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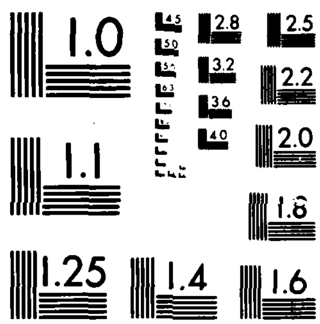

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30 November 1985

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1 AUGUST 1985 - 30 NOVEMBER 1985
FINAL REPORT

Corrosion-Control (CC) Program
SIMA Pilot CC Shop Service Test and Technical Support

Volume I
Final Report - Sections 1 to 8

Contract N66001-85-C-0350

Prepared for:

COMMANDER
NAVAL OCEAN SYSTEMS CENTER
SAN DIEGO, CALIFORNIA 92152

In support of:

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16. Abstract (Limit: 200 words)

The objective of the SIMA Corrosion-Control Services Program was to develop a functional and production capability for SIMAs to deliver and support corrosion-control coating systems being used by the Navy in new construction ships and in the maintenance, repair and overhaul of ships in service. This report presents the results of the one-year Service Test of the SIMA San Diego Pilot Corrosion-Control Shop and the recommendations for establishing Corrosion-Control Production Shops at SIMAs. The one-year Service Test was completed on 30 November 1985. The establishment and operation of the Pilot Shop are summarized. For the Production Shop, recommendations are included for organization, manning, equipment, shop operation, shipboard operation, installation kits, planning and training to implement the establishment of a SIMA Production Shop.

17. Document Analysis a. Descriptors

Corrosion	Paint	Intermediate Maintenance Activity
Aluminum	Ships	Corrosion Control Shop
Metallizing	Thermal Spray	Process Instruction
Powder Coating		

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

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EXECUTIVE SUMMARY

BACKGROUND and REQUIREMENTS

This is the final report of the Pilot Shore Intermediate Maintenance Activity (SIMA) Corrosion-Control (CC)-Shop Service Test conducted from 13 September 1984 through 30 November 1985. It presents all the relevant technical information compiled and analyzed during the Service Test along with the lessons learned. Recommendations are made for the CC-Shop facility, equipments, industrial processes, shop layout and production flow, consumables, manning and training for a baseline CC Shop capable of simultaneously providing ship-to-shop and shop-to-shop for three ships' availabilities lasting eight or more weeks and shipboard services with a portable/containerized wire-sprayed-aluminum (WSA) system for one ship in overhaul.

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 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 Commander, Naval Surface Pacific Fleet (COMNAVSURFPAC) and/or Naval Sea Systems Command (NAVSEA). Development of CC programs will benefit operating units of COMNAVSURFPAC by:

- Reducing the excessive ship's force manhours spent on corrosion prevention and control,
- extending the service life of shipboard components and areas from marine corrosion, and
- reducing/eliminating the attendant material, labor and schedule costs to repair/replace.

Accordingly, COMNAVSURFPAC initiated a program in 1984 to evaluate the SIMA CC-Shop feasibility, develop a test plan and install a Pilot CC Shop at SIMA(SD) to provide near-term service for ships of the Pacific Fleet commencing in September 1984.

The scope of this pilot work included developing and validating through a one-year service test:

- Selection, installation and operation of industrial plant equipment (IPE).
- Industrial processes for wire-sprayed aluminum (WSA) and electrostatic-sprayed powder (ESP) coatings.

- Makeup and issue of installation kits for the proper reassembly and installation of ship-to-shop items preserved by the CC Shop.

- CC-Shop manning, organization, management, operating procedures and standard times for the preservation of representative shipboard components.

- Planning concept and procedures for CC Work Packages (CCWP) for tended ships starting with an initial Planning Assist Visit (PAV) through to the automated work requests (AWR) in the ship-class Master Job Catalog (MJC).

- Training and training materials for CC Shop, Planning and Quality Control personnel.

The Pilot CC Shop Service Test, September 1984 through November 1985, provided the forum to investigate the equippage, manning and modus operandi for a production SIMA CC Shop. The scope of the Service Test included evaluation and demonstration/validation of the planning procedure; shop manning and organization; industrial plant equipment (IPE); shop operating procedures, process instructions, quality control and records; customer ship post-CC-availability inspection and feedback; and training. There were numerous technical, management and interface issues that were evaluated. This Executive Summary provides the Service-Test recommendations for the establishment of a Corrosion-Control Production Shop in COMNAVSURFPAC SIMAs. The recommendations are for: (a) shop function and organization; (b) production requirements for ship-to-shop and shop-to-shop; (c) production requirements for in-situ shipboard work; (d) fastener and installation kits for the proper reassembly and reinstallation of preserved components; (e) SIMA planning requirements; and (f) training.

RECOMMENDATIONS

A. <u>**SIMA Planning**</u> (Section 2)

- CC Planning and work accomplishment can logically follow the conventions and protocol of the Navy's Ship Maintenance and Material Management (3-M) Manual (OPNAVINST 4790.4 series). Figure 2-3 gives the recommended activities and functional flow.

- During initial phases of the COMNAVSURFPAC CC Program and until S/F have entered CC SMAFs in their CSMP, it is recommended that SIMA Planning and the SIMA CC-Shop Master provide CC Planning Assist Visits (CCPAV) to assist customer ships in conducting CC surveys and in developing the CC SMAFs for entry into the CSMP.

- In order to maximize the preservation services delivered to the customer ships, each ship must have a coordinator who can devote the majority of his time to the CC efforts. It has been found that assigning this position to personnel who have already been assigned additional colateral duties involved with the availability, such as the

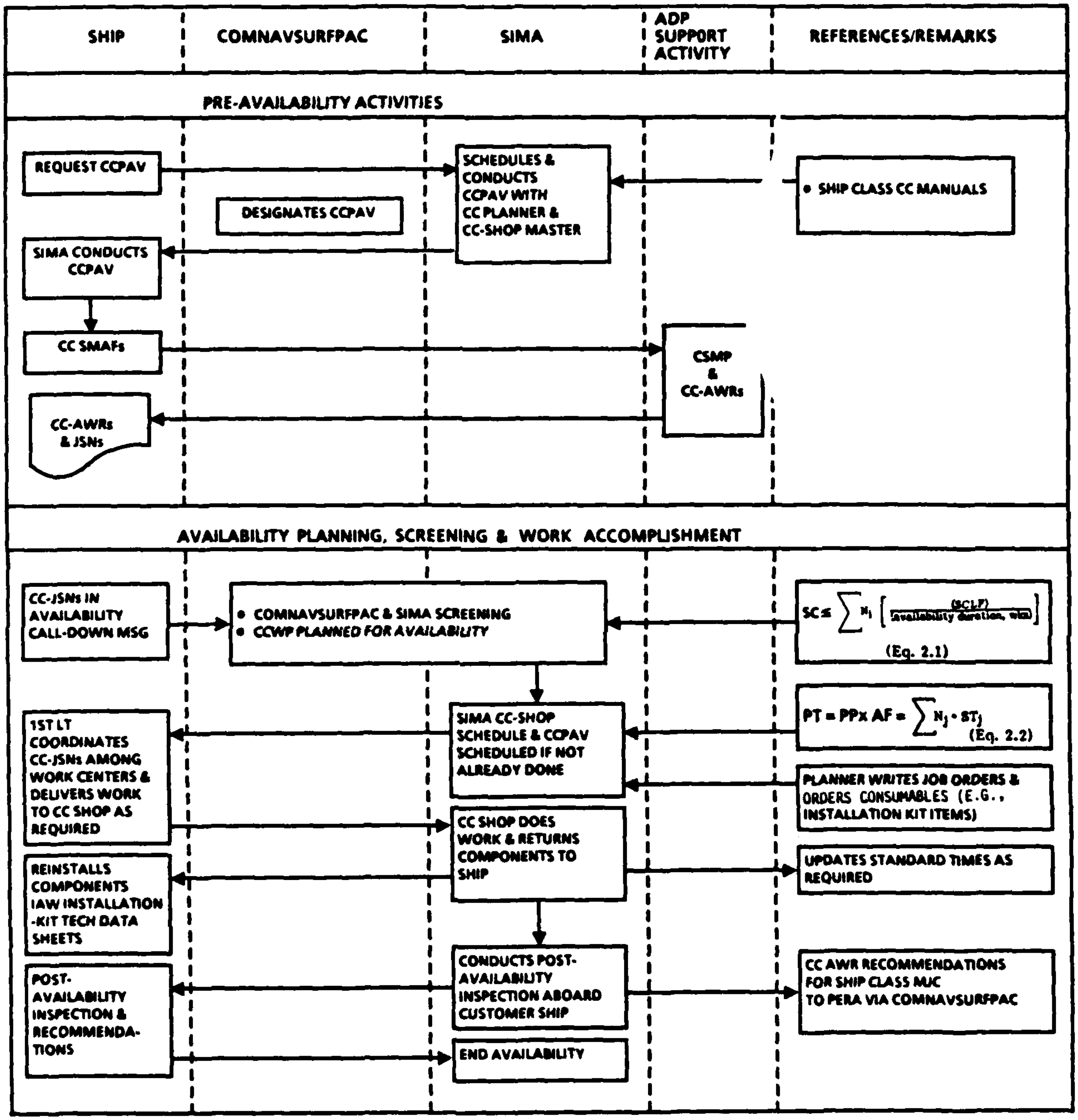

Figure 2-3 Corrosion-Control Planning and Work Accomplishment

ship's 3-M coordinator, does not benefit the ship to the full extent. It is therefore recommended that the ship's First Lieutenant be ship's CC Coordinator among the ship Work Center Supervisors and Division Officers. The First Lieutenant should also prioritize the CC JSNs for the SIMA availabilities and ROHs.

- SIMA CC services should be limited to ships in availabilities lasting greater than eight weeks. A "SIMA ship-loading" equation, based on existing/planned CC-Shop IPE and facilities should be used to screen and schedule ships for CC availabilities.

- A "SIMA CC-Shop-loading" equation, based on assigned production personnel and production standard times, should be used to screen work to the CC Shop.

B. <u>**Shop Function, Organization, Manning and IPE**</u> (Section 3)

- <u>**Function**</u> - The SIMA CC production shop should operate as a lead shop to provide WSA and ESP coating services, technical assistance and material support for installation kits for CC-Shop preserved components for assigned ships and units.

- <u>**Services**</u> - The production shop should be capable of (a) providing technical advice on the causes and prevention of shipboard corrosion and the application of the 15 NAVSEA-designated CC systems and (b) delivering production services for WSA (NAVSEA Systems 1 and 2) and ESP (NAVSEA System 4), and (c) makeup and issuing installation kits for the reassembly and reinstallation of WSA and ESP preserved components.

- <u>**Organization**</u> - The SIMA CC Shop should be in the Production Department since it provides support to assigned ships, units and other production shops. The Hull Repair Group and Services Group are logical organizational assignments for the CC Shop.

- <u>**Manning**</u> - The exact manning requirements for a production shop will vary at each SIMA as a function of shop's IPE, physical plant/layout, workload requirements, port loading, numbers of ships simultaneously in availabilities, and types and size of shops at the SIMA generating shop-to-shop workload. Planned facilities and equipment for the CC Shop dictate the manning requirements. Table 3-4 lists the recommended positions that need to be considered for the production shop, the rate and typical duties.

Table 3-4 Production Shop Manning

POSITION	RECOMMENDED RATE	TYPICAL DUTIES
Shop Master	CPO	Liaison with ships and SIMA Shops
Assitant Shop Master	PO1	Direct Shop operations
Receipt Inspection, Final Inspection	PO2	Check in/out product, ensure product delivered ready for processing
Degreasing, Masking	FN/SN	Prepare items for preservation process
Strip Blasting	FN/SN	Operate strip blast unit
Anchor-Tooth Blasting	FN/SN	Operate anchor-tooth blast unit
Strip- and Anchor-Tooth Blast Unit Support	FN/SN	Move product in/out of blast units, load/unload grit
WSA Operators	FN/SN	Apply WSA coatings
WSA Support	FN/SN	Move product
Painting	FN/SN	Operate paint spray booth
Fastener and Installation Kit Petty Officer (IKPO)	PO1	Prepare installation kits, assist ship in installation
Supply Petty Officer, Assistant IKPO	PO2	Maintain consumables Assist Fastener Petty Officer
Shop Quality-Control Inspector	PO2	Provide direct QC support
Training and PMS Petty Officer	PO1	Train operators and direct PMS Program
ESP Operators	PO3*	Operate ESP Facility

* Anticipated ESP Operator Recommended Rating. Further evaluation is being conducted and recommendation will be finalized upon completion of the Pilot ESP Facility Service Test.

- **IPE and Facilities** - The equipment classes for a SIMA CC Shop are shown in Table 3-5. The specific size and quantity of each equipment class will be determined by the size of the Shop. Complete WSA- and ESP-coating equipments are provided. The SIMA, Pearl Harbor CC Shop layout is shown in Figure 3-3 as a typical example. The Plan of Action and Milestones (POA&M) for the SIMA(PH) CC Shop implementation (Figure 3-4) is also provided to illustrate the typical schedule of events and time required to install a CC Shop. Typical line diagrams for electrical power, water and air are shown in Figures 3-5, 3-6 and 3-7. As a second example, the SIMA(SD) MILCON Project CC-Shop Layout is shown in Figure 3-8.

Text continues on page xiv

Table 3-5

PRODUCTION SHOP EQUIPMENT CLASSIFICATIONS

IPE	
Surface-Preparation IPE	**WSA-Coating IPE**
• Degreaser	• Portable/Containerized WSA Unit
• Reach-In Blast Cabinet	• WSA Spray Equipment
• Portable/Containerized Blast Unit	• Waterwash Booth
• Abrasive Blast Unit (Walk-In)	**Painting IPE**
	• Waterwash Booth

MISCELLANEOUS EQUIPMENT	
Painting Equipment	**Mat'l Handling/Storage Equipment**
• Paint Spray Gun Assembly	• Storage Cabinet
• Paint Mixers	• Flammable Liquid Storage Cabinet
Testing/QA Equipment	• Pre-Expended Bins
• Zinc- and Aluminum-Identification on Steel Kit	• Small Parts Storage
• Surface Profile Measurement Apparatus	• Oxygen and Acetylene Bottle Storage Racks
• Portable Electric Psychrometer	• Work Table
• Holiday Detector	• One-Ton Electric Hoist and Swing Boom
• Wet Film Thickness Gauge	• Half-Ton Hand-Operated Chain Hoist
• Dry Film Thickness Gauge	• Mobile Hydraulic Floor Crane
	• Hydraulic Pallet Truck
	• Platform Truck

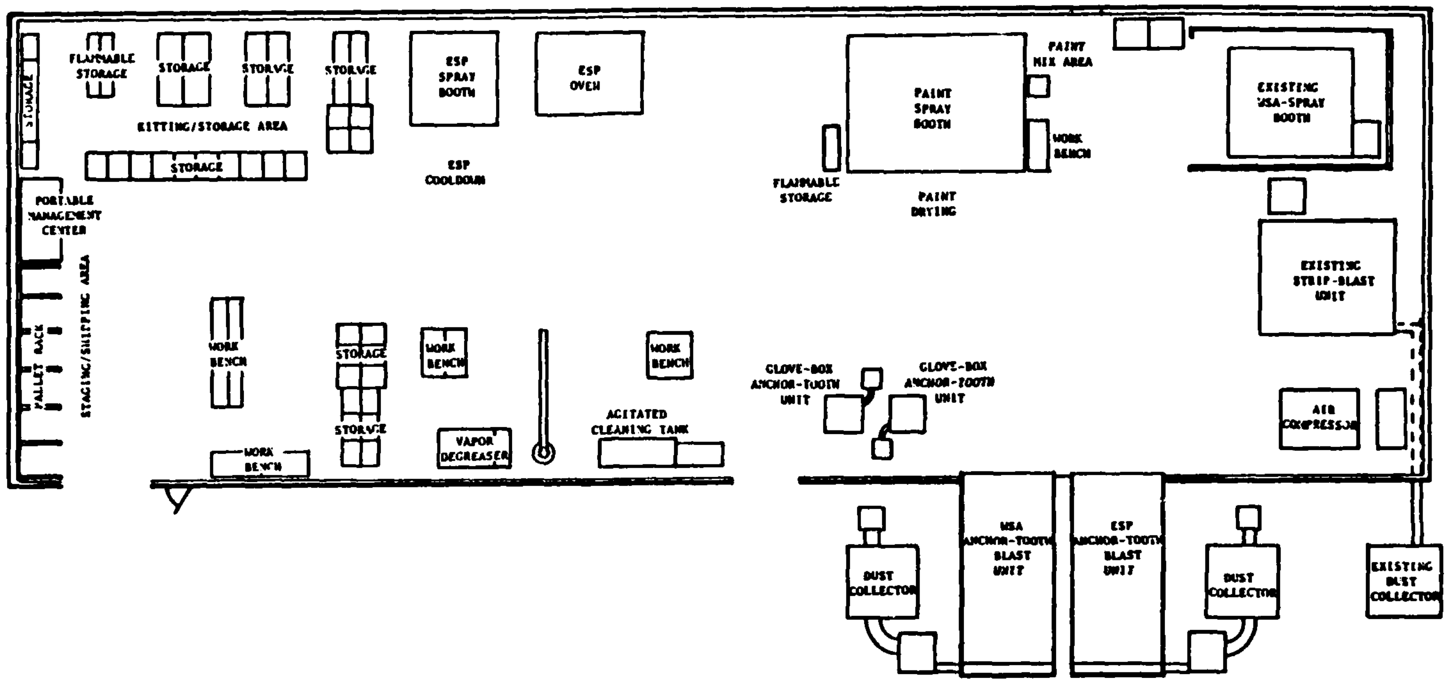

Figure 3-3 SIMA Pearl Harbor Production CC Shop

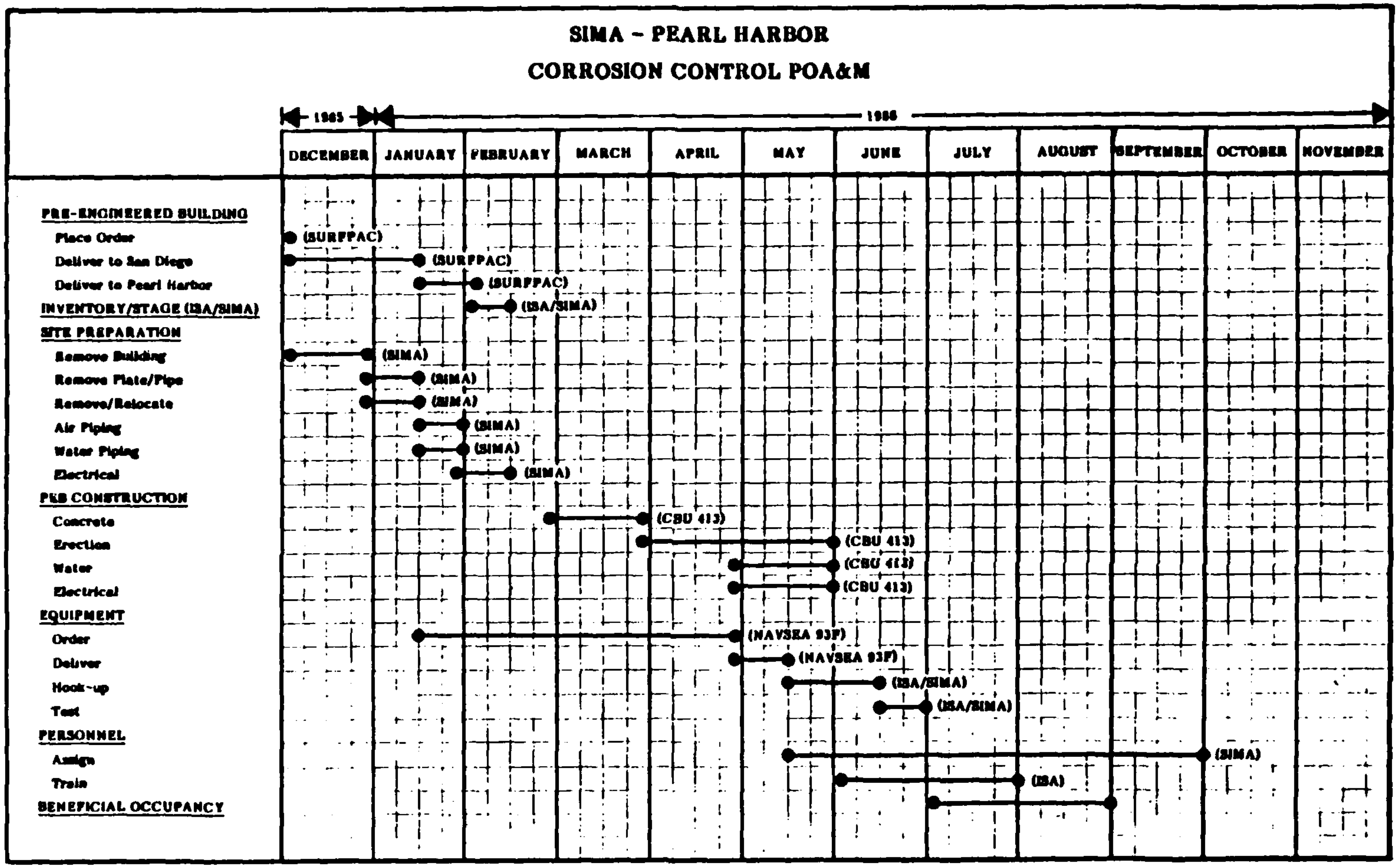

Figure 3-4 Proposed POA&M for SIMA(PH) CC Shop

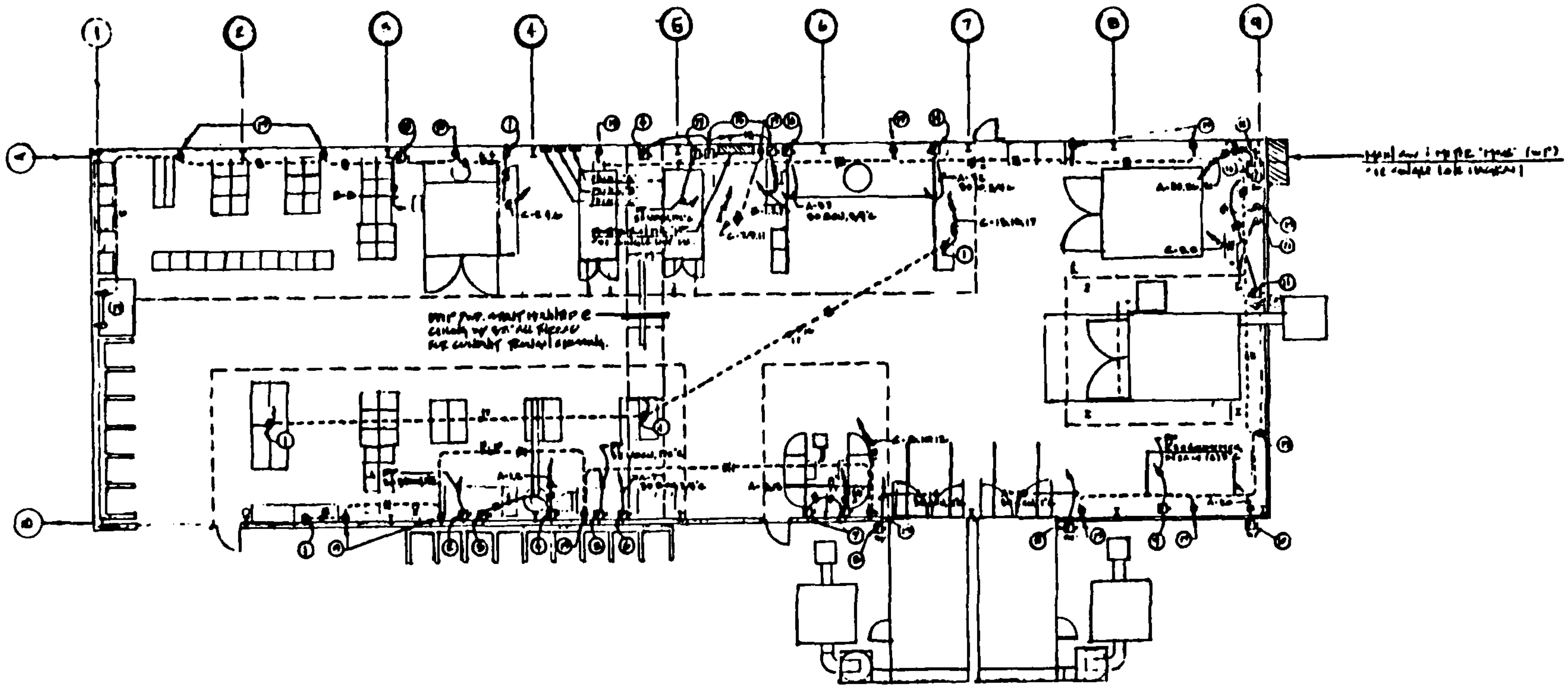

Figure 3-5 SIMA(PH) Electrical Power Line Diagram

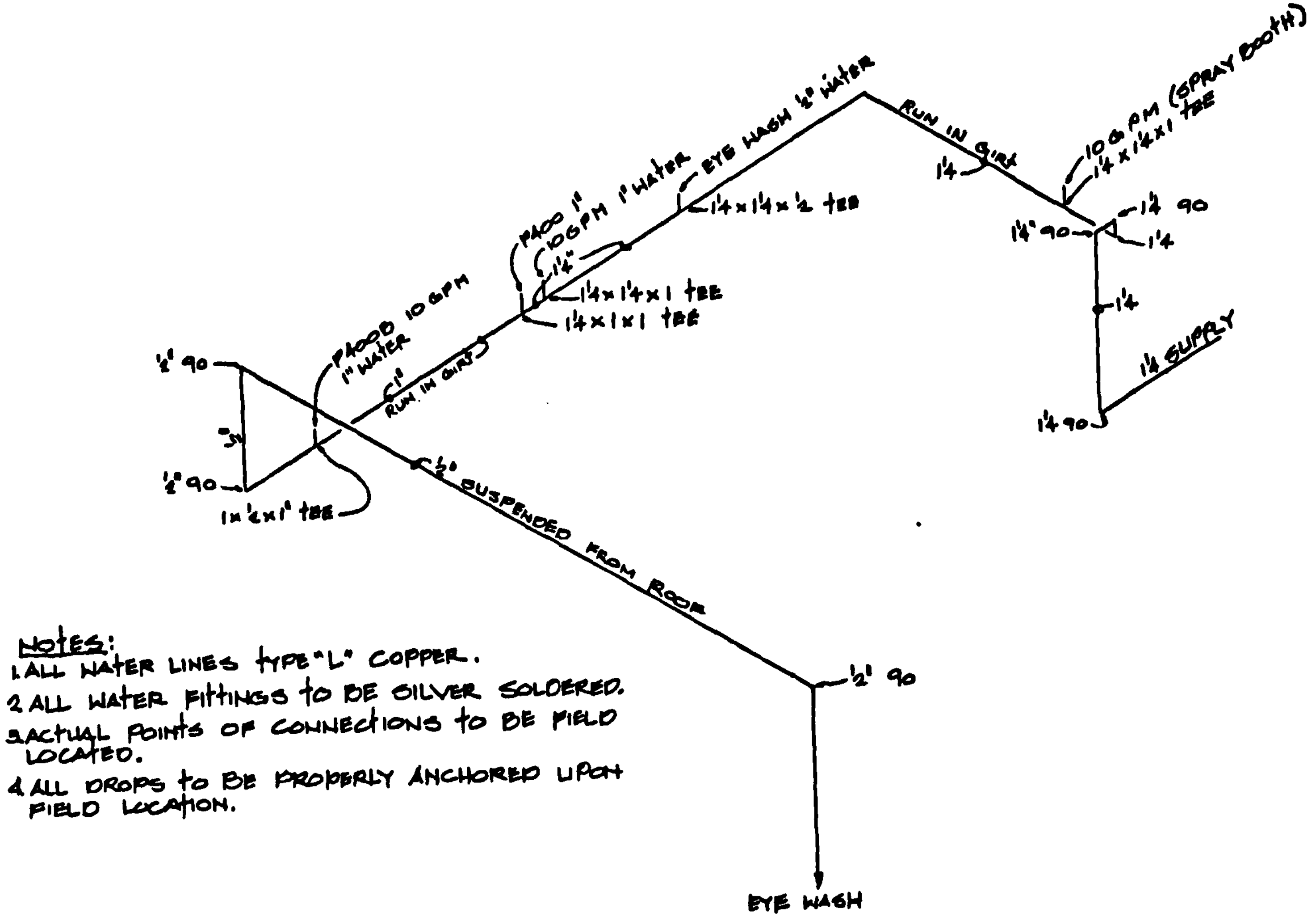

Figure 3-6 SIMA(PH) Water Line Diagram

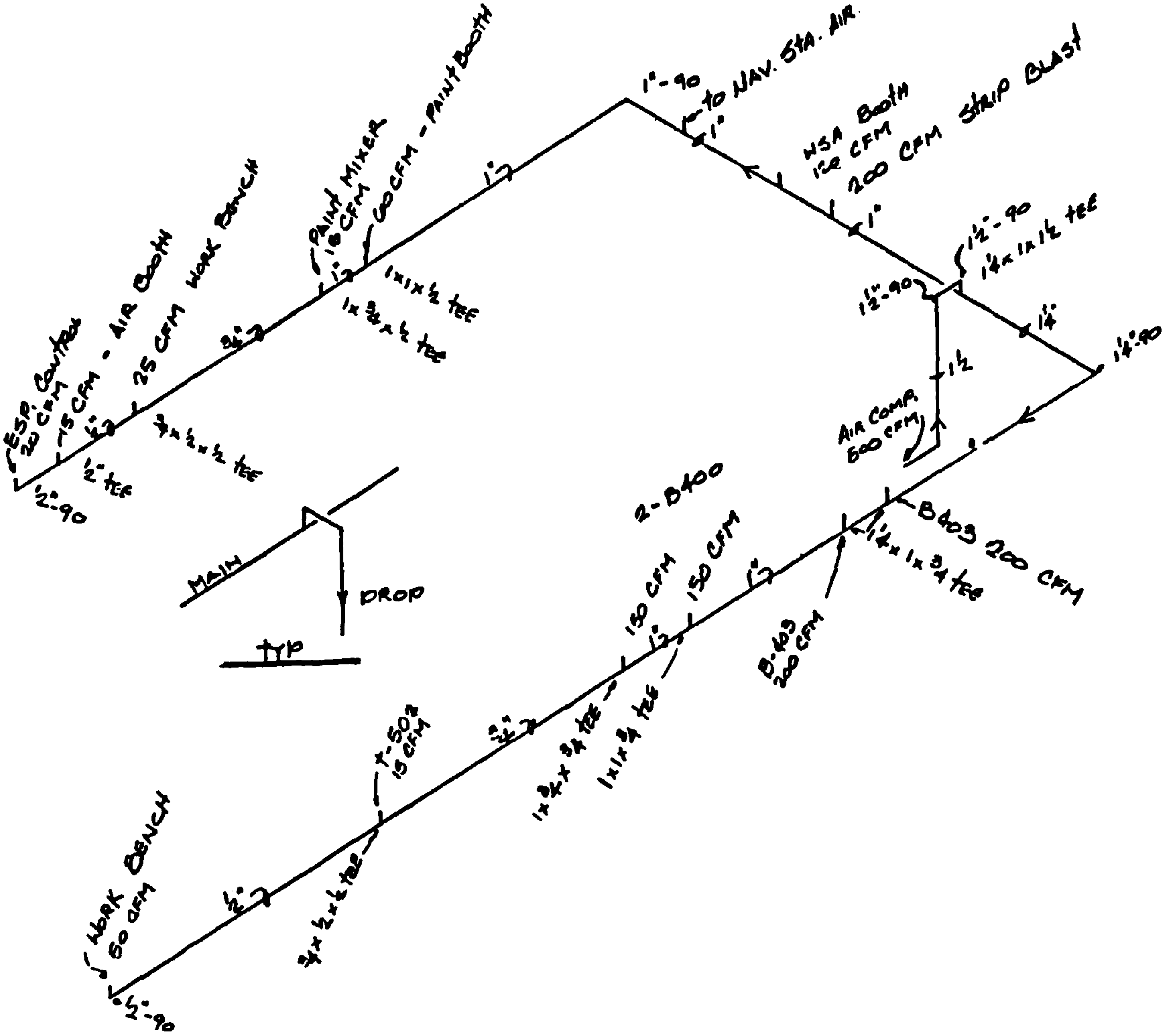

Figure 3-7 SIMA(PH) Air Line Diagram

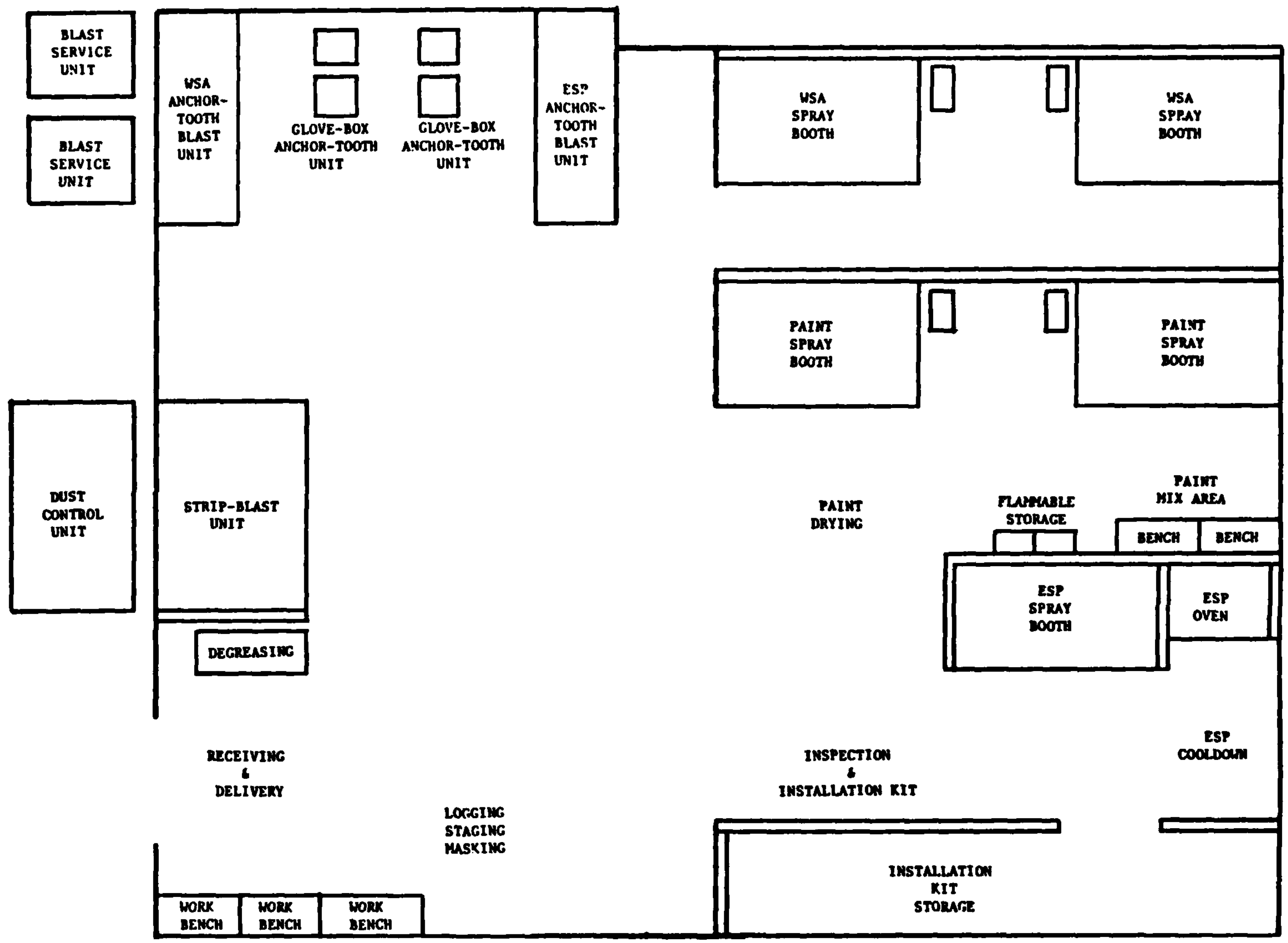

Figure 3-8 SIMA(SD) MILCON Project P-012 CC Shop

C. **Production Shop Requirements** (Section 4)

- **Wire-Sprayed Aluminum (WSA) Coatings**

WSA coatings should be applied in accordance with DoD-STD-2138(SH), NSTM 631 and the SIMA(SD) Process Instruction No. 7100-18-84 Rev. 1 (Appendix A4-2).

- **WSA Production**

The CC Shop should consist of nine basic stations:

.. Receipt Inspection,
.. Degreasing,
.. Masking,
.. Strip Blasting,
.. Anchor-Tooth Blasting,
.. WSA,
.. Painting,
.. Installation-Kit Makeup and Issue, and
.. Final Inspection and Customer Pickup.

Note: The ESP Pilot CC Shop Service Test is currently in progress under a separate contract. Final recommendations for the ESP production facility will be provided at the end of the ESP Service Test. An additional three stations in the CC-Shop are expected to be needed: ESP anchor-tooth blasting, ESP spray and ESP curing.

- **Production-Shop Records**

As supported by the Pilot CC-Shop experiences, forms are required to maintain shop organization and effectiveness. Some forms used during the Service Test are no longer needed, however the following forms, or suitable equivalent forms, are recommended.

.. Production-Control Work-Load Log (Figure 3-9)

.. Daily-Assignment/Time-Study Worksheet (Figure 4-6)

.. Production-Control Record (Figure 4-3)

.. Shipboard CC Post-Availability Inspection Sheet (Figure 3-11)

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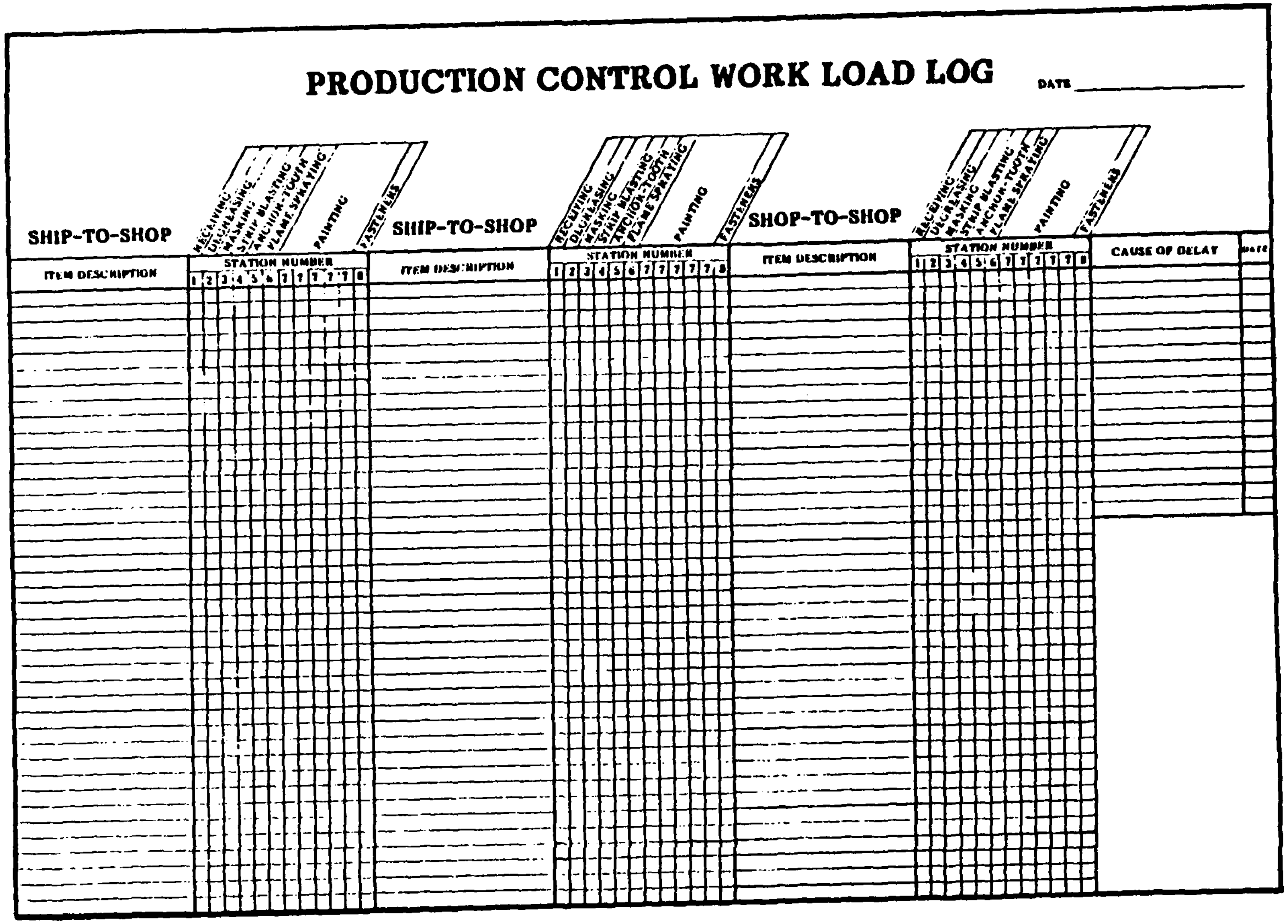

PRODUCTION CONTROL WORK LOAD LOG DATE ______

SHIP-TO-SHOP

ITEM DESCRIPTION

RECEIVING
DEGREASING
MASKING
STRIP BLASTING
ANCHOR-TOOTH
FLAME SPRAYING
PAINTING
FASTENERS

STATION NUMBER

1 2 3 4 5 6 7 7 7 7 7 8

SHIP-TO-SHOP

ITEM DESCRIPTION

RECEIVING
DEGREASING
MASKING
STRIP BLASTING
ANCHOR-TOOTH
FLAME SPRAYING
PAINTING
FASTENERS

STATION NUMBER

1 2 3 4 5 6 7 7 7 7 7 8

SHOP-TO-SHOP

ITEM DESCRIPTION

RECEIVING
DEGREASING
MASKING
STRIP BLASTING
ANCHOR-TOOTH
FLAME SPRAYING
PAINTING
FASTENERS

STATION NUMBER

1 2 3 4 5 6 7 7 7 7 7 8

CAUSE OF DELAY

DATE

Figure 3-9 Production-Control Work-Load Log

SHOP 961
CORROSION CONTROL
DAILY ASSIGNMENTS/TIME STUDY
WORKSHEET

______________ Date

NAME	1 Station Assignment	2 Shop Production	3 Corrective Maintenance	4 Military	5 Training	6 PMS	7 Personal Business	8 Other	REMARKS
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									
12.									
13.									
14.									
15.									
16.									
17.									
18.									
19.									
20.									

STATION ASSIGNMENT KEY

0. Leave, Liberty, Tad, Etc.
1. Receipt, Tag, Degrease
2. Masking
3. Rough Blast Unit
4. Anchor Tooth Blast Unit
5. Wire Spray Booth
6. Spray Booth
7. Station Runner
8. Installation Kits
9. Quality Assurance
10. Supply
11. Supervisor

1. Fill out form daily.
2. Block 1 - Enter number corresponding to station assigned.
3. Blocks 2-8 - Enter number of man hours expended in each category.

* Explain in Remarks Column

Figure 4-6 Daily-Assignment/Time-Study Worksheet

CORROSION-CONTROL SHOP
WIRE-SPRAYED-ALUMINUM
PRODUCTION-CONTROL RECORD

USS ______________________________
Ship   Hull Number

Job Control Number (JCN) ______________   Production Control Number ______________

Item Description ______________   Location Deck Frame Side ______________

TYPE COATING:

____WSA(HT) Sys 1

____WSA(LT) Sys 2

FINISH COLOR

____HRAP

____HAZE GRAY

____DECK GRAY

____OTHER ____________

SECTION	PROCESS SEQUENCE INSPECTIONS			DATE	TIME	SHOP QCI SIGNATURE
1.	Receipt, Degrease, Degalvanize, Dealuminize					
2.	Masking	Plug				
		Tape				
3.	Strip Blast					
4.	Anchor Tooth 2-3 mils		mils			
5.	Thermal Spray		High mils			
	Sys 1 10-15 mils	Sys 2 7-10 mils	Low mils	Operator Name		

		Seal, Barrier and Topcoat				ATTACH PROFILE TAPE HERE
		Type/DFT Rqmt	Measured DFT	Date	Time	
CC SYS 1	6.	HRAP/1.5 mils				
	7.	HRAP/1.5 mils				
CC SYS 2	8.	150/0.5-0.75 mil				
	9.	151/3 mils				
	10.	150/3 mils				
	11.	TC/1.5 mils				
	12.	TC/1.5 mils				
	13.	Final Thickness				
	14.	Final Assembly Inspection				

ISA EXP. FORM CCP-1 REV 6(08-15-85)

Figure 4-3 Production-Control Record

CORROSION CONTROL SHOP
SHIPBOARD CC POST-AVAILABILITY INSPECTION SHEET

USS ____________________ DATE ____________________

		CORRECT INSTALLATION		COATING DAMAGE		COATING THICKNESS				
ITEM	LOCATION	YES	NO	YES	NO	WSA	WSA & PAINT	ESP	OBSERVED CONDITION	RECOMMENDATIONS

The above items were inspected upon reinstallation and found to be in the condition listed. A copy of this report has been issued to the Ship CC Coordinator in order to provide the corrective action recommended.

Prepared by: ____________________ Shop Master ____________________
Signature

Figure 3-11 Shipboard CC Post-Availability Inspection Sheet

• Production-Shop Procedures

.. Shop Master and Personnel Duties

WSA coating is a new technology in the Navy and its success extremely operator dependent. In light of this fact, the Shop Master must be completely knowledgeable in WSA procedures. The Shop Master must be able to identify candidate components and possible resulting problems. The Shop Master must also have "subject matter" knowledge of all the services delivered by the CC Shop. He must assist Planning in conducting CC Planning Assist Visits to assist customer ships in developing their CC work lists, SMAFs and Availability Call Down Message. He must be aware of the workload status at all times, the quality and proficiency of shop work and be in constant contact with the ShipSup to schedule and deliver the product in a cost-effective and timely manner. Additionally, support personnel are required to perform "overhead" duties: Assistant Shop Master, supply support and records and Shop Quality Control.

.. Planning

To establish the proper workload scheduling, the CC-Shop Master must provide the planner with constant feedback on the production time standards and consumable requirements and usage. The time-standard data base will need to be updated with continuing production experience and improve IPE and shop layout.

.. PMS

Shop PMS program must be developed and implemented to maintain efficient shop operation. The recommended PMS procedures have been prepared and presented to SIMA(SD), Code 8220. This package is presented in Appendix A4-7 and can be used as a guide for other CC Shop PMS procedures.

.. Quality Assurance

A QA program is mandatory to maintain a successful CC-program. The recommended QA procedures are included in the SIMA(SD) Process Instructions No. 7100-18-84 Rev. 1 for WSA; No. 7100-19-84 for ESP. Shop Quality Control Inspectors should be assigned.

.. Shop Records

Due to the importance of maintaining accurate paperwork, a dedicated Supply/Record Petty Officer is required. A convenient method of maintaining such records as supply/inventory and production summaries by ship, would be to input this data into a computer bank.

.. **Corrosion-Control Work-Accomplished Book**

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 the CC project. During the tour of the USS CUSHING by Shop 06I and ISA, WSA items were observed that had been chipped with chipping hammers and ESP-coated items had been painted over with standard haze-gray topcoat. Discussion with S/F 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 since they were not clearly identified as being preserved. These items required additional processing and thereby reduced the shop production. It was therefore determined that a complete listing of preserved components is required to maintain a successful CC program onboard customer ships. This listing is also useful in CCWP screening. It is recommended that the CC Work-Accomplished Information Book continue to be published and distributed. This book should be completed as a joint effort of the Supply/Record Petty Officer and the SIMA Corrosion-Control Technical Advisor based upon the records maintained by the shop.

D. Shipboard Production (Section 5)

Presently, the in-situ application of WSA onboard U.S. Naval vessels is accomplished by master ship repair (MSR) contractors and their subcontractors or S/F. Upon ship's request, the type desk officer can approve the work to be included in the overhaul package. SIMA can develop the capability of performing in-situ WSA application onboard Navy surface vessels. In order to determine the merit of a SIMA to perform in-situ WSA application, a Service Test was performed by the Pilot CC Shop at SIMA(SD) utilizing shop and S/F personnel, present WSA process techniques and available equipment.

- **Portable/Containerized WSA Services**

The use of containerized abrasive blast and wire spray aluminum systems aboard ROH ships are recommended to be utilized by S/F and supervised by SIMA personnel during overhaul to preserve non-removable components. This is essentially a portable/containerized CC Shop on the ship (or support barge/pier area). Installation Kit support may also be provided resources permitting.

- **Ship Spaces/Areas**

It is recommended that in-situ application of WSA be performed only during overhaul because it requires heavy industrial equipment for debris containment and control, wire spraying and painting and sufficient time to preclude interference with other scheduled work. SIMA and S/F working together should be able to apply the WSA system at a rate of about 125 sq.ft. per day; 2000 sq.ft. would take about 4 weeks.

- **Manning**

Table 5-11 lists the recommended SIMA and S/F crew for shipboard WSA services; First and Second Class Petty Officers from SIMA and Third Class Petty Officers and Firemen/seamen from Ship's Force.

Table 5-11 Recommended Shipboard Team Manning Per Shift

	ONE-SPACE PRODUCTION CAPACITY	TWO-SPACE PRODUCTION CAPACITY
Shipboard Leading P.O. (1st Class, SIMA)	1	1
Operator(s)		
(2nd Class, SIMA)	1	1
(3rd Class, Ship's Force)	1	3
Assistant/Safety Observer (FN/SN, Ship's Force)	2	4

- **IPE**

.. Grit disposal should be by containers that hold four cubic yards (13,000 lbs). Disposal would be via normal SIMA industrial waste methods. As an option SIMA could obtain the services of a grit reclamation company to provide a container and pick up the container when full.

.. Canvas tarps, thin wall conduit and conduit frame maker clamps should be used to construct grit blast and ventilation enclosures.

.. A five-horsepower ventilation blower and eight- to ten-inch ducting combination should be used because one man can move and set up the gear. One 15-horsepower ventilation motor was used for the Service Test; three five-horsepower ventilation motors should have been used.

.. 250 SCFM air at 80- to 100-psi are required for the shipboard services: about 230 SCFM for abrasive blasting and 15 SCFM for personnel breathing in the surface-preparation mode; about 30 SCFM for the flame-spray gun and 15 SCFM for personnel breathing.

.. Large amphibious ships provide room for equipment staging. Smaller combatant ships, such as cruisers and destroyers, have room for equipment staging only on flight decks, forecastles and fantails. The equipment size and weight should be discussed with the SUPSHIP, MSR contractor and ship before the shipboard CC services commence to address the effect of the equipment on the ships' buoyancy, alignment procedures and foot traffic.

.. The use of recommended production methods, equipment, manning and scheduling discussed in detail in Section Five shall ensure the shipboard application of in-situ WSA will be economically feasible and meet quality assurance standards required by DoD-STD-2138(SH).

E. **Fastener and Installation Kits** (Section 6)

General Recommendations

- SIMAs should maintain sufficient fastener inventory for two ships of each class of ship tended by that particular SIMA.
- Fasteners should be 316 stainless steel or ceramic coated.
- An Installation-Kit Petty Officer is recommended to be assigned to assemble installation kits and provide technical assistance to S/F during reinstallation of preserved components.

SIMA Recommendations

- Continue surveys to develop Installation-Kit Books for each ship class. After completing the initial survey of one ship of each class, survey several ships of each class to update Installation-Kit Books. Incorporate completed books in the Ship-Class Corrosion-Control Manuals.
- Develop an automated data base of Installation-Kit Technical-Data Sheets, planning information and supply support.
- Continue to explore the use of Naval Reserve units to manufacture non-standard fasteners, such as pyro-locker clips.

F. **Training** (Section 7)

- **CC-Shop Technician Course:** The CC-training course developed and used for training the CC-Shop Technicians should be used, validated and updated during the startup training for SIMA(PH) CC Shop planned for May-June 1986. Table 7-1 lists the lesson plan titles and recommended class and shop OJT times for three units:

  I - Marine Corrosion, Causes, Prevention and Control

  II - WSA: Equipment and Application Processes

  III - ESP: Equipment and Application Processes

Table 7-1 SIMA CC Training Curriculum

UNIT	LESSON	TITLE	SHOP TECH CLASS (hr)	SHOP TECH OJT (hr)	PAGE NO. A7-1-
I		**MARINE CORROSION, CAUSES, PREVENTION AND CONTROL**			
	1	Introduction and Corrosion Discussion	2	—	6
	2	Corrosion; Causes and Control	2	—	27
	3	Corrosion Evaluation and Control	2	—	39
	4	CC Systems 1 and 2: WSA	2	—	51
	5	CC Systems 3: Paints	3	14	83
	6	CC System 5: Non-Skid Deck Coating	1	—	119
	7	CC System 4: Powder Coating	3	—	134
	8	CC Systems 6-9: Fasteners and Preservation Materials	1	—	144
	9	CC Systems 10-15: Sealing and Coating Compounds	1	—	158
	10	Installation Kits	1	7	170
	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	—	186
	2	CC Using WSA, Part I - Surface Preparation	4	20	195
	3	CC Using WSA, Part II - Wire Spraying	4	28	206
	4	CC Using WSA, Part III - PMS	4	8	213
	5	CC Using WSA - Certification Tests	2	6	218
		UNIT TOTAL	**18**	**62**	
III		**ESP EQUIPMENT AND APPLICATION PROCESS**			
	1	ESP-Coating Review and GEMA ESP Equipment	2	6	236
	2	NORDSON ESP Equipment	2	6	258
	3	ESP Spray Booth, Curing Oven and Containers	2	6	283
		UNIT TOTAL	**6**	**18**	
		COURSE TOTAL (141 hrs ≈ 18 days)	**38 (2)**	**101**	

* Will be developed for the SIMA(PH) CC-Shop Startup Training.

- **CC Wire-Spraying Technicians:** WSA technicians should have approximately 20 hours in the classroom (1/4 of training time) and 60 hours "hands-on" in the Shop (3/4 on-the-job training time). Of the 60 hours "hands-on" in the Shop, a minimum of 20 hours should be spent observing and working with a "journeyman" flame sprayer using the WSA gun to learn its proper operation, application and to become proficient in spraying techniques on non-production items. The remaining 40 hours (2nd week of training) of OJT should be spent working in the CC-Shop to develop proficiency.

- **Trainee Prerequisites**

  (1) **CC-Shop Technician** should be

  .. E3-E5.
  .. Preferably from the deck or hull groups.
  .. Assigned to the SIMA CC Shop for a three-year tour of duty.
  .. A' 'e to pass the WSA certification courses.

  (2) **CC-Shop Training Instructor** should be

  .. E6 or above, preferably a BM or a HT.
  .. A graduate of a Navy instructor school within five years prior to being assigned to a SIMA CC Shop.
  .. Have a minimum of 12-months WSA system experience.
  .. A certified WSA operator in good standing.
  .. Have a minimum of two years work in a SIMA CC Shop and have a substantive understanding of the shop services and modus operandi.
  .. Be involved in daily production work in WSA, ESP and painting in the SIMA CC Shop to maintain his skill and proficiency.

- **CC-Shop Start-Up Training:** Classroom and OJT for new CC-Shop installations should begin four to six weeks before the Shop's IOC date. This will permit the start-up crew to be training while assisting in the check-out of the installation and operability of the shop's IPE.

- **Maintenance Training:** A continuing training program should be established to maintain the knowledge and improve skill proficiency. A senior CC-Shop Petty Officer should be assigned collateral duty as the training PO. The training PO could also plan and deliver the support training for tended ships and other SIMAs.

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ABBREVIATIONS

ADP	Automated Data Processing
AO	Oiler
AT	Anchor Tooth
AWR	Automated Work Request
BM	Boatswain Mate
CC	Corrosion Control
CCPAV	Corrosion-Control Planning Assist Visit
CCWP	Corrosion-Control Work Package
CER	Cost Estimating Relationship
CG	Guided-Missile Cruiser
CO	Commanding Officer
COMNAVSURFPAC	Commander, Naval Surface Force, U.S. Pacific Fleet
CPO	Chief Petty Officer
CSMP	Current Ship's Maintenance Project
DC	Damage Control
DD	Destroyer
DDG	Guided-Missile Destroyer
DFT	Dry Film Thickness
ESP	Electrostatic-Sprayed Coating
FF	Frigate
FFG	Guided Missile Frigate
ft	Foot (12 inches)
FY	Fiscal Year
HT	Hull Technician

ABBREVIATIONS (Cont'd)

I	Indoctrination
ID	Identification
IKPO	Installation-Kit Petty Officer
IMA	Intermediate Maintenance Activity
IMAAC	Intermediate Maintenance Activity Area Coordinator
IMAV	Intermediate Maintenance Activity Availability
IMMS	Intermediate Maintenance Management System
INSURV	Board of Inspection and Survey
IPE	Industrial Plant Equipment
IUC	Intermediate Unit Commander
JSN	Job Sequence Number
ISA	Integrated Systems Analysts, Inc.
kV	Kilovolts (1000 Volts)
LP	Lesson Plan
LHA	Amphibious Assault Ship
LST	Landing Ship, Tanks
LOE	Light-Off Examination
3M	Maintenance Material Management
MDS	Maintenance Data Supplier
mhr	Manhour
mil	0.001 Inch
MILCON	Military Construction
MIN AREA	Minimum area required to be preserved in a two-day period by a SIMA for economic feasibility
MJC	Master Job Catalog

ABBREVIATIONS (Cont'd)

MSR	Master Ship Repair
NAVSEA	Naval Sea Systems Command
OJT	On-the-Job Training
OP	Chief of Naval Operations - abbreviation for an internal organizational activity or code
OPNAV	Office of the Chief of Naval Operations
PAV	Planning Assist Visit
PEB	Pre-Expended Bin
PERA	Planning and Estimating for Repair and Alterations
POA&M	Plan of Action and Milestones
POD	Plan-of-the-Day
POM	Program Objectives Memorandum
Port TT	Portside Bulkheads and Decks Around Forward Turntable
PRAV	Planned Restricted Availability
psi	pounds per square inch
PWC	Public Works Center
QA	Quality Assurance
QC	Quality Control
R	Restricted
RAV	Restricted Availability
ROH	Regular Overhaul
"S" Availability	Ship-to-Shop Availability
SB	Strip Blast
SEA	Naval Sea System Command - abbreviation for an internal organizational activity or code

ABBREVIATIONS (Cont'd)

SIMA	Shore Intermediate Maintenance Activity
SIMA(SD)	Shore Intermediate Maintenance Activity, San Diego
SIMA(LB)	Shore Intermediate Maintenance Activity, Long Beach
SIMA(PH)	Shore Intermediate Maintenance Activity, Pearl Harbor
S/F	Ship's Force
SFWL	Ship's Force Work List
ShipSup	Ship Superintendent
SLPO	Shipboard Leading Petty Officer
SMAF	Ship's Maintenance Action Form
sq.ft.	Square Foot (144 in^2)
SQCI	Shop Quality Control Inspector
STBD TT	Starboard Bulkheads and Decks Around Forward Turntable
SRA	Selected Restricted Availability
SS	Stainless Steel
TAD	Temporary Additional Duties
TDS	Technical Data Sheet
TYCOM	Type Commander
WSA	Wire-Sprayed Aluminum
WSA(HT)	Wire-Sprayed Aluminum (High Temperature)
WSA(LT)	Wire-Sprayed Aluminum (Low Temperature)
WT	Watertight

SECTION ONE

INTRODUCTION

1.0 BACKGROUND

This is the final report of the Pilot Shore Intermediate Maintenance Activity (SIMA) Corrosion-Control (CC)-Shop Service Test conducted from 13 September 1984 through 30 November 1985. It presents all the relevant technical information compiled and analyzed during the Service Test along with the lessons learned. Recommendations are made for the CC-Shop facility, equipments, industrial processes, shop layout and production flow, consumables, manning and training for a baseline CC Shop capable of simultaneously providing ship-to-shop CC services for three ships' availabilities lasting eight weeks or more, one regular overhaul, shipboard mode services with a portable/containerized wire-sprayed-aluminum (WSA) system for one ship in overhaul and shop-to-shop CC services to support SIMA production 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 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 Commander, Naval Surface Pacific Fleet (COMNAVSURFPAC) and/or Naval Sea Systems Command (NAVSEA). Development of CC programs will benefit operating units of COMNAVSURFPAC by:

- Reducing the excessive ship's force manhours spent on corrosion prevention and control,
- extending the service life of shipboard components and areas from marine corrosion, and
- reducing/eliminating the attendant material, labor and schedule costs to repair/replace.

Accordingly, COMNAVSURFPAC initiated a program in 1984 to evaluate the SIMA CC-Shop feasibility, develop a test plan and install a Pilot CC Shop at SIMA(SD) to provide near-term service for ships of the Pacific Fleet commencing in September 1984.

The scope of this pilot work included developing and validating through a one-year service test:

- Selection, installation and operation of industrial plant equipment (IPE).
- Industrial processes for wire-sprayed aluminum (WSA) and electrostatic-sprayed powder (ESP) coatings.

- Makeup and issue of installation kits for the proper reassembly and installation of ship-to-shop items preserved by the CC Shop.

- CC Shop manning, organization, management, operating procedures and standard times.

- Planning concept and procedures for CC Work Packages (CCWP) for tended ships starting with an initial Planning Assist Visit (PAV) through to the automated work requests (AWR) in the ship class Master Job Catalog (MJC).

- Training and training materials for CC Shop, Planning and Quality Control personnel.

At the 22 June 1985 review of the NAVSEA Shipboard Program, SEA 05M1 and OP-433 informed COMNAVSURFPAC that the SIMA(SD) Pilot CC-Shop Project will serve as a model for CC programs of the U.S. Navy and be used to define the CC-Shop services, facilities, equipment, industrial processes and manning for the Navy's SIMA-Upgrade Program. Specifically, the findings of the Service Test will be a major factor in defining the Fiscal-Year (FY86-90) Program Objectives Memorandum (POM) line item for SIMA CC shops.

The overall objective of the SIMA CC-Services Program is to develop a functional and production capability for SIMAs to deliver and support CC-coating systems being used by the Navy in new construction ships and in the maintenance, repair and overhaul of ships in service. The five phases of the program are:

Phase I	Concept Formulation
Phase II	Develop SIMA(SD) Pilot CC Shop and Service Test Plan
Phase III	Conduct Pilot CC-Shop Service Test
Phase IV	Define System Specification and Life-Cycle Management Support Plans
Phase V	The Procurement, Installation/Training, Operation for a Production CC Shop at COMNAVSURFPAC SIMAs

1.1 OBJECTIVE

The objective of the Pilot CC Service Test was to operate the Pilot SIMA CC Shop for one year and obtain the data essential to the establishment of a CC capability within all SIMAs under COMNAVSURFPAC. The test entailed the evaluation of facility requirements, industrial plant equipment (IPE), manning requirements, training, production control, and quality assurances all tailored to recommend the steps necessary to design, install and operate SIMA CC Shops in COMNAVSURFPAC.

1.2 SCOPE and APPROACH

The scope of the SIMA CC-Services program was to develop a functional capability for SIMAs to deliver CC services, ship-to-shop, shop-to-shop and onboard ships, i.e.,

- Technical advice on the causes and prevention and control of marine corrosion.
- Production services for
  - .. WSA coatings.
  - .. ESP coatings.
  - .. Installation kits and technical data sheets for the proper reassembly/installation of preserved components.

The approach was to develop facilities and IPE, manning requirements, interface with the Fleet, production problems and solutions, planning interfaces with the ship and shop, processes and training requirements for personnel. A rationale will be presented to extrapolate the Pilot-Shop information to a production CC Shop responsive to the port loading, simultaneous Selected Restricted Availabilities (SRAs) and Regular Overhauls (ROHs) and shop-to-shop workload.

1.2.1 Phase I - Concept Formulation.

This Phase was performed to determine if it would be feasible for a SIMA to implement/deliver in a production mode the 15 NAVSEA-designated CC Systems (Ref. 1-1). The initial criteria established for evaluation were:

- Manning
- Organization
- Industrial Process
- Facilities and Equipment
- Quality Assurance
- Safety

1.2.2 Phase II - Develop SIMA(SD) Pilot CC-Shop and Service Test Plan.

The plan was implemented after it was deemed feasible to have SIMAs provide corrosion control services under Phase I. The implementation included providing a Physical-System Design and the development of a Service-Test Plan (Ref. 1-1).

1.2.3 Phase III - Conduct Pilot CC-Shop Service Test.

This Phase was the implementation of a Service-Test Program. It consisted of five tasks which would result in recommendations and conclusions for the establishment of a production-shop capability within all SIMAs under COMNAVSURFPAC. The tasks were:

- Provide technical, engineering and management recommendations for the SIMA CC-Shop Supervisor, SIMA Planning, SIMA Production Control, Quality Assurance, Safety and training staffs.

- Provide the methodology and actions necessary to interface with Ship's Force (S/F) to develop the CC Work Package; deliver the 15 NAVSEA-designated CC services; assure proper component reinstallation and maintenance; and finally to provide a method for S/F to maintain a current inventory of processed components.

- Provide productivity standards for the CC Shop which are compatible and useable by SIMA Planning to evaluate shop workload and material inventories.

- Develop organizational and operating procedure recommendations for the CC Shop for ship-to-shop, shop-to-shop and shipboard work.

- Develop recommendations for systems operation, maintenance and scheduling for onboard-ship application services. Develop and identify the required IPE, manning and process instructions for the shipboard mode.

Note: Refs. 1-2 and 1-3 reported the Service-Test status in December 1984 and July 1985 respectively.

1.2.4 Phases IV and V - IPE and Facility Specifications and Installation Requirements.

These phases have been initiated by COMNAVSURFPAC. The identification of CC production facilities has been accomplished for SIMA, San Diego, Pearl Harbor and Long Beach. The CC Shop for SIMA, Pearl Harbor, is a Special Project being designed and installed for a July 1986 initial operating capability (IOC). The CC Shops for SIMA(LB) and SIMA(SD) are included in the Military Construction (MILCON) programs scheduled respectively for 1986 and 1989.

REFERENCES for SECTION ONE

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.

1-2 Sulit, R. A. and O. G. O'Brien, ASW and Support-Ship Corrosion-Control (CC) Program: SIMA Pilot CC Shop Service Test and Technical Support, ISA(WC)-ITR-104, 11 December 1984, Contract N66001-84-D-0032, Delivery Order 0009.

1-3 Kullerd, S. et.al., ASW and Support-Ship Corrosion-Control (CC) Program: SIMA Pilot CC-Shop Service Test and Technical Support, ISA(WC)-ITR-106, 31 July 1985, Contract N66001-84-D-0015, Delivery Order 0002.

SECTION TWO

CORROSION-CONTROL WORK PACKAGE PLANNING AND EXECUTION

2.0 GENERAL

The definition and management of CC work is based on the current conventions and procedures for work definition and management as specified in the Ship's Maintenance and Material Management (3-M) Manual (Ref. 2-1). This section presents an overview of the 3-M Maintenance Data System (MDS) and work-package development/execution as background to the recommendations for S/F to enter CC work in their Current Ship Maintenance Project (CSMP) and for SIMA scheduling and accomplishing the CC work.

During the initial phases of implementing the COMNAVSURFPAC CC program, the SIMA CC-Shop Master (and for SIMA(SD), their Engineering Department (Code 7000) GS-11/12 Engineering Technician Advisor) will be required to visit customer ships and provide technical assistance in surveying the ship and in developing CC Ship Maintenance Action Forms (SMAF) (OpNav 4970/2K) for entry into the ship's CSMP. Technical assistance may also be requested to assist the First Lieutenant in prioritizing the CC Job Sequence Numbers (JSN) for the ship's "Availability Call Down Message."

2.1 OVERVIEW OF CC WORK IN CONTEXT OF THE MAINTENANCE DATA SYSTEM AND SIMA AVAILABILITIES

2.1.1 Maintenance Data System (MDS)

The MDS is an automated management information system to provide information about certain fleet maintenance and maintenance-support actions for use by various levels and areas of management throughout the Navy, with particular emphasis on providing information at the shipboard level. The MDS requires reporting maintenance actions. Those maintenance actions which (a) require assistance of an activity external to the ship (e.g., supply support, IMA, depot, etc.); (b) cannot be accomplished by S/F in 30 days (or timeframe specified by the Type Commander (TYCOM)); and (c) describe an uncorrected deficiency reported by the Board of Inspection and Survey (INSURV) is defined as deferred maintenance actions.

From the deferred-maintenance actions reported, the CSMP file is developed by the automated data processing (ADP) facility servicing the ship, IMA, and TYCOM. The CSMP categorizes and sequences the deferred maintenance actions. From the CSMP file, computer reports are provided to the ship, the intermediate unit commander (IUC), and TYCOM. These reports provide either a detailed or summary listing of deferred-maintenance information in various formats for planning use by the ship or higher management.

The CC work that cannot be accomplished by the various ship work centers, i.e., the deferred CC work, must be entered into the ship's CSMP. The sum of the deferred CC work in the CSMP makes up the deferred CC-work requirements of the ship. The call down of the CC JSNs for a particular availability constitutes the requested CC work package for that availability.

2.1.2 MDS Forms

The following forms are used to report information into the MDS:

A. **OPNAV 4790/2K: Ships Maintenance Action Form (SMAF)** - This form is used by maintenance personnel to report:

a. Deferred maintenance actions.

b. Completed maintenance actions which do not result in configuration changes (including those previously deferred).

This form also allows the entry of screening and planning information for management and control of IMA workloads. Shipboard Work Centers will prepare CC SMAFs for their deferred CC work, the sum of the deferred CC work being the ship's CCWP.

B. **OPNAV 4790/2Q: Automated Ships Maintenance Action Form** - This form, which is completed by a computer, contains the same information as the SMAF. Additional handscribed information may be entered by maintenance personnel. This form may be used as an AWR.

C. **OPNAV 4790/2L: Supplemental Form** - This form is used by maintenance personnel to provide amplifying information relating to a maintenance action reported on an OPNAV Form 4790/2K (e.g., drawings, listing, etc.) for use by repair activities. The information on this form will never be entered into the computer.

D. **OPNAV 4790/2P: Maintenance Planning and Estimating Form** - This form is used with the SMAF deferring maintenance to be done by an IMA under the Intermediate Maintenance Management System (IMMS). It is designed so that screening and planning may be done in detail. This planning will include information pertinent to the Lead Work Center, Assist Work Center(s), material requirements, technical documentation and cost estimates required to complete the maintenance action.

A 4790/2P form can also be used by an IMA in conjunction with a Master Job Catalog (MJC). The MJC is used to pre-plan work required of an IMA for ships being tended and generally contains information concerning pre-planned jobs in the following categories:

a. Standard routines for providing services (electric power, steam, crane, etc.).

b. PMS requirements which require IMA or SIMA assistance.

c. Selected configuration changes.

d. Standard maintenance routines as prescribed by higher authority to be done by an IMA or SIMA.

e. Standard calibration/test/inspection routines independent of repair routines for support and test equipment.

E. **<u>OPNAV 4790/2R: Automated Work Request (AWR)</u>** - This form combines the information from the SMAF and the Maintenance Planning and Estimating Form (OPNAV Forms 4790/2K and 4790/2P). The AWR is available in four copies. The AWR has been designed for machine and hand printed entries. This form may be used:

a. As an automated work request.

b. As an ADP-produced work control document for internal IMA use.

c. When using an item from the MJC.

The maintenance person reports deferred maintenance using either the SMAF (OPNAV 4790/2K) or the automated SMAF (OPNAV 4790/2Q). The use of a 2K or 2Q depends on the ship having an ADP system aboard. This reported deferred maintenance action is then placed as part of the ship's CSMP file. The deferred-maintenance action information may then be produced as an AWR at any Intermediate Maintenance Activity Area Coordinator (IMAAC) along the West Coast. The AWR will then be utilized as the work control document to perform the deferred maintenance action corrected by an IMA.

2.2 OVERVIEW OF SIMA WORK (Ref. 2-2)

2.2.1 <u>Types of Availabilities</u>

Ships are normally assigned:

- Alongside (restricted): SIMA "R" availabilities.
- Ship-to-shop: SIMA "S" availabilities.
- Special-purpose SIMA availabilities: limited scope to support an inspection or operational evaluation.
- Concurrent SIMA availabilities designed to support depot availabilities such as Routine Overhauls (ROHs), Planned Restricted Availabilities (PRAVs) and Selected Restricted Availabilities (SRAs).
- Intermediate Maintenance Activity Availabilities (IMAVs).

<u>Note:</u> FFG-7 Class ship availabilities with depot-level scope are accomplished solely by an IMA.

2.2.2 Scope of SIMA Work

SIMA work is available for equipment repairs and maintenance that are beyond the capability and capacity of S/F and which does not require the assistance of depot-level activities. The ship is responsible for determining the need for IMA assistance and making the appropriate request via the chain-of-command.

2.2.3 Priority of Work

IMAs shall give first priority to work requiring the assignment of an emergency availability, second priority to alongside-availability work and third priority to ship-to-shop-availability work.

2.2.4 Work Request Data

All IMA availability work packages, with the exception of special-purpose and emergent availabilities, shall use AWRs, (OPNAV 4790/2R) from the CSMP or MJC items. During the ship's force review process, additional work requests not in the CSMP may be inserted.

2.3 SHIP'S CC WORK PACKAGE (CCWP) DEVELOPMENT

A ship's CCWP are those deferred maintenance actions which pertain to corrosion control or preservation. The development of the CCWP may originate from the following sources:

- DoD-STD-2138(SH), Metal-Sprayed Coating Systems for Corrosion Protection Aboard Naval Ships, (Ref. 2-3).
- NAVSEA Ship-Class Corrosion-Control Manuals (Ref. 2-4 to 2-12).
- Specifications for Building (of which Ref. 2-13 is an example).
- COMNAVSURFPAC guidance and instructions as COMNAVSURFPAC Maintenance Manual (Ref. 2-2) and the Instruction for Shipboard Preservation with Wire Sprayed Aluminum (Ref. 2-14). The scope of Reference 2-14 should be updated to promulgate the current TYCOM CC Program, policy, implementation guidance and action requirements.

2.3.1 Initial Implementation of CC Program

During the initial period of the COMNAVSURFPAC Shipboard CC Program and until the majority of ships have defined, prioritized and entered their CC work in their CSMP, it is recommended that the SIMA CC-Shop Master (and for SIMA(SD), their Engineering Department (Code 7000) GS-11/12 Engineering-Technician Advisor) provide technical assistance to the ship's First Lieutenant and Work Center Supervisors. This technical assistance will be to ensure (1) all SMAFs or automated SMAFs request the proper type of preservation among the 15 NAVSEA-designated systems for all the applicable items/spaces; (2) the SIMA has the capability to perform the preservation on each item; (3) all suitable items/spaces are documented as deferred maintenance actions on the ship's CSMP; and (4) provide technical assistance on CC problems.

The SIMA CC-Shop Master would conduct the CC Planning Assist Visit (CCPAV) about 90 days before the availability to develop the initial CC work package by:

(1) Surveying the ship with S/F personnel and recommend items/spaces which should be preserved.

(2) Instruct S/F in preparation and prioritization of SMAFs.

(3) Reviewing the CCWP for completeness and accuracy when the ship submits its alphanumerical listing of JSNs requested for accomplishment during that availability.

SIMA CC availabilities should be limited to those availabilities in support of RAV/SRA/PRAV/ROH/IMA's of equal to or greater than eight weeks in length. This time requirement is necessary to provide effective planning, screening and production control to maximize CC services delivered to tended ships. Portions of the CCWP not accomplished during the availability will be already documented as deferred maintenance items on the ship's CSMP and may be submitted for accomplishment during subsequent availabilities.

Ideally, all CC jobs should be evaluated, engineered and entered into the Ship Class MJC and the Class Maintenance Plan. If the CC AWRs are not in the MJC, SIMA should nominate the CC work and forward a recommended CC AWRs to the cognizant Planning and Estimating for Repair and Alterations (PERA) organization via COMNAVSURFPAC (N41). This action is necessary to "capture the lessons learned and put them into the corporate data base."

2.3.2 Ship-SIMA-TYCOM CCWP Algorithm

The ship's deferred CC work should be developed in the same manner as other deferred work. Table 2-1 gives the actions for CC work and availability planning and work submission procedures. Figure 2-1 is the flow chart showing the planning actions. The major steps are:

1. Ship requests or COMNAVSURFPAC designates the ship to receive a CCPAV from the SIMA.

2. Ship Work Centers inspect their equipments, spaces/areas for corrosion prevention and control work items. The NAVSEA Ship-Class Corrosion-Control Manual (or comparable Ship-Class Corrosion-Control Manual if none has been issued for their ship class) lists topside items for CC work. Table 2-2 gives the status of the Ship Class Corrosion-Control Manuals as of 1 October 1985.

3. Work Center Supervisors write up deferred CC work on SMAFs (OPNAV 4790/2K) and submit them to the Ship's 3-M Coordinator for entry into the ship's CSMP. Use the "2-LIMA" (OpNav 4790/2L, Supplemental Form) whenever necessary to provide amplifying instructions and/or drawings/sketches.

Table 2-1 **CORROSION-CONTROL WORK and AVAILABILITY PLANNING and WORK-SUBMISSION PROCEDURES**

ACTION DATE	ACTION ACTIVITY	ACTION DESCRIPTION
Continuing	Ship	On-going program of cleaning and preservation.
Continuing	Ship	Ship Work Centers prepare corrosion-control (CC) SMAF's for application of WSA and ESP coatings for components authorized in their Work Center spaces; refer to Ship Class Corrosion-Control Manual and COMNAVSURFPACINST 9630.1C. Use 2 LIMA to list the location of multiple like components and/or sketches of special coating/installation requirements.
A-6 mo	TYCOM	Conduct ROH Work definition Conference; screen and prioritize CC AWRs especially CC work made possible due to planned equipment removal or work. Designate ROH ship to receive shipboard portable WSA containers and schedule S/F training/certification with the performing SIMA.
SIMA SHIP-TO-SHOP AVAILABILITY $\geq$ 8 WKS		
A-90 days	SIMA(SD)/Ship	Technical assist visit to develop initial or update CC SMAFs for entry into CSMP.
A-75 days	Ship	Ship review CSMP (and CC AWRs) and validate Availability Work Package.
A-60	Ship	(1) Ship submit an alpha-numeric list of JSNs (including CC JSNs) desired for accomplishment by message to SIMA, info COMNAVSURFPAC. (2) SIMA will call down required AWRs and screen. (3) SIMA will process AWRs as necessary.
A-45	TYCOM/SIMA/ Ship	Conduct pre-arrival conference and define work package.

ACTION DATE	ACTION ACTIVITY	ACTION DESCRIPTION
A-35	SIMA	(1) SIMA complete screening work package including CC JSNs; send message to ship listing screening actions; schedule arrival conference. (2) CC work not planned due to reasons of priority or CC Shop capacity will be returned to the ship if on 2Ks or AWRs.
A	SIMA/Ship	Commence Availability.
C-2	SIMA/Ship/ISIC	SIMA conduct Departure Conference.
C	Ship	Complete Availability. Ship ensure all deferred work and departures from specification requiring later correction and/or technical evaluation are entered in the CSMP.

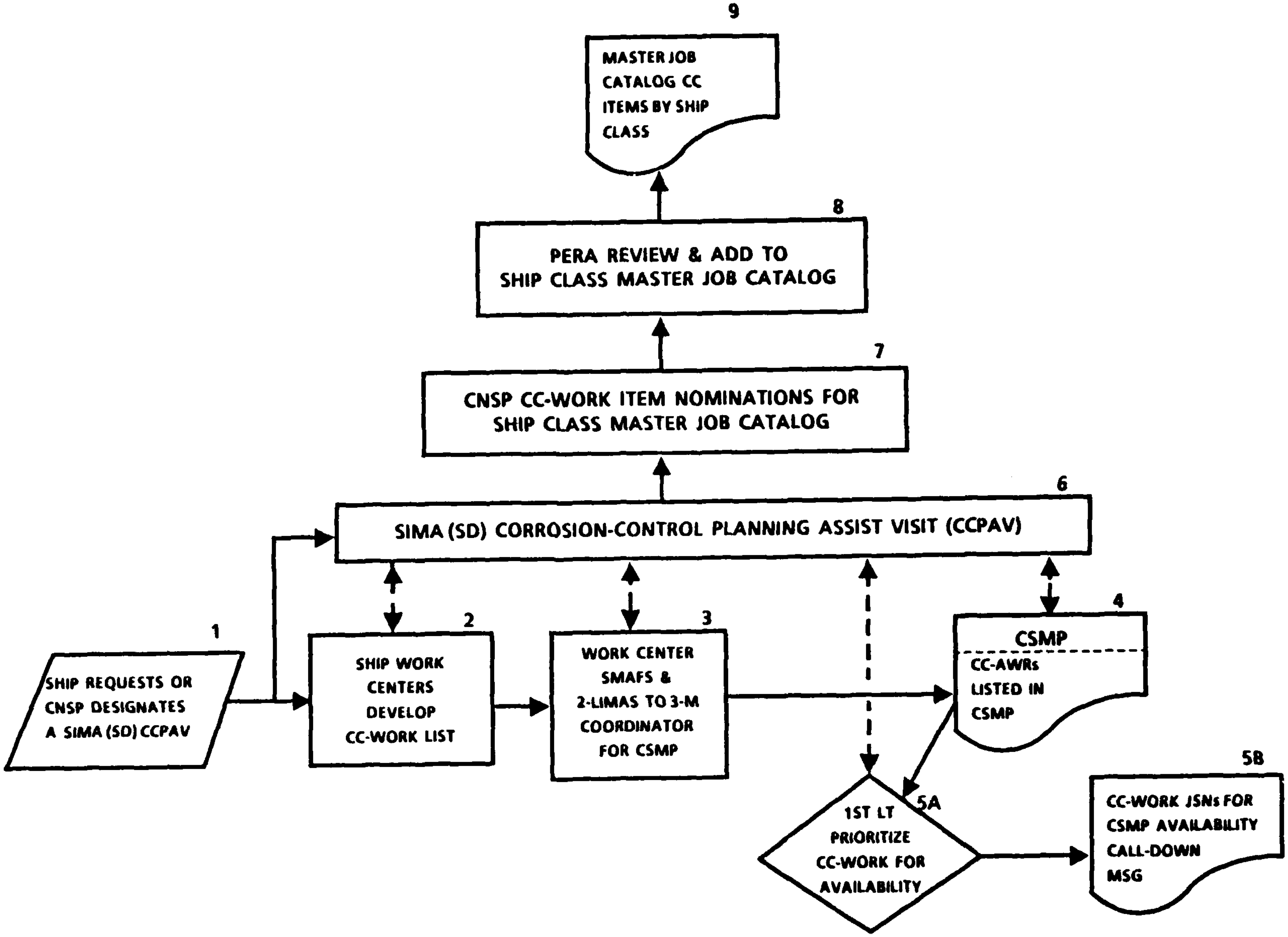

Figure 2-1 Ship-SIMA-TYCOM Corrosion-Control Work Package Algorithm

4. The CC SMAFs are transmitted to the ADP support activity for entry into the Ship's CSMP as AWRs. The list of CC-AWRs in the CSMP makes up the deferred CCWP.

5A/5B. For a given availability, the First Lieutenant coordinates and prioritizes the CC work among the ship's Work Centers and submits them, by JSNs, to the 3-M Coordinator for the ship's overall CSMP JSN call-down message.

6. The SIMA CC-Shop Master (and/or his GS-11/12 Engineering Technician Advisor for SIMA(SD) will brief/instruct the ship's First Lieutenant, Division Officers and Work Center Supervisors on TYCOM CC Program; applicable instructions, specifications and reference documents; inspect/survey equipment/spaces/areas assisting Work-Center Supervisors in the identification, preparation of SMAFs and prioritization of CC work; and assist the First Lieutenant in review and prioritization of the CC SMAFs. The CCPAV should be scheduled and accomplished 90 days prior to the availability in which the CC work is to be accomplished.

Table 2-1 presents the recommended CC activities showing the action date, activity and description.

The SIMAs nominate CC-work items for the Ship-Class MJC providing a proposed CC AWR (OpNav 4790/2K) with the estimated SIMA manhours (Blocks 60 and 72 for the Lead and Assist Work Centers respectively). The average in-shop time required for processing components should be stated in the Remarks Block 50.

7. COMNAVSURFPAC reviews nominated CC-work items for the Ship-Class MJC and forwards them to the cognizant PERA as appropriate.

8/9. PERA should review and add the CC-AWR to the MJC. This action will provide the mechanism for putting lessons learned into the "corporate memory."

Figure 2-2 shows the interface of the proposed Ship's CCWP Algorithm to the IMA Work Algorithm, Figure 2-1 of Reference 2-2 (COMNAVSURFPAC Maintenance Manual).

Note: The "availability CSMP-JSN call-down message" has been added between the "CSMP" and "IMA Screen CSMP and Ship Messages" blocks in Figure 2-1 of Reference 2-2 to show how the CC JSNs feed into the other availability JSNs.

2.4 NUMBER OF SIMULTANEOUS SHIP-CC AVAILABILITIES AT A SIMA

The production CC Shops are being manned and outfitted to deliver:

- Technical assistance to ships on the 15 NAVSEA-designated CC Systems.
- Ship-to-shop production services for WSA- and ESP-coating systems.

Table 2-2 COMNAVSEASYSCOM Ship-Class Corrosion-Control (CC) Manuals (1 October 1985 Status)

SHIP CLASS	NAVSEA NO. and TITLE	STATUS
AO-177	NAVSEA 9630-AD-MAN-010/AO-177CL, Corrosion-Control Manual for AO-177	April 1982
FF-1052	NAVSEA S9630-AC-MAN-010/FF-1052CL, Corrosion-Control Manual for FF-1052	April 1983
FFG-7	NAVSEA S9630-AG-MAN-010/FFG-7CL, Manual, Corrosion-Control for FFG-7	November 1983
DD-963	NAVSEA S9630-AB-MAN-010, Corrosion-Control Manual for D-963 Class	January 1985
		SEA 05M1 Draft
LST-1179	Corrosion-Control Manual for LST-1179 Class	March 1983
CG-16	Corrosion-Control Manual for CG-16 Class	April 1983
LPD-4	Corrosion-Control Manual for LPD-4 Class	January 1984
LHA-1	Corrosion-Control Manual for LHA-1 Class	March 1984
LPH-2	Corrosion-Control Manual for LPH-2 Class	May 1984

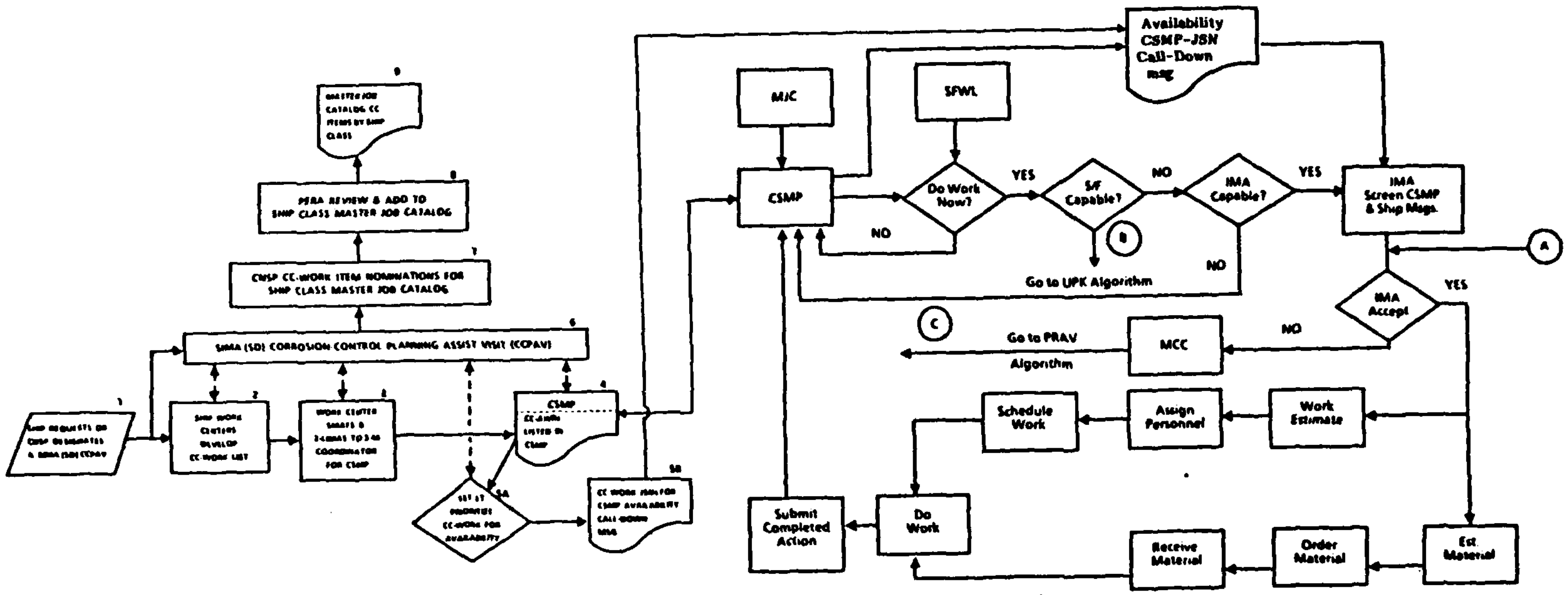

Figure 2-2 **Interface of Ship's CC Work Package and IMA Work Algorithms**

- Makeup and .issue installation kits (e.g., ceramic/316-SS fasteners, gasketing, insulation, anti-seize and sealants) for the proper reassembly and installation of items preserved by the CC Shop.

- SIMA shop-to-shop CC services.

- S/F training and SIMA supervision for assigned ROH ships using the portable/containerized WSA system.

Plans for installing a CC Shop and delivering CC services in the COMNAVSURFPAC SIMAs are given in Table 2-3. The production and support capabilities are based on production standard time estimates developed in the Service Test and the planned IPE and facility allocations.

Table 2-3 Existing and Planned SIMA CC Shops in COMNAVSURFPAC

		PRODUCTION and SUPPORT CAPABILITIES			
		SHIP-TO-SHOP		SHOP-TO-SHOP	SHIPBOARD
SIMA	IOC	SRA/RAV/PRAV 8 wks duration (Ships)	ROH (Ships)	For SIMA Assist-Shop (Items/Mo)	Portable WSA Container Sys for ROH Support (Ships)
San Diego Pilot	Dec 85	1	0	50	0
San Diego Plate Yd Upgrade	Jun 86	3	2	900	1
Pearl Harbor	Jul 86	3	1	300	1
Long Beach MILCON + IPE	FY87	3	1	300	1
San Francisco	FY87	TBD	TBD	TBD	1
Puget Sound	FY88	TBD	TBD	TBD	1
San Diego MILCON P-012 + IPE	FY89	3	2	900	1

SIMAs will have a fixed industrial capacity for CC services which generally will be much smaller than the potential work load. Effective planning, screening and production control is required to maximize CC services delivered to tended ships. Accordingly, SIMA CC service will be planned and delivered concurrent with availabilities equal to or greater than eight weeks, i.e., concurrent with RAV/SRA/PRAV/ROH.

The number of ships, N, assigned simultaneously to a SIMA for CC concurrent availabilities can be estimated, for planning purposes, by:

$$SC \leq \sum N_i \left[\frac{(SCLF)}{(\text{availability duration, wks})} \right] \quad \text{(Eq. 2.1)}$$

where: SC = notional CC-Shop Capacity, the sum of the SRA/RAV/PRAV and ROH columns in Table 2-3.

N_i = number of ships in Ship Class i being concurrently supported by the CC Shop, each availability being eight wks.

SCLF =Ship-Class Loading Factor. The SCLF is based on the Pilot CC Shop being able to complete one "all other" ship-class average CCWP in eight weeks with no other work assigned to the shop.

SIMA	NOTIONAL CAPACITY*
San Diego, Pilot	1
San Diego, Plate Yard Upgrade	5
Pearl Harbor	4
Long Beach	4
San Francisco	TBD
Puget Sound	TBD
San Diego, MILCON P-012	5

* Based on the SIMA(SD) Pilot CC Shop being one.
TBD = To be determined.

SHIP CLASS	SCLF
AE, AFS, AOE, AOR, AD	5.3
BB	11.4
LHA, LPH	16.0
All Others	8.0

2.5 SIMA SCREENING AND CC-SHOP LOADING

The Pilot CC Shop is capable of delivering all the 15 NAVSEA-designated CC systems. However, the capacity is limited by the IPE and shop working space and layout. The IPE and shop layout dictate the size and numbers of shipboard items that may be simultaneously scheduled in the shop. The number and quality of CC-Shop production personnel is also a major factor in the CC Shop throughput.

The maximum size of items that can be preserved with WSA is limited by the inside dimension of the anchor-tooth blasting unit: seven-ft long by five-ft wide by seven-ft high. The maximum size for ESP coating is seven-ft long by three-ft wide by four-ft high as limited by inside dimensions of the oven.

The production throughput of the CC Shop is given by the following relationship:

$$PT = PP \times AF = (A)\ ST_a + (B)\ (ST_b) \ldots + (N)(ST_n)$$

$$PT = PP \times AF = \sum N_j \cdot ST_j \qquad \text{(Eq. 2.2)}$$

where PT is the CC Shop production throughput.

PP is the number of personnel in the CC-Shop assigned to production duties.

AF is the CC Shop's allowance factor and is dependent on characteristics such as the CC Shop's IPE, layout and the numbers and quality of the production personnel.

ST is the standard time, i.e., the average time to produce the produ t without any interferences as performed by the average journeyman worker. The standard time to apply the WSA-preservation system is given in Appendix A4-3.

a, b, ..., n are the item classes.

A, B, ..., N are the number of items in the respective classes.

Note: PP x AF is the CC-Shop's average production capacity.

2.6 RECOMMENDED SIMA PLANNING PROCEDURES

The recommended SIMA CC planning and CC-Shop work-loading procedures are given in Figure 2-3. The "pre-availability" or continuing CC activities and the "availability planning, screening and work accomplishment" activities are indicated in a flow-diagram format which include all the action activities cited in subsections 2.4 through 2.5. The major references for the planner are indicated along with the ship loading (N_i) and CC-Shop loading ($N_j \cdot ST_j$) equations, 2.1 and 2.2.

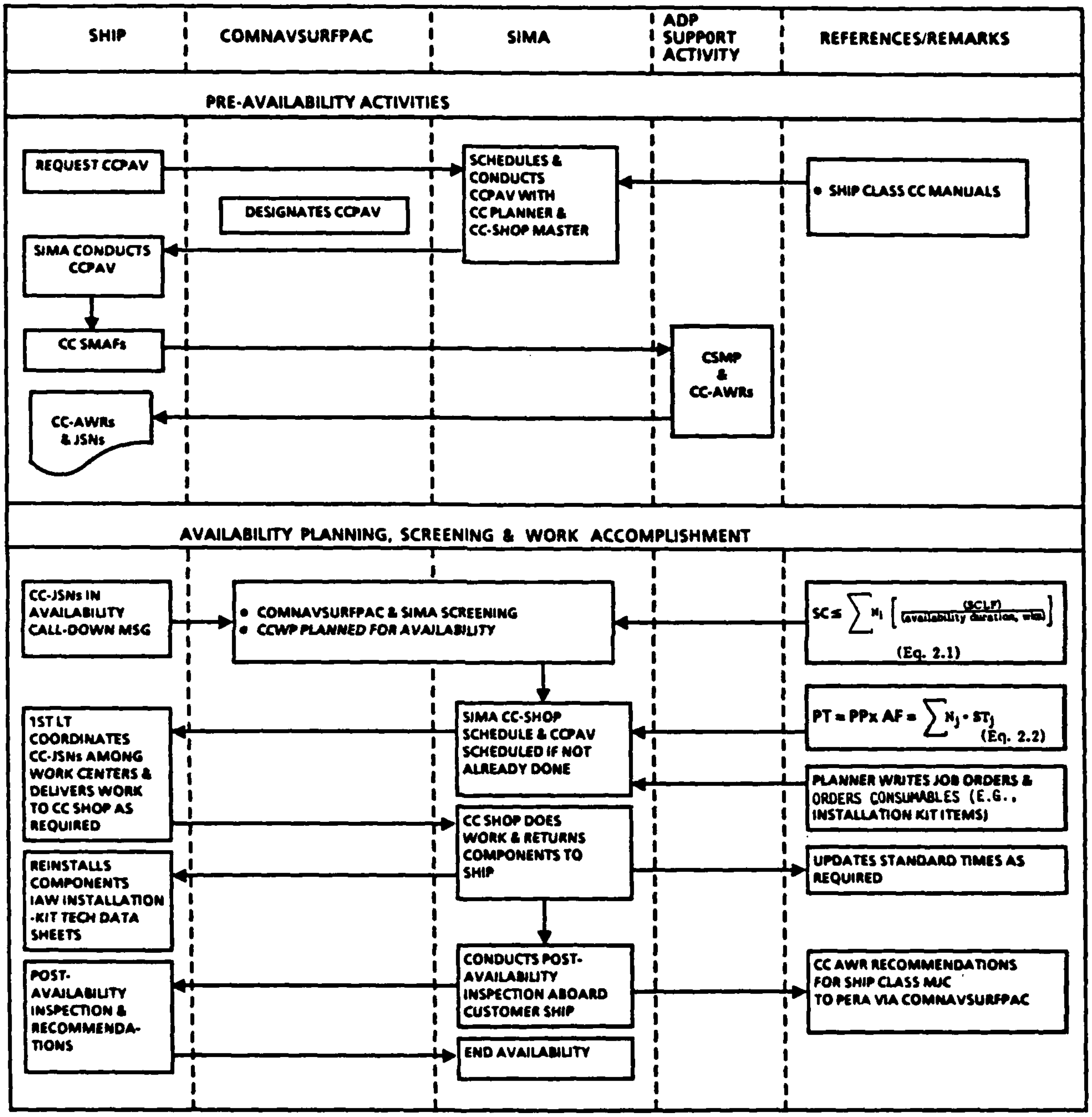

Figure 2-3 Corrosion-Control Planning and Work Accomplishment

REFERENCES for SECTION TWO

2-1 OPNAVINST 4790.4A, Ship's Maintenance and Material Management (3-M) Manual, OP-434. 27 August 1984.

2-2 COMNAVSURFPACINST 4700.1A, Ch-2, Commander Naval Surface Force, U.S. Pacific Fleet, Maintenance Manual, 2 November 1982.

2-3 DoD-STD-2138(SH), Metal-Sprayed Coating Systems for Corrosion Protection Aboard Naval Ships, 23 November 1981.

2-4 S9630-AG-MAN-010/FFG-7CL, Manual, Corrosion-Control for FFG-7 Class, 30 November 1983.

2-5 NAVSEA 9630-AD-MAN-010/AO-177CL, Corrosion-Control Manual for AO-177 Class, April 1982.

2-6 NAVSEA S9630-AB-MAN-010, Corrosion-Control Manual for DD-963 Class, January 1985.

2-7 Corrosion Control Manual for LHA-1 Class, NAVSEA 05M1 Draft, March 1984.

2-8 NAVSEA S9630-AC-MAN-010/FF-1052CL, Corrosion-Control Manual for FF-1052 Class, April 1983.

2-9 Corrosion-Control Manual for LST-1179 Class, NAVSEA 05M1 Draft, March 1983.

2-10 Corrosion-Control Manual for CG-16 Class, NAVSEA 05M1 Draft, April 1983.

2-11 Corrosion-Control Manual for LPH-2 Class, NAVSEA 05M1 Draft, May 1984.

2-12 Corrosion-Control Manual for LPD-4 Class, NAVSEA 05M1 Draft, January 1984.

2-13 Specifications for Building Guided Missile Destroyer DDG-51, Section 630, Corrosion Prevention and Control, Draft RFP, circa 1984.

2-14 COMNAVSURFPACINST 9630.1B, Shipboard Preservation with Wire Sprayed Aluminum (WSA), Code N43/WPC 797, 22 December 1982.

SECTION THREE

PILOT CORROSION CONTROL SHOP

3.0 GENERAL

The SIMA(SD) Pilot CC Shop was established on the basis of facility, IPE and manning concepts approved by COMNAVSURFPAC at the 27 April 1984 In-Process Review to develop an organizational and pilot production capability that would serve as the basis for developing recommendations for implementing CC production shops in other SIMAs (Ref. 3-1). The Pilot Shop was to be a small shop manned by six SIMA personnel trained to provide CC services and certified to apply the wire sprayed aluminum (WSA) coating in accordance with DoD-STD-2138(SH) for metallizing (Ref. 3-2). The Shop's IPE would be a combination of existing SIMA IPE used for WSA augmented with equipment purchased or leased specifically to provide the necessary technical capacity for applying and controlling the quality of WSA systems along with the installation kits of preserved components in the ship-to-shop and the shipboard modes. The Flame Spray, Inc. portable/containerized WSA System, Model 5005 was evaluated as part of the Service Test.

This section describes the establishment of the Pilot CC Shop for the one-year Service Test, the organization and manning of the shop, the IPE utilized and the operational procedures. It includes the conclusions drawn from the experience gained in the Service Test and the recommendations for the establishment of production CC Shops at COMNAVSURFPAC SIMAs.

3.1 FUNCTIONS, ORGANIZATION and MANNING

3.1.1 Functions

The functions of the Pilot CC Shop were to:

A. Operate and administer the CC Shop as a lead shop to provide ship-to-shop and shipboard CC services and technical information/assistance to tended ships.

B. Operate and administer the CC Shop as an assist shop to provide shop-to-shop CC services and technical information/assistance to other SIMA lead shops.

C. Assist the SIMA Planning Department in the planning, estimating, scheduling and coordination of CC services to integrate the new CC shop into the SIMA planning system.

D. Maintain the technical and productive capability to diagnose and select appropriate corrosion prevention measures for ship-to-shop, shop-to-shop and shipboard components.

E. Train and maintain requisite numbers of personnel for shop/shipboard operations.

F. Serve as the test vehicle to provide the necessary experience required to formulate recommendations on how to establish a production capability for CC services in COMNAVSURFPAC SIMAs.

The CC services delivered consisted of the 15 NAVSEA-designated CC Systems. Systems One and Two, high- and low-temperature WSA coatings, were delivered by the Pilot CC Shop using the containerized modules. System Four, powder coating, was provided through pre-planned contract support by an outside vendor. The rest of the NAVSEA Systems were delivered by providing technical advice and material support in the makeup and issue of installation kits for components preserved for assigned ships and units.

3.1.2 Organization and Manning

The Pilot CC Shop was initially established as Code 3850, Shop 06I, in the Production-Engineering Division, Code 3800, in the Production Department, Code 3000. The Pilot CC Shop was to operate for one year (November 1984 through November 1985). In September 1985, SIMA(SD) departments were reorganized and the Pilot CC Shop transferred from the Production Department to the Industrial-Plant Manager. The Shop became Code 8120 under the SIMA(SD) Industrial Engineer, Code 8100, and the Industrial-Plant Manager, Code 8000.

At the end of the Service Test, SIMA(SD) plans to transfer the CC Shop to the Hull-Repair Group, Code 3100, of the Production Department when the CC Shop is moved from its present location at Building 61 to an interim facility adjacent to Building 125 in a plate yard. This interim facility, a pre-engineered building containing the Pilot Shop's IPE augmented with additional IPE in a production-efficient layout, is planned to provide a production-efficient capability until a permanent building is completed in FY89 under MILCON Project P-012 that will consolidate the Hull Repair Group in one building.

A logical argument can be made for assigning the Production-CC Shop to either the Hull-Repair Group or to the Service Group. Hull Repair because wire spraying is an allied industrial art to welding, Hull Technicians (HTs) are the cognizant artificer rating, and the shop's primary service will be to apply the WSA-coating system. Additionally, the majority of shop-to-shop or Lead Work Center jobs originate within the Hull-Repair Group for assistance by the CC Shop. The majority of topside items processed by the CC Shop are the repair responsibility of Hull-Repair Group.

The Production-CC Shop can also be organizationally located in the Services Group because the Boatswain Mate (BM) is normally assigned to the Services Group and has been historically responsible for "painting and preservation" aboard ships.

The initial recommendation was to man the small Pilot CC Shop with six Navy personnel using existing IPE in the Metal Build-up Shop, 31M, and a containerized WSA system (Ref. 3-2). The six consisted of one supervisor, one technical assistant and four WSA operators. A Chief Boatswain Mate was requested to be the Shop Supervisor because "corrosion prevention and control" is part of the BM-rating skills and already included in his career path. Due to personnel availability at SIMA(SD), a Chief Machinist Mate was assigned to be the CC-Shop Master.

Ten personnel were initially assigned to the Pilot CC Shop, the six originally recommended plus four from Shop 31M who were performing WSA work prior to the establishment of Pilot CC Shop (Ref. 3-3). Due to personnel turnover, Shop manning ranged from a low of ten to a high of 16 with a total of 23 personnel assigned over the one-year Service Test. The shop manning at the end of the Service Test was 16 personnel. Increased manning was required to meet functions and requirements that evolved during the Service Test, i.e., need for installation kits (see Section Five) and addition of a powder-spray station in the Pilot CC Shop. Table 3-1 lists the initial and final manning for the Pilot CC Shop. Of the initial ten personnel assigned, six have remained with the Shop throughout the one-year Service Test.

Table 3-1 Initial and Final Pilot CC-Shop Manning

INITIAL MANNING	OCTOBER 1984		
MMC	Shop Supervisor	HT2	WSA Technician
MM1	Assistant Shop Supervisor	MM3	WSA Technician
EN2	Quality Assurance and Supply	HT3	WSA Technician
HT1	WSA Technician	MMFN	WSA Technician
BT2	WSA Technician	MMFN	WSA Technician
FINAL MANNING	**NOVEMBER 1985**		
HTCS	Shop Supervisor	HT2	WSA Technician
HT1	Assistant Shop Supervisor	HT2	WSA Technician
MM1	Quality-Control Inspector	HT2	WSA Technician
BT3	Fasteners/Supply	HTFN	WSA Technician
BT1	Records - Receiving	HTFN	WSA Technician
MM2	WSA Technician	EN2	ESP Operator
BT2	WSA Technician	MM3	ESP Operator
HT2	WSA Technician	HTFN	ESP Operator

The need for an increase in shop manning during the Service Test can be illustrated by the evolution of the requirement for the makeup and issue of installation kits and the subsequent need to assign a Installation-Kit Petty Officer.

A. **Problem:** S/F reinstalling items with mild-steel fasteners resulting in running rust.

Solution: Inform S/F to purchase Type 316 stainless steel (SS) fasteners and use for reinstallation.

Result: Additional ship-to-shop liaison.

B. **Problem:** Type 316-SS fasteners not readily available in Navy Supply system.

Solution: Contractor purchase Type 316-SS fasteners and provide to S/F based on S/F information as to size and quantity.

Result: Need for fastener storage and work area in CC Shop.

C. **Problem:** S/F information not reliable as to size and quantity of required fasteners.

Solution: SIMA and contractor personnel conduct ship check for types, size and quantity of required Type 316-SS fasteners for each item and assemble a fastener requirements list for each item processed. Installation Kits with required fasteners and lubricants/sealants made up by Shop personnel.

Result: Assign Shop personnel to conduct ship checks and make up installation kits.

D. **Problem:** S/F not using installation kit properly, e.g., placing washer in wrong order resulting in damage to coatings.

Solution: Installation-Kit Petty Officer visit ships and provide direct instruction and technical assistance to S/F when reinstalling processed items.

Result: Additional ship visits required by Shop personnel. Contractor identifies need for technical data sheets to illustrate and specify how items are to be reinstalled with the correct materials, i.e., fasteners, washers, anti-seize, etc.

This example illustrates that the CC-Shop personnel must work directly with S/F and provide technical assistance to insure the proper installation and provide preservation maintenance information for the CC-services delivered. Direct liaison between the SIMA CC Shop and their customer ships is required, especially during the initiation and introduction of these improved CC services. Valuable customer requirements and feedback can also be obtained. If this is not done, much of the CC effort will be wasted by corrosion of improper-material fasteners and damage by fasteners to WSA and ESP coatings.

Similar developments during the Service Test resulted in the requirement for assignment of support personnel to order and maintain supply inventories, conduct quality-control inspections, maintain receipt and production records.

As shown in Table 3-1, SIMA(SD) only assigned engineering and repair ratings, however personnel from any rating could be utilized. The major requirement for personnel is to have a mechanical ability to operate the blast unit, WSA and ESP equipment and spray painting. Personnel assigned should also have the discipline to follow quality-control procedures. Previous experience in WSA application would reduce the training effort. The ability to understand SIMA operating instructions and process instructions is essential.

3.2 INDUSTRIAL PLANT EQUIPMENT (IPE)

As a result of the decision to install a small CC Shop as the Pilot CC Shop for the one-year Service Test, 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 CC IPE at SIMA(SD) currently being used for WSA in Metal Build-up Shop, 31M.
- Use of portable/containerized WSA units that could be placed outside of existing buildings precluding requirements for shop space and building modifications.

The IPE used in the Service Test is listed in Table 3-2.

Discussions with SIMA(SD) resulted in the decision to establish the Pilot CC Shop in and adjacent to Building 61. This would permit use of the existing shop area and installed IPE of the existing Metal Build-up Shop, 31M. The vapor degreaser, large abrasive-blast unit and paint spray booth were located within Building 61 and the portable/containerized WSA units for anchor-tooth blasting and spraying located in the parking area at the west side of the building. This placed all of the elements of the Pilot CC Shop in the same area. Building 149 was assigned to the Pilot CC Shop for storage and staging purposes (Ref. 3-2).

The configuration of the SIMA(SD) Pilot CC Shop is provided in Figure 3-1 and the functional flow in Figure 3-2.

Table 3-2 Industrial Process Equipment, Pilot CC Shop 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	Flame Spray, Inc., Container Model 5003A
• Wire-Sprayed-Aluminum Unit	Flame Spray, Inc., Container Model 5003B
• Paint Spray Booth	DEVILBUS 8' Water Wash
• WSA Equipment	METCO WSA Systems with 10E (2), 11E and 12E (2) Guns
• Breathing Air Compressor	Air Driven
• Degreaser Hoist	Electric
• Paint Spray Equipment	GRACO 700, 800 Units, Binks
• Paint Drying Racks	Manufactured by SIMA(SD)
• Office Container	8' x 20' Module
• Surface Profile Gage	TESTEX "Press-o-Film"
• Psychrometer	
• Coating Thickness Gage	PENTEST Model
• Pyrometer	
• Wet Film Thickness Gage	
• Hydraulic Floor Crane	
• Elcometer - Digital	
• Thermo-Conductivity Meter	
• Sealing Kit	Installation Kit Bag Seal

Based on the Service Test and technical evaluations, a design for production shop for COMNAVSURFPAC SIMAs was developed. The sequence of production operations was examined and the flow of product from work station to work station was reviewed to optimize production flow.

The facility size and IPE layout for a typical SIMA production shop is illustrated by Figure 3-3, the proposed SIMA(PH) facility. Separate areas are provided for receiving, storage, WSA application, ESP coating and painting. Product moves from station to station through the central aisle. Laydown areas for staging and paint drying are included. As experienced in the Service Test, large paint-drying areas are required due to the eight to 72-hour curing time required between four coats of the five-coat paint system required for the WSA (low-temperature) coating. The flow of material should be planned to minimize distances between stations to reduce transport time and inter-station interference. This example is cited to show how a SIMA with minimum CC capability (existing IPE) can be modified to incorporate the existing IPE into the full-IPE requirement for a CC production shop. What is sacrificed in this facility is the less then ideal industrial equipment layout for functional flow. The efficiency of shop production is somewhat compromised to accommodate existing site condition and useable IPE. The proposed Plan of Action and Milestones (POA&M) for the CC-Shop installation (Figure 3-4) illustrates the steps required and may be used as the guide for planning similar projects. Typical line diagrams for electrical power, water and air are shown in Figures 3-5, 3-6 and 3-7.

A second example is provided for a Production Corrosion Control Shop in Figure 3-8. This SIMA(SD) MILCON Project scheduled for completion in 1989 provides an industrial-engineered facility capable of providing the most-efficient shop equipment layout. The size, numbers and types of equipment will provide the capability to perform the complete spectrum of work required.

The generic specifications for Production CC Shop equipment are provided in Appendix A3-1. These generic specifications are based on a review of vendor information and the requirements for the production shop. Included are cost and utility estimates based on vendor information. The controlling factor in equipment selection was the determination of the maximum size of product that should be processed in the production shop. For WSA, the largest item is a helo net frame 18-ft. long by 7-ft. wide.

A shop monorail system was considered but not recommended due to cost and inflexibility, however an overhead multiple-rail-trolley handling system should be considered for the painting station where five coats of paints must be applied for the WSA (low-temperature) coating. A generic specification, however, was not developed for an overhead multiple-rail trolley handling system for the painting station.

Text continues on pg. 3-16.

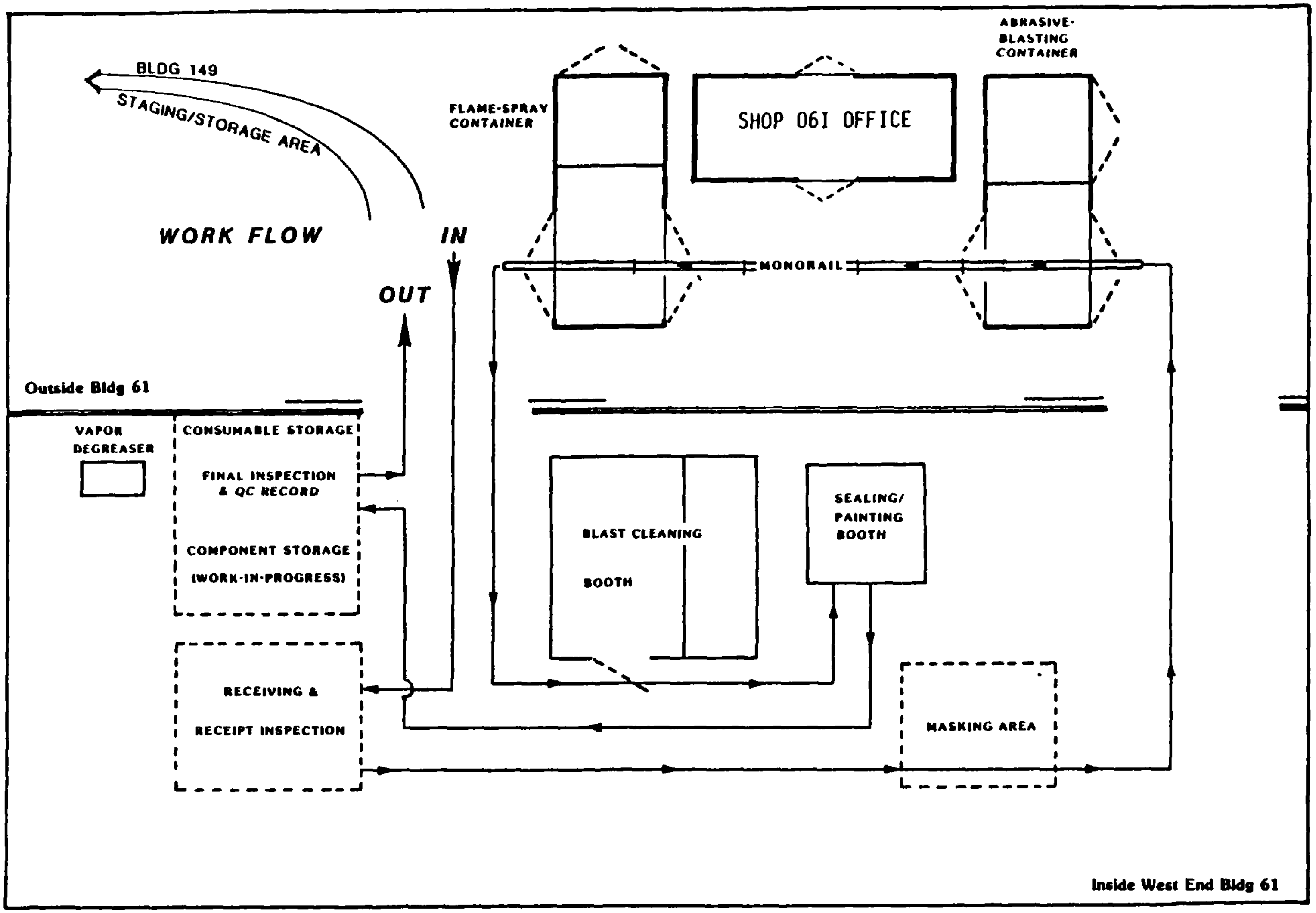

Figure 3-1 SIMA(SD) Pilot CC Shop

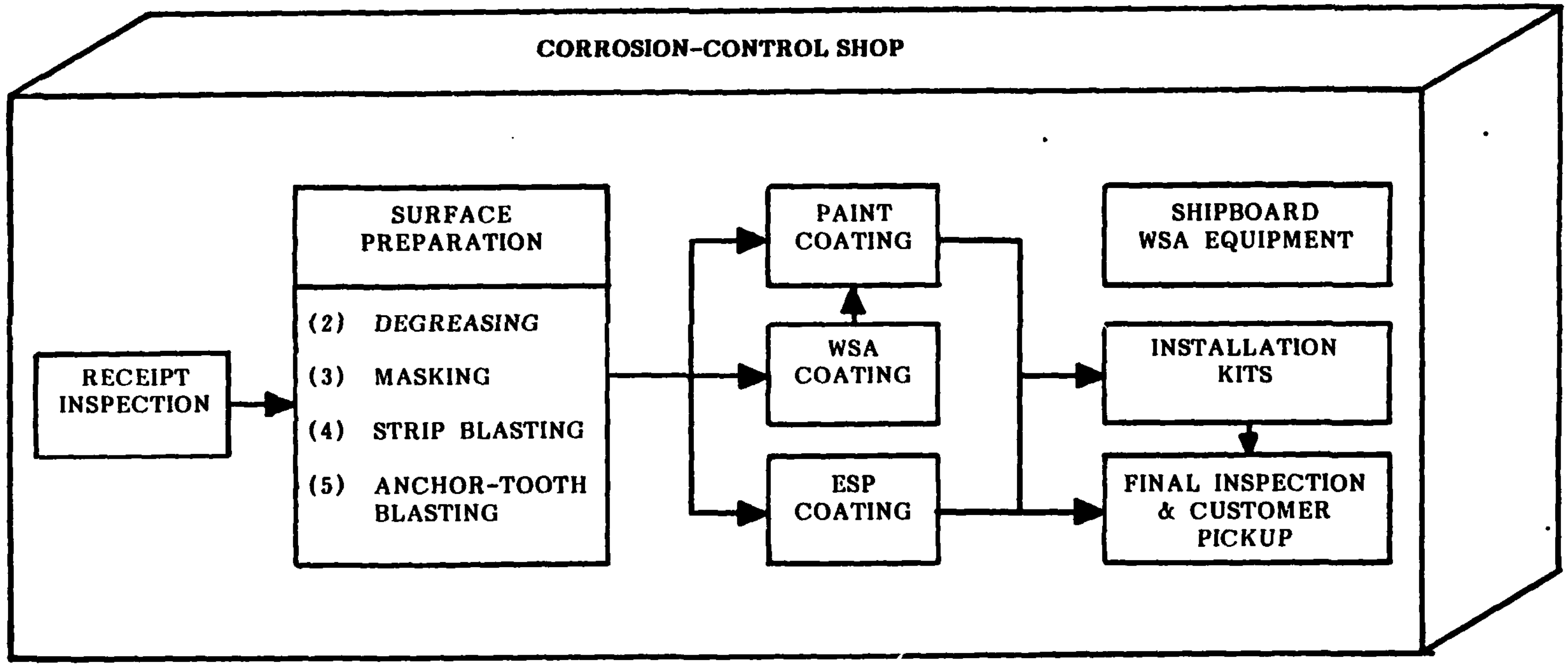

Figure 3-2 Functional Flow of CC Shop

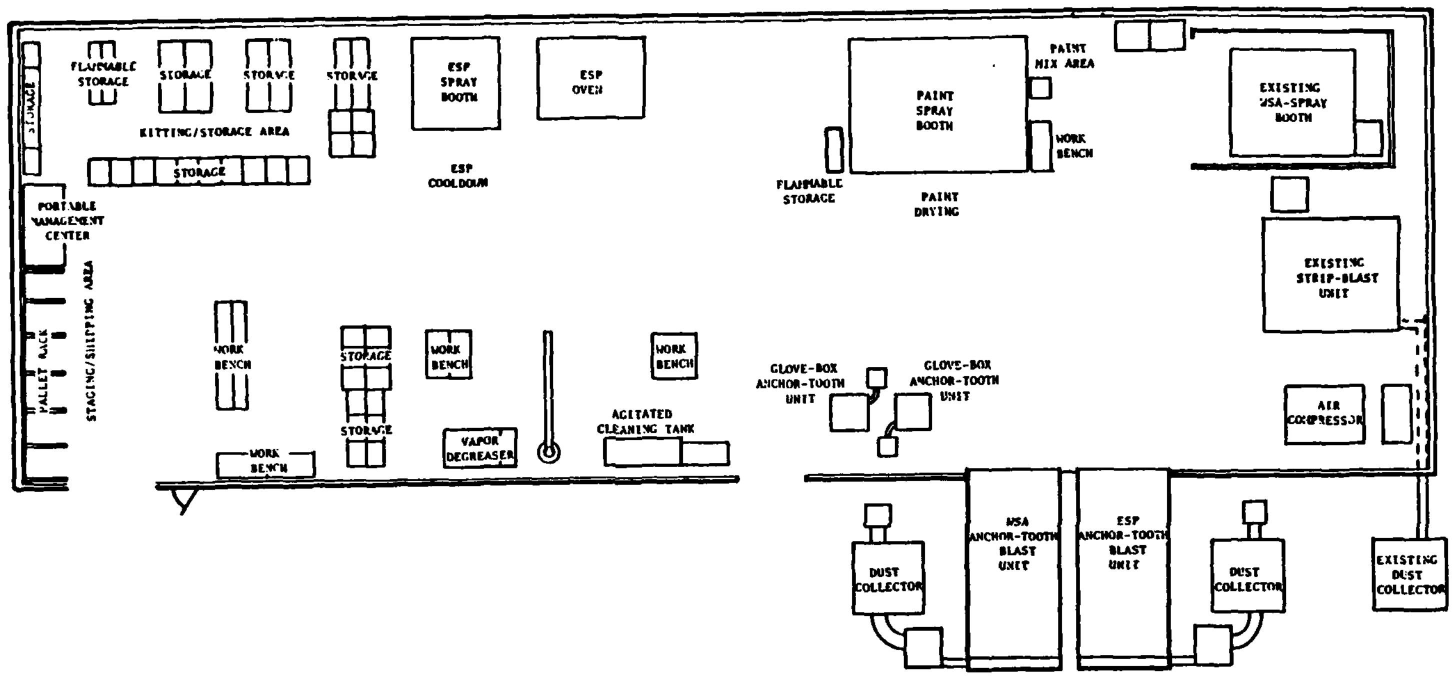

Figure 3-3 SIMA Pearl Harbor Production CC Shop

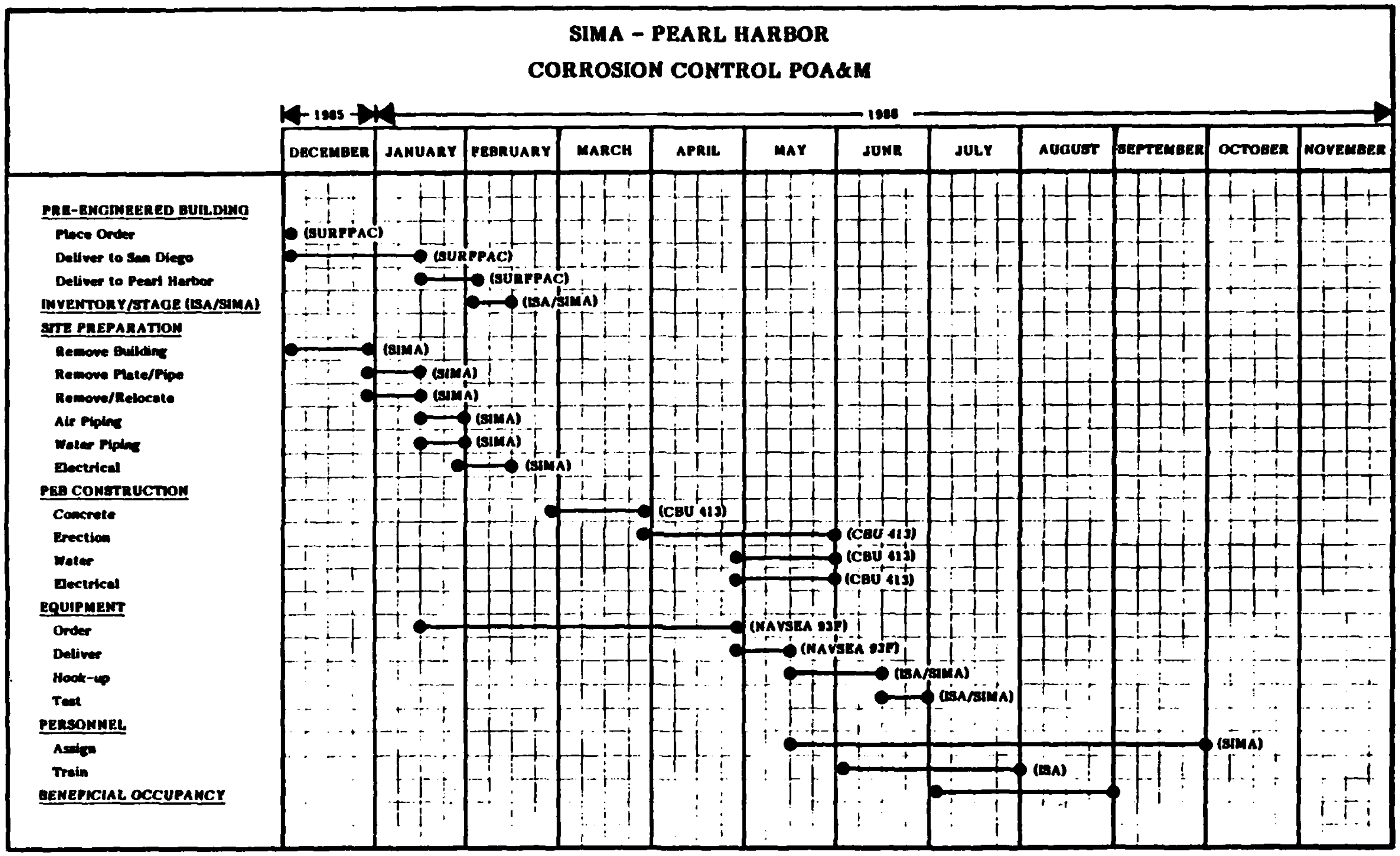

Figure 3-4 **Proposed POA&M for SIMA(PH) CC Shop**

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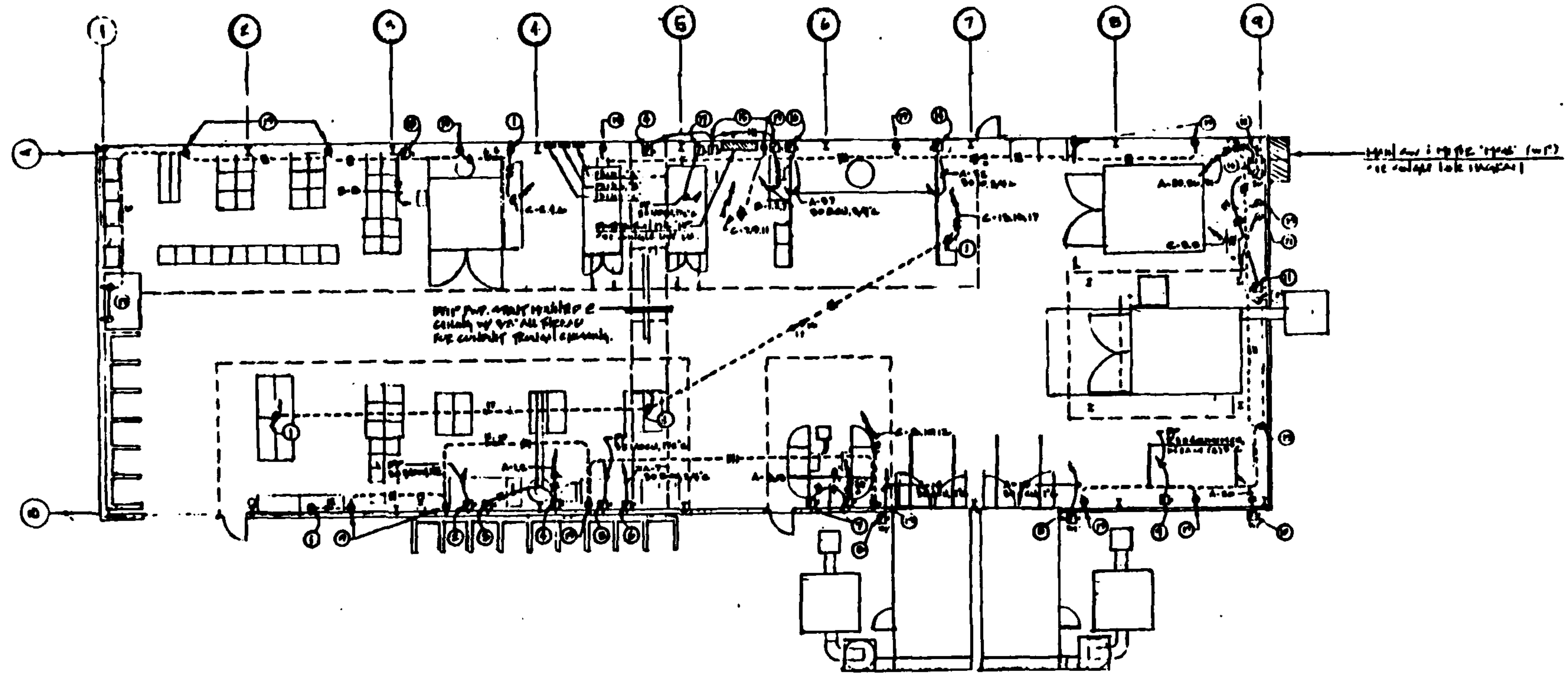

Figure 3-5 SIMA(PH) Electrical Power Line Diagram

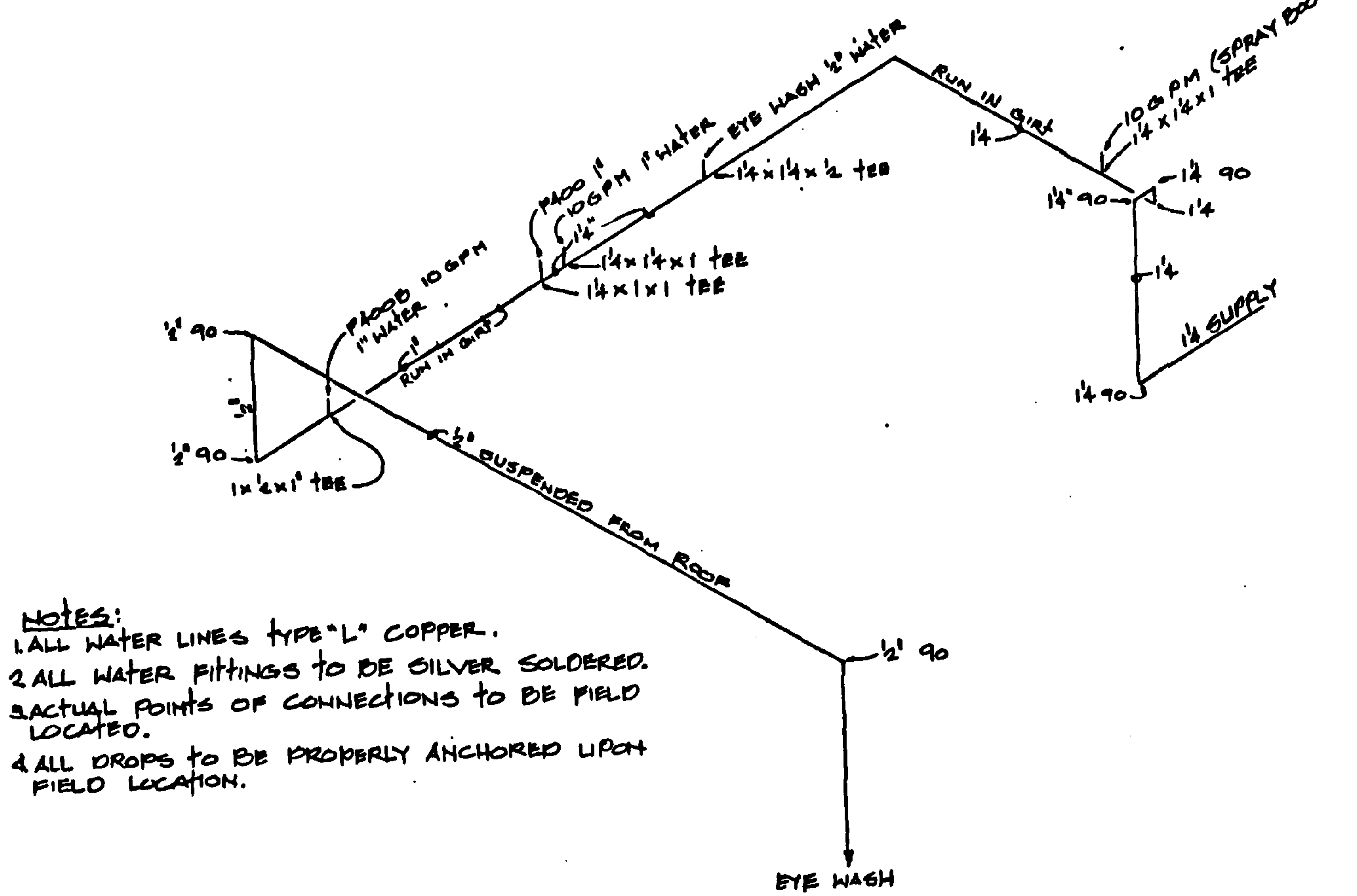

Figure 3-6 SIMA(PH) Water Line Diagram

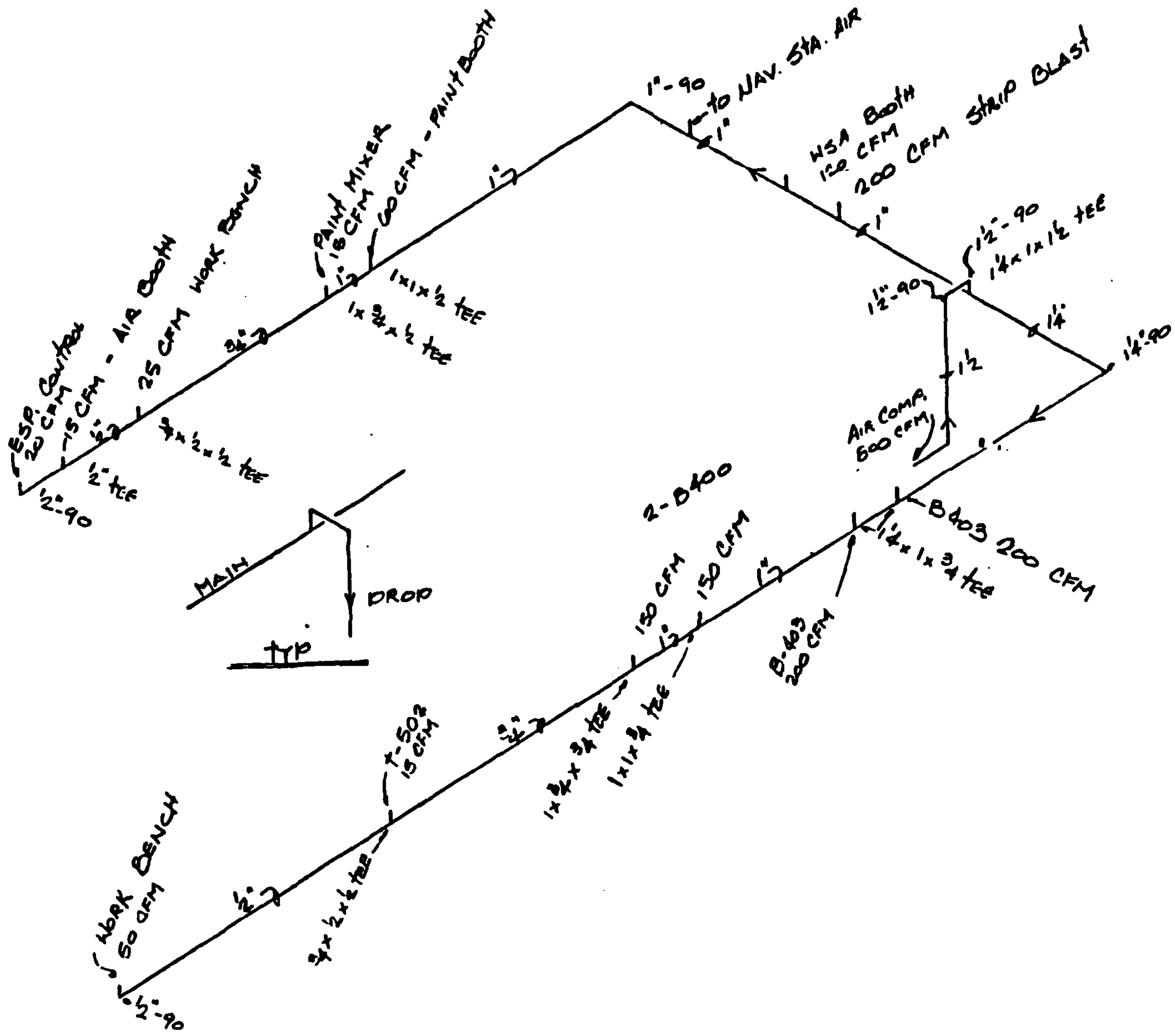

Figure 3-7 SIMA(PH) Air Line Diagram

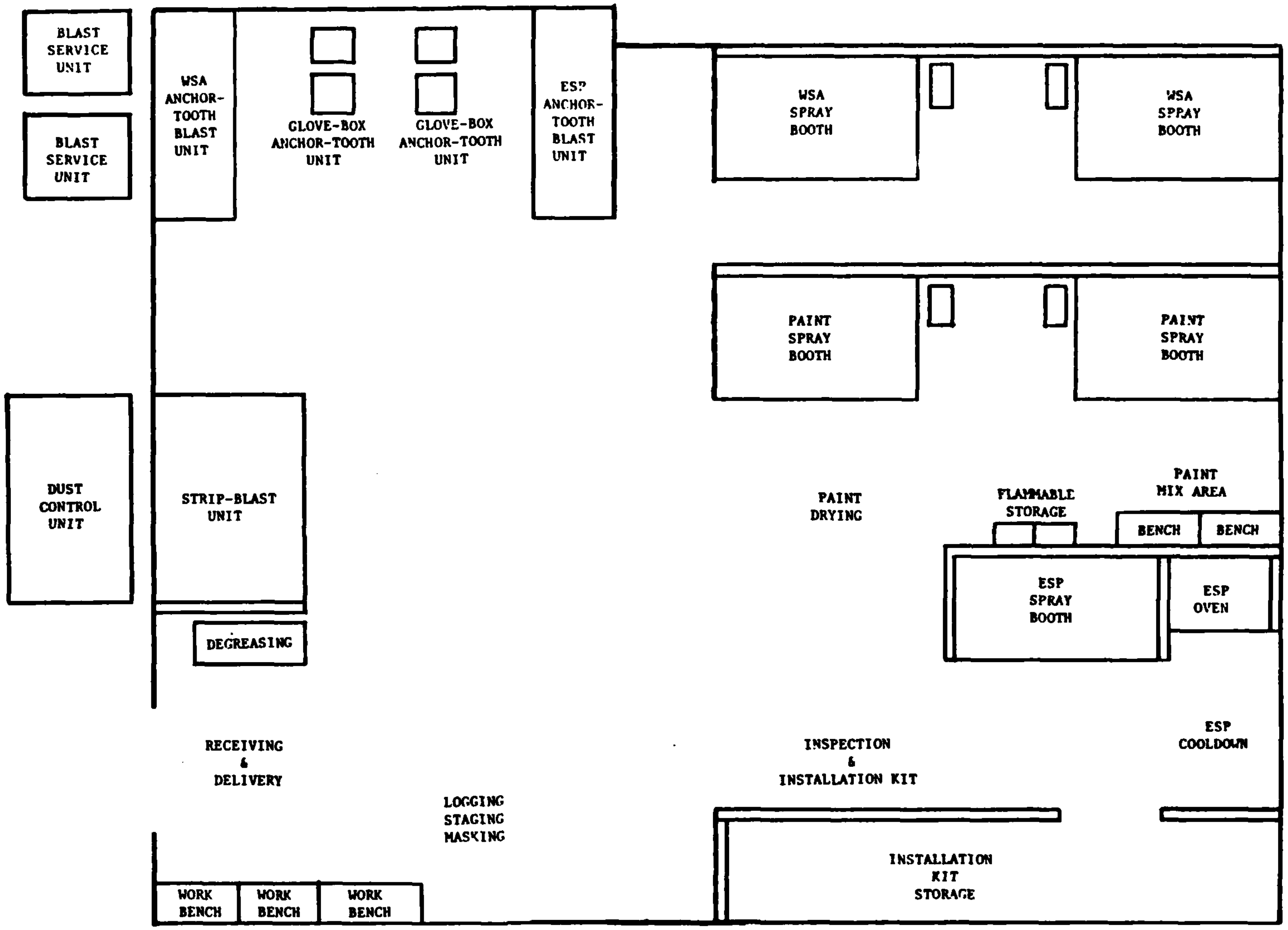

Figure 3-8 **SIMA(SD) MILCON Project P-012 CC Shop**

3.3 MODUS OPERANDI DURING SERVICE TEST

3.3.1 Planning

Initial Service Test planning and scheduling functions were conducted by contractor personnel and COMNAVSURFPAC staff. Planning is discussed in Section Six. During the Service Test, contractor and Shop 06I personnel conducted briefings for the ship assigned to a CC availability. This briefing explained the CC program and the ship and shop responsibilities to carry out the availability. It was recognized early that extensive documentation would be required for data collection for the Service Test and for quality control. Forms were developed and modified as necessary to collect and analyze the data. A ship check was conducted by contractor, Shop 06I and S/F to identify those items that would be either wire sprayed or sent to a commercial applicator for powder coating. Ship check records were filled out for each item or group of items. The resulting list of items was arranged by the ship with shop assistance in order of priority. The CC Shop then requested the items from the ship and worked the items in the order of priority. This method bypassed the SIMA planning and documentation system in that SIMA planning did not determine shop workload. Automated work requests (AWR) were generated by the ship as a matter of policy.

Section Six of this report discusses in detail the recommendations for the planning process to develop the CCWP. The key points to consider are the need for shop supervision to be directly involved in the planning process. Aggressive action is required. CC shop personnel need to make contact with the ship and work closely with responsive S/F personnel to ensure program success. The Shop Master must interface with the Ship Superintendent (ShipSup) to ensure that S/F schedule and deliver products to the shop to an on "as required basis". Accurate and thorough ship checks must be conducted to properly identify items, establish priority lists and extent of disassembly required by S/F.

3.3.2 Production

3.3.2.1 Functional Flow

Production in the Pilot CC Shop began in November 1984. All stations were operational and product was moved from station to station by hand or on carts. An immediate problem which was identified was the need for large laydown areas adjacent to the work stations. These areas were required to stage items at the various work stations so that the operator could work steadily and not spend time moving product in and out of his station work area. Consequently, throughout the Service Test, the quantity of product processed was limited due to the operator having to spend a significant amount of time moving the product from station to station.

The maximum size of items that could be processed by the Pilot CC Shop was limited by the anchor-tooth blasting unit with inside dimensions of 7-1/2-ft high x 7-1/2-ft wide x 10-ft long. Even though the WSA and paint booths are only 7-ft and 8-ft long respectively, they are open booths so that the item could be wire sprayed and painted in sections. The limiting weight and size was determined primarily by the manual lifting capacity of Shop personnel.

3.3.2.2 Services Delivered

The Pilot CC Shop was equipped and manned to (a) provide technical advice on the causes and prevention of shipboard corrosion and the application of the 15 NAVSEA-designated CC systems and (b) provide production services for (1) WSA (NAVSEA Systems One and Two), (2) contractor services for ESP coating (NAVSEA System Four) and (3) installation kits for components preserved by the Pilot CC Shop. Table 3-3 identifies the 15 NAVSEA-designated systems and the method of delivery during the one-year Service Test. Production shops will be equipped to deliver all 15 NAVSEA-designated CC systems including ESP coatings.

Of the 15 NAVSEA CC Systems, the WSA and ESP coatings require follow-on production services. The rest require only material support or technical advice from the Shop.

WSA has been applied since the start of the Service Test using the WSA containers. Painting services were provided for the WSA items and only occasionally as straight paint coatings.

The ESP coatings were provided by a contractor since the Service Test did not initially include an ESP station in the pilot shop.

Note: The ESP-coating station was designed to be housed in two eight-feet x eight-feet x 20-feet container units. It was fabricated and installed in the Pilot CC Shop in October 1985 and is currently undergoing its service test. This ESP-coating service test will be reported separately and is not included in this report.

The third major area of work was in developing and implementing a strategy to properly reinstall preserved components on the customer ships, i.e., supporting materials. It was recognized that to provide a complete CC service, improved fasteners should be provided with the WSA- and ESP-preserved items. Ships were surveyed for fastener requirements and pre-expended bins established to furnish fastener installation kits for the WSA and ESP items preserved. The importance of correct fastener installation was determined by follow-up inspection onboard the assigned ships. S/F in general was not installing the fasteners or incorrectly installing them. Pilot CC-Shop personnel were assigned to go onboard the ships and provide technical assistance to the S/F for fastener installation.

3.3.2.3 Quality Assurance

A SIMA(SD) Process Instruction for WSA (No. 7100-18-84) (Ref. 3-4) was developed and approved for use in the Pilot CC Shop by SIMA(SD). It incorporated quality-control provisions of DoD-STD-2138(SH) for WSA application (Ref. 3-2).

Table 3-3 CC Services Delivered During Service Test

CC SYSTEM	COATING SYSTEMS	METHOD OF DELIVERY
1	Wire-Sprayed Aluminum (WSA) (10-15 mils) + 2-coats DoD-P-24555 heat-resistant aluminum paint (3 mils DFT)	Shop Production
2	Wire-Sprayed Aluminum (WSA) (7-10 mils) + 5-part sealer/barrier/topcoat epoxy-polyamide, silicone-alkyd paint schedule (9.5-9.75 mils DFT)	Shop Production
3	Paint Coating Systems specified in NSTM 631	Shop Production (to WSA items)
4	Electrostatic-Sprayed Powder (ESP)	Outside Contract
5	Non-Skid Deck Coating (flush deck scuttles and hatches)	Technical Advice
6	Ceramic-Coated Fasteners	Material Support
7	Water-Displacing, Clear, Corrosion-Prevention Compound	Material Support
8	Anti-Seize Thread Compound	Material Support
9	316-Stainless Steel (SS) Fasteners	Material Support
10	Sealing and Coating Compound	Material Support
11	Polysulfide Sealant	Material Support
12	Multi-Pin Connection Protection	Technical Advice
13	Dielectric Barriers (Polyvinyl, Glass-Reinforced Insulation Gaskets and Nylon Washers)	Technical Advice and Material Support
14	Vapor Phase Inhibitor	Technical Advice
15	Strippable Coating	Technical Advice

Continual review of shop operations and quality-control practices resulted in the conclusion that shop personnel were not consistently applying WSA to the specifications of DoD-STD-2138(SH). A draft Quality-Assurance Shop-Operating Procedure was written and provided for use in the Pilot CC Shop. This draft included a revision of the Production-Control Record to include specific inspections of the products during the WSA process and the requirement for an assigned Shop Quality-Control Inspector (SQCI) to actually conduct and sign for the inspections. This draft Quality-Assurance procedure was not fully utilized by the Shop in that SIMA(SD) did not consider it was necessary to designate a Shop Quality-Control Inspector but rather each operator should monitor his own work.

Revision One to the WSA Process Instruction was issued in October 1985. Revision One expanded the Quality Control and Method sections incorporating the DoD-STD-2138(SH) specifications verbatum.

The production shop should have SQCIs specifically designated to monitor the WSA- and ESP-production process. In the Service Test, quality control conducted by the operators was not satisfactory. The operators did not produce consistent quality products. Independent checks by the SQCI are necessary to ensure the requirements of DoD-STD-2138(SH) are met for anchor-tooth depth, WSA and paint thickness and time intervals from anchor-tooth blasting through final painting.

3.3.2.4 Record System

During the Service Test, the volume of data collected for analysis required the assignment of one shop person to full-time records management. The forms developed for this data collection are discussed in Section Three. The need for these forms was initially considered to be only for the Service Test. However, experience in the shop with problems of accountability of items, work-load analysis, projections and quality control indicate that some of these forms or modifications of them should be used in the production shops.

The maintenance of accurate records in the CC-production shop is a critical element in the capability of the shop to function as a integral part of the SIMA Fleet-support effort. The following records should be used in the production shop.

- **Production-Control Work-Load Log (Figure 3-9)** - It is a record of each product in the shop and its status. This record is necessary to prevent items from being "lost" and as a check that all items have been returned to the ship. Without this record, the shop would have to be physically inventoried to locate a ship's product.

PRODUCTION CONTROL WORK LOAD LOG

DATE ____________

SHIP-TO-SHOP	RECEIVING / DEGREASING / MASKING / STRIP BLASTING / ANCHOR-TOOTH / FLAME SPRAYING / PAINTING / FASTENERS	SHIP-TO-SHOP	RECEIVING / DEGREASING / MASKING / STRIP BLASTING / ANCHOR-TOOTH / FLAME SPRAYING / PAINTING / FASTENERS	SHOP-TO-SHOP	RECEIVING / DEGREASING / MASKING / STRIP BLASTING / ANCHOR-TOOTH / FLAME SPRAYING / PAINTING / FASTENERS		
ITEM DESCRIPTION	STATION NUMBER 1 2 3 4 5 6 7 7 7 7 7 8	ITEM DESCRIPTION	STATION NUMBER 1 2 3 4 5 6 7 7 7 7 7 8	ITEM DESCRIPTION	STATION NUMBER 1 2 3 4 5 6 7 7 7 7 7 8	CAUSE OF DELAY	DATE

Figure 3-9 Production-Control Work-Load Log

- **Production-Control Record (Figure 3-10)** - This record is for recording the inspection results for the product. The record travels with the item through the shop. It lists the type of coating, color requirements and information that identifies the item, ship, location on the ship and JSN and shop control numbers. The profile tape used to measure the anchor-tooth depth is attached to the record and the record is the record of the production process as required by DoD-STD-2138(SH).

- **Shipboard CC Post-Availability Inspection Sheet (Figure 3-11)** - An important method of determining the success of the CC work done by the production shop is to conduct follow-up inspections onboard the ships serviced. These inspections can provide the feedback necessary to evaluate the quality control of the production process, the correct use of Installation Kits by S/F and the in-service performance of the CC coating. Based on these feedback reports, training, process instructions, quality control and the Installation-Kit Technical-Data Sheets (TDs) can be updated.

3.3.2.5 CC Work-Accomplished Book

A CC Work-Accomplished Book was developed to provide the ship and SIMA Planning a list of the items processed in the CC availability (Appendix A4-5). This would permit the ship to maintain a history of items preserved and for SIMA Planning to formulate the work package for the next CC availability by identifying items already done. The list is required since the individual items are not marked or otherwise identified onboard ship. Consideration was given to determine various ways to mark each item. NAVSEA 05M1 stated that it was investigating various methods for identification of processed items.

The CC-Work Accomplished Book includes a discussion of corrosion and methods of repair of processed items. This information was extracted and updated from the NAVSEA CC Manuals for ships and was included since only four manuals have been issued by NAVSEA to October 1985. Five other manuals have been drafted.

3.4 RECOMMENDATIONS

- **Function** - The SIMA CC production shop should operate as a lead shop to provide WSA and ESP services and technical assistance and material support for installation kits for assigned ships and units.

- **Organization and Manning** - The SIMA CC Shop should be in the Production Department since it provides support to assigned ships, units and other production shops. The Hull-Repair Group and Services Group are logical organizational assignments for the CC Shop.

CORROSION-CONTROL SHOP
WIRE-SPRAYED-ALUMINUM
PRODUCTION-CONTROL RECORD

USS ____________________________________
Ship   Hull Number

______________________________ ______________________________
Job Control Number (JCN)   Production Control Number

______________________________ ______________________________
Item Description   Location Deck Frame Side

TYPE COATING:

____WSA(HT) Sys 1

____WSA(LT) Sys 2

FINISH COLOR

____HRAP

____HAZE GRAY

____DECK GRAY

____OTHER ____________

SECTION	PROCESS SEQUENCE INSPECTIONS		DATE	TIME	SHOP QCI SIGNATURE
1.	Receipt, Degrease, Degalvanize, Dealuminize				
2.	Masking	Plug / Tape			
3.	Strip Blast				
4.	Anchor Tooth 2-3 mils	mils			
5.	Thermal Spray	High mils			
	Sys 1 10-15 mils; Sys 2 7-10 mils	Low mils	Operator Name		

		Seal, Barrier and Topcoat Type/DFT Rqmt	Measured DFT	Date	Time	ATTACH PROFILE TAPE HERE
CC SYS 1	6.	HRAP/1.5 mils				
CC SYS 1	7.	HRAP/1.5 mils				
CC SYS 2	8.	150/0.5-0.75 mil				
CC SYS 2	9.	151/3 mils				
CC SYS 2	10.	150/3 mils				
CC SYS 2	11.	TC/1.5 mils				
CC SYS 2	12.	TC/1.5 mils				
	13.	Final Thickness				
	14.	Final Assembly Inspection				

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Figure 3-10 **Production-Control Record**

CORROSION CONTROL SHOP
SHIPBOARD CC POST-AVAILABILITY INSPECTION SHEET

USS ______________________ DATE ______________________

ITEM	LOCATION	CORRECT INSTALLATION		COATING DAMAGE		COATING THICKNESS			OBSERVED CONDITION	RECOMMENDATIONS
		YES	NO	YES	NO	WSA	WSA & PAINT	ESP		

The above items were inspected upon reinstallation and found to be in the condition listed. A copy of this report has been issued to the Ship CC Coordinator in order to provide the corrective action recommended.

Prepared by: ______________________ Shop Master ______________________
Signature

Figure 3-11 Shipboard CC Post-Availability Inspection Sheet

The exact manning requirements for a production shop will vary at each SIMA as a function of shop's IPE, physical plant/layout, workload requirements, port loading, numbers of ships simultaneously in availabilities, types and size of shops at the SIMA generating shop-to-shop workload. Planned facilities and equipment for the CC Shop dictate the manning requirements. 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 3-4 lists the recommended positions that need to be considered for the production shop, the rate and typical duties. Support personnel are required to keep the blast units, WSA and painting booths in full-operation by having personnel available to move product, set-up equipment, minor maintenance, obtain blast grit, etc. allowing the operators to work full time.

The leading CPO should be Boatswain's Mate (BM) or Hull Technician (HT) because the preservation and corrosion control are in the career path of the BM; the HT because the WSA coating is the major-Shop product and flame spraying is an allied discipline to welding. Personnel should be assigned for a full-tour at the Shop and not rotated between Shops. Consideration should be given for relevant training such as QA and PMS in addition to WSA and powder coating.

A key ingredient is strong shop leadership. The CC Shop provides a service in which it is usually difficult to detect poor workmanship. Failures may not show up for months or years. Strict quality control is required. The Shop leadership must also be sensitive to S/F needs. Corrosion control has great visibility to the ship's company since it affects the appearance of the ship as well as the crew's pride in their ship. The Shop leadership must be able to work well with S/F.

The Shop Master must be a strong leader, teacher and manager. CC work requires attention to substrate preparation and application of multiple components of a coating system in specified time intervals and environments. There is no non-destructive examination method for end-item inspection and acceptance; the exact process control must be followed. Therefore, the IPE must be set up and operated properly and the industrial process instructions must be followed explicitly.

- **IPE** - The equipment classes for a SIMA CC Shop are shown in Table 3-5. The specific sizes and quantities of each equipment class will be determined by the size of the specific CC Shop. Complete WSA-and ESP-coating equipments are described. The products can be degreased, strip-blasted, anchor-tooth blasted, WSA coated and painted in the production shop.

- **Planning** - The planning process will be discussed in detail in Section Six. The Shop Master and shop personnel must maintain a close working relationship with their customer ship.

Table 3-4 **Production Shop Manning**

POSITION	RECOMMENDED RATE	TYPICAL DUTIES
Shop Master	CPO	Liaison with ships and SIMA Shops
Assistant Shop Master	PO1	Direct Shop operations
Receipt Inspection, Final Inspection	PO2	Check in/out product, ensure product delivered ready for processing
Degreasing, Masking	FN/SN	Prepare items for preservation process
Strip Blasting	FN/SN	Operate strip blast unit
Anchor-Tooth Blasting	FN/SN	Operate anchor-tooth blast unit
Strip- and Anchor-Tooth Blast Unit Support	FN/SN	Move product in/out of blast units, load/unload grit
WSA Operators	FN/SN	Apply WSA coatings
WSA Support	FN/SN	Move product
Painting	FN/SN	Operate paint spray booth
IKPO	PO1	Prepare installation kits, assist ship in installation
Supply Petty Officer, Assistant IKPO	PO2	Maintain consumables Assist Fastener Petty Officer
Shop Quality-Control Inspector	PO2	Provide direct QC support
Training and PMS Petty Officer	PO1	Train operators and direct PMS Program
ESP Operators	PO3*	Operate ESP Facility

* Anticipated ESP Operator Recommended Rating. Further evaluation is being conducted and recommendation will be finalized upon completion of the Pilot ESP Facility Service Test.

Table 3-5

PRODUCTION SHOP EQUIPMENT CLASSIFICATIONS	
IPE	
Surface-Preparation IPE	**WSA-Coating IPE**
• Degreaser	• Portable/Containerized WSA Unit
• Reach-In Blast Cabinet	• WSA Spray Equipment
• Portable/Containerized Blast Unit	• Waterwash Booth
• Abrasive Blast Unit (Walk-In)	**Painting IPE**
	• Waterwash Booth
MISCELLANEOUS EQUIPMENT	
Painting Equipment	**Mat'l Handling/Storage Equipment**
• Paint Spray Gun Assembly	• Storage Cabinet
• Paint Mixers	• Flammable Liquid Storage Cabinet
Testing/QA Equipment	• Pre-Expended Bins
• Zinc- and Aluminum-Identification on Steel Kit	• Small Parts Storage
• Surface Profile Measurement Apparatus	• Oxygen and Acetylene Bottle Storage Racks
• Portable Electric Psychrometer	• Work Table
• Holiday Detector	• One-Ton Electric Hoist and Swing Boom
• Wet Film Thickness Gauge	• Half-Ton Hand-Operated Chain Hoist
• Dry Film Thickness Gauge	• Mobile Hydraulic Floor Crane
	• Hydraulic Pallet Truck
	• Platform Truck

- **Services** - The production shop should be capable of (a) providing technical advice on the causes and prevention of shipboard corrosion and the application of the 15 NAVSEA-designated CC systems and (b) delivering production services for WSA (NAVSEA Systems One and Two).

- **Quality Assurance** - A SQCI should be assigned with no other duties. All Process Instructions used in the production shop should include QC provisions.

- **Records** - As a minimum, the following records should be maintained.

  - Production-Control Work-Load Log (Figure 3-9).

  - Production-Control Record (Figure 3-10).

  - Post-Availability Inspection Sheet (Figure 3-11).

- **CC Work-Accomplished Book** - The ship should be provided a CC Work-Accomplished Book that records all items preserved on the ship. This historical record should be maintained by SIMA Planning to be used to plan subsequent CC availabilities. The CC Work-Accomplished Book should be prepared and issued by the SIMA CC Shop.

REFERENCES for SECTION THREE

3-1 Sulit, R.A. and O. G. O'Brien, ASW and Support-Ship Corrosion-Control (CC) Program Pilot SIMA CC Shop, ISA(WC)-101, 14 September 1984, Contract N66001-84-D-0032, Delivery Order 0003.

3-2 DoD-STD-2138(SH), Metal-Sprayed Coating Systems for Corrosion Protection Aboard Naval Ships, 23 November 1981.

3-3 Sulit, R.A. and O. B. O'Brien, ASW and Support-Ship Corrosion-Control (CC) Program: SIMA Pilot CC Shop Service Test and Technical Support, ISA(WC)-ITR-104, 11 December 1984, Contract N66001-84-D-0032, Delivery Order 0009.

3-4 Shore Intermediate Maintenance Activity, San Diego Process Instruction No. 7100-18-84 Rev. 1, Wire-Sprayed Aluminum (WSA) for Corrosion Protection; NAVSEA Corrosion-Control (CC) Systems 1 and 2.

3-5 Kullerd, S., et al, ASW and Support-Ship Corrosion-Control (CC) Program: SIMA Pilot CC-Shop Service Test and Technical Support, ISA(WC)-ITR-106, 31 July 1985, Contract N66001-84-D-0015, Delivery Order 0002.

SECTION FOUR

SERVICE TEST: IN-SHOP PRODUCTION

4.0 GENERAL

In-shop production is comprised of two different types of work: ship-to-shop and shop-to-shop. Shop production procedures for both types of work are similar and have evolved from process requirements and instructions, IPE, SIMA management and operating procedures and lessons learned during the one-year Service Test, in which the Pilot CC Shop completed 11 ship-to-shop availabilities, one shipboard concurrent availability and approximately 650 shop-to-shop components.

4.1 CC SERVICES DELIVERED

The Pilot CC Shop was equipped and manned to provide (a) technical advice on the causes and prevention of shipboard corrosion and the application of the 15 NAVSEA-designated CC systems and (b) production services for (1) WSA (NAVSEA Systems One and Two), (2) contractor services for ESP coating (NAVSEA System Four) and (3) installation kits for components preserved by the Pilot CC Shop. Table 4-1 lists the CC services provided in the ship-to-shop, shop-to-shop and shipboard modes.

Table 4-2 presents a summary of the Pilot CC-Shop work accomplished during the 11 designated ship availabilities. Representative items preserved for each customer ship are indicated along with the total number of items preserved with WSA and ESP coatings during the specified period. Approximately 1800 components were preserved for these 11 ships. A listing of all components preserved during the Service Test is provided in Appendix A4-1.

4.2 WIRE-SPRAYED ALUMINUM (WSA) COATING

4.2.1 <u>Industrial Process Instruction</u>

WSA coatings are applied in accordance with DoD-STD-2138(SH) "Metal Sprayed Coating Systems for Corrosion Protection Aboard Naval Ships," (Ref. 4-1) and NAVSEA S9086-VD-STM-000, Chapter 631, "Preservation of Ships in Service (Surface Preparation and Painting") (Ref. 4-2). A SIMA(SD) Process Instruction No. 7100-19-84 Revision 1, October 1985 (Appendix A4-2) for WSA applications has also been developed to explicitly state the equipment, material, safety, quality control, operator training and certification, method and feedback to be used to apply the WSA-coating system.

4.2.2 <u>WSA Production Processes</u>

The CC-Shop production stations were established and laid out to deliver and control the quality of the major elements of the production process. The following subsections describe the work conducted at these nine stations:

Table 4-1 Pilot CC-Shop Services Delivered by Mode

CUSTOMER	TECHNICAL ASSISTANCE	WSA (Hi-Temp)	WSA (Lo-Temp)	PAINT	ESP	INSTALLATION KITS
SHIP-TO-SHOP						
USS ALBERT DAVID (FF-1050)	X		X	X	X	
USS BERKELEY (DDG-15)	X	X	X	X	X	X
USS BRONSTEIN (FF-1037)	X				X	
USS COPELAND (FFG-25)	X		X	X	X	X
USS FRESNO (LST-1182)	X		X	X	X	
USS HENRY B. WILSON (DDG-7)	X	X	X	X	X	
USS SCHENECTADY (LST-1185)	X		X	X	X	X
USS STEIN (FF-1065)	X		X	X		X
USS TRUXTUN (CGN-35)	X		X	X		X
USS WADSWORTH (FFG-9)	X		X	X	X	X
SHOP-TO-SHOP						
SHIPFITTER SHOP 11A			X	X		
VALVE SHOP 31D		X		X		
PIPE SHOP 56A		X		X		
ENGINE SHOP 31E		X	X			
SHEETMETAL SHOP 17A			X	X		
FLEET VALVE-MAINTENANCE SHOP	X					
SHIPBOARD						
USS SCHENECTADY (LST-1185)	X		X	X		X

Table 4-2 Summary of Pilot CC Shop Ship-to-Shop CC Work Accomplished

SHIP NAME & NUMBER	TYPE & DATES OF AVAILABILITY	NUMBER OF ITEMS: Wire-Sprayed Aluminum (WSA)	Powder Coating	TOTAL	REPRESENTATIVE COMPONENTS: Stanchions	Vent Screens	Signal Lights	Signal Lt. Filters	Rope Reels	Portable Davits	Hawse P. Covers	1MC Speakers	WT Doors	RAS Piping	Running Lts	P-250 Boxes	Raised Hatches	Fog Applicators	Pyro Lockers	Gun Mounts	Floodlights
USS BRONSTEIN FF-1037	SRA Oct-Nov 84	0	33	33		X	X	X				X						X			
USS ALBERT DAVID FF-1050	SRA Oct-Nov 84	29	131	160	X	X	X	X	X	X	X	X						X			
USS FRESNO LST-1182	Oct-Nov 84*	186	5	191	X	X			X		X										
USS TRUXTUN CGN-35	Oct-Nov 84*	20	5	25							X					X					
USS BERKELEY DDG-15	SRA Dec 84 - Jan 85	78	112	190	X	X	X	X	X	X	X		X	X			X	X		X	
USS FLETCHER DD-992	SRA Jan 35	230	216	446	X	X	X	X			X			X		X	X	X	X	X	X
USS COPELAND FFG-25	SRA Feb-Mar 85	97	151	248			X	X	X		X	X					X		X	X	X
USS HENRY B. WILSON DDG-7	Jan-Feb 85*	5	68	73			X														
USS WADSWORTH FFG-9	SRA Jan-Mar 85	68	88	156	X		X										X		X		X
USS STEIN FF-1065	SRA Apr-Jul 85	22	0	22							X		X								
USS SCHENECTADY LST-1185	ROH/PRAV Apr-Aug 85	116	138	254	X	X			X			X	X			X	X		X		X

* Not in an availability. Processed at the request of COMNAVSURFPAC (N81).

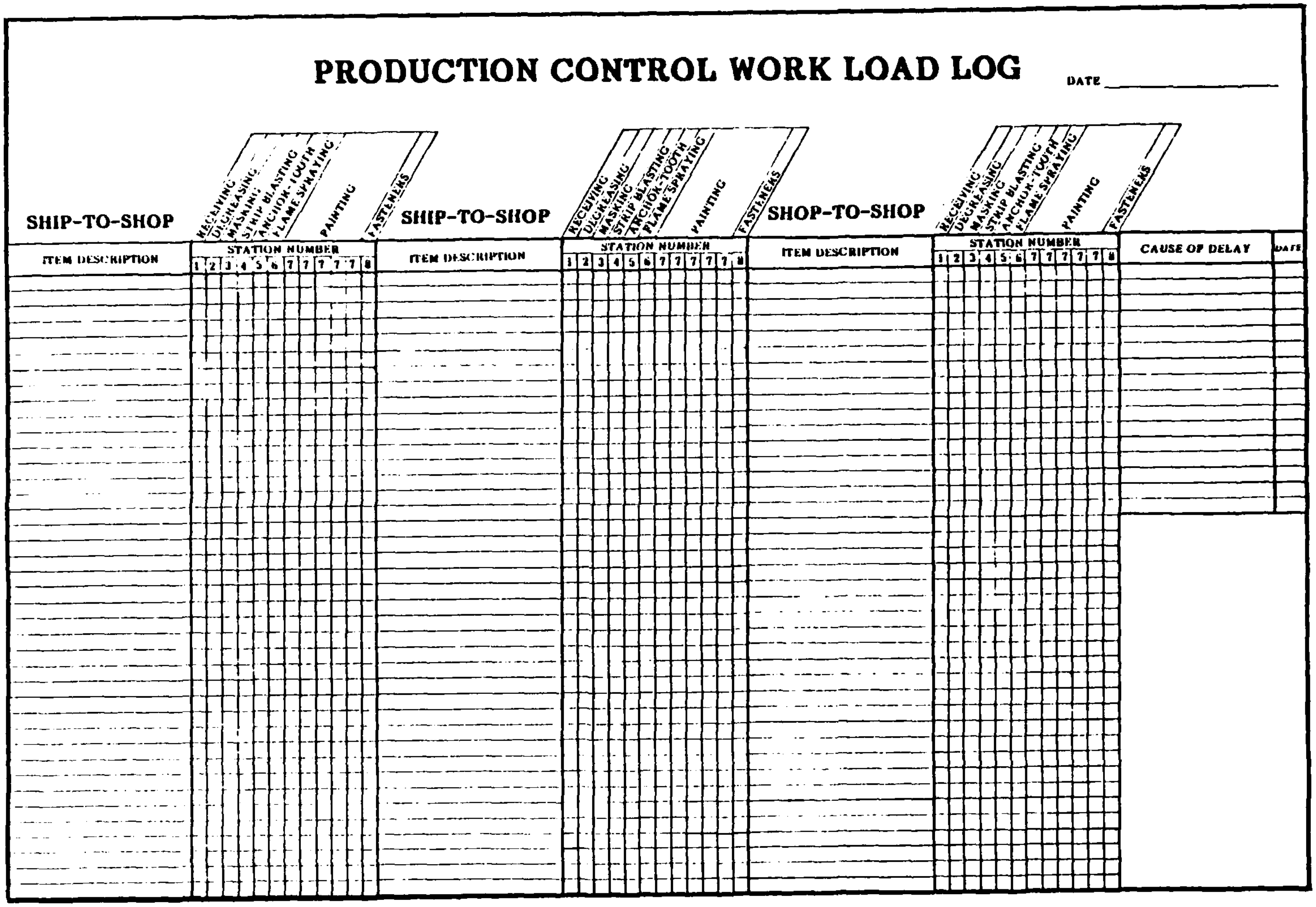
STATION	NAME/FUNCTION
1	Receipt Inspection
2	Degreasing
3	Masking
4	Strip Blasting
5	Anchor-Tooth Blasting
6	WSA
7	Painting
8	Installation-Kit Makeup and Storage
9	Final Inspection and Customer Pickup

4.2.2.1 Station 1 - Receipt Inspection

The operator at this station was responsible for entering each component into the shop record system. The component's Job Sequence Number (JSN), noun name and date delivered to the Shop were entered onto the Production-Control Work-Load Log. (Figure 4-1). This form also allows the completion dates at each station to be logged-in to ensure product tracking and timely completion.

During the Pilot-Shop operation, this form was supplemented by the WSA Priority List (Figure 4-2) to organize the ship/shop coordination. This form permitted the ship to list in descending order of priority the items that they wished to have preserved based upon the manpower savings expected from the CC-Shop services. The Shop then documented the dates the customer ship was requested to deliver components, when they were actually delivered, completed and picked up by the customer ship.

The receipt-inspection technician also inspected components for suitability and readiness for WSA application. Complete disassembly by S/F was essential in order to devote maximum shop manpower to preservation services rather than to component disassembly. Components were also inspected for repair work requirements. Depending on the extent of work required, this work was either done by shop personnel or by an Assist Shop. The CC Shop had a minimum capability for repairs however, production throughput was affected when repair vice CC work was performed by shop personnel.


PRODUCTION CONTROL WORK LOAD LOG

DATE ____________

SHIP-TO-SHOP

ITEM DESCRIPTION	RECEIVING 1	DEGREASING 2	MASKING 3	STRIP BLASTING 4	ANCHOR-TOOTH 5	FLAME SPRAYING 6	7	7	7	7	PAINTING 7	FASTENERS 8

SHIP-TO-SHOP

ITEM DESCRIPTION	RECEIVING 1	DEGREASING 2	MASKING 3	STRIP BLASTING 4	ANCHOR-TOOTH 5	FLAME SPRAYING 6	7	7	7	7	PAINTING 7	FASTENERS 8

SHOP-TO-SHOP

ITEM DESCRIPTION	RECEIVING 1	DEGREASING 2	MASKING 3	STRIP BLASTING 4	ANCHOR-TOOTH 5	FLAME SPRAYING 6	7	7	7	7	PAINTING 7	FASTENERS 8

CAUSE OF DELAY	DATE

Figure 4-1 Production-Control Work-Load Log

U.S.S. ____________________ PAGE ___ OF _____

SHIP'S PRIORITY AND STATUS REPORT

WIRE-SPRAYED ALUMINUM

SHIP'S PRIORITY	ITEM DESCRIPTION	QUANTITY	L.W.C.	J.S.N.	DATES					REMARKS
					CALLED FOR	DELIVER TO O6I	O6I START	O6I COMPL	S/F PICK-UP	

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Figure 4-2 WSA Priority List

Occasionally, components entered the Shop with previously-applied metallized coatings, such as galvanized or WSA coatings. It is important to identify these components because blasting damaged the metallized or galvanized coating and required additional chemical removal techniques. During Pilot CC-Shop operation, detection of these coatings was not possible and resulted in coating-removal assistance from either the Engine Shop, Shop 31E, or an outside contractor. This created delays in these components being returned to the ship and required extra shop-personnel attention in transporting and tracking these items.

Upon acceptance, the items are tagged for identification. The Shop had a supply of dog tags and shower clips with three-digit numbers preceded by a letter. This eliminated the need for constant replenishment. This tag number was also written on the Production-Control Work-Load Log for ease of identification of similar components. Each complete component also was issued a Production-Control Record (Figure 4-3) which traveled with the component through the production process with production and QC data entries made as production progressed. An attempt to issue one Production-Control Record for a lot of identical components with the same JSN was tried by the shop without success due to production steps not always being performed on all items at the same time. Multi-part components, such as a valve with a separate bonnet, could be listed on one sheet since they were processed as a unit.

4.2.2.2 Station 2 - Degreasing

In order to achieve a good WSA-coating bond to the base metal, the substrate surface must be free of grease, oil and dirt. This cleaning was accomplished through the use of a vapor degreaser containing 1,1,1 trichloroethane. The vapor degreaser maintained the solvent at 130°F in conjunction with condenser coils located at the top of the tank thus creating a controlled vapor space. Safety precautions for working with trichloroethane are specified in NSTM 631 (Ref. 4-2).

Depending upon the size of the component, the operator placed the component within the vapor space with either an overhead hoist or a suspended stainless-steel wire-mesh basket. When using the overhead hoist, the part was rigged securely and suspended in the vapor space. Small items were placed in the wire-mesh basket, lifted with the hoist to its supports and the degreaser lid was closed. These items were normally exposed for approximately 20 minutes and required no additional surface cleaning because the solvent leaves no chemical contaminants or residue on the component surface. For heavy grease-deposition areas, a lance was available to directly apply the solvent for more concentrated cleaning. Occasionally, the trichloroethane tank was overfilled and the components were actually submersed in the liquid. This actually decreased the effectiveness and should be avoided.

An alternative method of surface cleaning used in the Pilot CC Shop is manual cleaning for small items with solvent and brushes.

During the Pilot CC-Shop operation, one technician manned Stations 2 and 3.

CORROSION-CONTROL SHOP
WIRE-SPRAYED-ALUMINUM
PRODUCTION-CONTROL RECORD

USS ______________________________
Ship   Hull Number

______________________ Job Control Number (JCN)

______________________ Production Control Number

______________________ Item Description

______________________ Location Deck Frame Side

TYPE COATING:

____WSA(HT) Sys 1

____WSA(LT) Sys 2

FINISH COLOR

____HRAP

____HAZE GRAY

____DECK GRAY

____OTHER ______________

SECTION	PROCESS SEQUENCE INSPECTIONS		DATE	TIME	SHOP QCI SIGNATURE
1.	Receipt, Degrease, Degalvanize, Dealuminize				
2.	Masking	Plug / Tape			
3.	Strip Blast				
4.	Anchor Tooth 2-3 mils	mils			
5.	Thermal Spray	High mils			
	Sys 1 10-15 mils / Sys 2 7-10 mils	Low mils	Operator Name		

		Seal, Barrier and Topcoat				ATTACH PROFILE TAPE HERE
		Type/DFT Rqmt	Measured DFT	Date	Time	
CC SYS 1	6.	HRAP/1.5 mils				
CC SYS 1	7.	HRAP/1.5 mils				
CC SYS 2	8.	150/0.5-0.75 mil				
CC SYS 2	9.	151/3 mils				
CC SYS 2	10.	150/3 mils				
CC SYS 2	11.	TC/1.5 mils				
CC SYS 2	12.	TC/1.5 mils				
	13.	Final Thickness				
	14.	Final Assembly Inspection				

ISA EXP. FORM CCP-1 REV 6(08-15-85)

Figure 4-3 Production-Control Record

AD-A163 670 CORROSION-CONTROL (CC) PROGRAM SIMA (SHORE INTERMEDIATE 2/2
MAINTENANCE ACTIV..(U) INTEGRATED SYSTEMS ANALYSTS INC
NATIONAL CITY CA W ADKINS ET AL. 30 NOV 85

UNCLASSIFIED ISA(WC)-107-VOL-1 N66001-85-C-0350 F/G 11/6 NL

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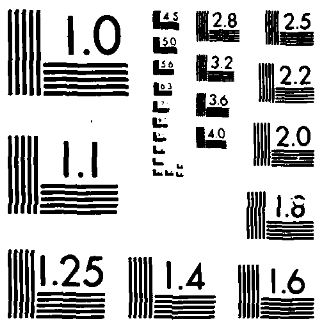


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

4.2.2.3 Station 3 - Masking

Many of the components which entered the Shop required protection of areas which would have been degraded by abrasive blasting or metal spraying, such as machined surfaces or identification plates. These parts received either taping or plugging. The tapes most commonly used by the Shop were green-duct and aluminum tape of various widths. Valve flange faces, thread areas and brass fittings were protected by placing tape in cross directions, overlapping each piece 50% thus providing four tape thicknesses of protection. Fastener holes were commonly plugged with reuseable rubber stoppers.

4.2.2.4 Station 4 - Strip Blasting

Strip blasting is performed to remove all corrosion products and all previously-applied coatings. The grit used in the strip blaster is 40-mesh garnet. This debris is recycled through a cyclone separator to remove the fines.

The operator was equipped with a blast helmet, ear plugs, steel-toed shoes and rubber gloves. The blast helmet was supplied with disposable face shields which were easily removed when they became scratched from the blasting grit causing difficulty in seeing. Conditioned breathing air was supplied into the helmet for operator comfort.

The blast unit has about a 1000-lb capacity. A 1-1/4-inch-inner-diameter (ID), two-braid blasting hose with a 3/8-inch ID, boron-carbide-lined, venturi nozzle was used. The hose also had a remote-control unit or "deadman lever" to immediately stop the flow of grit when the hose and lever were released. The grit was pressurized to 80-100 pounds per square inch (psi) which was sufficient to remove all surface coatings and contamination and recycled back to the pressure pot by the air-swept floor through a classifier which rejected fine particles and debris.

The pressure of the system is extremely important. Although higher pressures allowed for faster removal of coatings, they also caused a deeper surface profile which resulted in possible loss of critical dimensions and damage to thin components. Other problems were experienced when larger grit sizes of blasting media were used. This created a two-to-three mil profile prior to anchor-tooth blasting, however it did not produce the rough surface required for WSA bonding.

4.2.2.5 Station 5 - Anchor-Tooth Blasting

In order for the WSA coating to adequately bond to the component substrate, an anchor-tooth profile of two to three mils is required. This is accomplished through abrasive blasting the surface to a white-metal finish (Ref. 4-3).

The operator at this station is provided with the same personnel safety equipment as the operator at Station 4. This blasting booth system was identical to the strip blasting system with the exception of the type of grit used. Aluminum oxide grit of 16-30 mesh at 80-100 psi was used in order to achieve a two-to three-mil profile depth. Aluminum oxide tends to break down on perpendicular planes which maintains the sharp edges required to create a rough and jagged rather than rounded or peened surface profile. Surface contamination is also avoided on both steel and aluminum surfaces due to the stability and anodic potential of the blasting media.

Proper blasting techniques are crucial in achieving the proper profile. Blasting at a distance of four-to-eight inches at a 45° to 90° angle to the surface will prevent excess time expended and the surface peaks from becoming peened over which destroys the sharpness required for bonding.

Sufficient lighting and ventilation is required for production efficiency and to prevent delays due to incomplete blasting. This occurred frequently in the early part of the Service Test, incomplete blasting due to poor lighting was a common occurrence. However, a quality nozzle light on the end of the blasting hose and brighter ceiling lights were installed eliminating this problem.

Due to the importance of the surface profile, a quality-control check point was specified for this station, visual examination and an anchor-tooth profile measure was made on each component. A replication tape was placed on the surface and rubbed so that the tape acquired the identical profile as the component surface. The height between the peaks and valleys of the profile was then measured using a dial micrometer. If the two-to-three mil anchor-tooth profile is not achieved, the item is reblasted. This tape was then attached to the Production-Control Record (Figure 4-3) to retain process documentation.

4.2.2.6 Station 6 - WSA

In addition to a rough surface to bond to, the WSA coating requires a oil- and moisture-free substrate. Although not specified in DoD-STD-2138(SH), the operator at this station used the hand-held wire-spray gun as a torch to preheat the part to 220°F to remove all moisture from the part. The WSA operator determined the surface temperature through the use of a pyrometer.

Upon achieving the proper temperature, the wire-feed mechanism was activated. The 1/8-inch-diameter, 99%-pure aluminum wire was then drawn into the gun by a turbine turned by compressed air. The gun was supplied with controlled compressed oxygen and acetylene which combined in the gun and burn to form the flame necessary to melt the aluminum. The molten aluminum was propelled to the surface by a stream of compressed air, flattened upon impact and formed into thin platelets (splats) which conformed to and adhered to the irregularities of the previously-prepared surface, as well as to each other. As the sprayed particles impinge on the substrate, they cool and build-up particle by particle, into a lamellar-coating structure.

Spray techniques included holding the gun five to eight inches away from and perpendicular to the surface, overlapping passes by one-half inch and applying subsequent coats at 90-degree angles to the previous coat with the minimum number of two crossing passes.

System One WSA is designed for components with operating temperatures greater than 175°F. This system specifies a WSA-coating thickness of 10-15 mils. For components with operating temperatures less than or equal to 175°F, System Two WSA is applied at a thickness of seven to ten mils. Upon proper-thickness verification using a magnetic thickness gauge, the component was moved to the painting station using clean cotton gloves in order to maintain a clean WSA coating.

4.2.2.7 Station 7 - Painting

Prior to sealing and topcoating the components, the paints were mixed thoroughly. One-part paints were mixed once with an air-driven mixer. Two-part paints required three mixing steps. Each part was mixed separately, combined and mixed again thoroughly. The paint was then allowed to set, usually for about one-half hour depending on the specified induction period.

The paint spray operator then poured the paint into a two-quart pressure cup which is attached to the paint spray gun which was designed and set for the specific paint to be sprayed. The component was then suspended in the water-wash booth and coated. Components frequently required rotation in order for the operator to spray toward the waterfall. Coating thickness was checked using a wet-film thickness gauge to ensure proper coating thickness prior to drying/curing.

For high-temperature applications ($>175^{\circ}F$) , the WSA coating was sealed and coated with two coats of heat-resistant aluminum paint (DoD-P-24555), 1.5 mils dry-film thickness (DFT) per coat. The first sealing was applied as soon as practical and not later than four hours after spraying. A minimum of two days of in-shop time is required for processing high-temperature components.

For low-temperature applications ($\leq 175^{\circ}F$), the WSA coating was sealed with one coat of 50%-diluted Formula 150 as soon as practical within four hours of WSA application. This layer of sealer must be 0.5-to 0.75-mils thick applied per MIL-P-24441. This sealer is followed by the epoxy-polyamide paint barrier coats (typically Formula 151 and 150 respectively), each being applied eight to 72 hours following the previous coat. The thickness of these two barrier coats is three-mils DFT. This second barrier coat is then followed by the first topcoat of TT-E-490 at a thickness of 1.5 mils DFT while the second barrier coat is still slightly tacky. A second topcoat of TT-E-490 is then applied 24 hours later. A minimum of five days of in-shop time is required for processing low-temperature components. Figure 4-4 illustrates the five-component paint schedule and the intercoat application times between paint coats.

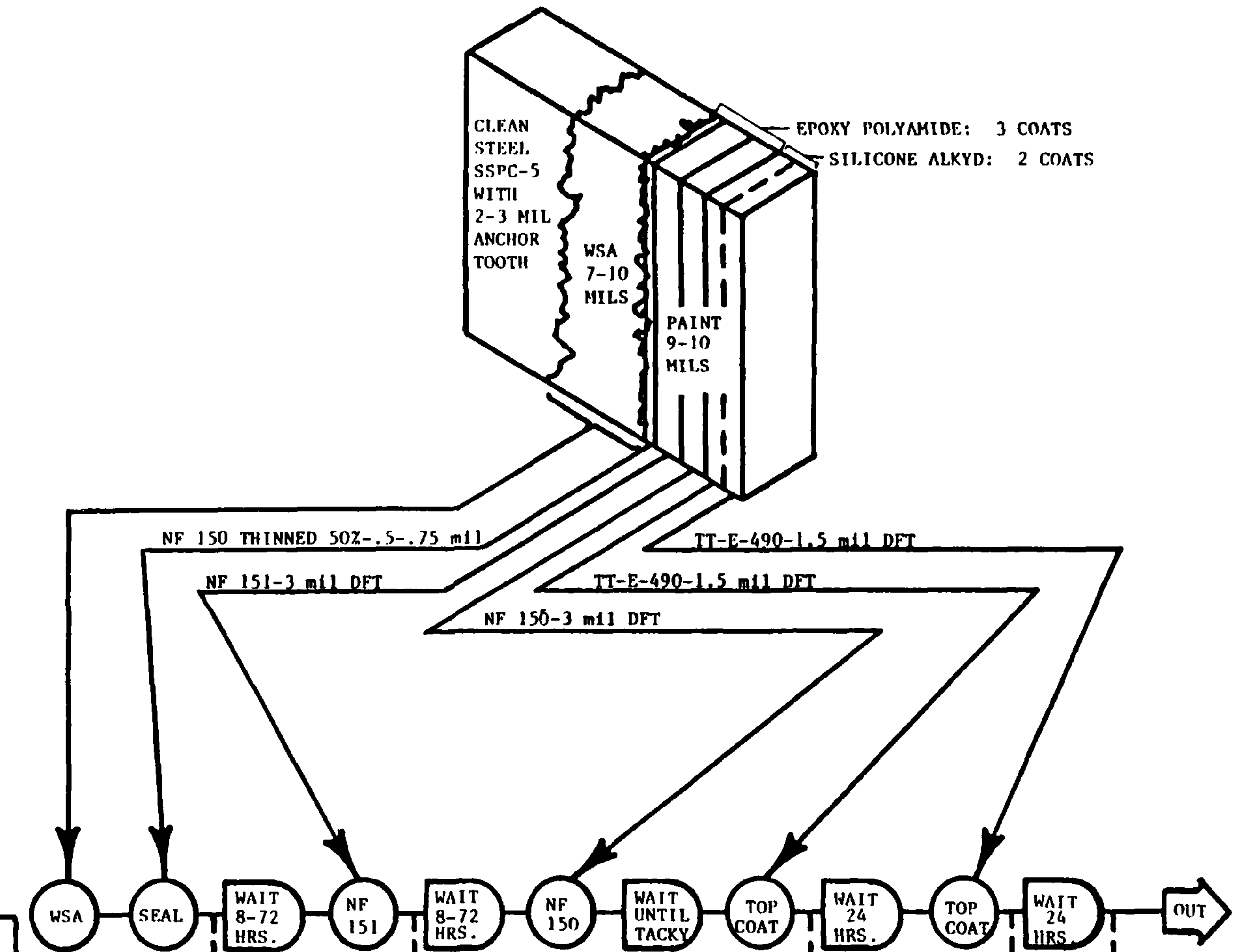
4.2.2.8 Station 8 - Installation Kit Makeup and Issue

This station was operated by a designated IKPO. He was responsible for:

(a) Designating the correct kit constituents for each component, assembling and attaching the kit to the component prior to its return to customer ship.

(b) Providing installation assistance to customer ships.

(c) Upon reinstallation of preserved components, inspecting and recording all observations on a "Shipboard CC Post-Availability Inspection Sheet" (Figure 4-5). A copy of the completed form was then given to the ship with recommended changes/corrections specified.



IN-SHOP TIME (days)						TOTAL
MIN.	1	1	1	1	1	5
MAX.	1	3	3	1	1	9

Figure 4-4 **Five-Component Paint Schedule and Intercoat Application Times for WSA (low temperature), NAVSEA CC System 2**

CORROSION CONTROL SHOP
SHIPBOARD CC POST-AVAILABILITY INSPECTION SHEET

USS ____________________ DATE ____________________

ITEM	LOCATION	CORRECT INSTALLATION YES	CORRECT INSTALLATION NO	COATING DAMAGE YES	COATING DAMAGE NO	COATING THICKNESS WSA	COATING THICKNESS WSA & PAINT	COATING THICKNESS ESP	OBSERVED CONDITION	RECOMMENDATIONS

The above items were inspected upon reinstallation and found to be in the condition listed. A copy of this report has been issued to the Ship CC Coordinator in order to provide the corrective action recommended.

Prepared by: ____________________ Shop Master ____________________ Signature

Figure 4-5 Post-Availability Inspection Sheet

These installation kits included fasteners, insulation materials and compounds defined by NAVSEA which are among the 15 NAVSEA-designated CC systems. Instructions for proper use of these materials and reinstallation are specified on a technical data sheet which was also included in the kit.

The primary information source for kit makeup and installation are the Installation Kit Technical Data Sheets (Appendix A6-2), for material procurement, the ship-class fastener requirements (Appendix A6-1).

During the Service Test, additional duties were assigned to the IKPO, such as ordering shop supplies, performing QA checks, etc. This prevented him from performing ship inspections and therefore resulted in incorrect installations being undetected. This situation was brought to the attention of the Shop Master and remedied.

4.2.2.9 Station 9 - Final Inspection and Customer Pick-Up

The operator at this station performed a final inspection of each component. The operator was responsible for ensuring all forms were complete, all QA steps had been performed and recorded, all measurements were in accordance with the process instruction, the coating had not been damaged and that the component was released to the ship with the proper installation kit.

4.2.3 WSA Production Records

In order to ensure efficient tracking and completion of work, specific forms had been developed to be used by the shop personnel.

4.2.3.1 Production-Control Work-Load Log (Figure 4-1)

This form was the primary means of tracking production. Dates of completed production were entered along with any delays that arise. This form was also used to schedule and plan a CC package. It was a convenient way to inform the ship when items were to be delivered to the shop, follow the work-package progress and ensure that deadlines were met.

4.2.3.2 Daily-Assignment/Time-Study Worksheet (Figure 4-6)

This form was utilized to schedule personnel at specific work stations and to account for all manhours available. This form enabled the Assistant Shop Supervisor to ensure personnel obtained ample experience in all appropriate work stations and to evaluate their individual and the overall CC Shop's productivity.

SHOP 061
CORROSION CONTROL
DAILY ASSIGNMENTS/TIME STUDY
WORKSHEET

______________ Date

NAME	1 Station Assignment	2 Shop Production	3 Corrective Maintenance	4 Military	5 Training	6 PMS	7 Personal Business	8 Other	REMARKS
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									
12.									
13.									
14.									
15.									
16.									
17.									
18.									
19.									
20.									

STATION ASSIGNMENT KEY

0. Leave, Liberty, Tad, Etc.
1. Receipt, Tag, Degrease
2. Masking
3. Rough Blast Unit
4. Anchor Tooth Blast Unit
5. Wire Spray Booth
6. Spray Booth
7. Station Runner
8. Installation Kits
9. Quality Assurance
10. Supply
11. Supervisor

1. Fill out form daily.
2. Block 1 - Enter number corresponding to station assigned.
3. Blocks 2-8 - Enter number of man hours expended in each category.

* Explain in Remarks Column

Figure 4-6 Daily-Assignment/Time-Study Worksheet

4.2.3.3 Production-Control Record (Rev. 5) (Figure 4-3)

This form was developed to ensure QC during each step of the production process. The heading was filled out by the receiver when the item to be processed was delivered and accepted into the Shop. The remainder of the form was completed by the SQCI as each step in the production process was completed and certified to be within specifications. This in-process inspection also allowed for correction of an out-of-specification condition at the station at which it occurred without having to repeat the entire production process. Completed records were then maintained as a permanent record for items completed for that ship.

4.2.3.4 Shipboard CC Post-Availability Inspection Sheet (Figure 4-5)

The purpose of the final shipboard inspection was to insure that all of the components that had been processed through the CC Shop were properly installed using correct fasteners, washers, anti-seize compound and sealants and there had been no coating damage during transport or reinstallation. The Shop Master delivered copies to the Ship's CC Coordinator and deficiencies and corrective actions were discussed. The Shipboard CC Post-Availability Inspection Sheet then became part of the CC-Shop's history file.

4.2.4 Production-Control Record (Rev. 4) (Figure 4-7)

This form was the data base from which the standard times to apply the WSA-preservation system to various items were developed. Standard times are the major parameter in work loading and managing the shop's production. This form was filled out by a designated shop Petty Officer and was required to document the production time for each component. This would normally be done on job cards which document each operator's time expended, however this procedure was not needed since the Pilot Shop was not part of the SIMA Planning system.

Allowances for normal shop interferences and interstation transporting, training, set up, fatigue and personnel stress factors have been accounted for and multiplied by these process element times in order to develop realistic shop-loading time values. These shop loading time values will serve as a planning basis to be updated as feedback concerning shop underloading or overloading is received from the Shop Master. The use of standard times and shop allowance factors are discussed in Section Six. A detailed explanation of the data collection and analysis is included in Appendix A4-3.

4.2.5 Lessons Learned

Throughout the duration of the Pilot-Shop operation, policies and procedures were continually being evaluated and modified in order to improve shop effectiveness and service to the fleet. These "lessons learned" deal primarily with:

CORROSION CONTROL SHOP SHIPCHECK/PRODUCTION CONTROL RECORD

USS ______ Name ______ Type Number

PHONE #: ______

SHIP CC COORD: ______

ALTERNATE: ______

TO BE COMPLETED BY SHIP'S CORROSION CONTROL COORDINATOR

ITEM DESCRIPTION ______

ITEM LOC. ___ Deck Frame Side   QTY ______

SHIP PRI # ______ APPROX. WT (lbs) ______

Additional Info on Reverse Side ______

FASTENERS

TYPE	DIA (IN)	LNTH	THDS /IN	QTY	MATERIAL
F1					
F2					
F3					
F4					
F5					
F6					

WASHERS

TYPE	ID (IN)	OD (IN)	THICK (IN)	QTY	MATERIAL
W1					
W2					
W3					
W4					
W5					
W6					

GASKETS/INSULATORS		ITEM MATERIALS	
TYPE		TYPE	
G1		M1	
G2		M2	
G3		M3	
G4		M4	

MATERIALS ITEM ATTACHED TO ______

SHOP RELEASE ______ Signature ______ Date

TYPE COATING:
__ WSA(HT)
__ WSA(LT)
__ POWDER

FINISH COLOR:
__ HAZE GRAY __ BLACK
__ DECK GRAY __ RED
__ WHITE __ HRAP

WSA PRODUCTION DATA (Minutes)

PROCESS SEQUENCE			TIME	OPER
SURFACE PREP	SOLVENT CLEAN			
	STRIP BLAST			
	ACID DIP			
	DEGALVANIZE			
MASKING	TAPE			
	PLUG			
ANCHOR-TOOTH	ANCHOR-TOOTH			
	PROFILE DEPTH			
THERMAL SPRAY	PREHEAT TO 220F			
	SPRAY			
	WSA DEPTH			
SEAL, BARRIER & TOPCOAT	2 COATS HRAP			
	150 - 0.5-0.75 mil			
	151 3 mil BARRIER			
	150 3 mil BARRIER			
	490 - 1.5 mil TOP			
	490 - 1.5 mil TOP			

DATES	Day	Mo	Yr
SHIPCHECK			
DEL. TO 061			
WORK COMPL			
CUST. PICK-UP			
DEADLINE			

QUALITY CONTROL:
Anchor Tooth Depth ___
WSA Thickness ___
Color ___
Fasteners ___
Final Thickness ___

Shipcheck by: ______

IAW ___ Ship Class CC Manual

Index # ______

Deviations: ______

ATTACH POLAROID PHOTOGRAPH HERE

	NAVSEA CC SYSTEMS	REQ'D	DEL'D
5	NON-SKID DECK COATING		
6	CERAMIC COATING		
7	WATER-DISPLACING COMPOUND		
8	ANTI-SEIZE COMPOUND		
9	IMPROVED FASTENERS		
10	SEALING & COATING COMPOUND		
11	POLYSULFIDE SEALANT		
12	PROTECTION OF ELEC CONN		
13	DIELECTRIC BARRIER		
14	VAPOR-PHASE INHIBITOR		
15	STRIPPABLE COATINGS		

ATTACH PROFILE TAPE HERE

ISA FYP FORM CCP1 REV 4 (07-15-85)

Figure 4-7 **Production-Control Record** (Rev. 4)

- Training,
- Shop Functions and Duties,
- Planning,
- PMS,
- Quality Control,
- Shop Records, and
- Component Identification

4.2.5.1 Training

All shop personnel must be trained to be familiar with causes of marine corrosion and the measures to prevent and control corrosion and have a detailed knowledge and journeyman shop skills to apply the WSA-coating and the ESP-coating systems and makeup and use of installation kits for shipboard items preserved with WSA or ESP coatings. Section Seven details the training requirements for CC-Shop personnel.

Due to the inherent rotation of Navy personnel, an effective training program is essential for new shop personnel and to maintain knowledge and skills of in-shop personnel.

4.2.5.2 Shop Functions and Personnel Duties

It is the responsibility of the Shop Master to be aware of the status of all components in the shop. He must also be aware of special deadlines imposed by customer ships and lead shops. The Shop Master is also required to know the production capability of his shop in order to maintain a backlog of work and coordinate the workload with the ShipSup. These responsibilities require that the Shop Master spend a large percentage of his time in the shop itself.

The second person in rank is responsible for daily assignment of stations. Daily-Assignment Sheets should be filled out a week at a time in order to ensure that the shop personnel are being rotated from station to station for experience. He is also responsible for correct production procedures and assistance during equipment malfunction.

The shop also requires a Petty Officer in charge of supplies and paperwork. Each Production-Control Record must be maintained for six months in accordance with DoD-STD-2138(SH). The shop consumables (Appendix A4-4) must also be monitored carefully because some require relatively long lead times since they are not in the Navy supply system.

There also must be a dedicated SQCI. Due to simultaneous work being done at all stations, the SQCI must be available at all times to perform the necessary measurements at the various production stages. The SQCI must also have a fully-trained substitute who can be removed from production when the SQCI is not available.

The IKPO position is also considered a full-time job. He is responsible not only for creating each installation kit, but must also be in constant contact with each ship ensuring that all items are reinstalled correctly.

4.2.5.3 Planning

It is the responsibility of the Shop Master to provide accurate feedback to the shop planner. This report presents a data base to be used by Planning for shop loading; however, due to shop turnover, changes in equipment, etc., this data base may require updating these numbers based upon actual shop production. Due to ship requirements, it is not possible to deliver all of one type of component at one time and this must be allotted for in scheduling.

4.2.5.4 PMS

In order to achieve maximum productivity, it is essential that downtime be prevented. PMS has always been stressed by the Navy and has been included in the Pilot Shop's weekly schedule since the beginning of the Service Test. The PMS package is currently being reviewed by SIMA(SD) and has not been finalized to date. This preliminary package is presented in Appendix A4-7. It should be noted that all maintenance requirements per manufacturer's recommendations are specified; however, it is not in the standard Navy PMS format which will need to be done by SIMA(SD).

4.2.5.5 Quality Control (QC)

The quality of WSA, paint and ESP coatings are dependent upon process control. The operator must strictly follow the industrial process instruction which specifies operator checkpoints to provide the QC for the products. A regimented QC program must be implemented to deliver quality products. This is especially true when production deadlines occur and output is stressed.

During the early stages of the Pilot Shop's operation, an excessive amount of solvent was being added to both the epoxy-polyamide and the silicone-alkyd paints. This paint thinning was required in order to be used with the paint spray gun which was found to be inappropriate for these type of paints. The paint sprayer was performing QC through the use of a wet-film-thickness (WFT) gauge. The readings appeared sufficient to the operator and would have been with a usual amount of thinner, however, thicknesses upon curing were unacceptable due to the low paint/solvent ratio. This discovery was made during post-availability inspections. Due to the thin topcoats, a considerable amount of green Formula 150 primer was visible after only minor wear and abrasion. A final QC thickness measurement would have indicated this problem immediately and avoided the need for S/F to apply an additional coat of paint.

It has also been found that operators will gundeck readings on occasion merely to save time. A dedicated-QC-Petty Officer assigned to continually audit the work will prevent these time saving attempts from occurring.

4.2.5.6 Shop Records

It is essential that all records be filled out accurately and be complete. Due to the number of components entering the shop from numerous sources, each item must be clearly and correctly identified. It must be remembered that the shop's major function is to serve the fleet and not lose components. Ships also have uncompromising deadlines that must either be met in accordance with all shop and production procedures or the work must be rejected. These deadlines must be recorded and those components be carefully tracked in order to meet those commitments.

Supply records provide a basis for future procurement. Tracking typical delivery times can avoid complete inventory depletion which would halt production. Order periodicity could also provide the necessary data for product quality comparisons and wastefulness. This could save the shop a considerable amount of money from their budget which could be used for other improvements.

4.2.5.7 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 the CC project. During the tour of the USS CUSHING by Shop 06I and ISA, WSA items were observed that had been chipped with chipping hammers and ESP-coated items had been painted over with standard haze-gray topcoat. Discussion with S/F 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 since they were not clearly identified as being preserved. These items required additional processing and thereby reduced the shop production.

It was, therefore, determined that in order to ensure the success and efficient operation of the CC program at the SIMAs and onboard ship, the following information is essential.

- 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.
- Guides to informing all personnel about the program and how it effects them.

These five requirements can be divided into two major categories:

- Information Resource, and
- Identification Method.

4.2.5.7.1 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 provide this necessary information because only four ship class CC Manuals of nine had been issued to the tended ships.

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 S/F through the ship's CC Coordinator to maintain the integrity of the preservation systems.

4.2.5.7.2 Identification Method

The identification of preserved components is the second step to the success of the program. Ship's Commanding Officers (COs) 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 CO with the SIMA, San Diego, Corrosion-Control Work-Accomplished Information Book. The book provided ease of preserved component identification through an alphabetized CCWP 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 system must be easily identified by ship personnel, relatively easy to apply, permanent, non-corrosive and capable of sustaining several coats of paint. Discussions with COs 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) is provided in Appendix A4-5.

4.3 ELECTROSTATICALLY-SPRAYED POWDER (ESP) COATING

During the pilot operation of the shop, all of the ESP coatings were applied by an outside contractor. Results of the SIMA(SD) Pilot Powder-Coating facility will be presented in an independent report to be released upon completion of the project.

4.3.1 Powder Resin Selection

Per discussions with major powder resin manufacturers, polyester resin was purchased for application by the coating contractor primarily due to its ultraviolet-light resistance to chalking and comparable corrosion resistance to epoxy resins. Due to compliance requirement to color and gloss standards, special orders meeting minimum quantities were purchased.

4.3.2 Industrial Process Instruction

Prior to application of the purchased resin, a process instruction needed to be developed since there were none in existence which were applicable to this service. This industrial process instruction (Appendix A4-6) was developed from the powder manufacturer's and applicator's recommendations for surface preparation and coating thicknesses and other parameters affecting the quality of the coatings. This document was presented for acceptance by NAVSEA and has been revised in order to ensure the level of performance required by the U.S. Navy.

4.3.3 Production Costs During Pilot Shop Operation

Components chosen for powder coating are designated using the NAVSEA Ship-Class Corrosion-Control Manuals, resin manufacturer's and the applicator's recommendations based upon prior experience as guidance.

Representative components along with the total quantity of powder-coated items for the CC availabilities is specified in Table 4-2. A complete summary of the components powder coated during the period of October 1984 through October 1985 is presented in Appendix A4-1.

The cost for powder coating is based upon a price per square foot to be coated. During the period of October 1984 through October 1985, a total powder coating cost of $46,462 has been incurred to preserve a total of 1052 components.

4.3.4 Lessons Learned

Throughout the course of the powder-coating program, the following recommended actions have been developed:

- Generic component specification for items to be powder coated is not feasible due to the variation in structural design, materials, exposure, etc., from one ship to another.
- It is essential that certain QA steps, such as anchor-tooth depth and coating thickness, are specified in order to guarantee the integrity of the coating.
- Immediate reinstallation of ESP-coated items is crucial in order to prevent coating damage.
- Correct installation of items must be specific and stressed to ship's personnel.

- Ship's personnel must be knowledgeable in the identification, care and repair procedures of powder coatings.

4.4 PRODUCTION CC-SHOP RECOMMENDATIONS

4.4.1 Wire-Sprayed Aluminum (WSA) Coatings

WSA coatings should be applied in accordance with DoD-STD-2138(SH), NSTM 631 and the SIMA(SD) Process Instruction.

4.4.2 WSA Production

The CC Shop should consist of nine basic stations:

- Receipt Inspection,
- Degreasing,
- Masking,
- Strip Blasting,
- Anchor-Tooth Blasting,
- WSA,
- Painting
- Installation-Kit Makeup and Issue, and
- Final Inspection and Customer Pickup.

4.4.3 Production-Shop Records

As supported by the *Pilot CC-Shop experiences, forms* are required to maintain shop organization and effectiveness. Some forms used during the Service Test are no longer needed, however the following forms, or any equivalent forms, are recommended.

- Production-Control Work-Load Log

- Daily-Assignment/Time-Study Worksheet

- Production-Control Record (Rev. 5)

- Shipboard CC Post-Availability Inspection Sheet

4.4.4 Production-Shop Procedures

4.4.4.1 Training

A regimented training program must be established to maintain shop product quality and productivity. Training is discussed further in Section Seven and presents recommended training programs.

4.4.4.2 Shop Functions and Duties

WSA coating is a new technology in the Navy and its success extremely operator dependent. In light of this fact, the Shop Master must be completely knowledgeable in WSA procedures. The Shop Master must be able to identify candidate components and possible resulting problems. Strong and visual leadership is required to maintain a smooth-running efficient operation. The Shop Supervisor must be aware of the workload status at all times and be in constant contact with the ShipSup and the SIMA Planner providing feedback on scheduling.

Support personnel are required to perform a variety of duties. A dedicated Supply Petty Officer, IKPO and SQCI are required in addition to an assistant shop supervisor.

4.4.4.3 Planning

In order to establish the proper workload scheduling, the supervisor must provide the planner with constant feedback on the production time standards. The time-standard data bank will need to be adjusted once consistent data supports the necessity for data adjustment.

4.4.4.4 PMS

Shop PMS requirements must be specified by Code 8220 and implemented in order to maintain efficient shop operation. The recommended PMS procedures have been prepared and presented to SIMA(SD), Code 8220. This package is presented in Appendix A4-7 and can be used as a guide for other CC Shop PMS procedures.

4.4.4.5 Quality Control

A QA program is mandatory to maintain a successful CC-program. The recommended QC procedures are included in the SIMA(SD) Process Instruction.

4.4.4.6 Shop Records

Due to the importance of maintaining accurate paperwork, a dedic .ted Supply/Record Petty Officer is required. A convenient method of maintaining such records as supply/inventory and production summaries by ship, would be to input this data into a computer bank. This would be the optimum solution although an organized filing system would also be adequate.

4.4.4.7 Component Identification

It has been demonstrated that a complete listing of preserved components is required to maintain a successful CC system onboard customer ships. This listing is also useful in CCWP screening. It is recommended that the CC Work-Accomplished Information Book continue to be published and distributed. This book could be completed as a joint effort of the Supply/Record Petty Officer and the shop civilian supervisor based upon the records already maintained by the shop.

REFERENCES FOR SECTION FOUR

4-1 DoD-STD-2138(SH), Metal Sprayed Coating Systems for Corrosion Protection Aboard Naval Ships, 23 November 1981.

4-2 Naval Ships' Technical Manual, NAVSEA 9086-VD-STM-000, Chapter 631, "Preservation of Ships in Service (Surface Preparation and Painting)".

4-3 Steel Structures Painting Council, Steel Structures Painting Manual, Vol. 2, "Systems and Specifications", Third edition, June 1983.

4-4 Sulit R. A. and O. G. O'Brien, ASW and Support-Ship Corrosion Control (CC) Program: SIMA Pilot CC Shop Service Test and Technical Support, ISA(WC)-ITR-104, 11 December 1984, Contract N66001-84-D-0032, Delivery Order 0009.

SECTION FIVE

SHIPBOARD SERVICE TEST

5.0 GENERAL

Presently, the in-situ application of WSA onboard U.S. Naval vessels is accomplished by master ship repair (MSR) contractors and their subcontractors or S/F. Upon ship's request, the type desk officer can approve the work to be included in the overhaul package. SIMA can develop the capability of performing in-situ WSA application onboard Navy surface vessels. In order to determine the merit of a SIMA to perform in-situ WSA application, a Service Test was performed by the Pilot CC Shop at SIMA(SD) utilizing shop and S/F personnel, present WSA process techniques and available equipment.

5.1 METHODOLOGY

The methodology utilized to determine the feasibility of a SIMA providing shipboard CC services is illustrated by Figure 5-1.

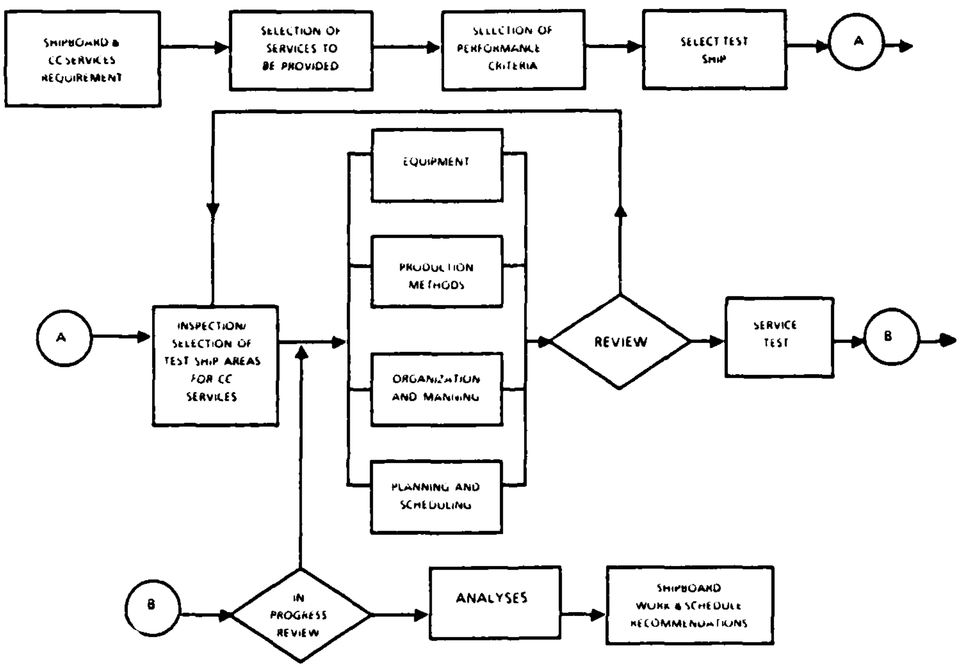


Figure 5-1 Methodology Diagram for SIMA Shipboard-Mode Service Test

5.2 SHIPBOARD CC SYSTEM SELECTION

The primary reasons to provide in-situ CC shipboard services are to reduce S/F manhours expended on preservation and improve a ship's material condition. WSA System Two with the applicable topcoat paint systems has been successfully applied aboard USS ROARK, USS CUSHING and USS SCHENECTADY to preserve turntables, bulkheads and decks. In-situ application of powder coatings are not feasible or authorized at this time. Therefore, NAVSEA-designated CC Systems One and Two, WSA high-temperature and low-temperature, respectively was selected as the shipboard CC service to be provided by a SIMA.

5.3 MEASURES OF PERFORMANCE

The criteria to determine the feasibility of an IMA to perform in-situ WSA services onboard a ship were selected as follows:

- Cost effectiveness of an IMA performing the in-situ WSA shipboard services versus the cost of a MSR contractor performing the services.

- Ability of SIMA personnel to meet quality-control standards during in-situ application of WSA.

The cost effectiveness of an IMA to perform in-situ WSA would be whether or not it is more expensive to the government to pay the costs for sailors to perform the service or to pay a MSR contractor to perform the service. IMA costs would be labor and materials. MSR contractors charge the government by the area that is preserved with WSA. Comparison of the government's IMA and MSR costs for in-situ WSA application will determine the economic feasibility of an IMA to perform in-situ WSA application.

Determination of IMA labor and material costs would be a function of the rate at which an IMA can perform in-situ WSA application. Application rate is a function of the geometric complexity of the space/area to be coated and accessibility to the space/area. Application rates would have to be determined for spaces of different geometric complexity and accessibility.

SIMA personnel will have to conform to Quality Control (QC) standards required by DoD-STD-2138(SH). Economic comparisons will be based on the assumption that both IMA and MSR meet these QC standards.

5.4 SERVICE TEST SHIP SELECTION

The criteria used to select a test ship were the following:

- Undergoing an extended maintenance period during the shipboard CC Service-Test time-frame.

- Moored at the Naval Station San Diego vice a MSR-contractor pier to reduce SIMA transportation delays.

- Accessible spaces without MSR contractor personnel engaged in equipment overhaul or a ship with spaces large enough to accommodate both contractor and SIMA equipment/personnel without mutual interference.

- Spaces requiring preservation which are good candidates for the application of WSA System Two.

- Ship containing a variety of spaces which allow for analysis of SIMA performance in differently configured spaces.

USS SCHENECTADY (LST-1185) was selected as the shipboard-mode test ship. USS SCHENEDTADY was undergoing a Planned Restricted Availability (PRAV) during the service-test time-frame moored at the Naval Station, provided ample space for equipment staging without contractor interference and contained a variety of spaces suitable for WSA application.

5.5 TEST SHIP INSPECTION

Commanding Officer, USS SCHENECTADY, and his Department Heads were briefed on the 15 NAVSEA-designated CC Systems, the CC services available at SIMA(SD) during the Pilot CC ship-to-shop Service Test, purpose of the shipboard Service Test and plans for the shipboard Service Test. USS SCHENECTADY had had their turntables and portions of tank deck bulkheads wire sprayed during a previous overhaul by a MSR contractor with excellent results. Commanding Officer, USS SCHENECTADY, enthusiastically supported in-situ WSA application and offered full support from his crew and use of USS SCHENECTADY to perform this Service Test.

The primary selection criteria of the areas to be accomplished during the shipboard Service Test would be based upon the need to analyze production rates on areas which, due to geometric complexity and ease of access, would cause different production rates. A space with simple geometry and with good accessibility, such as a bulkhead or deck, would provide data for which production should be at a maximum rate. Spaces with complex geometry and/or difficult access, such as a small space with watertight door opening, should decrease the production rate. The need to measure production rates as a function of geometric complexity and ease of access is necessary to determine the production rate that can be obtained by an IMA. The IMA production rate must be determined to calculate labor and consumable costs for an IMA for in-situ WSA application. The MSR contractor costs are a function of the area preserved with WSA. The comparison of IMA and MSR costs will determine the economic feasibility of an IMA to perform in-situ WSA application.

An inspection was conducted of the USS SCHENECTADY to determine the areas suitable for WSA application and which offered varying geometric complexity and/or ease or difficult access. The initial inspection revealed several internal and external areas of varying geometric complexity and ease of access in need of preservation. An arbitrary index for degree of geometric complexity and ease of access was established. The digit one being assigned to the most complex geometrically and least ease of access and the digit three being the least complex geometrically and with the best accessibility. Areas initially selected for accomplishment are listed in Table 5-1 and 5-2 by area, geometric complexity and ease of access.

All these areas are adjacent to an adequate open deck area which could be used for equipment staging. Compartments and passageways would give the opportunity to observe production in confined areas where access and ease of working within would be limited; therefore, an assumed slower rate of productivity would be expected. Decks and bulkheads would give the opportunity to observe production at an assumed maximum production rate. Selection of the vang pads would allow for production on an area where staging or scaffolding would be required over the side of the ship. USS SCHENECTADY would provide an opportunity to observe varying production rates and problems encountered on a variety of spaces directly applicable to other ship classes to determine the economic feasibility of an IMA to perform in-situ WSA applications.

An informal review of the areas selected for preservation during the shipboard service test was held. ISA and SIMA(SD) personnel deemed that some areas were too large for accomplishment in the six-week time frame and did not meet the established criteria. In an effort to reduce the selected areas and select more complex areas geometrically, discussions were held with the CO of the USS SCHENECTADY. These discussions resulted in selection of smaller areas and compartments on the tank deck which were high-maintenance areas for S/F. The CO was confident adequate S/F-preservation attention would be given to topside areas and desired to have the majority of the WSA applied to tank deck areas. The total of the areas originally selected was 2542 square feet (sq.ft.). A production rate of 425 sq.ft. per week would have to be accomplished to complete the entire area. Since this would be the initial attempt by a SIMA to perform in-situ WSA application, a production rate of 425 sq.ft. per week was not deemed feasible. The need to observe production on areas with a higher degree of geometric complexity and poorer accessibility and to reduce total areas resulted in the elimination of all areas on the main deck with exception of the port and starboard vang pads, two helo control panels and the port boat-davit keel rest. The additional tank deck compartments which were selected included the chemical warfare stowage passageway (3-70-1), the compartment above the JP-5 pumproom (3-54-4) and the forward and after mogas-hose-reel-stowage vestibules (3-99-1 and 3-186-1 respectively).

The areas finally selected for accomplishment during the service test are listed in Tables 5-3 and 5-4. The number of spaces/areas remained at 11; yet the total area decreased from 2542 sq.ft. to 826 sq.ft. Areas to be accomplished offered a range of geometric complexity and accessibility to allow for production rate determination on a variety of spaces.

Table 5-1 Tank Deck Areas (Original Plan)

SPACE NOMENCLATURE	AREA (sq ft)	GEOMETRIC COMPLEXITY	EASE OF ACCESS
Gunnery-Division-Storage Compartment (3-248-1)	45	3	3
CPO-Baggage-Storage Compartment Passageway (3-54-3)	31	2	2
Port, Bulkheads and Decks around around the Forward Turntables between Frames 52 and 71	135	3	3
Starboard Bulkheads and Decks around the Forward Turntables between Frames 52 and 71	160	3	3

Table 5-2 Topside Areas (Original Plan)

SPACE NOMENCLATURE	AREA (sq ft)	GEOMETRIC COMPLEXITY	EASE OF ACCESS
Bow Ramp area on the Main Deck	76	3	3
Deck Area and Ramp Support Structure from the forward edge of the ramp from the tank deck to the bow	1680	3	3
Inner Section of the Ramp Roller Support up to the Ramp Roller Beam	160	3	3
Passageway, 1-12-2, on the Port Side of the Forward Side of the Main Deck	32	2	2
Port Boat-Davit Frame	117	2	3
Port and Starboard Vang Pads	180	2	1
The Flight Deck Caisson Clamps	40	3	3

Table 5-3 Tank Deck Areas (Revised Plan)

SPACE NOMENCLATURE	AREA (sq ft)	GEOMETRIC COMPLEXITY	EASE OF ACCESS
Gunnery-Division-Storage Compartment (3-248-1)	45	2	2
CPO-Baggage-Storage Compartment Passageway (3-54-3)	31	2	2
Port, Bulkheads and Decks around around the Forward Turntables between Frames 52 and 71	135	3	3
Starboard Bulkheads and Decks around the Forward Turntables between Frames 52 and 71	160	3	3
After Mogas-Hose-Reel-Stowage Vestibule (3-186-1)	27	1	1
Forward Mogas-Hose-Reel-Stowage Vestibule (3-99-1)	26	1	1
Chemical-Stowage-Locker Passage (3-70-1)	48	2	2
JP5-Pump-Room Passage (3-54-4)	30	2	2

Table 5-4 Topside Areas (Revised Plan)

SPACE NOMENCLATURE	AREA (sq ft)	GEOMETRIC COMPLEXITY	EASE OF ACCESS
Port Boat-Davit Frame	117	2	3
Port Vang Pad	90	2	1
Helo Control Panels (2)	120	3	3

Six weeks was deemed adequate time to perform the onboard work, collect production data and develop lessons learned. The scheduled Service Test start date was 8 July 1985. This date anticipated all equipment would be available. USS SCHENECTADY was scheduled to undergo light-off examination (LOE) during the week of 26 August 1985. In order to complete the Service Test and remove all equipment in sufficient time for the ship to prepare for LOE, 16 August 1985 was selected as a completion date for the shipboard Service Test. The duration between 8 July and 16 August was six weeks.

Production delays and slow production rate occurred during the Service Test which caused the elimination of spaces originally planned for accomplishment. The areas eliminated included: port boat-davit frame, port vang pad and the forward helo control panel. USS SCHENECTADY's PRAV completion date was extended into the month of September and allowed for extension of the Service Test until 30 August. This extension allowed the Service Test to run for eight weeks. During the eight weeks, 560 of the 826 sq.ft. originally scheduled for accomplishment were completed. Even though not all areas were preserved, areas of different geometric complexity and ease of access were accomplished to allow for analysis.

5.6 PLANNING AND SCHEDULING

Plans were based upon SIMA providing shipboard CC services in the same fashion as SIMA provides other shipboard services to the Fleet. SIMA would provide personnel, equipment and consumables to accomplish the job. The ship would provide space to stage equipment, perform interference and waste consumable removal and provide electrical power sources. To perform this service, an approach would be taken in preserving the areas presented in Section 5.5 to preserve an area without disrupting adjacent work or equipment in the allotted time. The major factors required to perform the task are as follows:

- Equipment
- Manpower
- Production Techniques
- Production Schedule

Any inadequacy of equipment, manpower, production techniques and/or schedules would result in a less than desired production rate. The absence of SIMA experience at providing any similar shipboard sandblasting and preservation services would also contribute to poor production. A philosophy was taken to obtain equipment, use the manpower available, schedule the work and utilize production techniques similar to in-shop WSA techniques and learn by trial and error onboard USS SCHENECTADY.

The scheduling of the work was attempted to provide an indicator of the progress. Additional areas could be preserved if the schedule was exceeded or areas would be deleted from the schedule if the schedule was not met. During the actual service test, production was slower than anticipated and the port boat-davit frame, port vang pads and a helo control panel had to be deleted from the candidate list.

Guidelines utilized in service-test scheduling are given in Table 5-5.

Table 5-5 Service Test Scheduling Guidelines

MAJOR PRODUCTION EVENTS	TIME
Strip Blast Any Space	1 Production Day
Anchor-Tooth Blast, Wire Spray and Seal Small Space	1 Production Day
Anchor-Tooth Blast, Wire Spray and Seal Large Space	2 Production Days
Move Equipment Between Spaces	1/2 Production Day

The schedule was utilized as a supervising tool by the shipboard leading Petty Officer (SLPO). By being able to tell on a daily basis whether the production schedule was being made, the SLPO would supervise the operators and laborers more closely. The daily-production schedule given by Table 5-6 proved to be a valuable tool for supervising shipboard WSA application. The amount of production completed would have been less if the SLPO did not have a daily goal to meet.

Table 5-6 Shipboard Production Proposed Schedule*

MONTH	TASK
July	
8	Move equipment into tank deck
9	Strip blast (SB) Gunnery-Division-Storage Compartment (3-248-1)
10	Anchor Tooth (AT), WSA and Seal (3-248-1)
11	Move equipment and SB, After Mogas-Hose-Reel-Stowage Vestibule (3-186-1)
12	AT, WSA and Seal (3-186-1)
15	Move equipment and SB Forward Mogas-Hose-Reel-Stowage Vestibule (3-99-1)
16	AT, WSA and Seal (3-99-1)
17	Move equipment and SB Chemical-Stowage-Locker Passageway (3-70-1)
18	AT, WSA and Seal (3-70-1)
19	Move equipment and SB CPO-Baggage-Stowage-Compartment Passageway (3-54-3)

Table 5-6 **Shipboard Production Proposed Schedule*** (Cont'd)

MONTH	TASK
July	
22	AT, WSA and Seal (3-54-3)
23	Move equipment and SB Starboard Bulkheads and Decks around Forward Turntable (STBD TT) between Frames 52 and 71
24	AT, WSA and Seal STBD TT between Frames 62 and 71
25	AT, WSA and Seal STBD TT between Frames 52 and 62
26	Move equipment and SB JP5-Pump-Room Passageway (3-54-4)
29	AT, WSA and Seal (3-54-4)
30	Move equipment and SB Portside Bulkheads and Decks around Forward Turntable (Port TT) between Frames 52 and 71
31	AT, WSA and Seal Port TT between Frames 62 and 71
August	
1	AT, WSA and Seal Port TT between Frames 52 and 62
2	Move equipment Topside
5	Strip Port Vang Pad
6	AT, WSA and Seal Port Vang Pad
7	Move equipment and AT, WSA and Seal both Helo Control Panels (Helo Control Panels were previously SB by S/F)
8	Move equipment and SB half of the Port Boat-Davit Frame
9	SB second half Port Boat-Davit Frame
12	AT, WSA and Seal half Port Boat-Davit Frame
13	AT, WSA and Seal second half Port Boat-Davit Frame
14	Remove equipment
15	Paint
16	Paint

* For brevity, the full paint schedule (primer, 2 barrier, 2 topcoats) was not cited in the table but was accomplished in accordance with DoD-STD-2138(SH).

The results of the service test indicated that the scheduling guidelines were overly ambitious. The maximum area that SIMA personnel could strip blast during the shipboard Service Test was 75 sq.ft per day. Large areas such as the turntable bulkheads and helo control panels took two days vice one day to strip blast. The maximum area that SIMA personnel could anchor-tooth blast, wire spray and seal in one production day during the shipboard Service Test was 50 sq.ft.; therefore, the anchor-tooth blasting, wire spraying and sealing of large areas (turntable bulkheads and helo control panels) took three days vice two days. The movement of equipment from preserved areas to another area took one day vice the one-half day scheduled. An additional four days were required to accomplish the turntable and helo control panel over the time allotted due to additional strip blast, anchor-tooth blast, WSA and sealing time. Another two days were required due to additional equipment movement time.

The original schedule did not include unexpected production delays. The delays encountered during the service test included crane scheduling, late arrival of equipment, difficulties in equipment utility hookup, equipment casualties, cancellation of hotwork due to ship's refueling evolutions and SIMA personnel availability.

Late equipment and utility hookup delays would be eliminated in the event CC shipboard services are established as a normal shipboard service by a SIMA. Production delays such as ship interferences (refueling evolutions), equipment casualties and crane services should be taken into account when scheduling. Additionally, availability of shop personnel on a continuous basis should be considered.

5.7 EQUIPMENT

Equipment was required to perform the following functions:

- Abrasively blast the selected areas.
- Clean up the abrasive grit following blasting.
- Ventilate the areas during abrasive blasting, wire spraying and painting and exhaust over the ship's side.
- Apply aluminum to the prepared surfaces.
- Painting.
- Storage of equipment, consumables and used abrasive grit.

Alternative equipment selections were investigated to determine the equipment most feasible for the shipboard service.

The use of containerized abrasive blasting and WSA systems was considered for the shipboard Service Test. Containerized equipment could provide the equipment to accomplish shipboard WSA application. This containerized equipment could be placed aboard auxiliary and amphibious ships where deck space is available and pierside to combatant ships where open deck space may not be available. These containers are designed to operate in remote areas by utilizing extensions to the blast hoses and WSA guns. The containerized equipment could also be utilized by S/F and/or SIMA personnel to preserve components removable from the ship, but not processed in the Production Shop. Containerized abrasive blasting and WSA equipment would provide the opportunity to do both shipboard component/space and removable components.

Advantages for using containerized abrasive-blast and WSA equipment are as follows:

- Removable components and shipboard components/spaces can both be preserved.
- Manning requirements could be filled by S/F with SIMA personnel providing training, quality control and supervision.
- Equipment would be in the containers and not separate pieces of equipment (blast pots and air dryer) therefore consolidating transportation requirements.
- Containers would provide necessary after-hours stowage for auxiliaries such as grit containment and pick-up equipment, consumables, paint equipment, etc.

Experience with the containerized blasting and WSA equipment in the SIMA ship-to-shop Service Test has shown successful results for WSA preservation of removable shipboard components. Therefore, the need to test their use in the shipboard CC Service Test for preservation of removable items was not necessary. The ability to observe the use of containerized WSA equipment for in-situ shipboard WSA application was not possible due to the nonavailability of the containers (in continuous use for the ship-to-shop mode).

Individual equipments would be utilized to perform the functions required for shipboard WSA applications during this Service Test. The use of individual equipment vice containerized equipment would provide experience and valuable information about performing shipboard WSA application without containerized equipment. Possibilities exist that requirements to perform shipboard WSA application on more ships than containers are available should be considered.

Specialized abrasive-blast equipment was utilized for the Service Test. In the event of shipboard CC services becoming a full-time requirement and containerized equipment not utilized, specialized grit-blast equipment should be purchased to increase production. One must recognize that the shipboard service-test production times will not be fully applicable to a full-production shipboard mode due to the lack of specialized equipment.

Shipboard service test equipment is listed in Table 5-7 by source utilized.

Table 5-7 Shipboard Service Test Equipment

EQUIPMENT NOMENCLATURE	PURCHASED	RENTED	PROVIDED BY SIMA (SD)
Abrasive Blast Equipment	X		
Abrasive Blast Grit Disposal		X	
Grit Blast Containment Material (Tarps, Clamps and Conduit)	X		
Ventilation Blower and Ducting		X	
Air Dryer		X	
Equipment Stowage Container		X	
Flammable-Liquid Stowage Locker			X
Flame Spray Gun and Auxiliary Equipment			X
Consumables			X
Abrasive Grit Vacuum Cleaner	X		
Air Compressor			X
Paint Spray Equipment			X

5.7.1 Abrasive Blast Equipment

Two 1600-lb abrasive-blast pots, KELCO model K130-D pressure-type and associated nozzles, hoses, nozzle holders and couplings were purchased for the shipboard CC service test. One pot would be used for strip blasting using copper slag. The other pot would be used for anchor tooth blasting using aluminum oxide. The 1600-lb capacity was of sufficient volume to minimize the production stops to refill the blast pots after using all the grit in the blast process.

5.7.2 Abrasive Blast Grit Disposal

Sandblast grit disposal presented a problem. The paint chips present in the spent grit causes the grit to be classified as a hazardous material which requires SIMA Safety to be involved in grit disposal as a hazardous material. The use of two types of grit posed another disposal problem. The two differant grits would have to be disposed of seperately, therefore could not be mixed in the same disposal container. Two sandblast containers were rented from a disposal company. At the completion of the shipboard CC service test the disposal company removed the containers and disposed of the grit. Following the shipboard CC service test, four tons of grit (both aluminum oxide and copper slag) were disposed of by the container sub-contractor.

5.7.3 Grit Blast Containment Material

Grit blast containment material was necessary to perform the following functions:

a. Provide an enclosure which would eliminate grit and dust from exiting the work area contaminating other areas

b. Surround the work area in relatively air-tight enclosure to enable the ventilation system to remove dust and aluminum overspray.

The containment materials utilized in the shipboard CC service test were eight-foot by eight-foot, fire-retardant, vinyl-coated nylon tarps; ten-foot by twenty-foot flame-retardant canvas tarps; twenty- ten-foot sections of 3/4-inch thin-wall conduit; clamps designed to utilize conduit as a frame; duct tape and wire. These materials adequately performed the functions required of containment materials. One problem encountered with this method was that following anchor-tooth blasting and wire spraying, grit trapped in the tarp material would fall on the work area as WSA or paint were being applied to the surface. This problem may be avoided with the use of lighter canvas material such as flame-retardant sheet plastic which may be taped into corners easier than the heavier tarps. This, however, would shred.

5.7.4 Ventilation

Ventilation was performed by the use of a fifteen-horsepower, 7000 cfm ventilation blower, two-hundred-feet of 16-inch-diameter, coiled-wire, canvas-covered ventilation ducting and five-hundred-feet of 16-inch-diameter polyethylene ventilation ducting. The coiled-wire canvas covered ducting was utilized on the suction side of the blower, for the section of ducting which hung over the ship's side and for discharge ducting around small-radius turns. The end of the section which hung over the ship's side was fitted with a sheet-metal attachment and spray nozzle. The nozzle was connected to fresh water by an ordinary garden hose. The nozzle purpose was to eliminate free-blowing dust from exiting the blower discharge by spraying fresh water in a fine pattern as the dust from the blower discharge was about to exit the ducting. The water and entrapped dust fell over the ship's side into a retaining bag. This method of dust control worked very well as no dust exited the discharge ducting. The polyethylene ducting was used as discharge ducting between the blower and the canvas covered coil ducting. The use of polyethylene ducting proved to be a time-and labor-saving device. The polyethylene ducting was lightweight and could be handled by one person vice the two people required to handle sections of the canvas-covered, coiled-wire ducting. Sections of the canvas-covered coil ducting were held together by wire and sealed with duct tape. The equipment and methods described above proved to be operational. The ventilation blower was difficult to move because of its weight. The use of smaller blowers could provide adequate ventilation and reduce relocation time.

DoD-STD-2138(SH) requires that during abrasive blasting the air in an enclosed area other than a designated blasting booth be changed at least one per minute. Metal spraying in an open area requires the use of eye and ear protection and an air respirator. Abrasive blasting also requires the use of an air respirator.

5.7.5 Air Dryer

A skid-mounted air-cooled after-cooler and refrigerated air dryer was provided to meet the requirements of DoD-STD-2138(SH). The air dryer was mounted on a skid with two lockable equipment stowage boxes. The skid was configured to allow for movement by a fork-lift truck. Rated dryer capacity was 250 cubic feet per minute.

The arrangement of the dryer and two equipment boxes on a skid was cumbersome. The physical size and weight would preclude the movement aboard smaller cruiser/destroyer-size ships.

5.7.6 Flammable-Liquid Stowage

Flammable-liquid-stowage locker provided by SIMA had a capacity of twelve five-gallon cans. The locker had ample stowage for paints, thinner, spray equipment and tools. The locker was easily moved by a pallet jack.

5.7.7 Flame Spray Equipment

The METCO 12E Flame Spray Gun was utilized for WSA application during the shipboard CC service test. Auxiliary support equipment included METCO Type 2AF air flowmeter, METCO Type 3G gas control unit, METCO Type 2GF gas flowmeter, METCO Type 2W wire control unit and hoses. The Flame Spray equipment performed well during the service test in conjunction with the properly planned maintenance.

5.7.8 Air Compressor

Compressed air is required for abrasive blasting, WSA application, painting and breathing. Each abrasive blast pot required 234 cfm at 100 psig for a 3/8-inch nozzle orifice. Two air compressors were available from SIMA(SD) Equipment Department, a 240-cfm Ingersoll-Rand Model SSR-EP60, electric-motor-driven air compressor or a 250-cfm, diesel-driven, Schramm Model 250 air compressor.

labor-saving device. The polyethylene ducting was lightweight and could be handled by one person vice the two people required to handle sections of the canvas-covered, coiled-wire ducting. Sections of the canvas-covered coil ducting were held together by wire and sealed with duct tape. The equipment and methods described above proved to be operational. The ventilation blower was difficult to move because of its weight. The use of smaller blowers could provide adequate ventilation and reduce relocation time.

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Flammable-liquid-stowage locker provided by SIMA had a capacity of twelve five-gallon cans. The locker had ample stowage for paints, thinner, spray equipment and tools. The locker was easily moved by a pallet jack.

5.7.7 Flame Spray Equipment

The METCO 12E Flame Spray Gun was utilized for WSA application during the shipboard CC service test. Auxiliary support equipment included METCO Type 2AF air flowmeter, METCO Type 3G gas control unit, METCO Type 2GF gas flowmeter, METCO Type 2W wire control unit and hoses. The Flame Spray equipment performed well during the service test in conjunction with the properly planned maintenance.

5.7.8 Air Compressor

Compressed air is required for abrasive blasting, WSA application, painting and breathing. Each abrasive blast pot required 234 cfm at 100 psig for a 3/8-inch nozzle orifice. Two air compressors were available from SIMA(SD) Equipment Department, a 240-cfm Ingersoll-Rand Model SSR-EP60, electric-motor-driven air compressor or a 250-cfm, diesel-driven, Schramm Model 250 air compressor.

The electric air compressor would be the preferred compressor to use, yet a shipboard electric power source of 450 volts AC, 89 amps, three phase, 60 hertz was not available. An adequate power supply was available from the pier, but the cable and electrical disconnect was not available to make the electrical connection during the Service Test. Therefore, the diesel-powered compressor was used and was placed on the ship's flight deck. Four hundred feet of hoses were required to reach the forward-turntable work areas with the air compressor on the flight deck. The compressor provided ample air for all requirements, however the diesel required fueling daily and was a noise and air pollutant.

5.7.9 Paint-Spray Equipment

The paint-spray equipment was utilized to apply epoxy-polyamide and silicone-alkyd paints to seal the WSA, act as barrier coats and to topcoat. The paint was mixed to NSTM Chapter 631 standards using a one-gallon Jiffy mixer and air-driven drill motor. The medium-production, lightweight, hand-held, pressure-fed compressed-air paint spray gun used was a Graco Model 700N. A two-quart pressure cup was utilized as the spray gun paint source. The spray gun and two-quart pressure cup worked well for all paint applications.

5.7.10 Consumables

All consumables were provided by SIMA during the shipboard CC service test and are listed in Table 5-8. It is assumed that the same amount of consumables would be used for every 550 sq.ft. of area preserved using WSA.

5.8 MANNING AND ORGANIZATION

Shipboard manning requirements were based on the requirements established for the Service Test and the scheduled requirements imposed by the ship. The original planning schedule was developed on the premise to strip blast an area one day then anchor-tooth blast, WSA and seal the next day, thereby allowing production in only one space at a time. The one-space operation necessitated the need for two operators trained in all operations associated with WSA application. One operator to be performing the process steps and another as a relief. The work crew selected were two WSA operators and a First Class Petty Officer. The Petty Officer was to supervise and provide technical guidance for the two operators. A fireman was added to the shipboard team to perform functions such as safety observer, painting and equipment staging/movement. All SIMA personnel selected were certified WSA operators. Two S/F personnel were assigned to the shipboard team to perform functions such as interference removal, equipment staging and used-grit disposal.

The initial manning plan involved was excessive. By limiting production to a single space, the need for two operators was not required and was reduced to one operator. During the final four weeks, the S/F personnel were underutilized since the majority of the interference removal and equipment staging was accomplished at the beginning of the Service Test.

Table 5-8 Consumables

CONSUMABLES	QUANTITY
Abrasive Blast Grit	8,000 lb
Aluminum Oxide	1,000 lb
Compressed Oxygen	9 bottles
Compressed Acetylene	4 bottles
Paint	
Epoxy-Polyamide Formula 150	2-5 gal cans
Epoxy-Polyamide Formula 151	2-5 gal cans
Silicone-Alkyd TT-E-490 Haze Gray	7 gals
Silicone-Alkyd TT-E-490 White	1 gal
Aluminum Wire	4 rolls (60 lb each)
Duct Tape	2 cases
Wire, #16	200 feet
1/4-inch Sisal Rope	400 feet

The shipboard-service organization is illustrated by Figure 5-2. Figure 5-2 illustrates the formal and informal liaison between commands and personnel during the service test. The solid lines denote formal liaison. The goal was to establish a service test with an organization as similar to the organization that exists during any shipboard work by a SIMA. ISA personnel performed the liaison tasks normally performed by the SIMA ship superintendent.

5.9 SERVICE TEST

Following the procurement of equipment, establishment of a schedule and allocation of manning SIMA and ISA moved the equipment movement onboard USS SCHENECTADY and to begin shipboard CC service. Delays were encountered and lessons were learned. The initial delay encountered was crane services. Public Works Center (PWC) and the MSR contractor cranes could not operate in the same vicinity. Both the PWC and MSR cranes proved unreliable at being able to meet shipboard Service-Test crane requirements.

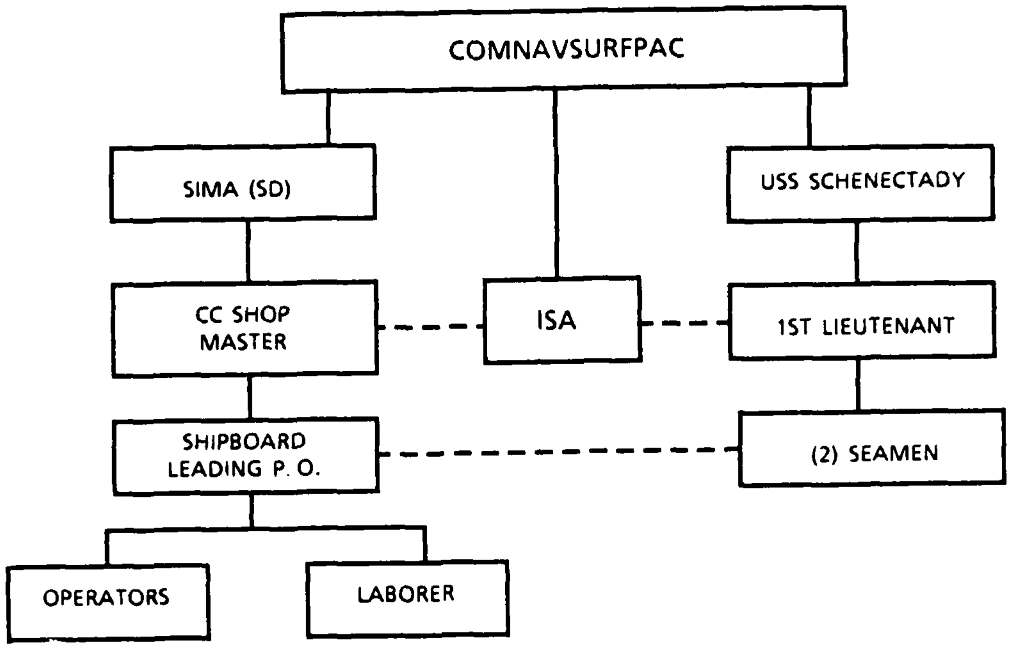

Figure 5-2 Shipboard Service Test Organization

Shipboard 450 VAC outlets are located on the damage control (DC) deck (the deck above the tank deck) of the USS SCHENECTADY. These 450 VAC outlets are protected by 25 amp breakers, and therefore the electric-motor-driven air compressor (89 amps) available from SIMA(SD) could not be used. All equipment electrical male plugs were changed to be compatible with shipboard female outlets.

Shipboard Service-Test equipment and consumables were located near the ship's center of gravity so as to minimize the effect on the MSR in-progress engine alignment.

The staging and hookup of equipment began in the tank deck and in such a manner that the equipment was out of foot-traffic paths. All ducting, wiring and hoses were tied to the bulkheads and overheads to improve personnel safety. Oxygen, acetylene and paint were staged topside to remove the combustibles from the ship's tank deck. Oxygen, acetylene and air hoses were run from topside to the tank deck through hatches and along ladders.

Interference removal and reinstallation was accomplished by S/F personnel assigned to the shipboard CC Service-Test team. Items removed as interference included non-watertight doors, watertight doors, ventilation ducting, hatches, hoses and stored shipboard equipment and consumables. The ship's personnel accomplished the interference removal before the WSA team built grit containment and reinstalled the interference after the final topcoat of paint had dried.

Grit containment set-up was accomplished using thin-walled conduit, conduit-frame clamps and fire-retardant tarps. The clamps were utilized to fasten the conduit together as either a box or wall around the area or compartment to be preserved. The ventilation ducting suction was placed in the upper portion of the containment enclosure framework. The tarps were overlapped on the frame and rolled at the deck to ensure at least some degree of air tightness. The grit containment enclosure kept grit from escaping the enclosure and formed a relatively air-tight enclosure. The enclosure leaked enough air to keep the tarps from sagging into the operator's way inside the enclosure.

SIMA(SD) personnel performed the gas-free inspection prior to the start of hot work each day. The SLPO was responsible for the daily scheduling of the hot work permit inspection. On two separate occasions, hot work could not be accomplished due to ship's refueling evolutions. No other situation occurred during the shipboard Service Test that prevented the hot work permit from being issued by the SIMA gas-free engineer.

Surface preparation was begun by sweeping away all loose debris and masking all surfaces near the area to be preserved such as copper-nickel piping, electrical cables and panels, duct work openings, etc. Surface preparation was accomplished by abrasive blasting to remove paint and corrosion and to prepare the surface with a proper profile for WSA application. Two 1600-pound-capacity abrasive-blast pots were utilized to abrasively blast the surfaces; one for strip blasting and one for anchor-tooth blasting. Initial strip blasting was attempted using copper slag (grit size 16) and resulted in excessive dust affecting the operator's vision. Aluminum oxide (grit size 16) was then utilized to strip blast to reduce airborne particle matter and eliminated operator vision problems. The aluminum oxide was sieved to remove debris and reused to strip blast until too small for blasting then disposed of in the grit containers.

Aluminum oxide (grit size 16) was utilized to anchor-tooth blast the surface following strip blasting. Unused grit was utilized for AT blasting to ensure proper anchor-tooth profiles. Anchor-tooth profiles obtained during the shipboard CC Service Test ranged from 2.7 to 3.0 mils using Testex Press-o-Film X-Course 1.5- to 4.5-mil tape.

The removal of spent grit from the prepared surface area was accomplished using a 55-gallon two-horsepower-capacity vacuum cleaner.

WSA application was accomplished utilizing METCO Flame Spray 12E guns and associated auxiliary equipment. The flame spray operator was assisted by another person to help feed the aluminum wire through the grit-blast enclosure. Oxygen and acetylene bottles were staged on the ship's main deck and hoses were run to workplace and attached to the METCO gas flow control meters. The METCO equipment performed well during the Service Test requiring only regular planned maintenance.

Heat caused by ineffective ventilation occurred while wire spraying the initial mogas-hose-reel room. The mogas-hose-reel rooms were the smallest spaces (30 cubic ft.) preserved during the Service Test. Entrance to the hose-reel rooms were 28-inches x 24-inches. The 16-inch-diameter hose was too large to be placed in the hose-reel entrance and permit access by the operator. The operator would kneel outside the hose reel room entrance within the grit enclosure and blast, WSA and paint within the hose-reel room. Initially, the 16-inch-diameter ventilation suction hose was placed in the top of the grit enclosure box built around the mogas hose reel room entrance. This placement of the suction hose did not adequately ventilate the space to reduce the heat within the room during WSA application. The heat caused temperatures to reach 180°F. The space was too hot for the operators to work while applying the WSA. A six-inch-diameter suction hose was fitted to the 16-inch blower suction and placed through the hose-reel-room entrance and placed in the upper portion of the space. This ventilation suction hose placement increased room ventilation and reduced room temperature to 92°F during WSA application. Properly sized hose and hose placement allowed for adequate ventilation and acceptable temperatures during WSA application.

Standards required by DoD-STD-2138(SH) were met by performing quality control checks. These checks included visual cleanliness, anchor-tooth profile, WSA thickness, paint WFT and final DFT measurements. Anchor-tooth-profile measurements resulted in readings of 2.7 to 3.0 mils indicating proper surface profiles were obtain during anchor-tooth blasting. WSA DFT measurements met DoD-STD-2138(SH) standards.

DFT readings were measured in every space preserved after final paint coats were dry. Table 5-10 gives the average shipboard CC Service-Test final DFT readings for each space preserved in the order the spaces were preserved from top to bottom of the figures as measured by ISA. The initial two spaces preserved had the thinnest final DFT readings. These readings are within the required 17- to 20-mil range for final DFT. As the shipboard CC Service Test progressed, the final DFT increased above 22 mils. As indicated by Table 5-9, all final coating thicknesses met or exceeded DoD standards.

SIMA personnel would check for proper WSA thickness during WSA application utilizing a PENTEST pull-off gauge Model EPP. The chemical-stowage-locker passageway, CPO-baggage-stowage passageway and JP5-pumproom passageway were configured with raised hatch combings in the deck of the spaces. These hatch combings were close to the bulkheads and required the use of an extension and angle nozzle on the METCO gun to meet WSA requirements of DoD-STD-2138(SH). WSA-coating thicknesses measured between seven to ten mils for all areas except the chemical-storage-locker passageway and the forward Mogas-Hose-Reel Room which reads 11 and 12 mils, respectively.

Table 5-9 **Shipboard CC Service-Test Final DFT Measurements**

SPACE NOMENCLATURE	NUMBER OF READINGS	AREA OF SPACE (sq.ft.)	AVG READINGS FINAL DFT (mils)
G-Division Stowage	43	45	17.0
AFT Mogas-Hose-Reel Room	43	27	18.7
Forward Mogas-Hose-Reel Room	18	26	25.5
Chemical-Stowage-Locker Passageway	42	48	25.3
Starboard Turntable Bulkhead and Decks	65	157	23.1
CPO-Baggage-Stowage Passageway	37	31	21.6
Port Turntable Bulkhead and Decks	57	135	22.3
JP5-Pump-Room Passageway	34	30	22.6
Helo Control Panel	32	60	23.4

Paint mixing application was conducted in accordance with DOD-STD-2138(SH) and NSTM 631 painting requirements. All paints were mixed with a Jiffy paint, one-gallon mixer, Model 919600, utilizing an air-operated drill motor with a minimum rotational speed of 500 revolutions per minute (rpm) to ensure paints were thoroughly mixed. Induction times following mixing were observed as per paint manufacturer's recommendations before application to the surface. All painting was accomplished utilizing a GRACO Model 700N air-spray gun, Type 03N fluid tip/needle combination, Type O air cap and two-quart pressure cup. All spaces were sealed with Formula 150 epoxy-polyamide immediately following completion of WSA application. Two subsequent Formula 151 epoxy polyamide barrier coats were applied one coat per day for the two work days following the seal coat. Two subsequent finish/final or topcoats of silicone alkyd, TT-E-490, were applied one coat per day for the two work days following the second barrier coat. Tack coats were applied between the second barrier coat and initial topcoat. SIMA personnel would check for proper paint thickness using a PRO-LINE paint company marine paint one- to 80-mils wet-film thickness (WFT) gauge during and following paint application.

5.10 ANALYSIS

The economic feasibility of a SIMA to perform in-situ WSA application depends on the production rate and methods utilized. The production methods must be similar to a MSR-contractor's methods to even approach the contractor's production rates.

The MSR-contractor's standard in San Diego is strip blasting, anchor-tooth blasting, WSA coating and applying the five-coat paint system at the rate of 500 sq.ft. per two days at $15.00 per sq.ft. with simple geometry and an accessible area. MSR contractors strip blast 500 sq.ft. in one eight-hour shift then anchor-tooth blast the same area in the first four hours of the second shift or day. During the second four hours of the second shift or day, the area is wire sprayed utilizing two wire-spray guns and sealed. The subsequent two barrier coats and two topcoats are applied one per day each day thereafter.

The shipboard Service-Test production rates are listed in Table 5-10. These rates are the actual application rates and do not include set-up times and other production delays. Analysis of these rates reveals that all processes of in-situ WSA application are a function of geometric complexity and accessibility. As the geometric complexity increases and accessibility decreases, all processes require more time per square foot.

There is a minimum area that a SIMA would have to preserve with WSA to be economically feasible. Assuming the use of shipboard WSA team as recommended and same consumable-usage rate as consumed during the shipboard Service Test, the following equation will determine the minimum area required for economical feasibility:

$$(\text{MIN AREA})\left(\frac{\$4500 \text{ Consumables}}{560 \text{ sq.ft.}}\right) + \left(\frac{\$910.10}{\text{WSA Team}}\right) = (\text{MIN AREA}) \left(\frac{\$15}{\text{sq.ft.}}\right)$$

MIN AREA = 130.7 sq.ft.

MIN AREA is defined as that minimum area required to be preserved in a two-day period by a SIMA for economic feasibility. $4500 per 560 sq.ft. is the total consumables cost during the shipboard Service Test and is the assumed consumable expense rate that will be realized in shipboard production. $15 per sq.ft. is the government cost for a MSR contractor to perform in-situ WSA application. $910.10 is the two-day salary and total compensation cost to the government for one First-Class Petty Officer, one Second-Class Petty Officer, one Third-Class Petty Officer and two firemen/seamen as reported by NAVCOMPTNOTE 7041 dated, 28 November 1984. This equation compares the two-day SIMA costs (consumables and salaries) to the MSR-contractor costs.

The minimum required area to be preserved by a shipboard WSA team in two days for the service to be economically feasible would be 130.7 sq.ft. or 326.7 sq.ft. per five-day work week.

Table 5-10 Shipboard Service-Test Production Rates

PROCESS STEP	G DIV STORAGE	STBD TURNTABLE	PORT TURNTABLE	HELO CONTROL PANEL	AVERAGE
Geometric Complexity	3	3	3	3	
Ease of Access	3	3	3	3	
Strip-Blast Production Rate sq.ft./Hr	48	32	45	*	42
Anchor-Tooth-Blast Production Rate sq.ft./Hr	56	39	56	27	45
WSA sq.ft./Hr	40	29	56	23	37
Painting sq.ft./Hr	200	240	324	217	245

* Ship's Force Strip Blasted

PROCESS STEP	AFT MOGAS	FWD MOGAS	CPO BAGGAGE PASSAGEWAY	AVERAGE
Geometric Complexity	1	1	1	
Ease of Access	1	1	2	
Strip-Blast Production Rate sq.ft./Hr	22	21	12	18
Anchor-Tooth-Blast Production Rate sq.ft./Hr	27	26	22	25
WSA sq.ft./Hr	30	21	41	31
Painting sq.ft./Hr	180	130	186	165

Table 5-10 **Shipboard Service-Test Production Rates** (Cont'd)

PROCESS STEP	JP5 PUMPROOM ENTRANCE	CHEMICAL WARFARE STORAGE	AVERAGE
Geometric Complexity	2	2	
Ease of Access	2	2	
Strip-Blast Production Rate $\frac{\text{sq.ft.}}{\text{Hr}}$	28	39	34
Anchor-Tooth-Blast Production Rate $\frac{\text{sq.ft.}}{\text{Hr}}$	42	27	35
WSA $\frac{\text{sq.ft.}}{\text{Hr}}$	36	26	31
Painting $\frac{\text{sq.ft.}}{\text{Hr}}$	187	248	218

Assuming an eight-hour work day, production rates listed in Table 5-10, and no time for military duties on simple geometry, easily accessible spaces, an IMA could strip blast 336 sq.ft. during an eight-hour work day. Assuming improved anchor-tooth-blasting techniques are utilized, SIMA personnel should be able to double the rate during anchor-tooth blasting or blast 336 sq.ft. in four hours. Assuming that the WSA rate of application would double with the utilization of two WSA guns, an IMA could apply WSA to 296 sq.ft. in four hours.

Utilizing MSR-contractor methods of strip blasting an area one day and anchor-tooth blast, WSA and seal the next day or shift, the limiting IMA production process would be the WSA application. An IMA should be capable of strip blasting, anchor-tooth blasting, applying WSA and sealing 250 sq.ft. in two eight-hour days or shifts. Based on a strip-blast rate of 336 sq.ft. per eight hours, anchor-tooth blast rate of 336 sq.ft. per four hours and WSA application rate of 296 sq.ft. per four hours, 10.4 hours would be required to preserve 250 sq.ft. with WSA. Therefore, 7.6 hours would be available for equipment staging, grit cleanup and military time in two days of production.

In-situ WSA application by an IMA is economically feasible with improved anchor-tooth-blasting techniques and the use of two WSA guns. IMA personnel are capable of performing in-situ WSA application in accordance with DoD-STD-2138(SH).

5.11 RECOMMENDATIONS

The in-situ application of WSA is a time consuming process which would require devotion of personnel for many weeks and many pieces of equipment; therefore, it is recommended that in-situ application of WSA be performed only during overhaul.

The use of containerized abrasive-blast and wire-spray-aluminum systems are recommended to be utilized by S/F and supervised by SIMA personnel during overhaul. S/F personnel may preserve both removable components and in-situ areas.

The manning for a shipboard WSA application team would be dependent upon equipment, production methods and the scheduling utilized. When the production methods and equipment dictate that blasting and WSA application can occur in only one space, the recommended shipboard team consists of one First-Class Petty Officer to act as SLPO, one Second-Class Petty Officer, one Third-Class Petty Officer to be the equipment operators and two fireman or seaman to act as safety observers and general labor. If the equipment and/or production methods allow for two-space production, additional two operators and assistant/safety observers are recommended. The shipboard-mode manning recommendations are summarized by Table 5-11.

Table 5-11 Recommended Shipboard Team Manning Per Shift

	ONE-SPACE PRODUCTION CAPACITY	TWO-SPACE PRODUCTION CAPACITY
SLPO (1st Class)	1	1
Operator(s) (2nd and 3rd Class)	2	4
Assistant/Safety Observer (FN/SN)	2	4

It is recommended the First-Class and Second-Class Petty Officers be SIMA personnel certified as WSA operators. The First-Class shall supervise, provide technical guidance and perform quality assurance checks. The Second-Class Petty Officer shall set up containerized systems and auxiliary support equipment, perform the WSA application and perform preventive and corrective maintenance on the equipment. The Third-Class Petty Officer shall be from S/F and shall perform strip and anchor-tooth blasting, WSA and paint application. The firemen/seamen shall be from S/F and perform safety observer, equipment staging and laborer functions.

Recommended grit clean-up equipment shall be a two-horsepower, 55-gallon-capacity vacuum cleaner.

Recommendations for grit disposal are to procure two containers of approximately four cubic yards (13,000 lb). These containers should hold three to six weeks of blast grit depending on production methods. As an option SIMA could obtain the services of grit reclamation company. These companies will provide a container, pick up the container when full and replace the container with an empty container. These companies will resell the grit after removing the contaminants and reclassifying the grit.

The use of canvas tarps, thin-wall conduit and conduit frame-maker clamps are recommended to construct grit-blast and ventilation enclosures.

The use and availability of three five-horsepower ventilation blowers and ducting would allow for ventilation of more than one space/area at a time and be easier to move and stage. The smaller ducting associated with a five-horsepower blower would allow for the ventilation of small spaces through small openings.

In view of the inherent exhaust, noise and fuel problems associated with a diesel-driven air compressor, the use of an electric-driven, 250 SCFM, rotary-screw air compressor is recommended for shipboard CC services. The use of two METCO 12E guns and auxiliary equipment are recommended for shipboard CC services.

A 350-SCFM, refrigerated air dryer and aftercooler are auxiliary equipment to the containerized systems and a separate air dryer would not be required.

USS SCHENECTADY has excellent room for equipment staging. Similar large amphibious ships would also present excellent room for equipment staging. Smaller combatant ships, such as cruisers and destroyers, would have room for equipment staging only on flight decks, forecastles and fantails. The setting of this equipment on a smaller DD- or CG-class ship would have an even larger effect on the ship's position in the water and could cause problems to any alignment procedures. The equipment size and weight should be discussed with the SupShip, MSR contractor and ship before the shipboard CC services to address the effect of the equipment on the ships' buoyancy, alignment procedures and foot traffic.

The recommended scheduling guidelines are to strip blast 250 sq.ft. the first shift or day, anchor-tooth blast the area during the first four hours of the second shift or day and apply WSA and seal during the second four hours of the second shift or day.

The use of these recommended production methods, equipment, manning and scheduling shall ensure the shipboard application of in-situ WSA will be economically feasible and meet quality control standards required by DoD-STD-2138(SH).

SECTION SIX

INSTALLATION KITS

6.0 GENERAL

During the SIMA Pilot CC-Shop Service Test, a need was recognized for detailed instructions for the proper reinstallation of processed components. This lack of information became evident during post-availability inspections. Processed components had been reinstalled by S/F to unprepared mounting or with incorrect fastener assemblies, i.e., nuts, bolts, washers, toggle pins, hasps, etc. This improper installation was also due to the nonavailability of the proper type of fasteners within the Navy Supply System.

Improved fasteners and reinstallation materials are specified in the NAVSEA Ship-Class CC Manuals as an attempt to prevent corrosion, however these manuals are deficient in that they contain technical errors and do not provide sufficient information for S/F to properly reinstall preserved components, e.g., preparation of mounting surfaces; specific type of fasteners and sealants; exact quantity, size and arrangement of fastener assemblies. During the Service-Test indoctrination of ships designated by COMNAVSURFPAC to participate in the program, Ship Class CC Manuals were not onboard in all cases. Those ships that did have them had difficulty in locating them. These manuals have only been issued to four ship classes and are in draft form for five additional ship classes.

Several examples of these deficiencies in the LPD-4 and LPH-2 Class Corrosion-Control Manuals illustrate the errors found in most of the manuals in general:

- Ceramic-coated fasteners are specified on a component from a bronze and copper/nickel salt-water system and a bronze AFFF system valve. Fasteners should be Monel or K-Monel.

- Replacement of mild-steel hinges and dogs on an aluminum life jacket locker with CRES 316 alloy or ceramic-coated hinges and dogs is specified without the use of polysulfide sealant or a dielectric barrier. The aluminum locker is described as being non-metallic and corrosion of the locker is evident in the picture.

- The replacement of existing fasteners with either CRES-316 or ceramic-coated fasteners is listed. The selection of the specific fastener material should be based the substrate material and the applied coating system. The CRES 316 and ceramic-coated fasteners are not interchangeable in all corrosion-control applications.

6.1 INSTALLATION KIT DEVELOPMENT

Various methods have been tried during the Pilot CC Shop Service Test to provide the customer ship with the proper fasteners including requesting the customer ship to: procure 316-SS or ceramic-coated fasteners; send existing fasteners with the component so that the CC-Shop could replace in kind; and identify fastener requirements. These methods, for varying reasons, were ineffective. However, four common reasons for the inability to achieve satisfactory results with these methods emerged.

- Customer ship personnel are not sufficiently knowledgeable in the NAVSEA CC systems and/or the NAVSEA Ship-Class Corrosion-Control Manuals are not explicit for S/F to determine fastener requirements (type/size/material) and other NAVSEA corrosion-control systems to be used for reinstallation.
- Wrong size/material requested by the customer ship.
- Long-lead time on fastener delivery.
- Components were not reinstalled correctly.

Therefore, in order for the SIMA to provide the customer ship with the proper fasteners (type/size/material), materials (anti-seize, polysulfide sealant, etc.) and detailed reinstallation instructions, it was necessary to provide the customer ships with installation kits and technical-data sheets (TDSs) containing the requisite technical information to allow S/F to properly reinstall the preserved component. To accomplish this, the following elements were developed:

- A pre-expended bin inventory for two ships of each class homeported at the location of the SIMA.
- Comprehensive detailed reinstallation instructions for each processed component.
- Installation-kit books for each ship class.
- Software for an automated system of maintaining pre-expended bin inventory and reinstallation instructions.

6.1.1 Pre-Expended Bin

In order to provide timely support for processing components and to deliver the proper fasteners to the customer ship, a pre-expended bin needed to be developed.

The initial pre-expended bin was established for the Pilot CC Shop in April 1985. The quantities, sizes and material for the fasteners in the initial pre-expended bin inventory were based primarily on the components that had been processed and fasteners requested by the customer ships to that time in the Pilot Program.

During post-availability shipchecks, it was noted that numerous components were mounted with the wrong diameter and/or length fasteners. It was then determined that to develop an accurate pre-expended bin, detailed surveys of each ship class would have to be accomplished.

In May 1985, detailed fastener surveys of each ship class commenced. These surveys consisted of identifying each component that could be processed through a SIMA CC Shop for the type, size, material and quantity of all fasteners required to properly reinstall the processed component. This data was then collated to provide the total fastener requirements for each ship of that class. Data for thirteen ship classes have been collated and is contained in Appendix A6-1.

The recommendation to stock the pre-expended bin with sufficient quantities of fasteners for two ships of each class homeported at the location of that SIMA was based on the long lead-time required to obtain certain fasteners and the estimated number of ships that would simultaneously be in a CC availability.

Note: The two-ship pre-expended bin loading estimate is qualitative. Usage must be maintained and evaluated to refine this stock level.

6.1.2 Automated System

The SIMA would maintain all the technical data sheet information in a data base. The TDSs would then be called up and printed as they are needed, eliminating the requirement to maintain numerous copies of each TDS. The automated system would perform several functions including:

- Maintain TDSs.
- Maintain a running pre-expended bin inventory by automatically deducting expenditures when TDSs are issued as part of the Installation Kits.
- List pre-expended-bin requirements/reorder points.
- Provide usage/cost-data history.

6.1.3 Reinstallation Instructions

Installation-Kit TDSs are being developed for each generic component that was identified by the initial survey of each ship class. Figures 6-1 through 6-5 are the five examples of Installation-Kit TDSs for various components from various ship classes. These sheets contain:

- Ship Class.
- Component description.
- Type, size material and quantity of fasteners required to reinstall one component.

TECHNICAL DATA SHEET

SHIP CLASS: FFG7 COMPONENT: CONTROLLER, BOAT DAVIT

FASTENERS

	DIAM	LNTH	QTY	MATERIAL	
F1	5/16	2 1/2	8	316	BOLT
F2	5/16	3	4	316	BOLT
F3	1/2	7/8	12	316	PIN
F4	1/2	2	4	CER	BOLT
F5	3/8	1 1/4	4	CER	BOLT
F6	1/2		4	CER	HEX NUT
F7	3/8		4	CER	HEX NUT
F8					
F9					
F10					

WASHERS

	DIAM	QTY	MAT'L
V1	5/16	12	316
V2	5/16	12	NYLON
V3	1/2	8	CER
V4	1/2	8	NYLON
V5	3/8	8	CER
V6	3/8	8	NYLON
V7			
V8			
V9			
V17			

GASKETS

	MATERIAL
G1	
G2	
G3	

COMPONENT

	MATERIAL
M1	STEEL
M2	ALUMINUM
M3	
M4	
M5	

NAVSEA CC SYSTEMS

1.	VSA (HT)	
2.	VSA (LT)	X
3.	TOPCOATS	
4.	POWDERED COATINGS	
5.	NON - SKID DECK COATINGS	
6.	CERAMIC COATINGS	X
7.	WATER DISPLACING COMPOUND	
8.	ANTI - SEIZE COMPOUND	X
9.	IMPROVED FASTENERS	X
10.	SEALING & COATING COMPOUND	
11.	POLYSULFIDE SEALANT	X
12.	PROTECTION OF ELEC. CONN.	
13.	DIELECTRIC BARRIER (ABS)	
14.	VAPOR PHASE INHIBITOR (VPI)	
15.	STRIPPABLE COATINGS	

SEE PAGE TWO FOR DETAILED ASSEMBLY DRAWING

INSTALLATION INSTRUCTIONS

PAGE 1 OF 2

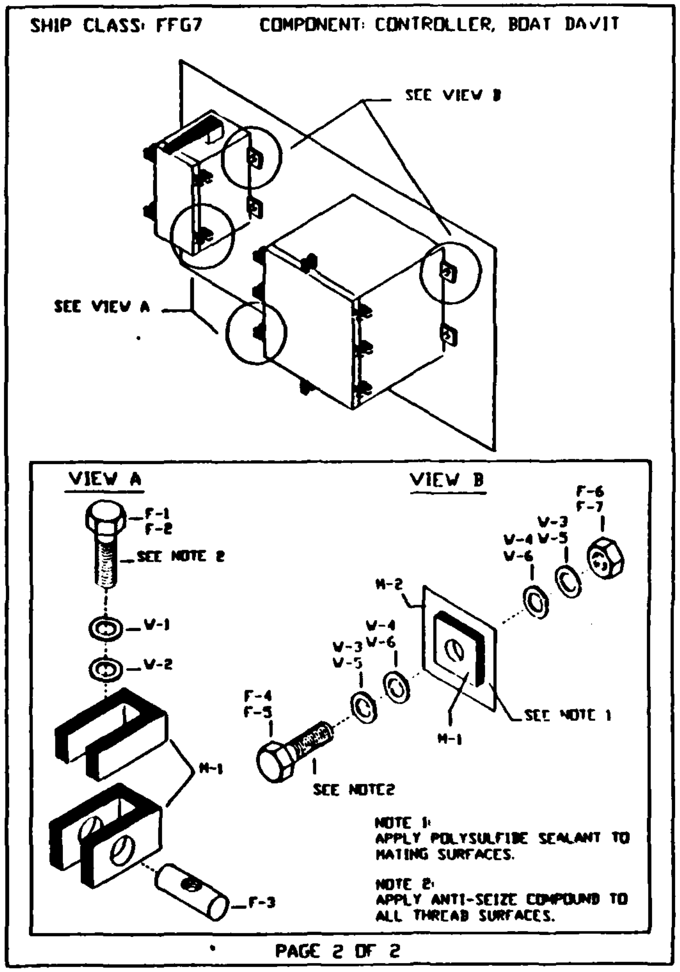

Figure 6-1 **Installation-Kit Technical-Data Sheet Boat Davit Controller (FFG-7 Class)**

TECHNICAL DATA SHEET

SHIP CLASS: CGN38 COMPONENT: CONTROLLER, BOAT DAVIT

FASTENERS

	DIAM	LNTH	QTY	MATERIAL
F1	5/16	2 1/2	4	316 BOLT
F2	1/4	1	14	316 BOLT
F3	1/2	7/8	4	316 PIN
F4	3/8	1	4	CER BOLT
F5	1/2	1 1/4	4	CER BOLT
F6	1/4		14	316 HEX NUT
F7	3/8		4	CER HEX NUT
F8	1/2		4	CER HEX NUT
F9				
F10				

WASHERS

	DIAM	QTY	MAT'L
V1	5/16	4	316
V2	5/16	4	NYLON
V3	1/4	28	316
V4	1/4	28	NYLON
V5	3/8	8	CER
V6	3/8	8	NYLON
V7	1/2	8	CER
V8	1/2	8	NYLON
V9			
V10			

GASKETS

	MATERIAL
G1	
G2	
G3	

COMPONENT

	MATERIAL
M1	STEEL
M2	ALUMINUM
M3	
M4	
M5	

NAVSEA CC SYSTEMS

1.	VSA (HT)	
2.	VSA (LT)	X
3.	TOPCOATS	
4.	POWDERED COATINGS	
5.	NON - SKID DECK COATINGS	
6.	CERAMIC COATINGS	X
7.	WATER DISPLACING COMPOUND	
8.	ANTI - SEIZE COMPOUND	X
9.	IMPROVED FASTENERS	X
10.	SEALING & COATING COMPOUND	
11.	POLYSULFIDE SEALANT	X
12.	PROTECTION OF ELEC. CONN.	
13.	DIELECTRIC BARRIER (ABS)	
14.	VAPOR PHASE INHIBITOR (VPI)	
15.	STRIPPABLE COATINGS	

SEE PAGE TWO FOR DETAILED ASSEMBLY DRAWING

INSTALLATION INSTRUCTIONS

PAGE 1 OF 2

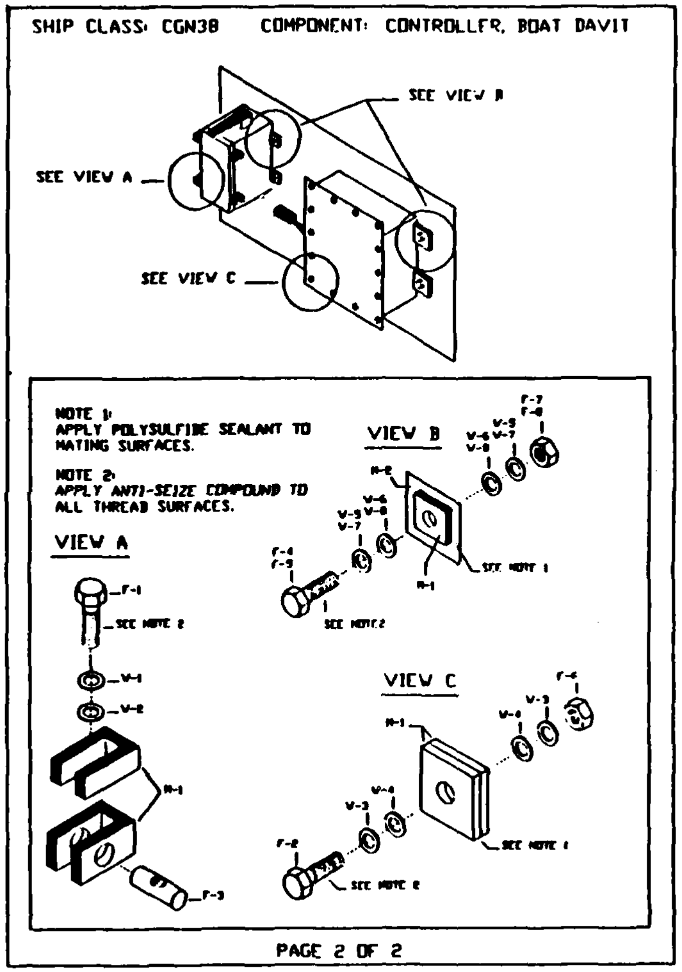

Figure 6-2 **Installation-Kit Technical-Data Sheet Boat Davit Controller (CGN-38 Class)**

TECHNICAL DATA SHEET

SHIP CLASS: FFG1   COMPONENT: CONTROLLER, CAPSTAN

FASTENERS

	DIAM	LNTH	QTY	MATERIAL	
F1	5/16	2 1/2	4	316	BOLT
F2	3/4	2	4	316	BOLT
F3	1/2	7/8	4	316	PIN
F4					
F5					
F6					
F7					
F8					
F9					
F10					

NAVSEA CC SYSTEMS

1.	VSA (HT)	
2.	VSA (LT)	
3.	TOPCOATS	
4.	POWDERED COATINGS	X
5.	NON - SKID DECK COATINGS	
6.	CERAMIC COATINGS	
7.	WATER DISPLACING COMPOUND	
8.	ANTI - SEIZE COMPOUND	X
9.	IMPROVED FASTENERS	X
10.	SEALING & COATING COMPOUND	
11.	POLYSULFIDE SEALANT	X
12.	PROTECTION OF ELEC. CONN.	
13.	DIELECTRIC BARRIER (ABS)	
14.	VAPOR PHASE INHIBITOR (VPI)	
15.	STRIPPABLE COATINGS	

WASHERS

	DIAM	QTY	MAT'L
W1	5/16	4	316
W2	5/16	4	NYLON
W3	3/4	4	316
W4	3/4	4	NYLON
W5			
W6			
W7			
W8			
W9			
W10			

GASKETS

	MATERIAL
G1	
G2	
G3	

COMPONENT

	MATERIAL
M1	STEEL
M2	STEEL
M3	
M4	
M5	

SEE PAGE TWO FOR DETAILED ASSEMBLY DRAWING

INSTALLATION INSTRUCTIONS

PREPARE ALUMINUM MOUNTING AS FOLLOWS

- REMOVE ANY OIL OR GREASE USING APPROPRIATE SOLVENTS.
- PREPARE MOUNTING SURFACE BY REMOVING ALL CORROSION PRODUCTS USING AN ALUMINUM OXIDE ABRASIVE DISK.
- APPLY A PRIMER COAT IMMEDIATELY USING FORMULA 150 TO A DRY FILM THICKNESS (DFT) OF 3 MILS
- APPLY A BARRIER COAT AFTER A MINIMUM OF 8 HOURS BUT NOT MORE THEN 72 HOURS HAS ELAPSED SINCE THE APPLICATION OF THE PRIMER COAT USING FORMULA 151 TO A DFT OF 3 MILS
- APPLY A TOP COAT WHILE THE BARRIER COAT IS TACKY (APPROXIMATELY 3-4 HOURS) USING TT-E-490 TO A DFT OF 1.5 MILS
- APPLY A SECOND TOP COAT WITHIN 24 HOURS USING TT-E-490 TO A DFT OF 1.5 MILS
- ALLOW PAINT SYSTEM TO THOROUGHLY DRY BEFORE REINSTALLATION OF THE COMPONENT

PREPARE STEEL MOUNTING AS FOLLOWS

- REMOVE ANY OIL OR GREASE USING APPROPRIATE SOLVENTS.
- PREPARE MOUNTING SURFACE BY REMOVING ALL CORROSION PRODUCTS USING A STAINLESS STEEL POWER WIRE BRUSH
- APPLY A PRIMER COAT IMMEDIATELY USING INORGANIC ZINC PRIMER TO A DRY FILM THICKNESS (DFT) OF 3 MILS.
- APPLY A BARRIER COAT AFTER A MINIMUM OF 8 HOURS BUT NOT MORE THEN 72 HOURS HAS ELAPSED SINCE THE APPLICATION OF THE PRIMER COAT USING FORMULA 150 TO A DFT OF 0.5-1 MIL
- APPLY A SECOND BARRIER COAT AFTER WAITING A MINIMUM OF 8 HOURS USING EITHER FORMULA 150 OR FORMULA 151 TO A DFT OF 3 MILS.
- APPLY A TOP COAT WHILE THE SECOND BARRIER COAT IS TACKY (APPROXIMATELY 3-4 HOURS) USING TT-E-490 TO A DFT OF 1.5 MILS.
- APPLY A SECOND TOP COAT WITHIN 24 HOURS USING TT-E-490 TO A DFT OF 1.5 MILS.
- ALLOW PAINT SYSTEM TO THOROUGHLY DRY BEFORE REINSTALLATION OF THE COMPONENT.

MOUNT COMPONENT AS FOLLOWS

- APPLY ANTI-SEIZE COMPOUND TO ALL FASTENER THREADS.
- APPLY POLYSULFIDE SEALANT TO ALL FAYING SURFACES AS SHOWN IN THE ILLUSTRATION ON PAGE 2.
- INSTALL THE FASTENER ASSEMBLIES PROVIDED AS SHOWN IN THE ILLUSTRATION ON PAGE 2 ENSURING THAT THE NYLON WASHERS ARE INSTALLED NEXT TO THE MOUNTING SURFACE AND/OR THE COMPONENT TO FORM A PROTECTIVE BARRIER FOR THE CONTROLS.
- REPAIR ANY CHIPS OR SCRATCHES IMMEDIATELY BY FEATHERING THE EDGES AND APPLYING A PAINT SYSTEM

PAGE 1 OF 2

SHIP CLASS: FFG1   COMPONENT: CONTROLLER, CAPSTAN

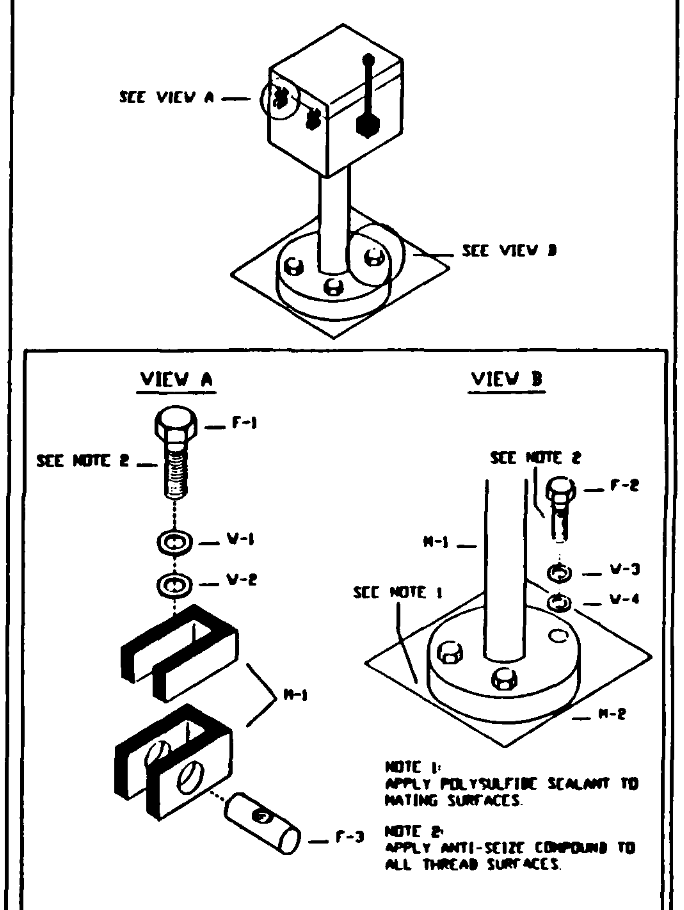

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Figure 6-3 Installation-Kit Technical-Data Sheet Capstan Controller (FFG-1 Class)

TECHNICAL DATA SHEET

SHIP CLASS: FFG7 COMPONENT: CONTROLLER, CAPSTAN

FASTENERS

	DIAM	LNTH	QTY	MATERIAL
F1	5/16	2 1/2	4	316 BOLT
F2	1/2	2	4	316 BOLT
F3	1/2	7/8	4	316 PIN
F4	1/2		4	316 HEX NUT
F5				
F6				
F7				
F8				
F9				
F10				

NAVSEA CC SYSTEMS

1.	VSA (HT)	
2.	VSA (LT)	
3.	TOPCOATS	
4.	POWDERED COATINGS	X
5.	NON - SKID DECK COATINGS	
6.	CERAMIC COATINGS	
7.	WATER DISPLACING COMPOUND	
8.	ANTI - SEIZE COMPOUND	X
9.	IMPROVED FASTENERS	X
10.	SEALING & COATING COMPOUND	
11.	POLYSULFIDE SEALANT	X
12.	PROTECTION OF ELEC. CONN.	
13.	DIELECTRIC BARRIER (ABS)	
14.	VAPOR PHASE INHIBITOR (VPI)	
15.	STRIPPABLE COATINGS	

WASHERS

	DIAM	QTY	MAT'L
V1	5/16	4	316
V2	5/16	4	NYLON
V3	1/2	8	316
V4	1/2	8	NYLON
V5			
V6			
V7			
V8			
V9			
V10			

GASKETS

	MATERIAL
G1	
G2	
G3	

COMPONENT

	MATERIAL
M1	STEEL
M2	STEEL
M3	
M4	
M5	

SEE PAGE TWO FOR DETAILED ASSEMBLY DRAWING

INSTALLATION INSTRUCTIONS

PREPARE ALUMINUM MOUNTING AS FOLLOWS:

- REMOVE ANY OIL OR GREASE USING APPROPRIATE SOLVENTS.
- PREPARE MOUNTING SURFACE BY REMOVING ALL CORROSION PRODUCTS USING AN ALUMINUM OXIDE ABRASIVE PAD.
- APPLY A PRIMER COAT IMMEDIATELY USING FORMULA 150 TO A DRY FILM THICKNESS (DFT) OF 3 MILS.
- APPLY A BARRIER COAT AFTER A MINIMUM OF 8 HOURS BUT NOT MORE THEN 72 HOURS HAS ELAPSED SINCE THE APPLICATION OF THE PRIMER COAT USING FORMULA 150 TO A DFT OF 3 MILS.
- APPLY A TOP COAT WHILE THE BARRIER COAT IS TACKY (APPROXIMATELY 3-4 HOURS) USING TT-E-490 TO A DFT OF 1.5 MILS.
- APPLY A SECOND TOP COAT WITHIN 24 HOURS USING TT-E-490 TO A DFT OF 1.5 MILS.
- ALLOW PAINT SYSTEM TO THOROUGHLY DRY BEFORE REINSTALLATION OF THE COMPONENT.

PREPARE STEEL MOUNTING AS FOLLOWS:

- REMOVE ANY OIL OR GREASE USING APPROPRIATE SOLVENTS.
- PREPARE MOUNTING SURFACE BY REMOVING ALL CORROSION PRODUCTS USING A STAINLESS STEEL POWER WIRE BRUSH.
- APPLY A PRIMER COAT IMMEDIATELY USING INORGANIC ZINC PRIMER TO A DRY FILM THICKNESS (DFT) OF 3 MILS.
- APPLY A BARRIER COAT AFTER A MINIMUM OF 8 HOURS BUT NOT MORE THEN 72 HOURS HAS ELAPSED SINCE THE APPLICATION OF THE PRIMER COAT USING FORMULA 150 TO A DFT OF 0.5-1 MIL.
- APPLY A SECOND BARRIER COAT AFTER WAITING A MINIMUM OF 8 HOURS USING EITHER FORMULA 150 OR FORMULA 151 TO A DFT OF 2 MILS.
- APPLY A TOP COAT WHILE THE SECOND BARRIER COAT IS TACKY (APPROXIMATELY 3-4 HOURS) USING TT-E-490 TO A DFT OF 1.5 MILS.
- APPLY A SECOND TOP COAT WITHIN 24 HOURS USING TT-E-490 TO A DFT OF 1.5 MILS.
- ALLOW PAINT SYSTEM TO THOROUGHLY DRY BEFORE REINSTALLATION OF THE COMPONENT.

MOUNT COMPONENT AS FOLLOWS:

- APPLY ANTI-SEIZE COMPOUND TO ALL FASTENER THREADS.
- APPLY POLYSULFIDE SEALANT TO ALL FAYING SURFACES AS SHOWN IN THE ILLUSTRATION ON PAGE 2.
- INSTALL THE FASTENER ASSEMBLIES PROVIDED AS SHOWN IN THE ILLUSTRATION ON PAGE 2 ENSURING THAT THE NYLON WASHERS ARE INSTALLED NEXT TO THE MOUNTING SURFACE AND/OR THE COMPONENT TO FORM A PROTECTIVE BARRIER FOR THE CONTROLLER.
- REPAIR ANY CHIPS OR SCRATCHES IMMEDIATELY BY FEATHERING THE EDGES AND APPLYING A PAINT SYSTEM.

PAGE 1 OF 2

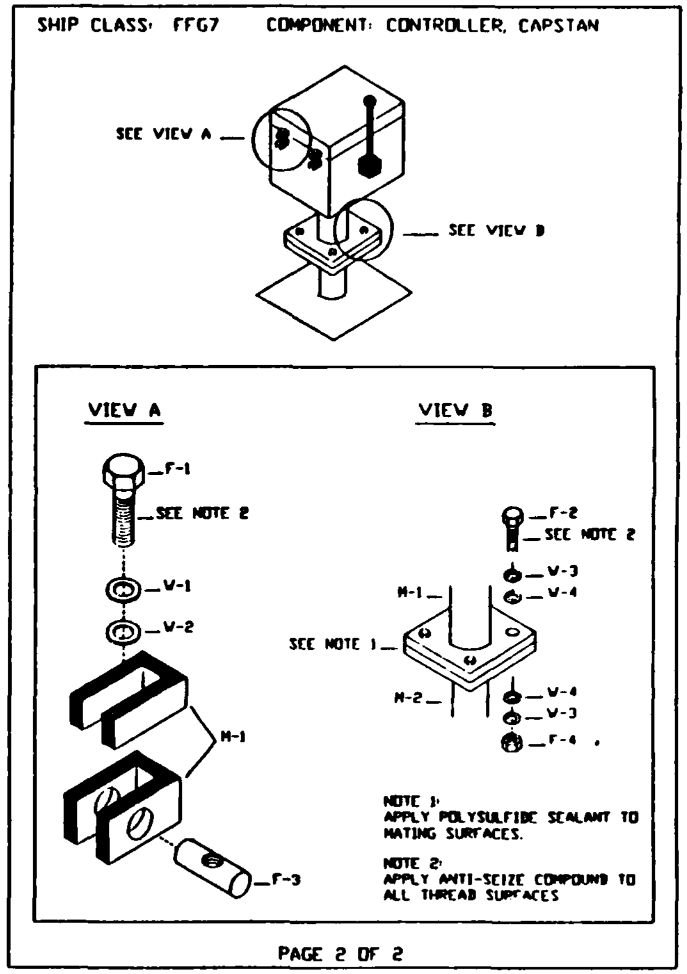


Figure 6-4 Installation-Kit Technical-Data Sheet Capstan Controller (FFG-7 Class)

TECHNICAL DATA SHEET

SHIP CLASS: STANDARD COMPONENT: BOX, SP TELEPHONE STOWAGE

FASTENERS

	DIAM	LNTH	QTY	MATERIAL
F1	3/8	1	4	316 BOLT
F2	3/8		4	316 HEX NUT
F3				
F4				
F5				
F6				
F7				
F8				
F9				
F10				

NAVSEA CC SYSTEMS

1.	VSA (HT)	
2.	VSA (LT)	
3.	TOPCOATS	
4.	POWDERED COATINGS	X
5.	NON - SKID DECK COATINGS	
6.	CERAMIC COATINGS	
7.	WATER DISPLACING COMPOUND	
8.	ANTI - SEIZE COMPOUND	X
9.	IMPROVED FASTENERS	X
10.	SEALING & COATING COMPOUND	
11.	POLYSULFIDE SEALANT	X
12.	PROTECTION OF ELEC. CONN.	
13.	DIELECTRIC BARRIER (ARS)	
14.	VAPOR PHASE INHIBITOR (VPI)	
15.	STRIPPABLE COATINGS	

WASHERS

	DIAM	QTY	MAT'L
V1	3/8	8	316
V2	3/8	8	NYLON
V3			
V4			
V5			
V6			
V7			
V8			
V9			
V10			

GASKETS

	MATERIAL
G1	
G2	
G3	

COMPONENT

	MATERIAL
M1	ALUM. (PC)
M2	STEEL OR ALUM.
M3	
M4	
M5	

SEE PAGE TWO FOR DETAILED ASSEMBLY DRAWING

INSTALLATION INSTRUCTIONS

PREPARE ALUMINUM MOUNTING AS FOLLOWS:

- REMOVE ANY OIL OR GREASE USING APPROPRIATE SOLVENTS
- PREPARE MOUNTING SURFACE BY REMOVING ALL CORROSION PRODUCTS USING AN ALUMINUM OXIDE ABRASIVE DISK
- APPLY A PRIMER COAT IMMEDIATELY USING FORMULA 150 TO A DRY FILM THICKNESS (DFT) OF 3 MILS
- APPLY A BARRIER COAT AFTER A MINIMUM OF 8 HOURS BUT NOT MORE THAN 72 HOURS HAS ELAPSED SINCE THE APPLICATION OF THE PRIMER COAT USING FORMULA 150 TO A DFT OF 3 MILS
- APPLY A TOP COAT WHILE THE BARRIER COAT IS TACKY (APPROXIMATELY 3-4 HOURS) USING TT-E-490 TO A DFT OF 1.5 MILS
- APPLY A SECOND TOP COAT WITHIN 24 HOURS USING TT-E-490 TO A DFT OF 1.5 MILS
- ALLOW PAINT SYSTEM TO THOROUGHLY DRY BEFORE REINSTALLATION OF THE COMPONENT.

PREPARE STEEL MOUNTING AS FOLLOWS:

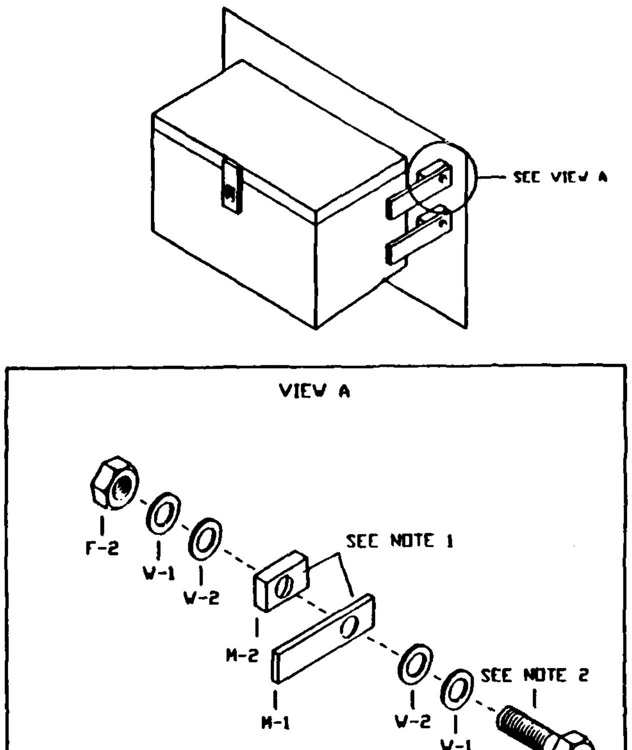
- REMOVE ANY OIL OR GREASE USING APPROPRIATE SOLVENTS
- PREPARE MOUNTING SURFACE BY REMOVING ALL CORROSION PRODUCTS USING A STAINLESS STEEL POWER WIRE BRUSH
- APPLY A PRIMER COAT IMMEDIATELY USING INORGANIC ZINC PRIMER TO A DRY FILM THICKNESS (DFT) OF 3 MILS
- APPLY A BARRIER COAT AFTER A MINIMUM OF 8 HOURS BUT NOT MORE THAN 72 HOURS HAS ELAPSED SINCE THE APPLICATION OF THE PRIMER COAT USING FORMULA 150 TO A DFT OF 0.5-1 MIL
- APPLY A SECOND BARRIER COAT AFTER WAITING A MINIMUM OF 8 HOURS USING EITHER FORMULA 150 OR FORMULA 151 TO A DFT OF 3 MILS
- APPLY A TOP COAT WHILE THE SECOND BARRIER COAT IS TACKY (APPROXIMATELY 3-4 HOURS) USING TT-E-490 TO A DFT OF 1.5 MILS
- APPLY A SECOND TOP COAT WITHIN 24 HOURS USING TT-E-490 TO A DFT OF 1.5 MILS
- ALLOW PAINT SYSTEM TO THOROUGHLY DRY BEFORE REINSTALLATION OF THE COMPONENT

MOUNT COMPONENT AS FOLLOWS:

- APPLY ANTI-SEIZE COMPOUND TO ALL FASTENER THREADS
- APPLY POLYSULFIDE SEALANT TO ALL FAYING SURFACES AS SHOWN IN THE ILLUSTRATION ON PAGE 2
- INSTALL THE FASTENER ASSEMBLIES PROVIDED AS SHOWN ON THE ILLUSTRATION ON PAGE 2 ENSURING THAT THE NYLON WASHERS ARE INSTALLED NEXT TO THE MOUNTING SURFACE AND/OR THE COMPONENT TO FORM A PROTECTIVE BARRIER FOR THE [illegible]
- REPAIR ANY CHIPS OR SCRATCHES IMMEDIATELY BY FEATHERING THE EDGES AND APPLYING A PAINT SYSTEM

PAGE 1 OF 2

SHIP CLASS: STANDARD COMPONENT: BOX, SP TELEPHONE STOWAGE



NOTE 1
APPLY POLYSULFIDE SEALANT TO MATING SURFACES OF BRACKETS M-1 AND M-2
NOTE 2
APPLY ANTI-SEIZE COMPOUND TO ALL THREAD SURFACES

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Figure 6-5 Installation-Kit Technical-Data Sheet SP Telephone Stowage Box (Standard)

- Material of the component.
- Material to which component will be mounted.
- Type of coating to be applied.
- Other NAVSEA-designated CC Systems required, i.e., anti-seize compound (System Eight), polysulfide sealant (System 11), etc.
- Detailed reinstallation instructions including surface preparation of the mounting surface.
- An exploded-view reinstallation drawing.

6.1.4 Software Description

The Installation-Kit TDSs were generated using a Zenith Z100 computer (with a minimum of 256K Bytes of memory) and a software program called Auto-Cad by Autodesk Incorporated (Ref. 6-1). The TDSs were printed using a Houston Instruments DMP-29 plotter. The Auto-Cad software also includes Drafting Extensions One and Two which increases the capability and versatility of the software.

The drawings are developed by first making detailed drawings of fixtures, such as handles, nuts, bolts and brackets. These drawings are then maintained in a library on the hard disk. The basic outline of the component is drawn on the screen and then the necessary fixtures are called up, scaled down and placed in their final position on the component drawing. The final component drawing is then scaled down and placed in position on the master Installation-Kit TDS and renamed in the files to reflect all changes.

These Installation-Kit TDSs will be incorporated in a file for specific ship classes and will be able to be called up for printing on the plotter. After the Installation-Kit TDSs are printed, the Installation Kits are then made up and delivered with the component to the customer ship.

6.1.5 Installation Kit Books

The collation of all the Installation-Kit Technical-Data Sheets of a ship class makes up the "Installation-Kit Book" for that ship class. Appendix A6-2 is the Draft Installation-Kit Book for the FF-1052 class ship.

Note: The photographs of each component should be replaced with a drawing of the component and an exploded-view of the fastener assembly as shown in Figures A6-1 through A6-5.

6.2 MAJOR FASTENER ISSUES/RESOLUTIONS

During the Pilot CC Service Test, several fastener issues were encountered. Two of these issues were procurement problems. The first issue was the procurement of 316 stainless steel (SS) toggle pins, which are used primarily for portable stanchions and flag/jackstaffs. Toggle pins (316-SS) were carried in the Navy Supply System and were not readily available from vendor sources. A Naval Reserve Unit in Orange, Texas, was contacted by COMNAVSURFPAC to manufacture the toggle pins. Arrangements to do this are not complete. A vendor in the San Diego area was eventually found and the toggle pins were obtained locally.

The second major issue, pyro-locker clips, remains to be resolved. Pyro-locker clips which are used to fasten the sun shields on the locker are commonly made of mild steel. Several vendors and metal shops were contacted but would not manufacture these clips from 316-SS unless sufficient quantities were ordered to make it cost effective for tooling up for 316-SS. One vendor, for example, indicated that in order to make the tooling economically feasible, a minimum order of 1500 would be required to fabricate these clips at a unit cost of $3.96.

6.3 RECOMMENDATIONS

Based on the lessons learned during the SIMA Pilot Corrosion-Control-Shop Service Test, the following actions are recommended:

- Continue surveys to develop Installation-Kit Books for each ship class. After completing the initial survey of one ship of each class, survey several ships of each class to update Installation-Kit Books. Incorporate completed books in the Ship-Class Corrosion-Control Manuals.

- Develop automated data base Installation-Kit Technical-Data Sheets, planning information and supply support.

- SIMA continue to explore the use of Naval Reserve resources to manufacture non-standard fastener, such as pyro-locker clips.

REFERENCES FOR SECTION SIX

6-1 Auto-Cad User's Manual, Autodeck Incorporated, Copyright 1985.

SECTION SEVEN

TRAINING

7.0 GENERAL

This section reports the technical training developed and delivered for the start up and during the conduct of the Pilot CC-Shop Service Test. The training included an initial two-week start-up training in WSA application processes followed by one-hour weekly or maintenance training on corrosion prevention and control and the operation and maintenance of the CC-Shop's IPE. This training program was needed for CC-Shop personnel because of their inexperience and lack of adequate background in the applied aspects of marine corrosion phenomenology and the measures for corrosion prevention and control. Further, knowledge and skill training reinforcement and personnel turnover requires an ongoing CC-Shop training program.

The start-up crew of the CC Shop, one Chief Machinist Mate (MMC), seven rated personnel (MM1, HT1, EN2, BT2, HT2, HT3 and MM3) and one Quality-Assurance Chief Petty Officer (CPO) from the SIMA Quality Assurance Department, were initially trained and certified for applying the WSA-coating system by Flame Spray, Inc. in August 1984 (Ref. 7-1). Subsequently, the scope of the training requirement was expanded to develop the starting-crew training and the weekly-maintenance training for the SIMA(PH) CC Shop planned for May-June 1986 using the "lessons learned" in the SIMA(SD) startup and service test training.

Awareness of and a basic understanding of the corrosion prevention and control aboard Navy ships is a requirement for all hands in general and for the "deck and engineering" ratings in particular. These new technology corrosion prevention and control systems are being used in new ship constructions and in the maintenance, repair and overhaul of ships in service. The introduction of the new CC Shop in the IMAs requires that a CC training program be developed, validated and delivered to CC-Shop personnel and the requisite planning, quality assurance and management personnel in the SIMA.

7.1 OBJECTIVES OF THE SIMA CC SHOP TRAINING PROGRAM

7.1.1 Terminal Objectives

The terminal objectives of the CC-Shop training program is to have CC-Shop personnel:

1. Man, operate and supervise a SIMA CC Shop.

2. Provide technical advice and assistance to tended ships and other SIMA Shops.

3. Deliver CC-production services to tended ships and other SIMA Shops.

4. Provide CC knowledge and skill training to CC-Shop personnel and other personnel as assigned.

7.1.2 Enabling Objectives

1. To develop and implement an ongoing training and certification program for the SIMA CC Shops.

2. To provide classroom and OJT on the CC-Shop organization and modus operandi and the theory and practical application of corrosion prevention and control for shipboard application and SIMA delivery; ιPE; production; quality assurance and control; and shop records.

Note: For the NAVSEA-designated corrosion prevention and control systems, only DoD-STD-2138(SH), the NAVSEA specifications for metallized coatings, requires formal training and certification for wire-spray operators.

7.1.3 Major Training Source Documents

The major references and source documents used for the development and delivery of the training program are listed below.

- NAVSEA S9086-VD-STM-000, Ch. 631, Preservation of Ships in Service (Surface Preparation and Painting).
- NAVSEA 0655-AA-JPA-010, Job Performance Aid for Metal Sprayed Coating Systems, 30 May 1983.
- DoD-STD-2138(SH), Metal-Sprayed Coating System for Corrosion Protection Aboard Naval Ships, 23 November 1981.
- NAVSEA Ship-Class Corrosion-Control Manuals.
- Corrosion-Control Using Wire-Sprayed Aluminum, Naval Reserve IMA-7 Training Program, circa 1980.
- Metallized Coatings for Corrosion Control of Naval Ship Structures and Components, Committee on Thermal-Spray Coatings for Corrosion Control, National Materials Advisory Board, NMAB-409, February 1983.
- SIMA(SD) Process Instruction No. 7100-18-84 Rev 1, Wire-Sprayed Aluminum (WSA) for Corrosion Protection: NAVSEA Corrosion-Control (CC) Systems 1 and 2, 25 October 1985.
- NACE Standards, Technical Practice Committee, February 1985.
- Steel Structures Painting Manual, Volumes I and II, Steel Structures Painting Council, June 1983.
- Corrosion Basics: An Introduction, NACE, 1984.

- Thermal Spraying, Practice, Theory and Application, American Welding Society, 1985.

- Corrosion Control by Organic Coatings, Henry Leidheiser, Jr. Editor, NACE, 1981.

- Corrosion Prevention by Protective Coatings, Charles G. Munger, NACE, 1984.

- Corrosion and Corrosion Protection Handbook, P. A. Schweitzer editor, Marcel Dekker Inc. publisher, 1983.

- Equipment Manufacture Operator and Field/Factory Maintenance Instructions for the CC-Shop's IPE and minor equipments.

  .. Ramco Vapor Degreaser

  .. Vacublast Strip Blaster

  .. Portable/Containerized Flame Spray System, Model 5005

     - Abrasive Blasting Unit

     - Wire-Spraying Unit

  .. METCO 10E, 11E and 12E Wire-Spray Guns

  .. GRACO and Binks Paint-Spray Equipment

  .. QC Instruments

  .. Electrostatic-Spray-Powder Equipment (GEMA Powder Sprayer, NORDSON Hopper Feeder and NPE-2M Gun, Spray Booth and Curing Oven.

Additionally, the current edition of the various quality, performance and technical Federal, professional society and Navy standards/specifications were also used.

7.2 TRAINING CONCEPT

The initial training concept for the enlisted personnel manning the Pilot CC-Shop Service Test was to use contractor (Flame Spray, Inc., San Diego) to provide the initial WSA training and certification followed by ISA classroom training and OJT in the CC Shop covering:

- 15 NAVSEA-designated CC Systems.

- Operation and Maintenance of the CC Shop's IPE.

- WSA Process Instruction.

- ESP Process Instruction.
- CC-Shop Management and Records.
- Planning, Scheduling and Ship Checks.

Table 7-1 summarizes the three curriculum units and lists the lesson plan titles for the CC-Shop Technician. Lesson plans were developed and delivered for all listed lessons except those asterisked. During the progress of the Service Test, additional orientation and technical training requirements became evident, namely:

- Ships assigned a portable/containerized WSA system by COMNAVSURFPAC and manned by S/F to apply the WSA coating system during ROH.
- Other SIMAs having WSA coating IPE.
- SIMA planning and quality-assurance staff.
- The CC Instructor for the above training.
- The CC-Shop Master in the management of the CC Shop and its interface with the other SIMA shops/departments and the maintenance and enhancement of the military and technical proficiency and quality of the CC Shop and its personnel.

7.3 TRAINING DEVELOPED AND DELIVERED DURING THE SERVICE TEST

7.3.1 Training Developed

The initial training curriculum and lesson plans were developed and delivered for instructing CC-Shop personnel in the prevention and control of marine corrosion and the 15 NAVSEA-designated CC systems. The curriculum was made up of three lessons on corrosion theory, prevention and control and five lessons covering the 15 Systems. The material was presented as part of an ongoing weekly training program for CC Shop personnel in a lecture and seminar mode including audio visual presentations.

SIMA CC Shop personnel were trained and certified for applying the WSA CC Systems 1 and 2 by completing the ten-day "CC Shop WSA-Training/Certification Course." The course covers the theory and practical aspects of the prevention and control of corrosion with emphasis on the WSA coating system; surface preparation, masking, anchor-tooth blasting, thermal spraying and sealing/topcoating; quality control; record keeping; DoD-STD-2138(SH); the SIMA WSA Process Instruction; installation kits and CC-Shop operations and management. Approximately 1/3 of the time was classroom training; 2/3 hands-on shop training in the SIMA CC Shop. Course completion and certification requires passing a written examination and applying the WSA coating to test panels and test shapes in accordance with DoD-STD-2138(SH). Certificates for satisfactory course completion were issued by SIMA(SD) Quality Assurance Department, Code 5000.

Table 7-1 SIMA CC-Shop Technician Training Curriculum

TITLE		SHOP TECH		PAGE NO.
UNIT	LESSON	CLASS (hr)	OJT (hr)	A7-1-
I	**MARINE CORROSION, CAUSES, PREVENTION AND CONTROL**			
	1 Introduction and Corrosion Discussion	2	—	6
	2 Corrosion; Causes and Control	2	—	27
	3 Corrosion Evaluation and Control	2	—	39
	4 CC Systems 1 and 2: WSA	2	—	51
	5 CC Systems 3: Paints	3	14	83
	6 CC System 5: Non-Skid Deck Coating	1	—	119
	7 CC System 4: Powder Coating	3	—	134
	8 CC Systems 6-9: Fasteners and Preservation Materials	1	—	144
	9 CC Systems 10-15: Sealing and Coating Compounds	1	—	158
	10 Installation Kits	1	7	170
	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	—	186
	2 CC Using WSA, Part I - Surface Preparation	4	20	195
	3 CC Using WSA, Part II - Wire Spraying	4	28	206
	4 CC Using WSA, Part III - PMS	4	8	213
	5 CC Using WSA - Certification Tests	2	6	218
	UNIT TOTAL	**18**	**62**	
III	**ESP EQUIPMENT AND APPLICATION PROCESS**			
	1 ESP-Coating Review and GEMA ESP Equipment	2	6	236
	2 NORDSON ESP Equipment	2	6	258
	3 ESP Spray Booth, Curing Oven and Containers	2	6	283
	UNIT TOTAL	**6**	**18**	
	COURSE TOTAL (141 hrs ≈ 18 days)	**38 (2)**	**101**	

* Will be developed for the SIMA(PH) CC-Shop Startup Training.

Additionally, technical training for the application of WSA was provided to (a) SIMA technicians manning the WSA station in the SIMA(SD) Fleet Valve-Maintenance Shop, (b) personnel from the USS BELLEAU WOOD (LHA-3) and (c) two personnel from SIMA(San Francisco).

The initial-lesson plan format used was the standard lesson-plan format used by the Navy, i.e., title, objective, materials and references, introduction, presentation, application, test, summary and assignment (TOMIPASTA). However, this format was later changed to the Shop Qualification Improvement Program (SQIP) format as per recommendation of SEA 075 that CC-Shop training would be delivered in the SQIP*.

SQIP training is aimed to increase the quality of repair work and improve the productivity of IMA shops by raising the knowledge and skills of repairmen to acceptable levels of proficiency. SQIP lessons are arranged according to the logical order of the troubleshooting and repair actions from the initial inspection and casualty/degradation estimate through the repair actions to the end-item reinstallation in the ship and acceptance testing. SQIP training is designed to be delivered in the IMA/SIMA job site without interrupting production work. Instructor Guides are developed for each SQIP course (table of contents, section on how to use the training materials, course outline, the required reference materials and the lesson plans). Each SQIP lesson plan has four sections:

(1) Instructor Preparation

(2) Instructor Presentation

(3) Instructor Follow-Through

(4) Training Aids

A SQIP Learner's Guide or workbook is also developed and is the student's supplement to the SQIP lessons.

The CC training materials developed and delivered during the Service Test have been reformatted into SQIP Instructor's Guide for the CC-Shop Technician Training Curriculum. Three units were developed (see Table 7-1):

I Marine Corrosion, Causes, Prevention and Control

II WSA: Equipment and Application Process

III ESP: Equipment and Application Process

Appendix A7-1 contains the lesson plans for the SIMA Corrosion-Control Shop Technician.

* Meeting among SEA 075 (P. Rogers, T. Neubert), SEA 05L16 (J. Simpson) and R. Sulit (ISA), 19 September 1985.

In addition to the courses and lesson plans developed for CC-Shop personnel, courses and lesson plans were developed for WSA-training and certification and the CC-Shop Master. During the period March 1985 to 30 November 1985, 13 enlisted personnel from the USS BELLEAU WOOD (LHA-3), seven enlisted personnel from SIMA(SD) Fleet Valve-Maintenance Shop and two senior Petty Officers from SIMA, San Francisco, were trained and certified as WSA Technicians. In addition, the Shop Master from SIMA CC Shop in Pearl Harbor was trained in the course materials and skills for the CC-Shop Technician, certified for applying the WSA coating system in accordance with DoD-STD-2138(SH) and trained in the CC-Shop management and modus operandi and CC-availability ship checks and planning.

A course for ESP Equipment and Application Process was developed and delivered in October 1985 for the start-up of the ESP Station in the SIMA(SD) CC Shop. Three Petty Officers and a BTC were trained. Three lessons were developed and delivered covering the attributes and the IPE and process requirements for powder coatings. OJT was conducted in the ESP Station detailing the operation and maintenance of the IPE and process quality control.

7.3.2 **Course and Lesson Plan (LP) Descriptions in the SQIP Format** (See Appendix A7-1 for the lesson plans)

Unit I - Marine Corrosion, Causes, Prevention and Control

Unit I is the course to teach the SIMA CC-Shop Technicians the causes, prevention and control of marine corrosion and painting OJT. The course is comprised of 12 lessons and lesson plans with visual aids and supplemental handouts. Unit I is designed for delivery in five days (eight hrs/day, 19 hrs classroom, 21 hrs OJT in the CC Shop; 40 hrs total).

Note: The Lessons 11 and 12 subject matter on Shop Modus Operandi and Shop Management, Planning and Scheduling were subsumed in Lessons 1 to 10 due to evolution of the Pilot CC Shop operating procedures during the service test. Lessons 11 and 12 will be developed for the start-up training of SIMA(PH) in May-June 1986.

Lesson 1: **Introduction and Corrosion Discussion** - An introduction to the course; corrosion theory and a general overview of corrosion causes, identification, prevention and control; and the 15 NAVSEA-designated CC systems.

Lesson 2: **Corrosion; Causes and Control** - A continuation of Lesson 1 with emphasis on shipboard corrosion inspection, diagnosis and corrosion prevention and control.

Lesson 3: **Corrosion Evaluation and Control** - Corrosion inspection, degradation/failure modes, correction and prevention; an overview of the 3-M Maintenance Data System and the preparation of CC Ship Action Maintenance Forms (SMAFs) for entry and management of CC work through the Current Ship Maintenance Project (CSMP); corrosion inspection guide; corrosion problem summary sheets and corrosion prevention plan.

Lesson 4: CC Systems 1 and 2: Wire Sprayed Aluminum (WSA) - Properties; ship applications including items/spaces approved for WSA by the TYCOM and NAVSEA; equipment, industrial process and quality-control procedures for the application of WSA coatings.

Lesson 5: CC Systems 3: Paints - Properties; applications with emphasis for WSA coatings; safety; equipment; industrial process and quality-control procedures for the application and curing/drying of paint coatings. OJT in the Painting Station of the CC Shop.

Lesson 6: CC System 5: Non-Skid Deck Coating - Purpose and application of non-skid deck coatings, surface preparation, coating preparation and application.

Lesson 7: CC System 4: Powder Coating - Introduction to basic plastic composition; types of plastic properties; why powder coating is used, environmental concerns; shipboard items to be powder coated; and the ESP application equipment, safety and process instruction.

Lesson 8: CC Systems 6, 7, 8 and 9: Fasteners and Preservation Materials - Uses of ceramic coatings; water-displacing, clear CC compound; anti-seize and 316 stainless steel fasteners.

Lesson 9: CC Systems 10, 11, 12, 13, 14 and 15: Sealing and Coating Compounds - Properties and uses of sealing and coating compounds; polysulfide sealant; protection of electrical connectors; plastic dielectric barrier, vapor phase inhibitor and strippable coatings.

Lesson 10: Installation Kits - Description and information for making up proper installation kits for the reassembly and reinstallation of customer ship product items.

Lesson 11: Shop Modus Operandi - Functional organization, manning, knowledge and skill requirements, training and certification, shop production control and QC procedures and records. This lesson plan will be developed for the SIMA(PH) startup crew training.

Lesson 12: Shop Organization and Management, Planning and Scheduling - Information and specification for CC Shop management, planning and scheduling of ship-to-shop and shop-to-shop production items. This lesson plan will be developed for the SIMA(PH) startup crew training.

Unit II - Wire Sprayed Aluminum (WSA): Equipment and Application Process

Unit II is the course for training and certification of CC-Shop technicians in WSA application. The course consists of five lessons. Lesson 1 summarizes the causes of marine corrosion and reviews corrosion prevention and control measures in general and the WSA coating system in particular. Lessons 2, 3, and 4 is the tape-slide training course on "CC Using WSA" coordinated with OJT in the appropriate production stations in the CC Shop. Lesson 5 administers the physical written and certification tests required by DoD-STD-2138(SH). Unit II requires 80 hours of instruction; 18 hours classroom, 62 hours OJT in the CC Shop.

Unit II, combined with Units I and III, provide for the necessary classroom training for the CC-Shop technician. Unit II alone provides the necessary training for WSA certification.

Lesson 1: Introduction to Corrosion for WSA Technicians - Introduction to Unit II, overview of corrosion theory and corrosion prevention and control, discussion of the 15 NAVSEA-designated CC systems high-lighting the WSA coating system.

Lesson 2: CC Using WSA, Part I - Surface Preparation - Technical requirements for WSA coating system; description of industrial plant equipments for application of WSA coatings; surface preparation, masking and cleaning; cleaning material nomenclature and use.

Lesson 3: CC Using WSA, Part II - Wire Spraying - WSA equipment nomenclature and use; lighting off; spraying of items; shutting down; QA; safety, sealing procedures; component handling and component reassembly procedures.

Lesson 4: CC Using WSA, Part III - PMS for METCO 12E Wire Spray Gun - METCO 12E WSA gun disassembly; daily, 16-hour and 40-hour maintenance; and gun reassembly.

Lesson 5: CC Using WSA, Certification Tests - Written examination and flame-spray skill tests for DoD-STD-2138(SH) certification.

Unit III - Electrostatic Powder Coating (ESP) Equipment and Application Process

Unit III consists of three lessons covering general ESP and plastics; GEMA powder sprayer, Type 701; NORDSON hopper feeder, NPE-2M gun and NPE-CC8 control console; ESP-spray booth and ESP-curing oven and containers. Each lesson requires two hours training in the classroom and six hours OJT in the ESP-Coating Station of the CC Shop.

Lesson 1: ESP-Coating Review and GEMA ESP Equipment - Review of CC System 4, ESP; basic plastic composition; differences between thermoset and thermoplastics; crosslinking; environmental concerns; why powder coating is used; shipboard items to be powder coated; and the powder coating process. GEMA ESP equipment nomenclature, startup, shutdown, changing of powder color; PMS, disassembly, cleaning and reassembly of manual gun; replacement of incorrect sleeve and cleaning ejector, troubleshooting and proper safety precautions.

Lesson 2: NORDSON ESP Equipment - NORDSON NPE-2M Gun specifications, nomenclature, theory of operation, disassembly, cleaning, (PMS) reassembly and use of troubleshooting guide. NPE-HR3 hopper feeder parts, functions, operation, maintenance and troubleshooting. Necessary information for proper operation, maintenance, features, functions, troubleshooting PMS and CMS of NORDSON NPE-CC8 control console.

Lesson 3: ESP Spray Booth, Curing Oven and Containers - Description and explanation of safety, start-up operation, shut down and PMS of ESP spray booth and curing oven.

7.3.3 Student Handouts and Training Aids

No student guides or workbooks were developed or used. However, photocopies were made of illustration, key points of information, charts, graphs and quizzes. These handouts were given to the students during the progress of their training to keep in their notebooks for outside study. These handouts along with their class notes and reading assignments served to re-enforce the classroom learning activities and increased retention of that learning.

Whenever possible and practical, actual items, equipment and other examples were used as training aids. Along with films, transparencies, slides and other audio visual materials, these examples were highly useful for stimulation, motivation and emphasis.

The reading materials/text used varied depending on the course and the lesson. For example, during the WSA lesson, readings from NAVSEA Corrosion-Control Manuals for Ships Classes FFG-7, etc. were assigned. For CC System 3, paint coating systems; readings from Chapter 631 Preservation of Ships in Service (Surface Preparation and Painting) NAVSEA S9086-VD-STM-000, were assigned.

7.3.4 Course and Delivery Effectiveness

Personnel certified for WSA assigned to the Pilot CC Shop were given one hour once a week classroom training in NAVSEA-designated 15 CC Systems. This training was delivered on Thursday mornings to coincide with their weekly (PMS) and not conflict with normal shop production.

New personnel assigned to the Pilot CC Shop, Fleet Valve-Maintenance Shop and two Senior Petty Officers from SIMA (San Francisco) were given training for certification in WSA application as per DoD-STD-2138(SH). Training was given to all personnel in groups of two to four depending on how many and when they were assigned to ships concerned.

All personnel were highly motivated, eager to learn and eager to participate in class and group discussions. In addition, the trainees were cooperative and helpful to each other and the instructor. Not only were the students ready and willing to participate in class and outside assigned activities, but also to help one another with their studies and OJT in the shop.

A concept and its application cannot be effectively learned unless a "hands-on" experience is provided as follow up the same day in the shop/lab. For example, the classroom lecture discussing and explaining the METCO 12E WSA gun system (setting up, lighting off, operation, WSA application and shut down) must be followed by OJT in the shop. However, even though OJT in the shop did not always coincide with and re-enforce the classroom training, students still learned and became proficient in shop skills; were able to learn as well as explain the shop process to others primarily because of their retention of classroom learning and interaction with one another in all phases of the training. When there had been OJT paralleling the classroom training as planned and scheduled, the trainees acquired the skills in a shorter time and scored higher on their WSA practical qualifications in wire spraying.

7.4 LESSONS LEARNED AND RECOMMENDATIONS

As stated previously, training is based on knowledge, classroom instruction, skills, on-the-job training and "hands-on" experience in the Shop. In order for a total learning experience to take place, there must be cooperation and coordination between the Shop Master and the Classroom Instructor, a coalition of classroom and "hands-on" training and separate space and equipment for both classroom training and OJT. The total curriculum developed (classsroom and OJT) and implemented must have reinforcement in all areas and from all persons involved. A lesson in the classroom must be reinforced in the Shop (lab) by covering the same material in a "hands-on" situation in the Shop or lab. The Shop Master has a special responsibility to ensure a balance of training and production in the SQIP format. Second shift and weekend work and/or training should be considered to ensure adequate skills training and maintenance of knowledge and proficiency.

A. General

Instruction on equipment operation and maintenance require either the actual equipment or a suitable simulation or training device in both the classroom and shop. Followed with the proper OJT, the requisite skill proficiency will be acquired. Classroom training and hands-on equipment operation and maintenance training in the shop were scheduled during the Service Test. Because of production schedules and lack of equipment dedicated to training, the classroom with follow-up OJT was not always possible. For example, there was no WSA gun system or quality assurance equipment dedicated as training aids.

New CC-Shop personnel as well as other personnel on temporary additional duty (TAD) from other facilities are assigned and must be trained and certified in a reasonable time period, e.g. two working weeks for the WSA technician. These personnel assigned to the CC Shop as replacements for other personnel being reassigned to other duties and the personnel assigned TAD can arrive one or more at a time and at anytime. In a production shop situation and the SQIP training format (no dedicated training aids and the training on the job site without interrupting production work), new personnel being assigned on short notice can have an effect on normal shop routine, production resulting in ineffective training. This situation can be remedied by proper planning, proper scheduling, cooperation and coalition of classroom and "hands-on" training using a qualified instructor.

B. WSA Certification Time

Trainees should have approximately 20 hours in the classroom (1/4 of training time) and 60 hours "hands-on" in the Shop (3/4 on-the-job training time) to become certified WSA operators. Of the 60 hours "hands-on" in the Shop, a minimum of 20 hours should be spent observing and working with a "journeyman" flame sprayer using the WSA gun to learn its proper operation, application and to become proficient in spraying techniques on non-production items. The remaining 40 hours of OJT should be spent working on functions at the other CC-Shop WSA stations learning the process and IPE and spraying production items under the direct supervision of a journeyman WSA operator.

C. Separate Equipment and Tools for Classroom Use

Ideally, the separate classroom and CC-Shop/lab facilities should have all necessary tools and equipment for the trainees use. A WSA gun should be reserved for use exclusively in the classroom for learning nomenclature, tear-down, PMS, overhaul and reassembly. In addition, a separate WSA system should be available for training so as not to interfere with CC-Shop production and routine. The use of dedicated IPE training aids may not be consistent with SQIP.

D. Trainee Prerequisites

Trainees for CC Shop Technicians should be:

- E3-E5.
- Preferably from the deck or hull groups.
- Assigned to the SIMA CC Shop for a three-year tour of duty.
- Be able to pass the WSA certification courses.

E. Instructor Prerequisite

The SIMA WSA Certification Instructor (training Petty Officer) should be:

- E6 or above, preferably a BM or a HT.
- A graduate of a Navy instructor school within five years prior to being assigned to a SIMA CC Shop.
- Have a minimum of twelve months WSA production-work experience.
- A certified WSA operator in good standing.
- Have a minimum of two years work in a SIMA CC Shop and have a substantive understanding of the shop services and modus operandi.
- Be involved in daily production work in WSA, ESP and painting in the SIMA CC Shop to maintain his skill and proficiency.

F. Training Aids Required

Training aids required for a SIMA CC Shop training program should include:

- "CC Using Wire Sprayed Aluminum", Slide/Tape Program, Naval Reserve IMA-7 Training Course.
- "Corrosion of Metals in Marine Environments", Training Film MN-11154, 21 min, color.

- 35mm slides of all phases of CC training.
- METCO 12E wire-spray gun exclusively for training.
- Access to the CC-Shop for training at all the major stations: receipt inspection, degreasing, masking, strip blasting, anchor-tooth blasting, wire spraying, ESP-coating, painting and installation kits makeup/issue.
- Examples of types of corroded items.
- Examples of items with various CC system coatings.
- Examples of fasteners, sealants and all other items for installation kits.
- 35mm carousel projector with cassette tape player.
- Overhead (transparency) projector.

G. Start-Up Training

Initial training of CC Shop personnel should begin immediately during shop set up, the installation of the IPE and development of the shop's process instructions. Involving the trainees with shop set up instills a better understanding of the shop's purpose, provides learning motivation, sets the stage for formal training and gives the trainee a feeling of being an important part of the shop's function. The instructor and Shop Master should work together to assure both knowledge of the shop and its equipment and skill in their operations are developed in the trainees for a strong foundation for future knowledge and skill enhancement.

Formal classroom and hands-on training should begin as soon as possible and during the shop set-up. All CC Shop personnel are to be certified in WSA operation and application prior to starting CC Shop production. The start-up training should include the curriculum for the Shop Technician in Table 7-1 and detailed in Appendix A7-1.

H. Maintenance Training

Maintenance training involves the ongoing CC training to maintain knowledge and skills. Unit I should be the model for maintenance training. It covers the 15 CC systems; corrosion theory, prevention and control, installation kits, shop operation procedures, management and planning.

A senior Petty Officer should be assigned as the training Petty Officer. The training Petty Officer would be responsible for having all the Learning Objectives, Curriculum Plans and Lesson Plans currently updated and all training aids and equipment in good working order.

As new personnel are assigned to the CC Shop, they would be given a briefing by the training Petty Officer to include the CC-Shop purpose, operation and functions. A description of plant equipment and CC stations would include first hand observation the stations and equipment in a production mode. Using the curriculum and lesson plans in Appendix A7-1, the training Petty Officer would draw up a training schedule combining classroom instruction and OJT to efficiently train and certify the trainee as a WSA operator as described in.

As part of the ongoing CC-Shop training, the training Petty Officer should schedule weekly training classes for certified CC-Shop personnel.

I. Special Training

The CC Shop could deliver special training, e.g., WSA certification/training for other than CC-Shop personnel. Additional, expanded or condensed versions of existing training, such as training personnel for the shipboard mode, would also be considered special training and could be delivered as needed.

REFERENCES FOR SECTION SEVEN

7-1 Sulit R. A. and O. G. O'Brien, ASW and Support-Ship Corrosion-Control Program: SIMA Pilot CC Shop Service Test and Technical Support, ISA(WC) 104, 11 December 1984, Contract N66001-84-D-0032, Delivery Order 0009.

SECTION EIGHT

PERFORMANCE INSPECTIONS AND ASSESSMENTS
of
PROCESSED ITEMS DURING SERVICE TEST

8.0 GENERAL

A series of inspections were conducted to evaluate the performance of WSA- and ESP-coated items and their installation kits at six- and 12-months intervals by the Pilot CC Shop. Six customer ships were visited: the USS ALBERT DAVID, USS BERKELEY, USS FLETCHER, USS TRUXTUN, USS FRESNO and USS COPELAND. The "Tech Eval visit" included:

- Visual evaluation of coating performance (i.e., blisters, cracks, pinholes, rust/oxidation from coating or substrate, physical damage and S/F maintenance/repair actions).

- Visual evaluation of the installation and use of the "installation kits" for the ships to which they were issued (i.e., proper use of insulators and gaskets, 316-SS fasteners; ceramic-coated fasteners, separation of dissimilar metals and degree of degradation in dissimilar metal contact areas).

- Determination of the probable cause of the degradation and the recommended fix.

- Physical measurement of degraded area included:

  - location and area of exposed substrate and/or inter-layer coatings, and

  - coating thickness(es).

- Color photography of selected items.

Copies of the inspection reports from the six ships visited are included in Appendix A8-1. This inspection information is summarized herein by WSA coatings, ESP coatings and installation. Pilot CC-Shop operations/IPE/QC were evaluated to determine the extent of impact on process performance versus in-service performance.

8.1 WSA COATINGS

A total of 293 WSA-preserved items were inspected over the period of the Pilot CC-Shop Service Test. Items which required S/F maintenance and/or repair actions at areas of substrate corrosion were considered to have some degree of degradation. These degradations, listed in descending percentages, are categorized as:

- 87% abrasion,
- 7% application,
- 4% design induced, i.e., items not compatible for surface preparation and/or application of the WSA coating, and
- 2% installation.

8.1.1 Stanchions with "weep holes"

Degradation: Running rust from the weep holes due to continual moisture and oxidation inside the stanchion.

Recommendation:

(1) Plug weld "weep holes" in existing stanchions.

(2) SIMA(SD) fabricate new stanchions without "weep holes." The cap of the stanchion should be the last welded item. Entrapped moisture will be consumed in the initial oxidation after which there will be no further degradation of the interior surfaces.

(3) NAVSEA design stanchions without "weep holes" and change drawings accordingly.

8.1.2 Stanchion "J" Hooks and Eyes

Degradation: On stanchion "J" hooks and eyes with bare lifelines, the WSA coating is abraded by the lifeline and the bare steel becomes a corrosion source. Application of plastic sleeves on the lifelines is standard shipboard practice; however, circumstances apparently delayed their reapplication.

Recommendation: S/F install plastic sleeves immediately upon reinstallation.

8.1.3 WT Doors, Ferrous Valves, Stanchion "J" Hooks and other Complex-Spray Geometries

Degradation: Potential for edge chipping on corners increases with coating thickness when the WSA is greater than ten mils thick. Poor adhesion is due to 45^{o} spray angle of the WSA on "first pass" and subsequent laminar buildup and difficulty in maintaining the five- to eight-inch spray-distance standoff. Even when the WSA is applied correctly, WSA thicknesses exceeding ten mils are susceptible to edge chipping in the handling, installation and use of the item.

Recommendation: Modify Shop procedures to specifically evaluate the "overspray" masking requirements and develop and use metal masks for recurring items where required.

8.1.4 Items with Attached Dissimilar Metals such as Ferrous WT Doors with Brass Wedges, Ferrous Boxes with Aluminum or SS Name Plates and SS and/or Bronze Hinges

Degradation: Running rust at edge of dissimilar metal edge when the WSA and/or paint coating fails. The Shop practice has been to mask the brass wedges and labels (because they are "riveted" and can't be replaced by the CC Shop).

Recommendation:

(1) CC Shop obtain tooling and materials to remove ID or name plates.

(2) Modify brass wedge masking to allow WSA coating up to 1/4-inch above the bridge line.

8.1.5 Ferrous Hinges on Ferrous Boxes/Lockers

Degradation: Running rust and eventual structural loss of the hinge. The mating surface of the hinge cannot be protected and still maintain its fit and function.

Recommendation:

(1) Replace mild-steel hinges with 316-SS or aluminum hinges. Production CC Shop will require Shop 17A (Sheetmetal) assistance to remove ferrous hinges and provide new 316-SS hinges. The Production CC Shop could then properly apply WSA and reassemble the hinges with a dielectric barrier, sealant and the proper fasteners.

(2) NAVSEA design boxes/lockers with 316-SS hinges installed with appropriate dielectric barriers and change drawings accordingly.

8.1.6 WSA Coating on Previously WSA-Preserved WT Hatch

Degradation: Localized peeling/delamination of WSA coating applied by Pilot CC Shop to a WT hatch previously preserved with WSA. Existence of previous coating could not be established until strip blasting removed the overlying paint which resulted in damage to WSA coating. Hatches were then sent to Engine Shop, Shop 31E, for chemical removal of the damaged coating in a caustic dip tank. Due to a backlog of work in Shop 31E and the ship's schedule, Pilot CC Shop cancelled the dipping and attempted to strip blast the remaining WSA coating. WSA was then applied over the anchor-tooth blasted WSA coating. This resulted in peeling of the newly-applied coating due to the poor bonding over the old WSA coating.

Recommendation:

(1) Production CC Shop requirements for in-shop caustic dip tank should be evaluated.

(2) Production CC Shop planning and tracking should be emphasized to ensure components are completed in order to meet both ship and shop schedules.

(3) Develop Production CC-Shop procedures for repairing local WSA-damaged area, i.e., feather-edge or cliff edge junction of new-WSA and sound old-WSA coatings.

(4) Develop permanent, local identification and testing methods/equipment to establish existence of previous coatings on components.

8.1.7 Installation Damage

Degradation: S/F has been observed incorrectly handling preserved items and using excessive force and incorrect tools to position and install WSA-preserved items resulting in coating damage to the WSA.

Recommendation: Increased emphasis on proper installation procedures and repair procedures for damaged coatings during CC briefings and instructions to the ship.

8.1.8 Fasteners and Installation Kits

Degradation: Prior to establishing the SIMA pre-expended fastener bin many components were installed by S/F with uncoated, cadmium- and/or zinc-plated fasteners. Many of these fasteners are now bleeding rust. Some mild-steel washers were used with 316-SS (or other types of SS) nuts and bolts. These mild-steel washers have experienced accelerated corrosion next to the SS.

Note: Prior to April 1985, customer ships were advised to procure 316-SS fasteners and nylon washers for the proper installation of components. Requesting customer ships to do this was discovered not to be practical due to cost and timely supply support. By April 1985, the Pilot CC Shop developed the sufficient data and experience to establish a "pre-expended bin" stock of 316-SS and ceramic-coated fasteners to be issued to ships as required.

Recommendation: See Section Six.

8.2 ESP COATINGS

Inspections of the six ships (USS ALBERT DAVID, USS BERKELEY, USS FLETCHER, USS TRUXTUN, USS FRESNO and USS COPELAND) were conducted and 211 items were inspected. Of those degraded items, 64 required rework. Lessons learned from the inspections are proving extremely useful in modifying the Pilot ESP Service-Test operations. The causes of coating degradation are categorized into design, application, installation and abrasion induced, with the percentages of each as follows:

- 67% design, i.e., items not compatible for surface preparation and/or application of the WSA coating,

Note: It was known prior to preservation that these components would degrade, however, the ESP coatings would provide greater service life than paint coatings. The design deficiency is primarily in those areas of the component where white-metal blasting was impossible. The crimped-frame vent screens are a case in point.

- 31% application,
- 1% installation, and
- 1% abrasion.

Note: Only cases in which the coating was degraded are considered above. The use of incorrect fasteners is not included in this list.

8.2.1 Vent Screens

Degradation: The current vent-screen designs have regions which cannot have coating material sprayed onto them; these areas may be referred to as shielded gap areas. One type of vent screen has the wire mesh crimped within a U-channel frame structure. The gap in which the mesh is secured is open to the atmosphere but cannot be completely cleaned in grit-blasting operations. Similarly, they cannot be completely coated in the ESP process. Another type of screen design has expanded metal tack-welded onto the frame. There are many places where the expanded metal is lying against the metal frame. These areas cannot be adequately grit-blasted clean nor coated.

Recommendation: Construct all vent screens with flat-bar frames and 1.5" square mesh screen made of 0.120" diameter wire (Ref. 8-1). This will eliminate sharp edges and allow fewer mesh contact points with frame to all be seal welded.

8.2.2 Mild Steel Hinges

Degradation: Hinges, in general, do not allow a coating system to provide complete protection. During coating, the hinge inherently shades part of itself. After coating, the separations between hinge teeth are either bare or will be worn bare. Either way, the bare steel will begin to rust, causing deterioration of the hinge and discoloration of the surrounding surfaces.

Recommendation: Replace all mild-steel hinges on topside items with 316-SS hinges. These should be properly insulated and fastened to the components after powder coating.

8.2.3 Fog Applicators

Degradation: Some chipping, down to bare metal, had occurred on several fog applicators due to operational requirements.

Recommendation: The chips may be repaired by S/F by sanding the exposed metal clean and roughening the adjacent coating, then applying paint.

8.2.4 Improper Installation

Degradation: Vent screens were chipped due to being hammered into place by S/F.

Recommendation: No powder-coated item should be hammered into place. Increase emphasis on proper installation procedures and repair procedures for damaged coating during CC briefings and instructions to the ship. In these instances, the vent screens did not fit easily because they were being installed in the incorrect locations..

8.2.5 Application Process and Materials

Degradation: Corrosion products visible along component welds, folds, lap seams and from pin holes on flat surfaces.

Recommendation:

(1) Application procedures that have been used thus far were those of a commercial applicator. The standard production process followed by the commercial applicator is not designed to solve the corrosion-control problem of the U.S. Navy. Services purchased from the applicator simply entailed their coating services; not a process development. Most of the commercial applicator's customers do not operate their items in the marine environment. Selection of the application was based on their previous experience on the test platform, USS CUSHING.

Analysis of ship inspections and input from the commercial application contractor, ESP-equipment manufacturers and powder manufacturers have resulted in the following list of probable causes of coating degradation. These observations occurred throughout the service test and corrective action was effected as soon as the discrepancy was noted.

Probable causes of coating degradation:

- Too thin (less than three mils) of a coating was applied on some of the flat surfaces exhibiting pinhole failure. Gaps along seams and folds are not being filled in by the thin coating.
- Surface profile had too deep of an anchor-tooth pattern (greater than three mils).
- The applied powder coating is not sufficiently thick to protect steel components.
- "Faraday Cage Effects" are present in tight corners and along edges.

Lessons learned have resulted in the following:

- Requiring that the commercial application contractor maintain the anchor-tooth profile at 1.0-1.5 mil for steel and aluminum greater than 1/8-inch thick and 0.5-1.0 mil for aluminum less than 1/8-inch thick.
- Coating all aluminum items with two coats of powder (each coat two-three mils minimum DFT).

- Coating all steel with a first coat of high-build (five-eight mils DFT) followed by a topcoat of (1.5-two mils DFT).

- Requiring QA certification with all products coated.

"Faraday Cage Effects" are considered to be important in all electrostatic-coating operations (including both powder and paint), but this issue will be better dealt with through the SIMA CC Pilot ESP facility. Personnel must be trained with an emphasis on this phenomenon's magnitude if they are expected to adequately solve the problem. The "Faraday Cage Effect" causes powder to be repelled in sharp-angled areas, due to the lines of force of the electrical field causing "back ionization." Minimizing this effect can begin by turning down the electrostatic voltage of the gun (operating range 80KV to zero, typical), but personnel in fast-production facilities do not take the time.

A thorough survey of all powder manufacturers was conducted, and it was determined that for Naval shipboard applications the recommended powder was a polyester powder. NAVSEA, 05M1, specified ASTM A775-81 epoxy.

At the request (verbal) of COMNAVSURFPAC to DTNSRDC, a literature survey and review was conducted to determine the preferred powder resin for shipboard application. As a result of this survey, DTNSRDC indicated that polyester resins were preferred over epoxies for improved heat- and light-resistance qualities and weathering properties.

COMNAVSURFPAC requested technical information to be furnished by NAVSEA to aid in the development of the industrial process and quality-control procedures for powder coatings to be applied by SIMAs.

NAVSEA directed use of an epoxy powder meeting the requirements of ASTM-775-81 (except color and gloss) and provided a recommended film thickness of eight-12 mils (Ref. 8-2). The ASTM-775-81 (updated and now designated ASTM-775/A775M-84 approved 31 August 1984, published October 1984) is for coating steel reinforcing bars (rebar). Rebar coatings are designed to be highly flexible but do not have high impact or abrasion-resistance. Impact and abrasion resistance is considered by the powder-resin manufacturers to be more important on ship components than coating flexibility.

A new requirement appeared that had not been previously considered nor specified. This was to topcoat the powder coating with the conventional Navy haze-gray paint, TT-E-490, to prevent the epoxy powder from chalking or fading. The purpose and driving force of choosing polyester powders was to eliminate chalking and fading of the applied coating and eliminate the need for painting. The manufacturers of powder coatings specifically developed the polyester powders to solve the problems encountered with epoxies when exposed to sunlight and weathering. Thermosetting powder resins were specifically developed to provide a durable, less-expensive method of corrosion resistance than the paint systems presently available.

REFERENCES FOR SECTION EIGHT

8-1 General Specifications for Overhaul of Surface Ships, NAVSEA S9AAO-AB-GOS-010.

8-2 NAVSEA Ltr 9630. Ser 05M1.141374, dated 12 September 1985.

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