THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Proceedings of the REAPS Technical Symposium

Paper No. 13:
Planning and Ship Outfitting
Production Control at Newport News

U.S. DEPARTMENT OF THE NAVY CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER
**Report Documentation Page**

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Proceedings of the
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September 11-13, 1979
San Diego, California
Mr. Bollinger has been associated with Newport News Shipbuilding for the past 20 years. During this time he has held various management positions in construction and production planning. He currently is in charge of the material grouping, pipe shop planning, and computer generated pipe detail drawing preparations within the Production Engineering Department.
I. INTRODUCTION

This report provides a general overview of the techniques used in developing the Product Plan at Newport News, and covers in more detail the implementation and control of the plan, with emphasis on ship outfitting.

The intent is to inform interested parties about the Outfit, Planning, and Control Methods used at Newport News. However, at this writing we are making extensive improvements to our material and production control systems. These improvements in time will alter some of the methods used in Outfit Planning and Control; and it is felt that these improvements may be of interest.

1.1 Material and Production Control Improvement(s)

The development and implementation of these improvements is complex, and involves almost all of the operating divisions. A committee has been established to coordinate and steer improvements. The committee is called "IMPCO Committee," and draws its name from improved material and production control. The tasks either completed or in-process by the IMPCO Committee are:

- Develop Synchronized Schedules
- Standardization of Key Company Numbers
- Converting to and Cataloging Part Numbers
- Simplify and Improve Accuracy of Material Selection
- Improve Material Requirements Planning
- Improve Record Accuracy
- Simplify Shop/Ship Material Requisitioning
- Improve Shop Planning, Control, and Performance Measurement
- Develop a Product Structure for Outfitting Similar to Structural

This list is not inclusive of all the on-going improvements but only cites the major tasks.
2. DEVELOPING THE PRODUCT PLAN

Although our approach to developing a product plan is basic, and probably does not differ from techniques used by other shipbuilders, it is subject to change due to the aforementioned IMPCO Projects.

In developing a product plan there are three segments of the plan; 1) Structural, 2) Outfitting and 3) Manufacturing. As stated earlier, this report is slanted toward the outfitting segment of the plan. However, you cannot explain the outfitting plan without briefly covering the other two segments.

2.1 Planning and Scheduling

Planning and scheduling begin during the proposal evaluation before award of a contract. Availability of facilities, manpower, and long lead time materials are reviewed. Working from the proposed delivery date, established by the "Invitation to Bid," tentative award, keel, launch, and delivery dates are determined. The ship's size, its type and the company's past performance on similar ships are considered.

There are six basic documents or schedules that are paramount to the development of the product plan. Each document is an integral part of the plan and in most instances each is dependent on the other in terms of its development. These six documents are:

- Structural Erection Diagram (SED)
- Space Control Diagram (SCD)
- Ships Group Index and Schedule (SGIS)
- Ships Drawing Schedule (SDS)
- Material Ordering Schedule (MOS)
- Manufacturing Group Index and Schedule (MGIS)

**Group Definition** - A group is a definite quantity of material to be installed or manufactured as a unit or units. The quantity of material included in a group is intended to be such as to allow maximum efficiency in handling, storing and installation, with minimum interference to adjacent work.

The following is a brief explanation of these documents:

2.2 Structural Erection Diagram (SED) (See enclosure (1))

The Structural Erection Diagram is a drawing of the inboard profile of the ship with one or more cross sectional views and shows the sequence in which the ship will be erected.
Using the contract drawings and other available information, the ship is divided into sections usually along major structural boundaries, such as decks and water tight bulkheads. These sections are further subdivided into erection units with their size largely determined from handling considerations. Each erection unit is identified by a four digit number, with the first two digits indicating the section number, and the last two indicating the planned sequence of unit erection within the section, for example

2008
20 Indicate Unit Erection Sequence
08 Indicates Section Number

Also shown on the Structural Erection Diagram is a breakdown of the major events for each structural section, such as:

- Drawings and Groups Complete
- Material Available
- Molds Complete
- Fabrication Complete
- Sub-Assembly Complete
- Erect on shipway

2.3 Spaces Control Diagram (SCD) (See enclosure (2))

The Space Control Diagram is developed for use in control of outfitting and aids in the development of the "Ships Group Index and Schedule" (see 2.4). This diagram divides the ship into space control divisions, each of which is identified by a space control number. Normally the rule for defining space control divisions is one deck level extending the width of the ship bounded fore and aft by main transverse bulkheads.

Unlike the Structural Erection Diagram the space control divisions are not numbered in sequence of erection, but are structured for the control of outfitting groups assigned to a given space.

2.4 Ships Group Index and Schedule (SGIS) (See enclosure (3))

The SGIS is the system that schedules the completion of outfitting groups both in the shops and on the ship. Using the "Erect on Shipway" date for structural sections; established in the Structural Erection Diagram, as the scheduling date for start of outfitting, the Ships Group Index and Schedule is prepared. The nature of the SGIS is structure, system, and space oriented. Each group number is either combination of a structural erection units number and space control number, or a
combination of an outfitting cost class number (system) and the space control number; for example

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Schedule dates are applied to these groups by establishing an installation start date (based upon the Structural Erection complete date on the Structural Erection Diagram) and working back through the following scheduled events (from latest to earliest):

- Installation Start
- Electrical Shop Complete
- Pipe Shop Complete
- Sheet Metal Shop Complete
- Machine Shops Complete
- Foundry Complete
- Material Available
- Groups and Drawing Issued
- Drawings Complete

Once developed the SGIS provides the scheduling framework for all other derivative schedules; Ships Drawing Schedule, Material Ordering Schedule, Manufacturing Group Index and Schedule, etc.

2.5 Ships Drawing Schedule (SDS) (See enclosure (4))

The Ships Drawing System (SDS) schedules the required drawings through the different design sections, and the applicable owner, for approval in time to meet the drawing need of the SGIS.

Design develops the SDS using the "Drawing Complete Date" established in the Ships Group Index and Schedule. Although some drawings may cover more than one group, the drawing is scheduled for completion to suit the earliest group shown in the SGIS. The SDS is inclusive of all the drawings required to construct the product, e.g. Structural, Piping, Electrical, Machinery, Ventilation, and Manufacturing drawings.

2.6 Material Ordering Schedules (M0S) (See enclosure (5))

The Material Ordering Schedule is the document that
schedules the in-yards date of the required purchased material to suit the Ships Group Index and Schedule.

The MOS is developed by Design in a manner similar to that used for the preparation of the Ships Drawing Schedule. Using the SGIS, "Contract Guidance Plans" and historical data, estimates are made of the gross material requirements to be ordered from vendors.

These estimates are scheduled according to need and are further refined and the schedule updated as the drawings are developed.

2.7 Manufacturing Group Index and Schedules (MGIS)  
(See enclosure (6))

A manufacturing group is in effect a purchase order to ourselves requiring the manufacture of an item(s) to support the timely construction of the ship.

The Manufacturing Group Index and Schedule is developed by the applicable Design divisions and the construction projects. It schedules the manufacturing groups through the various shops to suit the material requirements of the Ships Group Index and Schedule.

3. IMPLEMENTING THE PLAN

The Ships Group Index and Schedule, Ships Drawing Schedule, Material Ordering Schedule and the Manufacturing Group Index and Schedule provide the major building blocks for the Product Plan. These schedules are computerized and along with other computer systems (to be explained later) provide management with the tools to implement and control the Product Plan. The Plan is implemented as these schedules and the applicable drawings are issued to Production Engineering and the construction trades.

3.1 Production Engineering (Outfitting)

Production Engineering is responsible for producing:

- Group Sheets (Material List)
- Shop Work Packages'

To suit the Ships Group Index and Schedule and the Manufacturing Group Index and Schedule by using the drawings issued by Design: Upon review of the drawings and schedules it may be determined that a group has not been provided in the schedule(s) or a group in the schedule(s) is not required. When this is determined appropriate action is taken to revise the schedules (MGIS or SGIS).
3.2 Group Sheet Preparation

A Group Sheet is a listing of the required material keyed to a specific group (system and space) on the ship. The list authorizes work and provides quantities, description, sources, and routing of the material.

At present there are two methods of physically preparing group sheets; one is the conventional manual method and the other is a computer assisted method, referred to as AGS (Automated Grouping System). The AGS system closely audits all data and produces a more legible, standardized computer printed group sheet (See enclosure (7)).

It also interfaces with the "Inventory Management System" (IMS) to aid in the Material Requirements Planning (MRP). Also group sheets are structured to aid in the preparation of material requisitions.

3.3 Pipe Detail Grouping Section

The Pipe Detail Grouping section is responsible for specifying the boundaries for Pipe Shop Assemblies (called details), which will be input to the CAPDAMS system (see section 3.4). This section also groups non-CAPDAMS material and prepares the preliminary piping arrangement drawing for use by the CAPDAMS section.

3.4 CAPDAMS Drawing Preparation Section (see enclosures (9) and (10))

CAPDAMS is the acronym for Computer Aided Piping Design and Manufacturing System which permits data entry and audit of pipe detail material and geometry data.

Using the prepared Preliminary Piping Arrangement Drawings, data is extracted and input to the CAPDAMS system. The system provides centerline check prints, individual Piping Detail Drawings and printed manufacturing instructions. In addition material requirements summed to the pipe detail level interface with the IMS system to aid MRP. The CAPDAMS output is issued to the Shop Work Package Planning Section.

3.5 Shop Work Package Planning Section

Upon receipt of group sheets and drawings, the Planning Section prepares and schedules work packages for the various shop(s) - Machine Shops, Steel Fabrication, Sheet Metal, Electrical and Pipe Shops, in accordance
with the SGIS or MGIS. A work package consists of a
brief description of the item(s) to be made, the
source for the required material, a schedule for
completion, the target hours required to complete the
work and the material requisitions.

The work package information is input to the "Production
Scheduling Control System (PSC) (see section 4), and
in the case of Pipe Shop Planning, input is made to
the Pipe Package Ordering System which draws the
material requirements from the CAPDAMS system by pipe
detail and interfaces with the IMS system to check
the availability and location of the material and,
in addition; generates material requisitions and
packing lists for the Material Support Division (see
enclosure (8)).

4. CONTROLLING THE PRODUCT PLAN

The Ships Group Index and Schedule, being the ship schedule
that all derivative schedules must support, provides adequate
management controls at the group level. However, because
of the number of items subordinate to the group requiring
manufacturing, the system does not provide sufficient
information required to most effectively manage a manufacturing
shop.

A computerized shop scheduling and control system is used
to provide feedback to the Ships Group Index and Schedule
and provides the shops a tool to measure the day to day
production performance. This system is known as the
"Production Scheduling and Control System" (PSC).

4.1 Production Scheduling and Control System (PSC)

PSC provides

- On-Line Detailed Work Status
- Daily/Weekly Work Sequence Lists
- Target Hours for Foremen
- Work Performance
  - Completed versus Delinquent Work
  - Actual versus Target Labor
- Data for:
  - Make or Buy Decisions
  - Capacity Planning
- Schedule for Material Requisitioning

Requirements:

- Work Breakdown According to Predefined Work Centers
- Realistic Schedule Dates
- Realistic Target Hours
- Accurate Feedback
The PSC system used in our Shops provides the framework for a total yard work management system.

4.2 Yard Production Scheduling and Control

Our objective is to have a total mechanized yard production scheduling and control system, capable of providing many levels of management information. Our progress to date includes the linking of the individual shop PSC systems to the SGIS thereby creating the basis for such a system. As a result, we can make inquiries by a given contract and group number, and the system will access the applicable shop PSC data bases to determine detailed production status (see enclosures (11) through (14)).

CONCLUSION:

This report has provided a brief overview of the techniques and systems used at Newport News in developing, implementing, and controlling the Product Plan, and was prepared in the spirit that the information may be of interest to other concerns.

ACKNOWLEDGEMENT:

This author wishes to thank Mr. D. F. Carneal and Mr. E. C. Kizer of the Newport News Shipbuilding and Dry Dock Company for their assistance in the preparation of the data for this report.

REFERENCES:

(a) Report of Task Group for Improved Production Scheduling and Control," chaired by Mr. C. C. Coon, dated June 29, 1979.

(b) "An Introduction to Grouping," Machinery Design Department, Newport News Shipbuilding and Dry Dock Company.

(c) "Production Control System," Newport News Shipbuilding and Dry Dock Company.
STRUCTURAL ERECTION DIAGRAM

Enclosure (1)

SPACE CONTROL DIAGRAM

Enclosure (2)
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**Material Control - Group Index and Schedule - Outfitting**

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**MATERIAL ORDERING SCHEDULE**

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**Enclosure (5)**
## MANUFACTURING GROUP INDEX & SCHEDULE

### General Information

**Job: 006613-10 Total**

### Description of Components

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<tr>
<th>Description</th>
<th>DC</th>
<th>PREL. ISSUE</th>
<th>DOC. &amp; ISSUE</th>
<th>MAN. RECD</th>
<th>MAN. COMP.</th>
<th>X:10 COMPL.</th>
<th>F:O COMPL.</th>
<th>M:10 COMPL.</th>
<th>O:10 COMPL.</th>
<th>P:O SHOPS COMPL.</th>
<th>E:10 SHOPS COMPL.</th>
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<th>E:10 ERECT. COMPL.</th>
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<td>2300-2414-1</td>
<td>01247-122100722</td>
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<td>102</td>
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<td>MANIF GAGE BOARDS</td>
<td>2300-2436-1</td>
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<td>130</td>
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### Distribution

| DISTRIBUTION | SN | PD | UD | WM | HPGC | CNO | HG | RS | RO | GB | OA | EL | SM | PS | HI | PG | RH | FO | A | B | C | O | Y | N | X | D | E | C | L | MS | AR |
|--------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

### Notes

- Total no. of copies for distribution: 04, 26, 18
- Hull no.: 6141
- Outfitting sheet no.: 2300
- Enclosure (6)
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<tr>
<td>4002-95831</td>
<td>4PC COVER-MBT VENT VALVE 4 ACB &amp; 5 ACB</td>
<td>ALUMINUM X10-MS</td>
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<td>4002-95833</td>
<td>4PC GASKET-13 JD X 10.125 ID X .125 THK</td>
<td>BUNA-N MS</td>
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<td>4002-95834</td>
<td>4PC SET SCREW #10-24 X .375 LG FL PF</td>
<td>ALUMINUM ST-MS</td>
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<td>4002-95840</td>
<td>40PC SCREW-SCH CAP .500 X 1.125 LG SELF LOCKING</td>
<td>ALUMINUM ST-MS</td>
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<td>4002-95841</td>
<td>32PC SET SCREW .500 X .500 LG</td>
<td>TEFLEX IM-MS</td>
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<td>4002-95842</td>
<td>4PC PIPE PLUG .500 RAISED 52 JD</td>
<td>CARRON STEEL ST-MS</td>
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<td>4PC SPRING RETAINER #4-4.500 DIA BAR</td>
<td>ALUMINUM IM-MS</td>
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**Figure P-2**

**Enclosure (7)**

---

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---

**Additional Information:**

- **Date:** 09/22/77
- **Project:** [Redacted]
- **Drawing and Item No.:** [Redacted]
# MATERIAL REQUEST

## Quantity Wanted

<table>
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<tr>
<th>Issue</th>
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<td>40959</td>
<td>PC</td>
<td>9717086</td>
<td>CPLNG 1.250 X 1.000 BRZ REDUCIN FE</td>
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<td>2.000</td>
<td>B16526</td>
<td>PC</td>
<td>9713498</td>
<td>FLANGE 1.000-150 LB BRZ SILVER BRA</td>
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<td>4.000</td>
<td>9821032</td>
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<td>9821032</td>
<td>TUBING 1.660 NOM OD X 0.065 MIN CU</td>
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## Additional Information

- **Department**: 618
- **Order Number**: 99163207
- **Package**: 618C02559
- **Container**: FLDG
- **Date**: 09-15-02
- **Location**: ORIGINAL

**Use SAFETY SENSE Every Day**

**NEWHALL NEWS SHIPBUILDING AND DRY DOCK COMPANY**
PIECE DETAIL MANUFACTURING RECORD

BEND PIPE 14 STEEL  SHOP  MACH  4
NOMINAL SIZE 2" OD  THICKNESS 0.220

BEND DIST  BEND CLOCKWISE-BEND  COORDINATES (TEMP NOT INCLUDED)

PTS  NS  GS  DG  TANG D.B.  RAD. ROULATION ANGLE  END PREP  TEMP  CUT
1  1  14.11  12.00  12.00  12.00  12.00  12.00  0.0  0.0  0.0
2  26.01  29.03  24.85  3.00  180.8  12.6  0.0  0.0  0.0
3  13.66  13.30  0.0  PN-18  0.0  7.53  0.0  0.0  0.0

DISTANCE FROM POINT 1 TO CENTER OF FIRST BEND  4.26
DISTANCE FROM CENTER OF LAST BEND TO POINT N  6.13

H DEPT  STOP  NAME  DATE  CHARGE  GROUP  ORDER #  042182
U 6666 6
L 1111 2
M 67 8 9  OME  MATERIAL IDENTIFICATION  QUANTITY  UNIT  DESCRIPTION  MATERIAL  PIECE  REV
BEND X X X X X MC-1  PN9831259  01  36  3/8  5,563X,220 MIN,:
5,1863  CU=1 70/30 *P171-1  A
X X X X X MC-1  PN973612  1  PC  5 FLANGE GROOVED  CU=1 70/30 *FL1  A

NOTES
CLEANING=WN PROC=83
WELD INDEX TABULATION DWG 2285-810
THIS DETAIL REQUIRES STAVE OPENING
ALLOWANCE ON END OF PIPE AS INDICATED IS FOR TEMP FABRICATION
* INDICATES NON-DEVIATIONAL MATERIAL, NO SUBSTITUTIONS ALLOWED
# INDICATES NON-DEVIATIONAL MATERIAL, NO VARIATIONS ALLOWED
WELDING 5S YUG C600=20 CL P1
WELDING AND FORMING = NN PROCEDURE H84

PRE ACID DETC. BEND MACH  PS/CU DEGR LAY FAB1 FAB2 WELD GRIND TEST REMV GALV DATE
CLEAN CLEAN CLEAN BEND BASE OUT FAB1 FAB2 WELD BARE CLEAN TEST REMV GALV SHIP
DATE

SUPV
MECH
INSP

TAG P171-1

CAPDAM ISSUED BY  MACH DES  210-617-619-620-2285-4200-5502  DETAIL DWG  A2285  318 REV B
Enclosure (11)

PSC - GROUP INQUIRY

HULL P/L  CLASS GROUP  SUBGRP  SSGRP  CD  E  C  D  C
617  D  2300  4102  5408  1  PS  P

DESIGN  GRPNG  A-MAT  C-MAT  X10  FO  MSS  DA  PIPE  EL  ES  EC
132  136  140  155  156  159  09068  08139  08039  X42A

CHEKPOINT? ALL
DO YOU WANT MATERIAL DUE STATUS? Y
X42 DIV

JOB NO=617C003401  DWG=A2300-732  ASSEMBLY S41-9
DET A

JOB NO=617C003402  DWG=A2300-732  ASSEMBLY S41-9
COMPLETE  RESP DEPT=X42

JOB NO=617C003403  DWG=A2300-732  ASSEMBLY S41-9
DET C

JOB NO=617C003404  DWG=A2300-732  ASSEMBLY S41-9
COMPLETE  RESP DEPT=X42

JOB NO=617C003405  DWG=A2300-732  ASSEMBLY S41-9
DET F

COMPLETE  RESP DEPT=X42

Enclosure (12)

PSC - JOB STATUS BY WORK CENTER

JOB
AREA? PS
ARE YOU ON A HARD COPY TERMINAL? Y
WHICH WORK CENTER? 42C-MD40
START DATE? (MMDDYY) 031279
END DATE? (MMDDYY) 062879

DOCUMENT  WORK ORDER  OP $  START  NORMAL  ACCUR  STATUS  PRIOR
618  D6200  7000  100  618C016013  005  052179  .0  .0 LATE  .0
618  D6200  7000  100  618C016012  005  052179  .0  .0 LATE  .0
617  D2300  4203  5530  617C005639  005  062579  .0  .0 LATE  .0
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618  D6200  7000  100  618C016028  005  052179  .0  .0 LATE  .0

247
ARE YOU ON A HARD COPY TERMINAL? Y
WHICH WORK CENTER? 43C-MO40

WORK CENTER=42C-MO40 TEXT=MM ORDERED

MACHINES= 0 MEN= 0 MOVE TIME= 0 CTIME= 0 DAY LEN= 8 OVRHD RATE= 0

MACHINE RATE= .00 LOAD CODE=1 LOAD PERCENT=085 BASIC CAPACITY= 8
WORK CTR SETUP LOSS= 0 WORK CTR LOSS FACTOR=.00 SU/PROC RATIO= 0

---

ENCLOSURE (14)

PSC - ORDER STATUS DATA

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ORDER=617C003401 DESC- L000002 M41-9 RESP-42 DEL, WORKING
ORDER=617C003402 DESC- L000000 S41-9 RESP-42 COMPLETED
ORDER=617C003403 DESC- L000000 S41-9 RESP-42 COMPLETED
ORDER=617C003404 DESC- L000000 S41-9 RESP-42 COMPLETED
ORDER=617C003405 DESC- L000000 S41-9 RESP-42 COMPLETED

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ORDER=617C003401 DESC- L000002 M41-9 RESP-42 DEL, WORKING
ORDER=617C003402 DESC- L000000 S41-9 RESP-42 COMPLETED
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ORDER=617C003404 DESC- L000000 S41-9 RESP-42 COMPLETED
ORDER=617C003405 DESC- L000000 S41-9 RESP-42 COMPLETED

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WHICH WORK ORDER? 617C003401

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Enclosure (13)
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The University of Michigan
Transportation Research Institute
Marine Systems Division
2901 Baxter Road
Ann Arbor, MI  48109-2150

Phone: 734-763-2465
Fax: 734-763-4862
E-mail: Doc.Center@umich.edu