl Harbor (PH). Met with POC, GSSC Donovan, and scheduled series of meetings with Production Officer, Planning Officer, Facilities Officer, Personnel Officer and Shop Supervisors. Repeated overview of Program amplifying that information which would be required by that SIMA Department, Shop or Office and compiling requisite survey information. Toured SIMA(PH) facilities.

3.2 22-04-85

Met with LT Black, Facilities/Engineering Officer, to discuss site locations for establishment of the CC Shop. SIMA(PH) is presently completing its current MILCON program which will be completed in August 1985. No additional MILCON is planned until 88/89.

- Two site locations were identified.

  .. The first was a 19,200 sq.ft. area presently occupied by Bldg. 230. The building will be torn down approximately June 85 as a part of present MILCON project.

  .. The second site is the "Hardstand area" (16,000 sq.ft.) with Bldg. 1604, Wire Spray Booth and Bldg. 1614, the Abrasive Blast Booth presently in place. Both sites were inspected for suitability of location and were acceptable.

  .. The Facilities Officer recommended that the "Hardstand area" be considered as the preferred site location. ISA concurred with the recommendations. A request to the CO was made via the XO to approve the recommendation. The "Hardstand area" was approved for location of the Corrosion-Control Production Shop.

3.3 23-04-85

Met with LT Cruzata, Planning Officer, to discuss planning functions performed at SIMA(PH) and requirements to interface CC Shop operations. SIMA(PH) Planning provides work scheduling for concurrent availabilities during SRAs and ROHs. The work package that SIMA(PH) performs is 60-75% during SRAs and 50-60% during ROHs. In the discussion, it was considered feasible to base the workload projections for the CC Shop on the following:

1. Three simultaneous SRAs (average).

2. One ROH.

3. Shop-to-Shop - 150 to 200 components/mo.

Planning will assign a full time CC Coordinator/Planner to be trained and provide dedicated coordination between customer Ships and Shop.

3.4 24-04-85

Met with LT Howard, Supply Officer, to discuss provisioning requirements that must be implemented prior to and during the CC Shop becoming operational. The issues discussed were consumables, such as aluminum wire, abrasive grit, masking materials, paint, equipment spare parts, 316 SS fasteners, ceramic coated fasteners, insulating materials, etc. It was pointed out that as a part of the CC upgrade program, funding for procurement of initial inventories of all consumables and parts would be furnished. Maintenance of future inventories would be the responsibility of SIMA(PH). Enclosure (1) was presented as a preliminary listing of required consumables and usage rate.

3.5 25-04-85

Met with Senior Chief in charge of personnel matters to discuss ratings required for assignment to the Corrosion Control Shop. SIMA(PH) rating mix indicated a shortage of Hull Technicians and Boiler Technicians but did have the other suggested ratings for manning the Shop (Enclosure (2)). The second alternative of Enclosure (2) was discussed and given sufficient time (90 days) the rating requirements could be met or acceptable substitutions could be found. Alternative two was chosen because Shop 99B, Corrosion Control, presently has a Chief Boatswain Mate in charge. There are four (4) personnel presently assigned to operate the existing Corrosion-Control Shop.

3.6 26-04-85

Formal presentation was given to entire SIMA(PH) staff including CO,XO, all department heads and Shop Masters. R. Parks, SEA05M1, presented overview of Corrosion Control Program, U.S. Navy and SIMA CC upgrade program with goals and funding. ISA, the support contractor for COMNAVSURFPAC, presented the Pilot SIMA CC Program and Service Test results to date with lessons learned. Issues, problems and preliminary POAs for establishing a CC Shop at SIMA(PH) were also discussed. Presented preliminary shop layout in a pre-engineered building for designated "Hardstand area" (Enclosure (3)) with required equipment and personnel manning. The shop area was approximately 16,000 sq.ft. divided into 8000 sq.ft. for production and 8000 sq.ft. for staging. The existing blasting building would be used for strip blasting and the existing wire sprayed aluminum (WSA) building would continue to be used for wire spraying. The major new equipments would be a degreasing unit, anchor-tooth blaster for WSA and electrostaticpowder (ESP) coatings, two glove box blasting cabinets, 2 ESP spray units and curing oven, 20-ft. water-wash paint-spray booth transferred from SIMA(SD) and a monorail system to move products among the shop work stations, especially in the paint drying area for applying and drying the 5-coat paint schedule for WSA low-temperature. A portable WSA container system is called out for "rotable IPE" to be loaned to ships in ROH so S/F, under SIMA(PH) CC Shop Supervisor, can apply the WSA coating as part of the WSA high-temperature and low-temperature coating system. The estimated shop manning was ten people. The shop size and manning should provide capacity to support work for three ships in SRAs, 1 ship in ROH and the SIMA shop-to-shop.

Various comments were made during and after the presentations.
Examples are: Can NAVSEA (05M1) assist in acquiring new billets for the Shop; will SIMA(PH) QA perform certification; workload projection seemed realistic; manning seemed realistic. No objections were raised about the preliminary facility and outfitting concepts.

3.7 29-04-85

3.7.1 Revisited Planning and discussed lead shop workload as it related to the CC Shop and component size/weight to determine equipment size requirements. Established workload by shop (computer printout) for twelve (12) month calendar period.

3.7.2 Revisited Shop 99B. Discussed local sources for consumables required by shop. Performed detailed survey of site for accurate dimensioning of pre-engineered building, staging area, utilities and sewage disposal. Determined that the site had 1500 KVA electrical power, 600 cfm air and water. The site has no natural

gas. It is not anticipated that Public Works for the Naval Station will be required for assistance.

3.8 30-04-85

Visited local vendors to determine services/materials available. Discussions indicated that vendors were willing to establish materials inventory to satisfy shop requirements on the majority of consumables and certain equipment spare parts.

3.9 01-05-85

Developed Preliminary POA&M for all major activities starting with survey (April 85) to the initial "turn-key" CC Shop operations (June 86).

3.10 02-05-85

Complete Preliminary POA&M, enclosure (4). Instructed the present 99B Shop Master in correct application of wire-spray aluminum in accordance with DoD-STD-2138(SH) and actions necessary to deliver WSA products in conformance with "2138".

3.11 03-05-85

3.11.1 Presented CC Shop layout and outfitting and the preliminary POA&M to the CO and Production Officer SIMA(PH) and CDR Schuhl, CNSP N-81 IMA Coordinator. The CC Shop layout and outfitting was that which was presented at the 26 Apr review. Conducted in-depth review of POA&M elements and milestone schedules. POA&M recommended 10-weeks of training for CC Shop Master at SIMA(SD) and the use of SIMA(PH) personnel to erect pre-engineered building. The POA&M training period was reduced from ten (10) weeks to six (6) weeks and the erection of the pre-engineered building would be subcontracted in lieu of using SIMA(PH) personnel. The shop location and the personnel requirements were confirmed. The CO pointed out that the building would have to be erected prior to shop equipment being shipped because site storage was not available. Equipment and initial stocks of consumables will be coordinated to be collected and staged at San Diego and/or delivered directly to the SIMA(PH) to arrive within two weeks after the pre-engineered building is erected and its utility services installed.

4. Excellent cooperation and support of the CO and Staff of SIMA(PH) allowed this site survey to be completed and preliminary recommendations developed in a 2-week period.

O. G. O'Brien

/dcd

cc: CNSL N42 (CDR M. Mielnik)
SEA 05MB(CAPT B. Sack)
05M1 (R. Parks)
91AD (R. Mason)
DTNSRDC 2803 (J. Montemorano)
SIMA, Pearl Harbor, CO (CDR Julian)
POC (GSSC T. Donovan)
SIMA, Norfolk, CO
POC (Master Chief Turner)

CORROSION-CONTROL SHOP CONSUMABLES

(30–40 Items/Week Production)

ITEM	MINIMUM INVENTORY	CONSUMPTION RATE
STAGE 1 - RECEIVING		
I.D. Tags	1 Box	1/Item
Electrical Ties	1 Box	1/Item
Dog Tags	1 Box	1/Item
Shower Clips	1 Box	1/Item
STAGE 2 - DEGREASING		
Trichloroethane	20 Gal.	As Req'd
Rubber Gloves	2 Pairs	As Req'd
Rags	As Req'd	As Req'd
STAGE 3 - MASKING		
Masking Tape	10 Rolls	As Req'd
Duct Tape - 1/2"	10 Rolls	As Req'd
Duct Tape - 2"	10 Rolls	As Req'd
Aluminum Tape	10 Rolls	As Req'd
Plugs (Various Sizes)	100 Ea.	As Req'd
STAGE 4 - STRIP BLASTING		
#36 Garnet Sand	5000 Lbs.	600 Lbs/20 Min
STAGE 5 - ANCHOR-TOOTH BLASTING		
#16 Aluminum-Oxide Grit	5000 Lbs.	600 Lbs/20 Min.
Press-O-Film	10 Rolls	1/Item
Gloves	10 Pairs	As Req'd
STAGE 6 - ALUMINUM-WIRE SPRAYING		
1/8" Aluminum Wire	2 Rolls (100 Lbs.)	12 Lbs./Hr.
Oxygen	6 Bottles	83 scfh
Acetylene	4 Bottles	40 scfh
Gloves	10 Pairs	As Req'd

Enclosure (1)

CORROSION-CONTROL SHOP CONSUMABLES

(30-40 Items/Week Production)

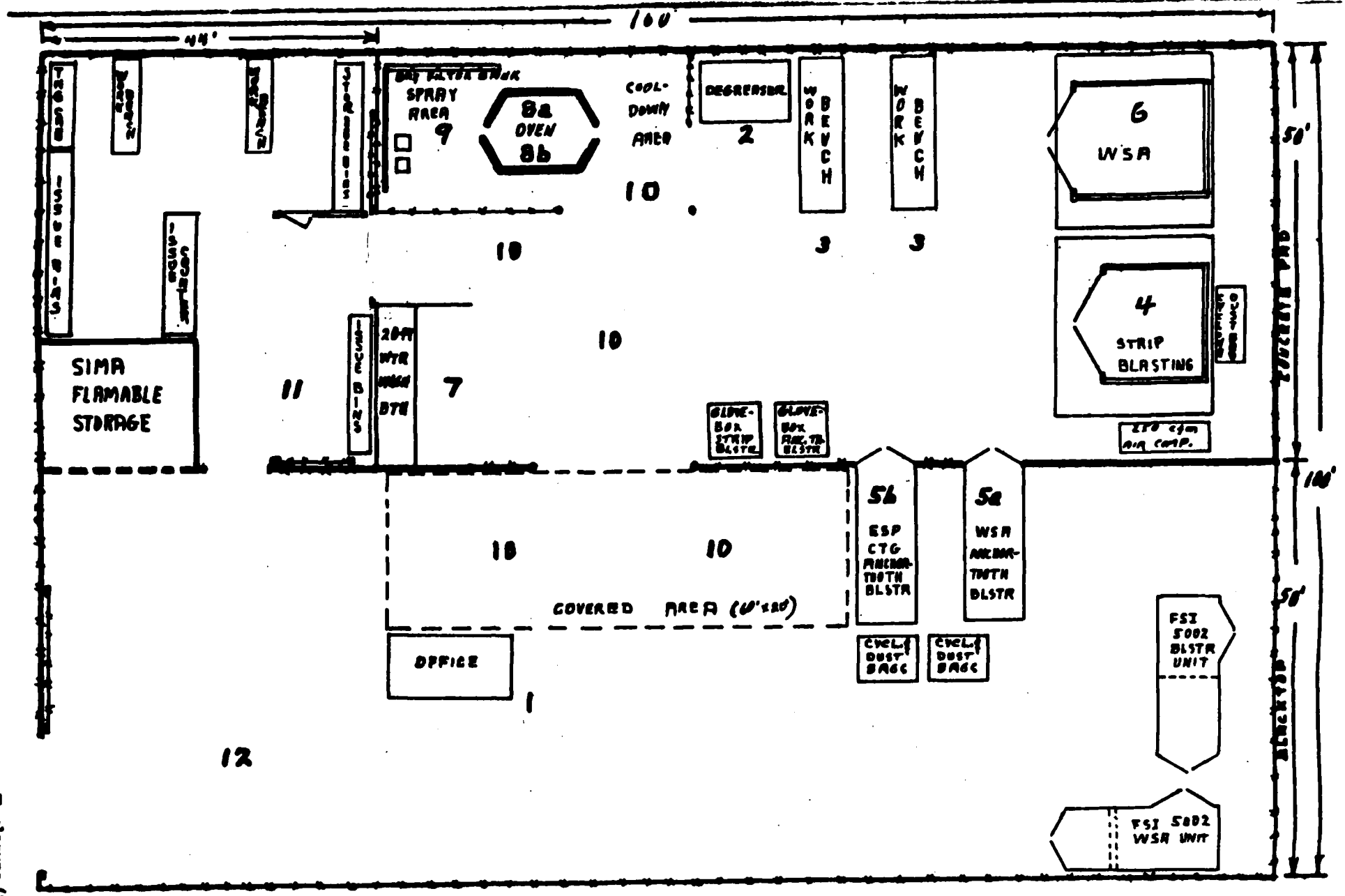
ITEM	MINIMUM INVENTORY	CONSUMPTION RATE
STAGE 7 - PAINTING		
Cheese Cloth (Strainer)	1 Roll	As Req'd
TT-E-781 EGM Thinner	10 Gal.	As Req'd
Formula 150 - Green Primer	20 Gal.	As Req'd
Formula 151 - Haze Gray Topcoat	20 Gal.	As Req'd
Formula 20 - Exterior Gray Deck	10 Gal.	As Req'd
Formula 30 - White Enamel	5 Gal.	As Req'd
TT-E-490 - Haze Gray Enamel	10 Gal.	As Req'd
TT-P-28 - Heat-Resisting Paint	10 Gal.	As Req'd
MIL-D-23003 - Type III - Non-Skid Deck Coating	5 Gal.	5 Gal/Use
STAGE 8 - INSTALLATION KIT DISTRIBUTING		
316 Stainless Steel Fasteners Assemblies (1 Nut, 1 Bolt, 1 Lock-Washer, 2 Flat Washers)	As Req'd	As Req'd
Ceramically-Coated Fastener Assemblies (1 Nut, 1 Bolt, 1 Lock-washer, 2 Flat Washers; only 1/2" where strenth requirement exists)	As Req'd	As Req'd
Nylon Washers	As Req'd	As Req'd
Neoprene with Cloth Reinforcement	1 Roll	As Req'd
Anti-Seize Compound	2 Cans	As Req'd
Teflon Tape	2 Rolls	As Req'd
Polysulfide Sealant	As Req'd	As Req'd

CORROSION CONTROL SHOP PERSONNEL RECOMMENDATIONS

(10 MAN SHOP)

	1ST	2ND	3RD	4TH
Shop Supv.	HTC	BMC	MMC	BTC
Asst. Shop Supv.	BM1	HT1	BT1	MM1
Supply P.O.	SK2	BT2	HT2	Supply Background
Fastener P.O.	MM2 or 3	EN2 or 3	HT2 or 3	
Shop Personnel	HT3, BT3, MM3, EN3 - Three Each			
Shop Personnel	HT/FN, BT/FN, MM/FN, EN/FN - Three Each			

Enclosure (2)



PROPOSED CC SHOP PLOT PLAN FOR SIMA(PH) PLAN # B

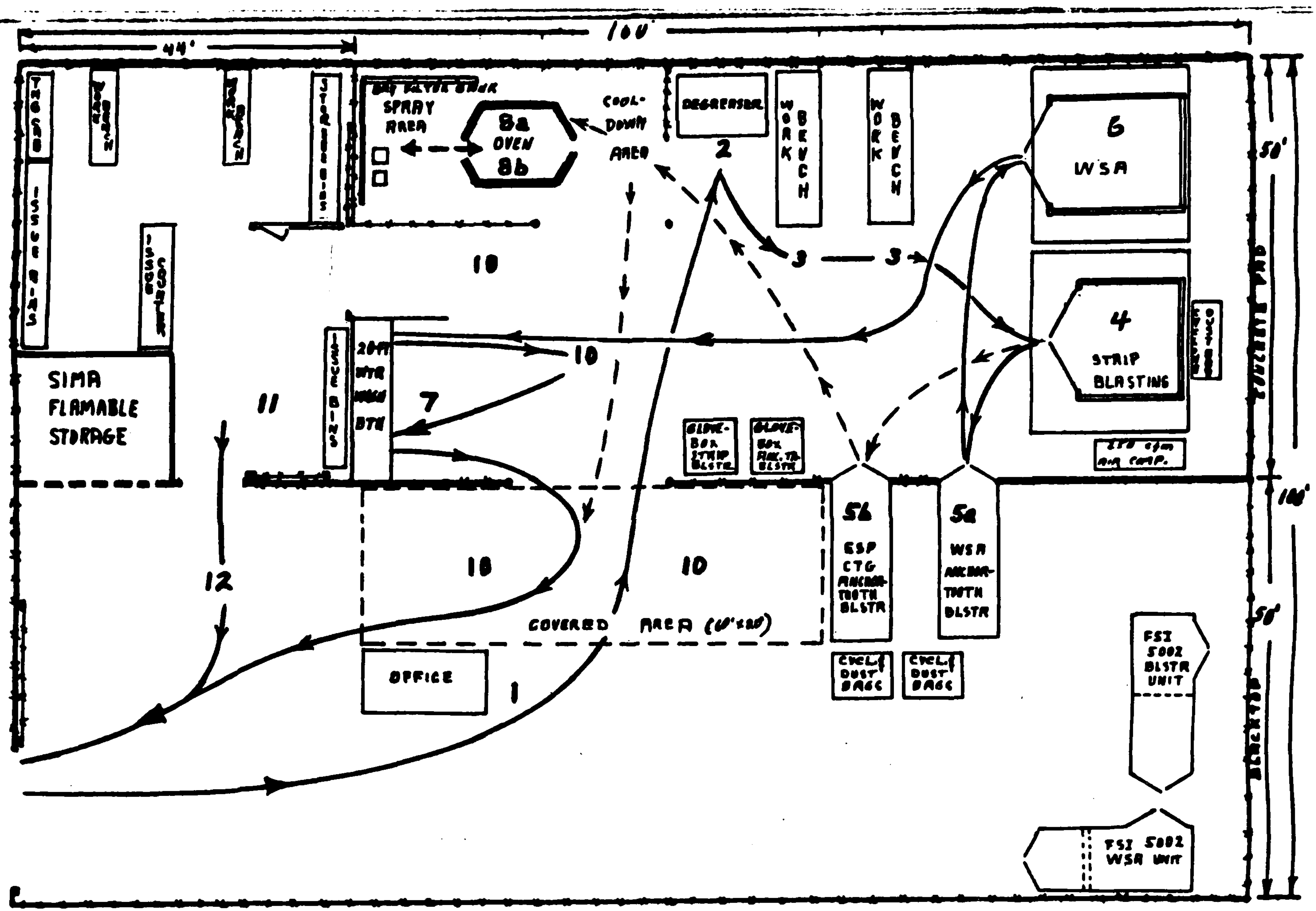
MAY 16 1985

Station/Function

1 - Receipt Inspection/Logging/Staging/Pickup
2a- Degrease 2b - deeply on de-rim To ship ffm
3 - Masking
4 - Strip Blasting
5a - Anchor-Tooth Blasting - WSA
7 - Painting
8a - Oven Preheat
8b - Oven Cure
9 - ESP Coating
10 - Paint Drying and ESP Cool Down

0 4 8 12 16 20
SCALE (FT)

Enclosure (3)



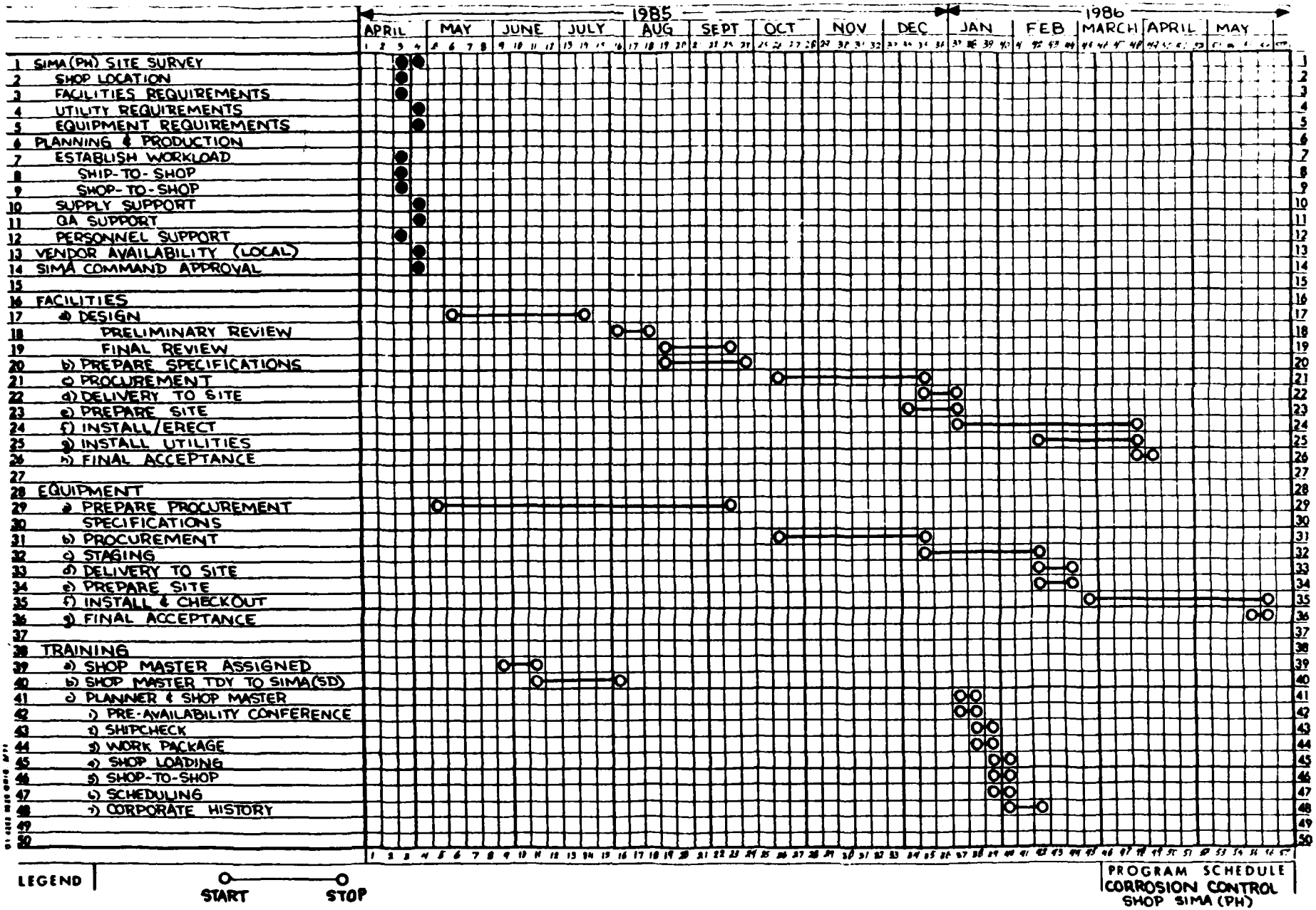
PROPOSED CC SHOP PLOT PLAN FOR SIMA(PH) PLAN # B

MAY 16 1985

Station/Function

1 - Receipt Inspection/Logging/Staging/Pickup
2a - Degrease 2b - degaly on de-slime To Shop 99a
3 - Masking
4 - Strip Blasting
5a - ...-Tooth Blasting - WSA
5b - Anchor-Tooth Blasting - ESP Coating
7 - Painting
8a - Oven Preheat
8b - Oven Cure
9 - ESP Coating
10 - Paint Drying and ESP Cool Down
11 - In...ation ...K) M...U/Stor...

CORROSION CONTROL SHOP SIMA(PH) POA&M



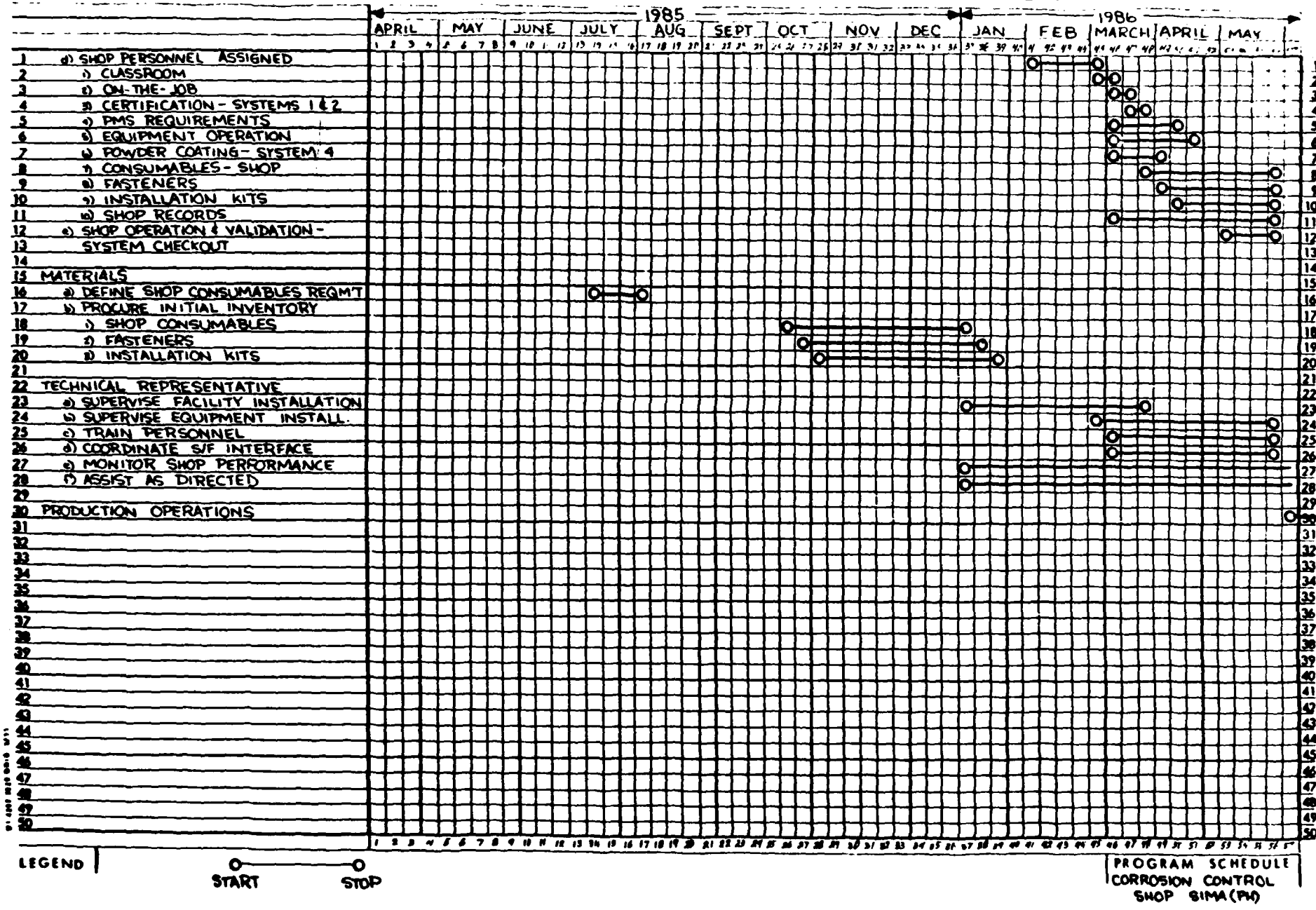
LEGEND

START ——— STOP

PROGRAM SCHEDULE
CORROSION CONTROL
SHOP SIMA (PH)

Enclosure (8)

CORROSION CONTROL SHOP SIMA (PH) POA&M



APPENDIX 9

SIMA(NORFOLK) SITE SURVEY

MEMORANDUM:

From: O. G. O'Brien 12 July 1985

To: CDR J. Schuhl, NAVSURFPACREADSUPPGRU N50

Subject: Site Survey at SIMA Norfolk to Determine Requirements for SIMA Corrosion Control Shop

Encl: (1) SIMA, Norfolk Corrosion-Control Shop Requirements and Site Surveys
(2) Shop Consumables
(3) Proposed Shop Personnel
(4) Shop Layout - Equipment
(5) Shop Layout - Enclosures Required
(6) Shop Layout - Compressed Air Distribution System
(7) Compressed Air System Cross-Connect Schematic
(8) Shop Layout - Major Electrical Requirements
(9) Site Survey Personnel List

1. SUMMARY

A pre-survey kickoff meeting was conducted for the Commanding Officer, SIMA (Norfolk), COMNAVSURFLANT IMA Coordinator and the SIMA staff. Coordination meetings were held with the Repair Officer, Planning, Production, Safety, Quality Assurance, Supply and Personnel Department heads. A post-survey meeting with the Commanding Officer, SIMA and the Repair Officer was held summarizing findings, recommendations, agreements and Plan of Action with all outstanding issues addressed and the latest draft of the CC Shop layout was reviewed. The production CC Shop location was assigned and types of equipment were defined. The SIMA (Norfolk) CC workload was established for shop loading, and the required number of personnel was estimated to satisfy the workload.

2. PURPOSE OF SITE SURVEY

The purpose of this survey was to establish the SIMA (Norfolk) workload (portloading and shop-to-shop) that would be required to be performed by a Corrosion Control Shop; establish the geographic location, facility and equipment requirements to satisfy the projected workload and assess the personnel requirements for efficient shop operations; ensure all planning factors are satisfied and to develop a Plan of Action and Milestones (POA&M) to implement a full-production shop capability in compliance with TYCOM and NAVSEA requirements as soon as possible within FY86.

3. SUMMARY OF VISIT

3.1 11-06-85

A formal presentation was given to the SIMA(Norfolk) staff including the Commanding Officer, Repair Officer and selected department heads. R. Parks, SEA 05M1, presented an overview of the Navy Wide Corrosion-Control Program and the SIMA CC upgrade program with goals and funding. ISA, the support contractor for NAVSURFPACREADSUPPGRU N50, presented the Pilot SIMA CC Program and Service Test results to date with lessons learned (Enclosure 1). ISA also presented the SIMA(SD) Interim CC Shop production facility and SIMA(PH) production facility as examples of facility requirements and equipment layouts and provided the preliminary site survey agenda. A brief question-and-answer period completed the briefing. We then met the POC, Master Chief Turner, R-2 Division supervisor.

ISA and the Repair Officer toured the SIMA facility to determine candidate site locations for CC Shop. SIMA (Norfolk) is contained in the first floor of a two-story building occupying approximately 255,000 sq.ft. There is one ancillary facility (valve barge) adjacent to drydock #2. As a result of the tour, the Repair Officer, requested that two alternate shop locations be developed giving preference to locating the CC Shop in the area presently being occupied by Shop 38A, the Outside Machine Shop. Detailed inspection of three preferred areas was conducted. The Shop 38A area was 1600 sq.ft. which is not sufficient for a CC Shop. Alternate locations, such as the Pump Shop (31G) and the Lagging Shop (57A) which comprised respective areas of 4000 sq.ft. and 4100 sq.ft were inspected. It was determined that the shop location should be located so that the present equipment in the existing CC Shop 71A (Abrasive Blast Unit and Wire Spray Room) could be utilized as part of the IPE of the new CC Shop. Therefore, the Lagging Shop area was not considered suitable.

A meeting was held with the Repair Officer to discuss the relocation of existing shops that were considered candidate areas for the CC Shop. The Repair Officer stated that the Pump Shop could not be relocated. We revisited the area and inspected the floor space occupied by Shops 31B and 64E in conjunction with 38A and 71A. The total area was considered feasible as it represented approximately 5100 sq.ft. No other alternatives within the building were considered acceptable. We were also informed by LT. Huffer that the Naval Station would not consider the erection of a pre-engineered building dedicated to Corrosion Control and were advised of the undue delay that would occur as a result of utility requirements involving PWC.

3.2 12-06-85

3.2.1 ISA and the SEA 05M1 representative met with the Commanding Officer and Repair Officer to review a preliminary shop layout utilizing Shops 38A, 31B and 64E. The equipment required for a CC Shop could be laid out in the area of 5100 sq.ft. eliminating selected bulkheads (walls). The relocation of the shops was agreed upon along with the shop layout concept. It was pointed out by the CO and RO that SIMA (Norfolk) did not have the resources (personnel/dollars) to perform the relocation of equipment nor to modify the designated area to accommodate the new CC Shop. Direction was given to proceed with this location.

3.2.2 Met with the Planning Officer to discuss the SIMA (Norfolk) workload, data system and CC availability requirements. The SIMA (Norfolk) workload consists of:

(a) IMAV's representing 65% of total (4 ships);

(b) concurrent availabilities representing 10 to 15% of total (6 to 8 ships); and

(c) emergent work representing 20-25% of the total.

The shop-to-shop workload was determined utilizing the Analysis Group analyzing computer historical data for specific shops that would interact with the CC Shop (lead - assist). The estimated shop-to-shop workload for the CC Shop would be approximately 700 components/month.

SIMA (Norfolk) utilizes the Engineer-Time-Value data system which is compatible with the data package being developed by the Pilot CC Program at SIMA(SD). We discussed the requirements to have a dedicated planner for the CC program who would be trained in all phases of corrosion control. The Planning Officer concurred with this request.

3.2.3 ISA and SEA 05M1 met with the Supply Officer and presented him with Consumables listing for CC Shop (Enclosure 2). We discussed what would be initially furnished as a part of the CC upgrade program and what would be required of SIMA (Norfolk) for sustaining the initial inventory stock levels. The Supply Officer pointed out that the TYCOM would have to be cognizant of the additional funding requirements in the ROVI budget, particularly for the required fastener inventory. He also requested a concerted effort by NAVSEA to have SPCC provide these items in the stock system. Additional information will be forwarded on fastener inventory requirements for each ship class as it is finalized.

3.3 13-06-85

3.3.1 ISA and SEA 05M1 met with Safety Officer to discuss any unique safety requirements for the equipment to be furnished for the CC Shop. The facility survey indicated that equipment drains were available for disposal of contaminated waste water; however, the Safety Officer stated that other means would have to be employed because the drainage system was not operational and was not anticipated to be operational.

Additional points brought to our attention by the Safety Officer were:

(a) open flames (WSA Booth) must be minimum of 50 linear feet from any volatile liquids (Paint Booth),

(b) the disposal of contaminated grit is arranged through PWC, and

(c) a substitution for trichloroethane should be considered utilizing a biodegradable emulsifier (SIMA(Norfolk) currently uses Cantol 736 obtained through open purchase from a local manufacturer).

3.3.2 We met with CWO Manning of Quality Assurance (QA) and discussed the QA requirements of the CC Shop. Presently, for NAVSEA CC Systems 1 and 2 (WSA), the certification requirements for WSA in accordance with DOD-STD-2138(SH) are being performed by Norfolk Naval Shipyard. The SIMA QA Department will assume the responsibility for operator certification once the CC Shop becomes operational. QA personnel CC training was discussed along with CC Shop QA requirements. SIMA (Norfolk) QA presently has the necessary equipment to provide certification testing.

3.3.3 We met with Senior Chief Mehan, Personnel, to discuss production rating-mix at SIMA (Norfolk). Presently the SIMA personnel breakdown per division is:

R-1 Division	108 HT
R-2 Division	288 BT, MR, EN, MM
R-3 Division	57 Electrical
R-4 Division	83 ET
R-5 Division	62 BM
R-6 Division	20
R-7 Division	13

The total SIMA (Norfolk) personnel compliment is 921 with a slight increase occurring thru Oct. '85. ISA discussed preferred ratings for CC Shop, such as HT's, BT's, BM's and so forth. Although the present CC Shop is assigned to the R-2 Division which does not have HT's, this rating could be assigned. Also, supply personnel ratings were discussed and SIMA has sufficient SK's that would allow assignment of this required rating.

3.3.4 ISA conducted a briefing of Pilot CC Shop program to all SIMA (Norfolk) Shop Masters on the functions, capabilities and capacity of the proposed SIMA (Norfolk) CC Shop, Shop 71A, in general and the potential shop-to-shop work in particular. For example, Shop 71A would be an assist-shop to support each shop for those products that should be preserved with wire spray aluminum. We stressed that components being fabricated/repaired by the lead shop should be analyzed for assignment to the CC Shop (assist shop). There was an excellent interchange of information and interest.

3.3.5 We performed an in-depth review of existing utilities within the selected area and the following determinations were made:

(a) An additional air compressor (800CFM @ 125 psi breathing-air quality) with dedicated piping system for CC Shop is required. Present air compressor has inadequate volume for CC Shop requirements, and the piping system would not satisfy air volume and is contaminated.

(b) Electrical distribution system needs minor modifications to satisfy CC Shop requirements.

(c) Water distribution system is satisfactory.

(d) Certain "non-load-bearing" walls will have to be removed to accommodate efficient shop production flow.

(e) Certain "non-load-bearing" walls will have to be constructed for efficient production flow.

(f) Possible minor exhaust ducting modifications will be required of the existing system.

(g) Component Handling system should be installed.

3.4 14-06-85

ISA met with the Commanding Officer, Repair Officer and R-2 Division Supervisor. Also in attendance was SEA 05M1 representative, Mr. Dale Sowell, and SEA 05M1 ARINC support contractor representative, Mr. Kevin Brown. We presented for review the latest drafts of CC Shop equipment layout, work enclosure requirements, air distribution system, cross-connect schematic and electrical requirements (Enclosures 4, 5, 6, 7 and 8).

We also discussed the results of the meetings held with the Planning, Supply, Safety, QA, Production and Personnel departments. ISA presented proposed CC Shop manning requirements (Enclosure 3) and discussed rating mix and number of personnel to support projected workload for the shop.

Mr. Sowell discussed the coordination that SEA 05M1 would perform with SEA 91AD for funding requirements to relocate existing SIMA (Norfolk) Shops and provide necessary modifications for new CC Shop. He planned to present the shop layouts and schematics (Enclosures 4-8) along with the specific shop relocation details and determine the necessary NAVSEA actions. He planned to research the issues and forward answers to SIMA (Norfolk) and ISA by 21 June 85.

It was agreed that a realistic POA&M could not be developed until Mr. Sowell provided information on the authority, funding and Navy and/or contractor support for the required building modifications. ISA will prepare the POA&M as soon as this information is provided.

The Commanding Officer expressed his enthusiasm for the Corrosion-Control Program. He accepted the proposed CC Shop layouts, relocation of the displaced shops and the building modifications subject to the provision of the required additional funding and authority. He concurred with the need for QA and planning as active participants in the program, along with a civilian shop advisor for continuity. He stated his next action would be to consider all impacts that the new CC Shop would present and compose a letter to SURFLANT covering these issues.

PROPOSED AGENDA FOR SIMA, NORFOLK, CC SHOP REQUIREMENTS & SITE SURVEY

SIMA, Norfolk CC Shop Rqmts and Site Survey 11-20 Jun 85

11 June	0930	Brief CO and Staff
11 June	1130	Tour facilities
11 June	1300	Review SIMA Master Plan and basic facility requirements and MILCON
12 June	0800	Identify potential CC Shop sites and establish alternatives
12 June	1000	Meet Facilities Officer
12 June	1300	Meeting Planning Officer to establish Ship-to-Shop and Shop-to-Shop workload, port loading, etc.
13 June	0800	Supply Officer - Discuss consumables, fasteners and installation kits. Discuss local vendor support
13 June	1300	Production Officer/Repair Officer Discuss Shop-to-Shop interface and Shop workload. Discuss personnel requirements
14 June	0800	Status Report to SIMA CO - Interim results of Survey
17 June	0800	Continue discussions/meetings with appropriate Department Heads
18 June	0800	Visit all major Shops and interface with Shop Masters
18 June	1300	Planning Officer - Define typical Shop-to-Shop workload - Monthly number of components
19 June	0800	Size Shop to workload requirements. Identify equipment requirements and personnel requirements
19 June	1300	Meet with Q.A. Department Discuss certification processes
20 June	0800	Present draft POA&M to SIMA CO and Staff with preliminary Shop layout. Review and approve location, workload and personnel
20 June	0800	Survey complete

CORROSION-CONTROL SHOP CONSUMABLES

ITEM	MINIMUM INVENTORY	CONSUMPTION RATE	SOUR
STAGE 1 - RECEIVING			
I.D. Tags	200	1/Item	NSN
Electrical Ties	6 Pkgs	1/Item	NSN
Dog Tags	200	1/Item	NS
Shower Clips	200	1/Item	NS
STAGE 2 - DEGREASING			
Respirator Charcoal Filters	25	1/Day	NSN
Trichloroethane	165 Gal.	As Req'd	NSN
Trichloroethane Spray Can	24 Cans	As Req'd	NS
Rubber Gloves/Apron	2 Pairs	As Req'd	NSN
Rags	As Req'd	As Req'd	NSN
STAGE 3 - MASKING			
Masking Tape	10 Rolls	As Req'd	NS
Duct Tape - 1/2"	20 Rolls	As Req'd	NS
Duct Tape - 2"	25 Rolls	As Req'd	NSN
Aluminum Tape	10 Rolls	As Req'd	O/P
Plugs (Various Sizes)	1000 Ea.	As Req'd	O/P
Utility Blades	10 Boxes	As Req'd	NSN
STAGE 4 - STRIP BLASTING			
#36 Garnet Sand	3000 Lbs.	600 Lbs/20 Min.	O/P
Face Shields (Disposable)	200	As Req'd	O/P
Ear Plugs	2 Boxes	As Req'd	NS
STAGE 5 - ANCHOR-TOOTH BLASTING			
#16 Aluminum-Oxide Grit	4200 Lbs.	600 Lbs/20 Min.	O/P
Press-O-Film (X-Coarse)	10 Rolls	1/Item	O/P
Gloves (Rubber)	6 Pairs	As Req'd	NS
Face Shields (Disposable)	200	As Req'd	O/P
STAGE 6 - ALUMINUM-WIRE SPRAYING			
1/8" Aluminum Wire	2 Rolls (100 Lbs.)	12 Lbs./Hr.	MET
Oxygen	6 Bottles	83 scfh	NS
Acetylene	4 Bottles	40 scfh	NS
Gloves (Cotton)	40 Pairs	As Req'd	NSN
Dust Filter (Yellow Button)	2 Boxes	As Req'd	NSN

• Open Purchase

CORROSION-CONTROL SHOP CONSUMABLES

ITEM	MINIMUM INVENTORY	CONSUMPTION RATE	SOURC
STAGE 7 - PAINTING			
Respirator Charcoal Filters	25	1/Day	NSN
Cheese Cloth (Strainer)	1 Roll	As Req'd	NSN
TT-E-781 EGM Thinner	20 Gal.	As Req'd	NSN
Formula 150 - Green Primer	60 Gal.	As Req'd	NSN
Formula 151 - Haze Gray Topcoat	50 Gal.	As Req'd	NSN
Formula 20 - Exterior Gray Deck	10 Gal.	As Req'd	NSN
TT-E-490 - White Enamel	5 Gal.	As Req'd	NSN
TT-E-490 - Haze Gray Enamel	20 Gal.	As Req'd	NSN
[redacted] - Heat-Resisting Paint	20 Gal.	As Req'd	NSN
MIL-D-23003 - Type III - Non-Skid Deck Coating	5 Gal.	5 Gal/Use	NSN
Gloves (Plastic)	80 Pairs	As Req'd	NSN
STAGE 8 - INSTALLATION KIT DISTRIBUTING			
316 Stainless Steel Fastener Assemblies	As Req'd	As Req'd	O/P
Ceramically-Coated Fastener Assemblies	As Req'd	As Req'd	O/P
Nylon Washers	500	As Req'd	O/P
Neoprene with Cloth Reinforcement	1 Roll	As Req'd	O/P
Anti-Seize Compound	10 Tubes	As Req'd	NSN
Polysulfide Sealant, Type I	3 Cans	As Req'd	NSN
Polysulfide Sealant, Type IV	3 Cans	As Req'd	NSN
Plastic Bags	2 Boxes	As Req'd	O/P

COMMERCIAL SUPPLIERS
of
CC SHOP EQUIPMENT

MASKING

Tapes

Oak Materials Group, Inc.
Fluorglas Division
Hoosick Falls, NY 12090
(518) 686-7301/4374

Industrial Specialties Division/3M
220-7E, 3M Center
St. Paul, MN 55144

Boyd Corporation
1385 Ramona Avenue
Chino, CA 91710

Plugs

Accurate Products Division
Lear Siegler, Inc.
4250 Morena Blvd.
San Diego, CA 92117

STRIP BLASTING/ANCHOR-TOOTH

Blasting Equipment

Diamond Air Compressor Co.
5229 Virginia Beach Blvd.
P. O. Box 12156
Norfolk, VA 23502
(804) 461-4192

Clemco Industries
P. O. Box 7680
San Francisco, CA 94120
(415) 570-6000

Abrasives

Norton Company
Materials Division
1 New Bond Street
Worcester, MA 01606
(617) 853-1000

E. I. DuPont de Nemours & Co., Inc.
6250 Fairview Road
P. O. Box 30517
Charlotte, NC 28230
(704) 364-1550

Quality Assurance

Testex, Inc.
P. O. Box 867
Newark, DE 19715
(302) 731-5693

B.I.E. Instruments, Inc.
2100 West Loop South
Houston, TX 77027
(713) 961-1921

ALUMINUM-WIRE SPRAYING

Spray Guns, Wire

METCO, Inc.
1101 Prospect Avenue
Westbury, L.I., NY 11590
(516) 334-1300
(METCO parts are also available through NSN)

Quality Assurance

B.I.E. Instruments
2100 West Loop South
Houston, TX 77027
(713) 961-1921

Elcometer, Inc.
P. O. Box 1203
Birmingham, MI 48012-1203
(313) 647-4860

KTA-Tator, Inc.
115 Technology Drive
Pittsburgh, PA 15275
(412) 788-1300

PAINTING

Paint Spray Guns

Speedflo Manufacturing Corp.
4631 Winfield Road
Houston, TX 77039
(713) 449-0201

Binks Manufacturing Company
9201 W. Belmont Avenue
Franklin Park, IL 60131
(312) 671-3000

Graco, Inc.
P. O. Box 1441
Minneapolis, MN 55440
(612) 623-6000

Paint Spray Booths

Protectaire Systems Company
1440 Holmes Road
Elgin, IL 60120
(312) 697-3400

PAINT (Cont'd)

Paint

Devoe Prufcoat Division
Grow Group, Inc.
13531 S. Choctaw
Baton Rouge, LA 70815
(800) 535-8076

Carboline Company
Building Products Division
1401 S. Hanley Road
St. Louis, MO 63144
(314) 644-1000

Porter Paint Co.
Porter Coatings Division
400 S. 13th Street
Louisville, KY 40201
(502) 588-9615

Paasche Airbrush Company
1909 Diversey Parkway
Chicago, IL 60614
(312) 281-6650

POWDER COATING

Powder Spray Guns

The DeVilbiss Company
Toledo, OH 45692

Volstatic, Inc.
7960 Kentucky Drive
Florence, KY 41042
(606) 371-2557

Nordson Corporation
4222 E. La Palma
Anaheim, CA 92807
(714) 996-8610

Powder

Ferro
4150 E. 56th Street
P. O. Box 6550
Cleveland, OH 44101
(216) 641-8580

Armstrong Products Company
Div. of Morton Thiokol, Inc.
P. O. Box 647
Warsaw, IN 46580
(219) 267-3226

Polymer Corporation
P. O. Box 422
Reading, PA 19603
(215) 929-5858

INSTALLATION KITS

316 Stainless Steel Fasteners

Sales Systems, Ltd.
700 Florida Avenue
Portsmouth, VA 23707
(804) 397-0763

Nelson Stud Welding Division
TRW Assemblies & Fasteners Group
Room 442
3600 West Broad Street
Richmond, VA 23230
(800) 523-5092

Ceramic-Coated Fasteners

Sermatech International, Inc.
155 South Limerick Road
Limerick, PA 19468
(215) 948-5100
Coating: Sermetel 725

Metallic Ceramic Coatings, Inc.
P. O. Box 1598
West Chester, PA 19380
(215) 279-1212
Coating: Xylar 1/Xylar 101

Chromolly
Manchester, CT
Attn: Carl Zambon
(203) 647-0916

Coatings for Industry, Inc.
Souderton, PA
(215) 723-0919
Coating: Alseal 518/Alseal 598

Polysulfide Sealant (Systems 10 and 11)

NSN 8030-00-008-7198
Products Research & Chemical Corp.
5430 San Fernando Road
P. O. Box 1800
Glendale, CA 91209
(818) 240-2060

SHOP MANNING - PROPOSED
71A
CORROSION CONTROL

Shop Master	HTCS
Shop Supervisor	BT1
Supply P.O.	SK2
I.K. P.O.	MM2
Q.A. P.O.	HT1

PRODUCTION

Wire Spray Aluminum	MR-2
	MR-3
	EN-2
	BT-2
	HT-3
	HT-2
	MM-2
	MM-3
	BT-3
	BM-2
	BM-3
	HT-2
	BT-2
Powder Coating	BM-1
	MR-3

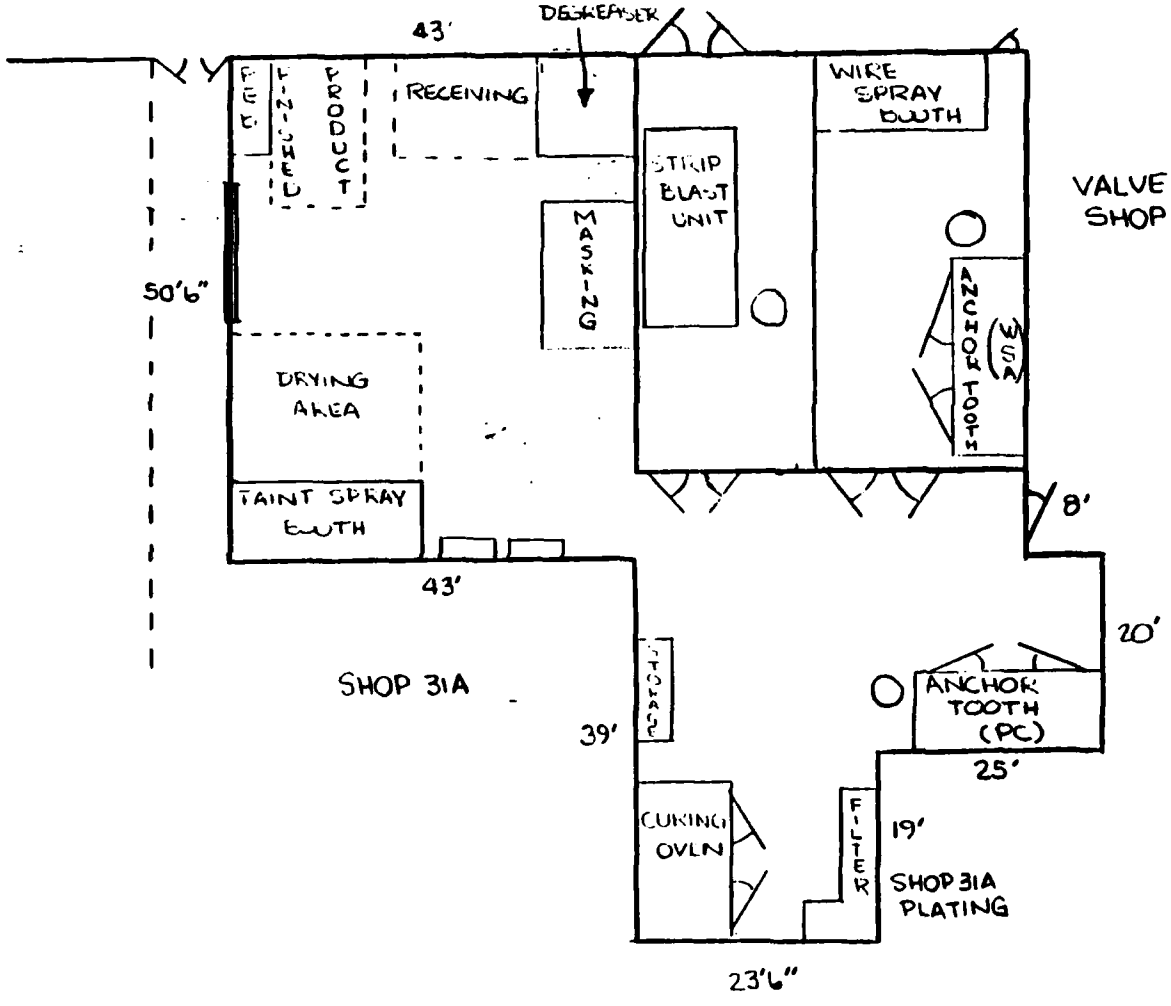
TOTAL MANNING: 20

RATING	NO.
HTCS	1
BT-1	1
SK-2	1
MM-2	2
HT-1	1
HT-2	2
HT-3	1
MR-2	1
MR-3	2
EN-2	1
BM-1	1
BM-2	1
BM-3	1
BT-2	2
BT-3	1
MM-3	1
	20

Enclosure (3)

CORROSION CONTROL SHOP 71A

EQUIPMENT LAYOUT

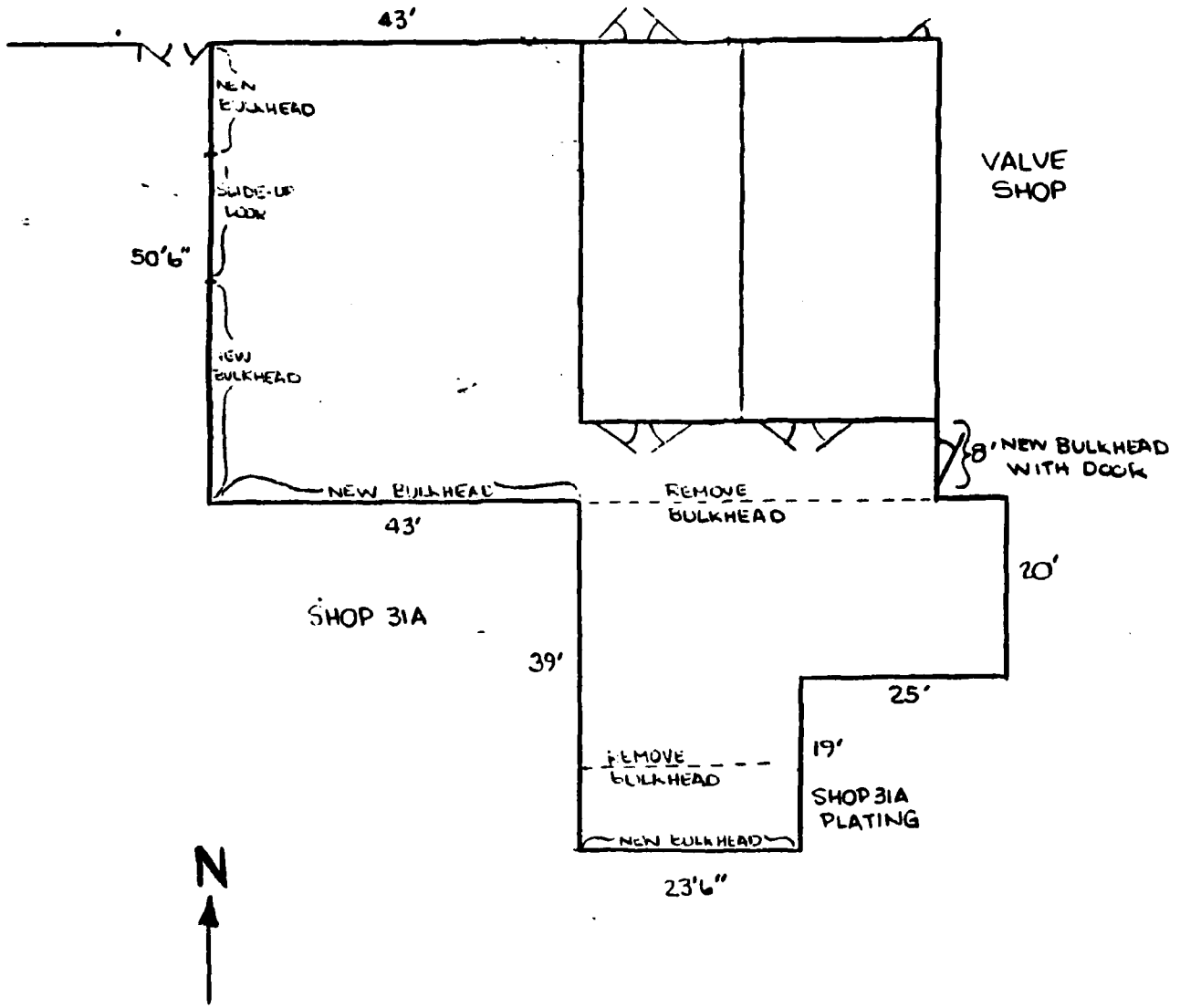


Enclosure (4)

✦ TWO ADDITIONAL CONTAINERS SHALL BE SUPPLIED CONTAINING ANCHOR-TOOTH AND WIRE-SPRAY EQUIPMENT FOR WORK REMOTE FROM SHOP 71A

CORROSION CONTROL SHOP 71A

ENCLOSURE REQUIREMENTS



Enclosure (5)

TOTAL LENGTH OF BULKHEAD TO BE ADDED -

WEST SIDE -	50' 6"	(INCLUDING 14' SLIDE-UP DOOR)
SOUTHWEST SIDE -	43'	
SOUTH SIDE -	23' 6"	
EAST SIDE -	8'	(INCLUDING 6' DOOR)

TOTAL ADDITION - 125' (LINEAL)
(APPROXIMATE HEIGHT = 16')

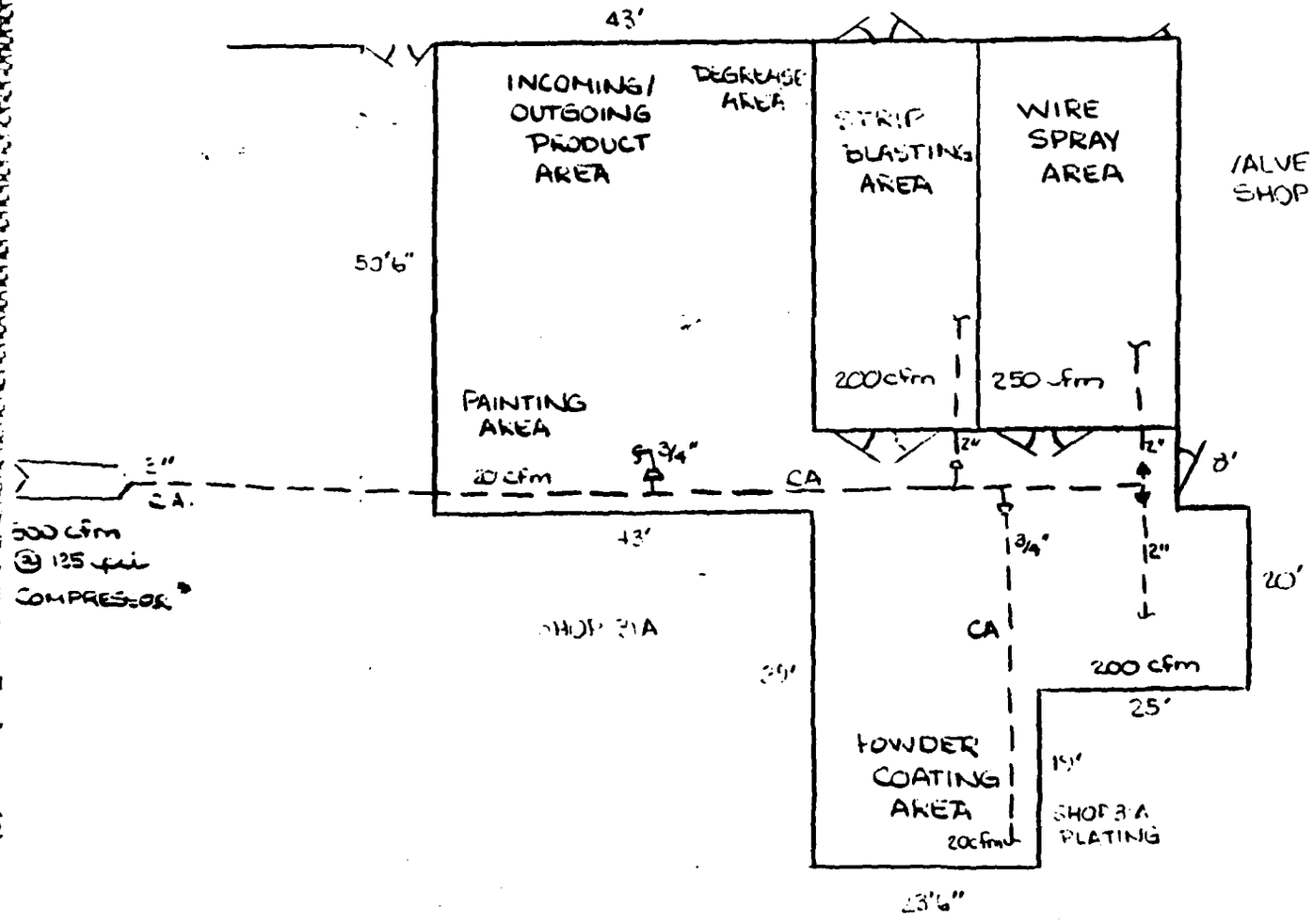
TOTAL LENGTH OF BULKHEAD TO BE REMOVED -

SOUTH SIDE -	21'
MIDSHOP -	41'

TOTAL REMOVAL - 62' (APPROXIMATE)

AMP

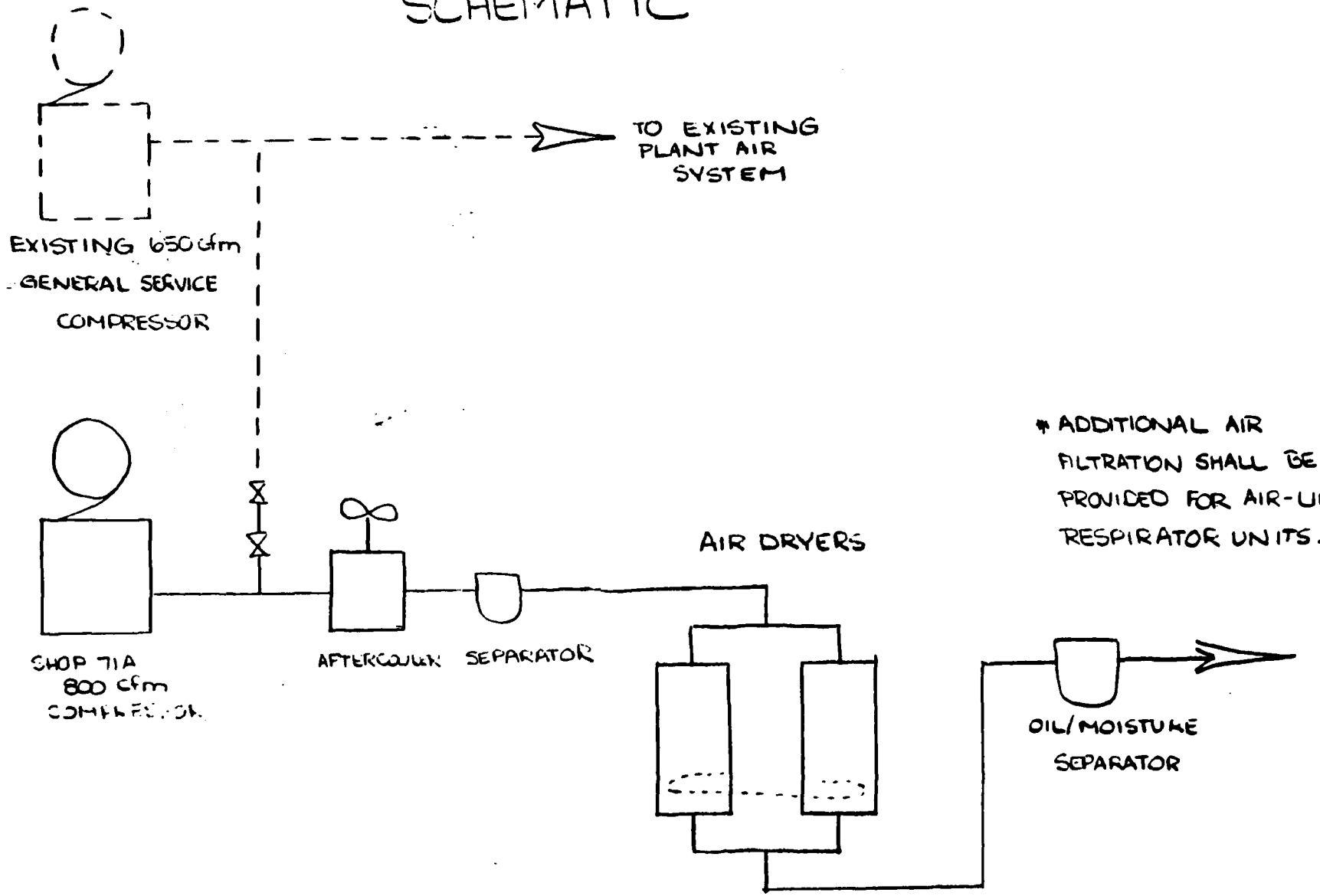
CORROSION CONTROL SHOP
AIR DISTRIBUTION SYSTEM



CA = Compressed Air

COMPRESSED AIR SYSTEM

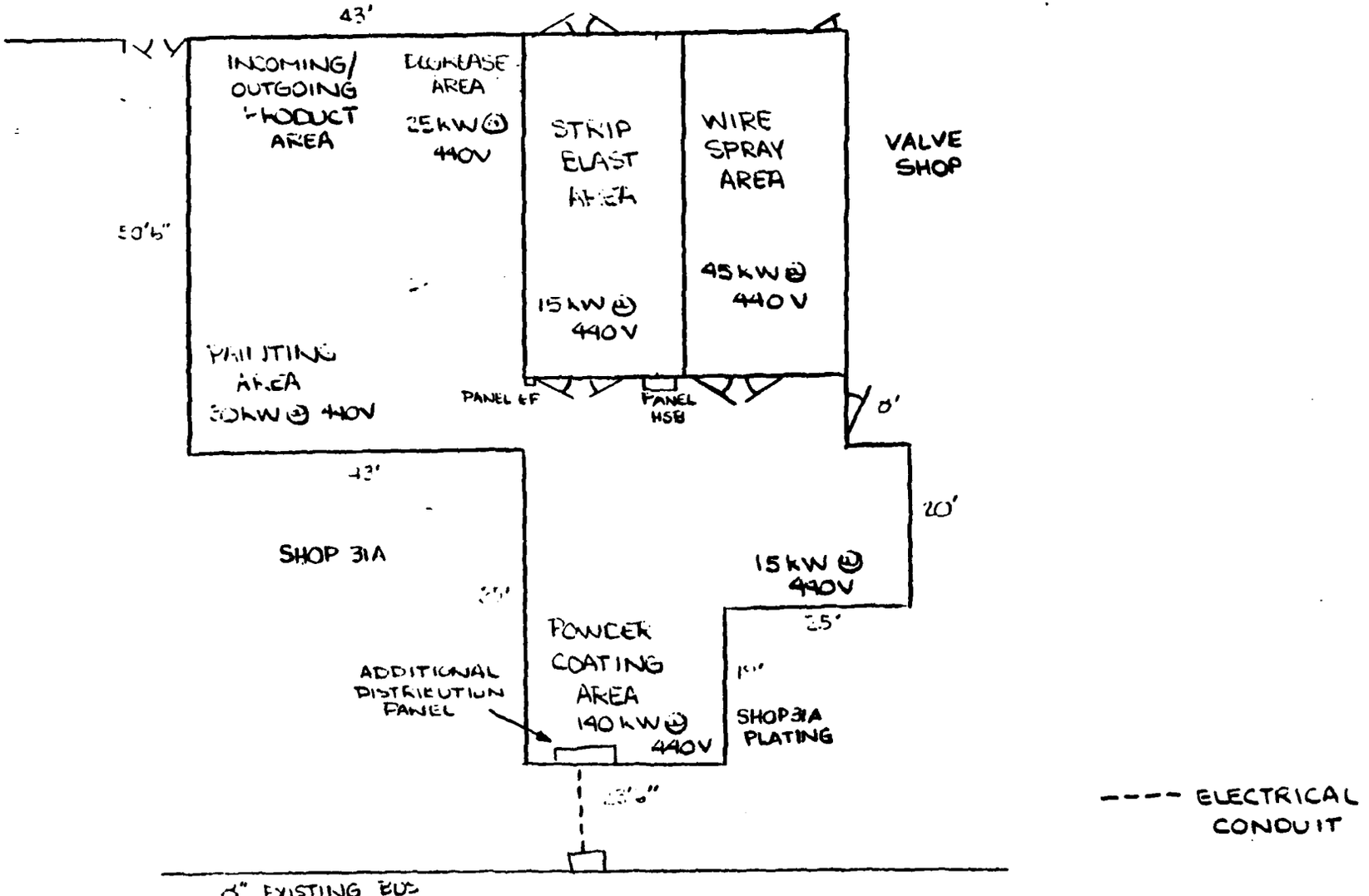
CROSS-CONNECT SCHEMATIC



NOTE: COMPRESSER SHALL BE LOCATED IN MECHANICAL EQUIPMENT ROOM NEAR THE EXISTING GENERAL SERVICE COMPRESSOR

Enclosure (7)

CORROSION CONTROL SHOP 71A
MAJOR ELECTRICAL REQUIREMENTS



Enclosure (8)

SITE SURVEY

PERSONNEL LIST

CDR. E. Rundberg	Commanding Officer, SIMA Norfolk
LT. CDR. J. Pesar	IMA Coordinator, COMNAVSURFLANT
LT. CDR. Graf	Supply Officer, SIMA Norfolk
LT. S. Huffer	Repair Officer, SIMA Norfolk
LT. Flint	Planning Officer, SIMA Norfolk
LT. Walker	Safety Officer, SIMA Norfolk
CWO Manning	Quality Assurance Officer, SIMA Norfolk
MC Turner	P.O.C. (R2 Division), SIMA Norfolk
S.C. Mehan	Administration Officer, SIMA Norfolk
MC Roddenberry	Production Officer, SIMA Norfolk
S.C. Foley	Planning, SIMA Norfolk
R. Parks	NAVSEA 05M1
D. Sowell	NAVSEA 05M1
T. Shanahan	ARINC
K. Brown	ARINC
O. G. O'Brien	ISA
A. Marie Robinson	ISA

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