ESTABLISHMENT OF PRODUCTION LINE FOR
MANUFACTURE OF 40-mm M169 CARTRIDGE CASE

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U. S. ARMY ARMAMENT RESEARCH AND DEVELOPMENT CENTER
CLOSE COMBAT ARMAMENT CENTER
DOVER, NEW JERSEY

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**Title:** Establishment of Production Line for Manufacture of 40-mm M169 Cartridge Case

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**Abstract:**
A fully automated production line with the capacity to produce 160,000 cartridge cases per month on a 1-8-5 basis was established. A demonstration test was performed to determine the actual production capacity.
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1. INTRODUCTION

1.1 FACILITY PROJECT OBJECTIVE

Amron Corporation set up a cartridge case production facility with the capability of 160,000 M169 cartridge case per month on a 1-8-5 basis, as stated in Contract DAAK10-82-C-0247.

As a requirement of this contract, a demonstration test was performed to determine actual production capacity.

Amron demonstrated this production capacity on hardware Contract DAAK10-83-C-0213.

Amron demonstrated to the Government the capability on those pieces of equipment procured under this contract.

1.2 MANUFACTURING FACILITY DEVELOPMENT

Debugging of the production machinery began in March of 1983 and was completed in May of 1983. Volume case production began in June of 1983. Debugging of automation then proceeded and was completed in October of 1984. The Demonstration Test was conducted from October 3, 1984 to November 9, 1984.
1.3 / MANUFACTURING PROCESS SUMMARY

The M169 cartridge case is manufactured from extruded aluminum rod. The rod is cold sawed into slugs, which are then extruded, drawn, and headed in mechanical press operations. Heat treatment to a T4 state is next followed by vent hole drilling, machining, and anodizing.

This report provides a flow chart and description of the manufacturing process, a summary of the demonstration test and lists a problem area which was encountered. Keywords: Automated production line.
2. PROCESS DESCRIPTION

2.1 Flow Process Diagram: A simplified flow process diagram is provided (Exhibit I) indicating each step in the cartridge case production manufacturing sequence by operation title and number. Also, this diagram includes inprocess inspection stations and material handling modes.

2.2 Manufacturing Process Description: The manufacturing process description is identified for each production manufacturing sequence as shown on the simplified flow process diagram (Exhibit I) and individual process description sheets (Exhibit II).
3. **SUMMARY OF DEBUG TESTING**

3.1 **OBJECTIVE:** To evaluate the equipment, manufacturing procedures, inspection procedures, and set-up and calibration procedures for the M169 cartridge case line and modify or correct as necessary. This was done while the M169 was in production. Quality of cartridge cases produced, as well as personnel talents and equipment performance, had been established based on government acceptance of M169 cartridge cases prior to shipment to the Army Ammunition Plant.

3.2 **MANAGEMENT:**

Andrew J. Vargo - Program Manager, Engineer Manager
Overall project responsibility including production manufacturing process development, equipment and tooling selections.

Shirley A. Peterson - Quality Control Manager
Overall quality assurance project responsibility for all gaging and testing procedures used in the manufacturing of the M169 cartridge case. This responsibility also dictated that in process controls be established on all production operations.
3.2 **MANAGEMENT:** Cont'd

William P. Novak - Production Manager

Overall production responsibility by providing competent personnel and supervision to set-up, debug and operate all production equipment provided under this project. This debugging cycle had been accomplished prior to demonstration test based on the fact that all equipment provided under this project was in production use to manufacture M1.69 cartridge cases for shipment to the U.S. Government.

3.3 **SCHEDULE:** The debugging cycle was performed on Amron's floor prior to the equipment release to production. This debugging phase has been completed on all manufacturing operations.

3.4 **COST:** All costs associated with the debugging cycle have been awarded under Amron's facility contract DAAK10-82-C-0247, CLIN 0001 for subject project.

3.5 **DATA COLLECTION:** Data collected and recorded during the debugging cycle consisted of equipment and quality problems, analyses of these problems, and the corrective action (s) taken. Equipment purchase description specifications were used in determining the final acceptance of this equipment. Corrective action was performed by the equipment vendor or Amron's personnel depending on responsibility.
### 3.6 GOVERNMENT SUPPORT:

Government furnished mater/government furnished equipment:

<table>
<thead>
<tr>
<th>Oper. No.</th>
<th>Description</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Saw Slug</td>
<td>Wagner KMLN-2 Cold Saw, Govt. I.D. No.003419-21043</td>
</tr>
<tr>
<td>60</td>
<td>Zinc Stearate Coat</td>
<td>Sweco Model FMD-20-HA Vibratory Finishing Mill Govt. I.D. No.003680-00523</td>
</tr>
<tr>
<td>70</td>
<td>Extrusion</td>
<td>Danly SSL-400 Press Govt. I.D. No.003443-08756</td>
</tr>
<tr>
<td>110</td>
<td>Draw</td>
<td>Danly SA-1-100 Press Govt. I.D. No.3443-08970</td>
</tr>
<tr>
<td>120</td>
<td>Trim</td>
<td>V &amp; O Trimmers (2) Govt. I.D. No.3449-01608 Govt. I.D. No.3449-01412</td>
</tr>
<tr>
<td>130</td>
<td>Head</td>
<td>Bliss #7 Press Govt. I.D. No.3443-08083</td>
</tr>
<tr>
<td>170</td>
<td>Drill Vent Holes</td>
<td>Drill Machines (2) Govt. I.D. No.3598-36432 Govt. I.D. No.3413-16570</td>
</tr>
</tbody>
</table>

Government facilities or services: None required
### SUMMARY OF RATE BUILD-UP ATTAINED DURING DEBUG TESTING:

<table>
<thead>
<tr>
<th>Month</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 1983</td>
<td>20,000</td>
</tr>
<tr>
<td>July 1983</td>
<td>30,000</td>
</tr>
<tr>
<td>Aug 1983</td>
<td>40,000</td>
</tr>
<tr>
<td>Sept 1983</td>
<td>50,000</td>
</tr>
<tr>
<td>Oct 1983</td>
<td>60,000</td>
</tr>
<tr>
<td>Nov 1983</td>
<td>70,000</td>
</tr>
<tr>
<td>Dec 1983</td>
<td>80,000</td>
</tr>
<tr>
<td>Jan 1984</td>
<td>90,000</td>
</tr>
<tr>
<td>Feb 1984</td>
<td>100,000</td>
</tr>
<tr>
<td>Mar 1984</td>
<td>105,000</td>
</tr>
<tr>
<td>Apr 1984</td>
<td>125,000</td>
</tr>
<tr>
<td>May 1984</td>
<td>125,000</td>
</tr>
<tr>
<td>June 1984</td>
<td>90,000</td>
</tr>
<tr>
<td>July 1984</td>
<td>90,000</td>
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<tr>
<td>Aug 1984</td>
<td>125,000</td>
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<tr>
<td>Sept 1984</td>
<td>144,000</td>
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<tr>
<td>Oct 1984</td>
<td>153,600</td>
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<tr>
<td>Nov 1984</td>
<td>201,600</td>
</tr>
<tr>
<td>Dec 1984</td>
<td>201,600</td>
</tr>
</tbody>
</table>
4. DEMONSTRATION PLAN

4.1 OBJECTIVE:
To demonstrate to the U.S. Government that Amron Corporation, Waukesha, Wisconsin (Antigo Plant), has successfully installed a production line for the M169 cartridge case with a capacity of 160,000 units per month on a 1-8-5 hours per month basis.

4.2 PRODUCTION REQUIREMENTS:
Each piece of production equipment assigned to this project and listed in Exhibit III was demonstrated by producing a minimum of 34,415 acceptable M169 cases in thirty five (35) hours. All equipment necessary to support the prove-out of a manufacturing operation, regardless of ownership or origin, was operated during the demonstration of that operation.
4.3 EQUIPMENT MAINTENANCE PROGRAM:

4.3.1 Amron's maintenance policy for the M169 cartridge case manufacturing line provides for periodic production equipment shutdown. Shutdown is scheduled after the need for repair has been identified by the manufacturing department and assessment has been made by in-house maintenance personnel. The equipment shutdown schedule is determined by two (2) main factors: length of equipment downtime needed for this repair and the size of the storage bank needed at this operation to comply with contractual delivery schedule.

If an equipment failure requires an excessive amount of time to repair, Amron's maintenance policy includes the use of alternate production equipment from other product lines. This is permitted provided that the replacement piece of equipment is compatible with the production operation and minimal change over time is required, also authorization for use is received from the PCO.

4.3.2 The individual manufacturing operations shown on Exhibit I (Process Flow Diagram) and Exhibit II (Process Description Sheets) identify the maintenance effort to be performed on the equipment and associated tooling. This effort is defined as follows:

- Preventive Maintenance Schedule.
- Manuals:
- Records/Documentation.
- Spare Parts:
4.3.3. The Amron Corporation did not plan to demonstrate any maintenance tasks during this test program. If any equipment failure had been realized during this period, Amron's standard maintenance program would have been used.

4.4 Environmental Considerations: The Amron Corporation has four (4) manufacturing processes, used in the production of the M169 cartridge case, that are under State and Federal environmental controls.

Operation Number 30, Clean and Etch:

Equipment: Ransohoff Rotary Drum Washer, 4-Stage with Drier.

Controls:

Wastewater ---- NR101 Effluent Reporting Section 144.54 of Wisconsin Statutes.


Hazardous Waste ---- Federal Regulations 3004 of RCRA.

Operation Number 80, Acid Clean:

Equipment: Ransohoff Rotary Drum Washer, 3-Stage.

Controls:

Wastewater — — NR101 Effluent Reporting Section 144.54 of Wisconsin Statutes.

Hazardous Waste — — Federal Regulations 3004 of RCRA.

Operation 100, Deoxidize And Soap Coat:

Equipment: Advance Curing Rotary Drum Washer, 3-Stage with Drier.

Controls:

Wastewater — — NR101 Effluent Reporting Section 144.54 of Wisconsin Statutes.

Hazardous Waste — — Federal Regulations 3004 of RCRA.
4.4. (Cont'd)

**Operation Number 210, Anodize:**

Equipment: ACA Anomatic, continuous belt, multiple tank, anodizing system.

Controls:

Wastewater — NR101 Effluent Reporting Section 144.54 of Wisconsin Statutes.


Hazardous Waste — Federal Regulations 3004 of RCRA.


4.5. Schedule: The demonstration test schedule was as shown on Exhibit IV, Demonstration Test Dates.

4.6. Government Support:

4.6.1 Government Furnished Material (GFM)  No additional Government furnished items were required in preparation or performance of this test.

4.6.2 Government Furnished Facilities  No additional Government furnished items were required in preparation or performance of this test.
4.7 Personnel Requirements:

4.7.1 Personnel required for performance of this demonstration test have been categorized by work function. The distribution of personnel is shown below:

<table>
<thead>
<tr>
<th>Personnel Category</th>
<th>Personnel Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production (Set-up &amp; Operators)</td>
<td>8</td>
</tr>
<tr>
<td>Inspection (Patrol &amp; Line)</td>
<td>4</td>
</tr>
<tr>
<td>Laboratory (Tool &amp; Gage, Chemical)</td>
<td>3</td>
</tr>
<tr>
<td>Maintenance (Tooling &amp; Equipment)</td>
<td>2</td>
</tr>
<tr>
<td>Support (Receiving, Shipping &amp; Stores)</td>
<td>1</td>
</tr>
<tr>
<td>Supervision</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>20</strong></td>
</tr>
</tbody>
</table>
4.8 Contractual data item requirements for the M169 facility are as defined on the DD form 1423 incorporated in contract DAAK10-82-C-0247. These data item requirements are defined below:

<table>
<thead>
<tr>
<th>Sequence No.</th>
<th>Description of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>A001</td>
<td>Final Technical Report</td>
</tr>
<tr>
<td>A002</td>
<td>Purchase Description</td>
</tr>
<tr>
<td>A003</td>
<td>Project Status Report</td>
</tr>
<tr>
<td>A004</td>
<td>Operational Baseline Listing</td>
</tr>
<tr>
<td>A005</td>
<td>Commercial Computer and Peripheral Equipment Manuals</td>
</tr>
<tr>
<td>A006</td>
<td>Instruction Manuals</td>
</tr>
<tr>
<td>A007</td>
<td>Demonstration Test Plan</td>
</tr>
<tr>
<td>A008</td>
<td>Drawings, Engineering Associated Lists</td>
</tr>
<tr>
<td>A009</td>
<td>Provisioning &amp; Other Procurement Screening Data</td>
</tr>
<tr>
<td>Sequence No.</td>
<td>Description of Data</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>A010</td>
<td>Subproject Funding Report</td>
</tr>
<tr>
<td>A011</td>
<td>Letter Progress Reports</td>
</tr>
<tr>
<td>A012</td>
<td>Equipment History Data Package</td>
</tr>
<tr>
<td>A013</td>
<td>Inspection System Program Plan</td>
</tr>
<tr>
<td>A014</td>
<td>Quality Inspection Test</td>
</tr>
<tr>
<td>A015</td>
<td>Demonstration and Evacuation Report</td>
</tr>
<tr>
<td>A016</td>
<td>Ammunition Data Card</td>
</tr>
<tr>
<td>A017</td>
<td>Utility Inspection Unserviceable Material Report</td>
</tr>
<tr>
<td>A018</td>
<td>Quality Engineering Inspection</td>
</tr>
<tr>
<td>A019</td>
<td>Equipment Descriptive Documentation</td>
</tr>
<tr>
<td>A020</td>
<td>Quality Inspection Defect Report</td>
</tr>
<tr>
<td>A021</td>
<td>Defense Priorities and Allocations</td>
</tr>
<tr>
<td>A022</td>
<td>System Safety Hazard Analysis Report</td>
</tr>
<tr>
<td>A023</td>
<td>ECP's and RFD/W's (Short Form)</td>
</tr>
<tr>
<td>A024</td>
<td>Bills of Material</td>
</tr>
</tbody>
</table>

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4.9 Demonstration Test Evaluation:

4.9.1 Representatives from the Engineering and Quality Assurance departments assisted in evaluating the results of this demonstration test. Government personnel involved in test evaluation represented the following agencies:

- ARRADCOM - Dover, New Jersey
- P.B.M. - Dover, New Jersey
- DCAS - Milwaukee, Wis

4.9.2 Conventional mathematics were used for the conversion and analysis of the test data. The ability of Amron to produce acceptable product at the required rates are exhibited by the data collected.

4.9.3 Amron's ability to produce at the stated manufacturing rate was demonstrated by the data collected during the test provides the basis of line acceptance.
5.1 TEST DESCRIPTION

Amron Corporation demonstrated to the U.S. Government the capability of 160,000 units on a 1-8-5 basis, for the M169 cartridge case production line as stated in Contract DAAK10-82-C-0247.

This demonstration test was performed in the presence of the following Government representatives:

Mr. Joseph McCarthy
US Army PBMA
Dover, New Jersey

Mr. Patrick Boushon
DCASMA
Appleton, Wisconsin

The production run was performed to insure the capability of each operation at the rate specified by the Government.

Amron demonstrated the awarded capacity using hardware provided under Contract DAAK10-83-C-0213.

The Demonstration Test Schedule is shown on Exhibit IV.
During this demonstration, Amron maintained detailed records on each operation.

These records included as a minimum:

a) Number of parts produced.
b) Number of parts scrapped.
c) Test start and stop time.
d) Cause of excessive downtime.
e) Average daily production rate.

Thirty-five hours of production were accumulated at each operation. In some cases where more than one identical machine was used at an operation, only one machine was demonstrated for the test. It was assumed that all identical machines would perform the same.

During the demonstration of the first several operations, a shipment of raw material was late in arriving and the demonstration had to be interrupted. This did not count as test time, and upon receipt of the raw material the test was resumed. Running out of raw material is considered a very rare occurrence on the M169 production line.

Machine downtime due to waiting for parts from a previous operation was termed administrative downtime.

5.2 DATA ANALYSIS

5.2.1 Failure data were recorded on the Prove-Out Data Collection Sheet. Notations on the sheets did not require further definition.
5.2.2. Production data were collected from part counters at mechanical operations. These same counts were used for subsequent finishing operations since the same piece parts were run through all machines in a series with no accumulation in between. Times were recorded by an observer with a stop watch.

5.2.3. Quality data were collected by charts which are a normal part of the Amron Quality Control System. Out of tolerance parts were normally produced during machine adjustments and counted by the set up person.

5.3 DEMONSTRATION TEST SUMMARY

Analysis results are listed under Exhibit V.

5.4 PROBLEM AREAS

1. No product quality problems were encountered during the test.
2. One serious mechanical problem was encountered. The lubrication system on the Sweco Vibratory Mill, Operation 60, was inoperative for two days due to a vacuum failure. Changing to a lower viscosity oil restored the machine to service, but an investigation with the manufacturer is proceeding to see if a simpler lubrication system can be retrofitted.
5.5 CONCLUSIONS

The demonstration run did net 100% of the awarded line capacity. These parts became the property of the Government through the current hardware contract and became part of the deliverable quantities.

Amron demonstrated the capability of the manufacturing operations to meet the (stated) rate by producing a minimum of 34,415 acceptable cartridge cases in 35 hours at each operation. All equipment necessary to support the prove-out of an operation, regardless of ownership or origin, was operated during the demonstration of that operation.

The ability to produce at the stated rate as evidenced by the data collected formed the basis of line acceptance.
Operation Number: 20

Operation Description: Saw 12 foot by 1.830 inch diameter aluminum bars into slugs approximately .803" long. Bars are loaded onto saw table by overhead crane and cut slugs discharge automatically onto conveyor belt.

Operation Characteristic: Cold sawing, extruded aluminum bars.

Equipment Description: Wagner model KMLN-2 cold saw with 14' infeed table and Bijur Mist Lubrication System; Year of Mfg. 1966.

Equipment Warranties: Expired

Calibration Requirements: Carriage speed, length of cut.

Inspection Requirements: 5 samples checked for correct weight each hour.

Certification Requirements: Material Yes Personnel

Manpower Requirements: Set-up: 1/2 man Patrol Inspector: 1/8 man

Safety Requirements: Standard safety requirements are enforced as directed by good working practices and O.S.H.A. regulations.

Special Environmental Controls: None

Preventative Maintenance Schedule:

Manuals: Operating Yes Maintenance

Records/Documentation: In process control charts Work order system - maintenance

Spare Parts: Drive Belts
Switches
Stock Clamps

EXHIBIT II
PROCESS DESCRIPTION

Operation Number: 30

Operation Description: Cartridge case blanks are automatically fed thru spiral drum type washer and are dried at the exit end.

Operation Characteristic: Alkaline clean, water rinse, caustic etch, water rinse, and dry.

Equipment Description: Ransohoff Four (4) Stage Horizontal Spiral Drum Washer with Dryer.

Equipment Warranties: Expired - Year of Mfg. 1968

Calibration Requirements: Drum speed, steam pressure, alkaline tank temperature, caustic etch temperature and dryer temperature.

Inspection Requirements: Appearance of etch
Frequency: (1) sample every 4 hours

Certification Requirements: Material ______ Personnel In-House

Manpower Requirements: Set-up: 1/5 man

Safety Requirements: Standard safety, requirements are enforced as directed by good working practices and O.S.H.A. regulations.

Special Environmental Controls: Outside air vent.

Preventative Maintenance Schedule: As required.

Manuals: Operating Yes Maintenance Yes

Records/Documentation: Work order system - maintenance Lab services

Spare Parts: Temperature Controls Steam Coils Trunion Wheels

EXHIBIT II
Waukesha, Wisconsin

PROCESS DESCRIPTION

Operation Number: 60

Operation Description: Cartridge case blanks are automatically fed thru vibratory finishing mill filled with Zinc Stearate powered extrusion lubricant and wooden peg media.

Operation Characteristic: Coat with Zinc Stearate lubricant.

Equipment Description: Sweco model FMD-20 HA Vibratory Finishing Mill.


Calibration Requirements: Amount of lubricant and wooden pegs in mill.

Inspection Requirements: At daily start-up.

Certification Requirements: Material _____ Personnel In-House

Manpower Requirements: Set-up: 1/4 man

Safety Requirements: Standard safety requirements are enforced as directed by good working practices and O.S.H.A. regulations.

Special Environmental Controls: Dust Collection System.

Preventative Maintenance Schedule: As required.

Manuals: Operating Yes Maintenance _____

Records/Documentation: Work Order System - Maintenance

Spare Parts: Discharge Screen
Vacuum Filters
Vacuum Pump
Vacuum Bowls

EXHIBIT II
24
Waukesha, Wisconsin

**PROCESS DESCRIPTION**

**Operation Number:** 70

**Operation Description:** Cartridge case blanks are automatically fed thru extrusion press and extruded.

**Operation Characteristic:** Extrusion

**Equipment Description:** Danly SSI-400 vertical straight side mechanical extrusion press.

**Equipment Warranties:** Expired - Year of Mfg. 1952

**Calibration Requirements:** Slide adjustment, knockout pressure, parts feeder.

**Inspection Requirements:** Seven (7) different dimensional checks and evidence of poor workmanship (5 pieces every 30 minutes).

**Certification Requirements:** Material ______ ______ Personnel In-House

**Manpower Requirements:**
- Set-up: 1/4 man
- Patrol Inspector: 1/8 man
- Utility: 1/4 man

**Safety Requirements:** Standard safety requirements are enforced as directed by good working practices and O.S.H.A. regulations.

**Special Environmental Controls:** Dust Collection System.

**Preventative Maintenance Schedule:**

<table>
<thead>
<tr>
<th>Manuals:</th>
<th>Operating</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Records/Documentation:</th>
<th>In process control charts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work order system - maintenance</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spare Parts:</th>
<th>Extrusion Punches &amp; Dies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Belts</td>
<td></td>
</tr>
</tbody>
</table>

**EXHIBIT II**
25
PROCESS DESCRIPTION

Operation Number: 80

Operation Description: Cartridge cases are automatically fed thru spiral drum type washer.

Operation Characteristic: Acid clean, water rinse.

Equipment Description: Ransohoff Three (3) Stage Horizontal Spiral Drum Washer.

Equipment Warranties: Expired - Year of Mfg. 1968

Calibration Requirements: Drum speed, steam pressure, acid tank temperature, rinse tank temperature.

Inspection Requirements: Cleanliness of parts
Frequency: (1) sample every 4 hours

Certification Requirements: Material ______ Personnel In-house

Manpower Requirements: Set-up: 1/5 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: Outside air vent.

Preventative Maintenance Schedule: As required.

Manuals: Operating Yes Maintenance ______

Records/Documentation: Work Order System - Maintenance Lab Services

Spare Parts: Temperature Controls
Steam Coils
Trunnion Wheels

EXHIBIT II
PROCESS DESCRIPTION

Operation Number: 90

Operation Description: Cartridge cases are annealed in this pot type annealing oven. Parts are loaded into pot from storage hopper. Overhead hoist positions pot in oven and then dumps pot into discharge hopper.

Operation Characteristic: Circulation of heat necessary to insure proper annealing of cartridge cases with good temperature uniformity.

Equipment Description: Despatch DT-26 natural gas pot type annealing oven.


Calibration Requirements: Temperature, length of cycle.

Inspection Requirements: 5 parts per load checked for hardness in lab.

Certification Requirements: Material Personnel In-House

Manpower Requirements: Set-up: 1/8 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: Outside air vent.

Preventative Maintenance Schedule:

Manuals: Operating Yes Maintenance

Records/Documentation: Base Recorder Charts - Process Control Work Order System - Maintenance

Spare Parts: Temperature Controller Blower Parts Blower Bearings Blower Motor

EXHIBIT II 27
Waukesha, Wisconsin

PROCESS DESCRIPTION

Operation Number: 100

Operation Description: Cartridge cases are automatically fed through spiral drum type washer.

Operation Characteristic: Deoxidize, rinse, soap coat, and dry.

Equipment Description: Advanced Curing Three (3) Stage Horizontal Spiral Drum Washer with Dryer.


Calibration Requirements: Drum speed, steam pressure, deoxidize tank temperature, hot water rinse tank temperature, soap tank temperature.

Inspection Requirements: Appearance of Soap Coat.

Frequency: (1) sample every 4 hours

Certification Requirements: Material ______ Personnel In-house

Manpower Requirements: Set-up: 1/5 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: Outside air vents.

Preventative Maintenance Schedule:

Manuals: Operating ______ Maintenance ______

Records/Documentation: Work System - Maintenance Lab Services

Spare Parts: Temperature Controls
Steam Coils
Trunnion Wheels

EXHIBIT II
28
PROCESS DESCRIPTION

Operation Number: 110

Operation Description: Cartridge cases are automatically fed through draw press and drawn.

Operation Characteristic: Draw

Equipment Description: Danly SA-1-100 vertical straight side mechanical draw press.


Calibration Requirements: Slide adjustment, die size, parts feeder speed.

Inspection Requirements: Four (4) different dimensional checks and evidence of poor workmanship (6 pieces every 30 minutes)

Certification Requirements: Material ___ Personnel In-house ___

Manpower Requirements: Set-up: 1/4 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls:

Preventative Maintenance Schedule:

Manuals: Operating ___ Yes ___ Maintenance ___

Records/Documentation: In process Control Charts
                      Work Order System - Maintenance

Spare Parts: Draw Punches & Dies
             Drive Belts.

EXHIBIT II
29
Waukesha, Wisconsin

PROCESS DESCRIPTION

Operation Number: 120

Operation Description: Cartridge cases are automatically fed through trimmer and trimmed to length.

Operation Characteristic: Rough trim

Equipment Description: V & O Model 983 trimmers (2).

Equipment Warranties: Expired

Calibration Requirements: Trim length.

Inspection Requirements: Two (2) different dimensional checks (6 pieces every 30 minutes).

Certification Requirements: Material _________ Personnel In-house

Manpower Requirements: Set-up: 1/4 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls:

Preventative Maintenance Schedule:

Manuals: Operating _________ Maintenance _________

Records/Documentation: In process Control Charts

Work Order System - Maintenance

Spare Parts: Trim Wheels
Arbor Assemblies
Drive Belts
Bearings

EXHIBIT II
Operation Number: 130

Operation Description: Cartridge cases are automatically fed through heading press.

Operation Characteristic: Form head.

Equipment Description: Bliss #7 horizontal toggle press.


Calibration Requirements: Slide adjustment, center block alignment, punch position.

Inspection Requirements: Eleven (11) different dimensional checks (5 pieces every 20 minutes)

Certification Requirements: Material ___________ Personnel In-house

Mannover Requirements: Set-up: 1/4 man Operator: 1/4 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls:

Preventative Maintenance Schedule:

Manuals: Operating ___________ Maintenance ___________

Records/Documentation: In process Control Charts Work Order System - Maintenance

Spare Parts: Punches & Dies Drive Belts Center Blocks Slides Crankshafts Bearings
PROCESS DESCRIPTION

Operation Number: 140

Operation Description: Cartridge cases in wire baskets are fed through a mesh Belt washer and dried.

Operation Characteristic: Alkaline clean, cold water rinse, hot water rinse, and dry.

Equipment Description: Ransohoff Three (3) Stage Mesh Belt Washer with dryer.


Calibration Requirements: Belt speed, steam pressure, alkaline tank temperature, rinse tank temperature, and dryer temperature.

Inspection Requirements: Cleanliness of part
Frequency: (1) sample every 4 hours

Certification Requirements: Material _____ Personnel In-house

Manpower Requirements: Set-up: 1/8 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: Outside air vent.

Preventative Maintenance Schedule:

Manuals: Operating Yes Maintenance _______

Records/Documentation: In process Control Charts Work Order System - Maintenance

Spares Parts: Stack Fan belts Bearings Pumps

EXHIBIT 11
Operation Number: 150

Operation Description: Cartridge cases in wire baskets are loaded onto grids and fed through a pusher type T-4 Quench Furnace.

Operation Characteristic: Circulation of heat necessary to insure proper solid solution treatment of metal followed by rapid water quench.

Equipment Description: Pacific Scientific pusher type T-4 Quench Furnace, natural gas fired, 3 zone control.


Calibration Requirements: Furnace temperature, quench tank temperature. Cycle time.

Inspection Requirements: Hardness test, chart recorder printouts. Frequency: 10 samples per grid.

Certification Requirements: Material ________ , Personnel In-house

Manpower Requirements: Set-up: Laboratory: 1/4 man
Utility: 1/4 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: Outside air vent.

Preventative Maintenance Schedule:

Manuals: Operating ________ Maintenance ________

Records/Documentation: In process Control Charts
Work Order System - Maintenance Recorder Charts

Spare Parts: Recorder
Controller
Bearings
Circulation Fan

EXHIBIT II
PROCESS DESCRIPTION

Operation Number: 160

Operation Description: Cartridge cases in wire baskets are loaded onto carts and aged in an artificial aging oven.

Operation Characteristic: Circulation of heat necessary to insure proper artificial age hardening of cartridge cases with good temperature uniformity.

Equipment Description: Despatch model DT200 gas fired artificial aging oven.


Calibration Requirements: Temperature, air flow baffle adjustment.

Inspection Requirements: Hardness test, chart recorder printout, tensile strength test.

Frequency: Hardness - 5 samples per rack.

Tensile: 5 samples per lot

Certification Requirements: Material __________ Personnel In-house

Manpower Requirements: Set-up: 1/8 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: Outside air vents

Preventative Maintenance Schedule:

Manuals: Operating Yes Maintenance Yes

Records/Documentation: In process Control Charts

Recorder Chart

Work Order System - Maintenance

Spare Parts: Recorder

Controller

Drive Belts

EXHIBIT II

34
PROCESS DESCRIPTION

Operation Number: 170

Operation Description: Cartridge cases are automatically fed into drill machines where vent holes are drilled.

Operation Characteristic: Drill six (6) vent holes.

Equipment Description: Three (3) special drill machines with six air powered drills on a common carrier.

Equipment Warranties: Expired - Year of Mfg. 1966 and 1968

Calibration Requirements: Carrier travel

Inspection Requirements: Five (5) different dimensional checks (8 pieces every 20 minutes).

Certification Requirements: Material _____ Personnel In-house

Manpower Requirements: Set-up: 1 man Tool & Gage Lab: 1/2 man Operators: 1 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A regulations.

Special Environmental Controls: None

Preventative Maintenance Schedule:

Manuals: Operating _____ Maintenance _____

Records/Documentation: In process Control Charts Work Order System - Maintenance

Spare Parts: Drill Bits Drill Motors

EXHIBIT II
35
Operation Number: 180

Operation Description: Cartridge Cases are automatically fed into screw machines where extractor groove and powder cavity areas are machined.

Operation Characteristic: Machine extractor groove, powder cavity, base, and trepan groove on cartridge case.

Equipment Description: 1-5/8 TA six spindle conomastics (2) with chucking mechanism conversion.

Equipment Warranties: Expired - Years of Mfg. 1950 and Unknown

Calibration Requirements:

Inspection Requirements: (28) dimensional checks
Frequency: 6 samples per machine every 30 min.

Certification Requirements: Material ______ Personnel In-house

Manpower Requirements: Set-up: 3/4 man Tool & Lab: 1/2 man
Inspector: 1/2 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: None

Preventative Maintenance Schedule:

Manuals: Operating ______ Maintenance ______

Records/Documentation: In process Control Charts
Work Order System - Maintenance

Spare Parts: Cutting Tools
Tool Holder
Collets
Spindle Bearings

EXHIBIT II
36
Process Description

Operation Number: 195
Operation Description: Perform tensile test per operating procedure.

Operation Characteristic: Record elongation by applying measured load input on prepared specimen.

Equipment Description: Baldwin #60 HVL Universal Testing Machine.

Equipment Warranties: Expired - Year of Mfg. 1977
Calibration Requirements: Outside Service
   Frequency: Twelve (12) month cycle
Inspection Requirements: (6) samples per lot.

Certification Requirements: Material _______ Personnel In-house

Manpower Requirements: Metallurgy Lab: 1/8 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: None

Preventative Maintenance Schedule:

Manuals: Operating _______ Yes _______ Maintenance _______

Records/Documentation: Calibration

Spare Parts: 

Exhibit II 37
Operation Number: 200

Operation Description: Cartridge cases are automatically fed through a rotary table trimming machine.

Operation Characteristic: Final trim to length, mouth size, and chamfer.

Equipment Description: M.S.O. three station rotary table trimming machines (2).

Equipment Warranties: Expired - Year of Mfg. 1963 and 1966

Calibration Requirements: Travel of cutting heads, position of cutting tools.

Inspection Requirements: (6) dimensional checks
Frequency: (6) samples each 30 minutes

Certification Requirements: Material ______ Personnel In-house

Manpower Requirements: Set-up: 1/4 man
Inspector: 1/8 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: None

Preventative Maintenance Schedule:

Manuals: Operating Yes Maintenance ______

Records/Documentation: In process Control Charts
Work Order System - Maintenance

Spare Parts: Cutting Tools
Collets
Bearings
V-belts

EXHIBIT II
Operation Number: 210

Operation Description: Cartridge cases are hand loaded, fed through belt type anodizing line, and hand unloaded.

Operation Characteristic: Deoxidize, rinse, etch, rinse, de-smut, rinse, anodize, rinse, dye, rinse, seal and dry.

Equipment Description: A.C.A. titanium belt anodizing line-eleven (11) tanks and dryer section.


Calibration Requirements: Belt speed, anodic coating thickness.

Inspection Requirements: Anodic coating, salt spray test
Frequency: Anodic coating (5) samples each 15 minutes
Salt Spray Test (1) sample each 8 hours

Certification Requirements: Material _______ Personnel In-house

Manpower Requirements: Set-up: 1/2 man Laboratory: 1/2 man
Operator: 1½ man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: Fume Scrubber

Preventative Maintenance Schedule:

Manuals: Operating _______ Maintenance _______

Records/Documentation: In process Control Charts
Recorder Chart
Work Order System - Maintenance

Spare Parts: Titanium Belts
Part Racks
Bearings

EXHIBIT II
Waukesha, Wisconsin

PROCESS DESCRIPTION

Operation Number: 230

Operation Description: Cartridge cases are automatically fed through a marking machine and stamped with identification characters.

Operation Characteristic: Mark with identification characters.

Equipment Description: Kiwi Coding machine with (2) turntables and automatic inker.


Calibration Requirements: Coder speed, stamp location

Inspection Requirements: Stamp appearance and location
Frequency: (6) samples each 30 minutes

Certification Requirements: Material ______ Personnel In-house

Manpower Requirements: Inspector: 1/8 man

Safety Requirements: Standard safety requirements are enforced as directed by Good Working Practices and O.S.H.A. regulations.

Special Environmental Controls: None

Preventative Maintenance Schedule:

Manuals: Operating Yes Maintenance ______

Records/Documentation: Work Order System - Maintenance

Spare Parts: Inking Wheel

EXHIBIT II
40
<table>
<thead>
<tr>
<th>Operation No.</th>
<th>Operation Description</th>
<th>Equipment Description</th>
<th>Ownership (Govt Furnished or Contractor)</th>
<th>Equipment Cycle Rate (100% Efficient) (Parts Per Hour)</th>
<th>Rate Demonstrated (Parts Per Hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>020</td>
<td>Cut Slugs</td>
<td>Wagner KMLN-2 Hydraulic Cold Saw W/Automatic Infeed table</td>
<td>4956 GFM</td>
<td>1,440</td>
<td>1,056</td>
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<tr>
<td>025</td>
<td>Cut Slug Inspection</td>
<td>Ransohoff (4) Stage Spiral Drum Washer W/Heated Dry-off section</td>
<td>2884 C</td>
<td>17,500</td>
<td>1,056</td>
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<tr>
<td>030</td>
<td>Clean &amp; Etch</td>
<td>Sweco Model FMD-20-HA Vibratory Finishing Mill</td>
<td>4963 GFM</td>
<td>18,000</td>
<td>1,056</td>
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<td>050</td>
<td>Zinc Stearate Coat</td>
<td>Danly #SS-1-400 Straight Side Mechanical Extrusion Press</td>
<td>4966 GFM</td>
<td>1,800</td>
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<td>Extrusion</td>
<td>Ransohoff (3) Stage Spiral Drum Washer</td>
<td>2857 C</td>
<td>25,000</td>
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<td>090</td>
<td>Anneal Condition &quot;O&quot;</td>
<td>Despatch Gas-Fired recirculating oven</td>
<td>765 C</td>
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<td>1,056</td>
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<td>095</td>
<td>Anneal Inspection</td>
<td>Advanced Curing (3) Stage Spiral Drum Washer w/Heated Dry-off section</td>
<td>4959 GFM</td>
<td>8,500</td>
<td>1,056</td>
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<tr>
<td>100</td>
<td>Deoxidize 4-Soap Coat</td>
<td>Danly #SA-1-100 Straight side Mechanical Press</td>
<td>4965 GFM</td>
<td>3,600</td>
<td>1,056</td>
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<tr>
<td>110</td>
<td>Draw</td>
<td>V &amp; O Trimmers Model 1983 w/Trim Arbor &amp; Rotating knife (2 required)</td>
<td>2425 GFM</td>
<td>2,100</td>
<td>528</td>
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<tr>
<td>115</td>
<td>Draw Inspection</td>
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<td>2134 GFM</td>
<td>2,300</td>
<td>528</td>
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<tr>
<td>120</td>
<td>Trim</td>
<td>Bliss #7 Horizontal Double Crankshaft Mechanical Press</td>
<td>4964 GFM</td>
<td>2,820</td>
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<td>125</td>
<td>Trim Inspection</td>
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<tr>
<td>130</td>
<td>Head</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>135</td>
<td>Head Inspection</td>
<td></td>
<td></td>
<td></td>
<td></td>
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**EXHIBIT III**
## Equipment Demonstrated for 160,000/UD Capability

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<thead>
<tr>
<th>Operation No.</th>
<th>Operation Description</th>
<th>Equipment Description</th>
<th>Ownership (Gr. Furnished or Contractor)</th>
<th>Equipment Cycle Rate (100% Efficient)</th>
<th>Demonstrated Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td>Spray Wash</td>
<td>Ransohoff (3)Stage Mesh Bolt Conveyor type Washer w/Cold air dry off</td>
<td>C</td>
<td>24,300</td>
<td>1,056</td>
</tr>
<tr>
<td>150</td>
<td>Solution Heat Treat T4</td>
<td>Pacific Scientific Gas Fired Pusher type Quench Furnace</td>
<td>C</td>
<td>6,480</td>
<td>1,056</td>
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<tr>
<td>155</td>
<td>T-4 Inspection</td>
<td>Despatch Model DT200 Gas Fired Artificial Age Oven</td>
<td>C</td>
<td>1,388</td>
<td>1,056</td>
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<tr>
<td>160</td>
<td>Artificial Age T-6</td>
<td>Special Design Air Driven 6-Spindle Drilling Machine w/rotary Index Table (2 Req'd)</td>
<td>GPM</td>
<td>1,020</td>
<td>352</td>
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<tr>
<td>170</td>
<td>Drill Vent Holes</td>
<td>Despatch Model DT200 Gas Fired Artificial Age Oven</td>
<td>C</td>
<td>1,020</td>
<td>352</td>
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<tr>
<td>175</td>
<td>Vent Hole Inspection</td>
<td>1-5/8-TA 6-Spindle Conomatic Chucking type Screw Machine (2 Required)</td>
<td>GPM</td>
<td>660</td>
<td>528</td>
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<tr>
<td>180</td>
<td>Head Turn</td>
<td>See Operation #140</td>
<td></td>
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<tr>
<td>185</td>
<td>Head Turn Inspection</td>
<td>Baldwin 60 HVL Universal Testing Machine</td>
<td>C</td>
<td></td>
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<tr>
<td>190</td>
<td>Spray Wash</td>
<td>M.S.O. Vertical Head Trimming Machine w/rotary Index Table (2 required)</td>
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<td>1,020</td>
<td>528</td>
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<tr>
<td>200</td>
<td>Final Trim, Size &amp; Chamfer</td>
<td>A.C.A. Titanium Belt Type Anodize line</td>
<td>C</td>
<td>4,500</td>
<td>1,056</td>
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<tr>
<td>220</td>
<td>Final Inspection (Salt Spray)</td>
<td>Salt Spray Cabinet</td>
<td>GPM</td>
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<tr>
<td>230</td>
<td>Mark &amp; Pack</td>
<td>Kiwi Coder Part Inking Machine</td>
<td>GPM</td>
<td>3,960</td>
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## EXHIBIT IV

### M169 Cartridge Case

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<th>OPERATION DESCRIPTION</th>
<th>TEST DATES</th>
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<tbody>
<tr>
<td>020</td>
<td>Cut Slugs</td>
<td>10-3-84 / 10-12-84</td>
</tr>
<tr>
<td>030</td>
<td>Clean &amp; Etch</td>
<td>10-3-84 / 10-12-84</td>
</tr>
<tr>
<td>060</td>
<td>Zinc Stearate Coat</td>
<td>10-3-84 / 10-12-84</td>
</tr>
<tr>
<td>070</td>
<td>Extrusion</td>
<td>10-3-84 / 10-12-84</td>
</tr>
<tr>
<td>080</td>
<td>Acid Clean</td>
<td>10-3-84 / 10-12-84</td>
</tr>
<tr>
<td>090</td>
<td>Anneal Condition &quot;O&quot;</td>
<td>10-3-84 / 10-15-84</td>
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<tr>
<td>100</td>
<td>Deoxidize &amp; Soap Coat</td>
<td>10-12-84 / 10-25-84</td>
</tr>
<tr>
<td>110</td>
<td>Draw</td>
<td>10-12-84 / 10-31-84</td>
</tr>
<tr>
<td>120</td>
<td>Trim</td>
<td>10-12-84 / 10-31-84</td>
</tr>
<tr>
<td>130</td>
<td>Head</td>
<td>10-12-84 / 10-25-84</td>
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<tr>
<td>140</td>
<td>Spray Wash</td>
<td>10-12-84 / 10-19-84</td>
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<tr>
<td>150</td>
<td>Solution Heat Treat T-4</td>
<td>10-12-84 / 10-30-84</td>
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<td>160</td>
<td>Artificial Age T-6</td>
<td>10-12-84 / 10-19-84</td>
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<tr>
<td>170</td>
<td>Drill Vent Holes</td>
<td>10-24-84 / 11-01-84</td>
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<tr>
<td>180</td>
<td>Head Turn</td>
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<tr>
<td>190</td>
<td>Spray Wash</td>
<td>10-12-84 / 10-19-84</td>
</tr>
<tr>
<td>200</td>
<td>Final Trim, Size &amp; Chamfer</td>
<td>11-01-84 / 11-15-84</td>
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<tr>
<td>210</td>
<td>Anodize</td>
<td>10-18-84 / 10-30-84</td>
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<tr>
<td>220</td>
<td>Final Insp. (Vent Hole Inspection)</td>
<td>11-01-84 / 11-09-84</td>
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<td>230</td>
<td>Mark &amp; Pack</td>
<td>11-01-84 / 11-09-84</td>
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<td>OPER. NO.</td>
<td>OPERATION DESCRIPTION</td>
<td>QTY ON HAND</td>
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<td>-------------</td>
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<tr>
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<td>Cut Slugs</td>
<td>1</td>
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<tr>
<td>030</td>
<td>Clean &amp; Etch</td>
<td>1</td>
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<tr>
<td>050</td>
<td>Zinc Stearate Coat</td>
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</tr>
<tr>
<td>070</td>
<td>Extrusion</td>
<td>1</td>
</tr>
<tr>
<td>080</td>
<td>Acid Clean</td>
<td>1</td>
</tr>
<tr>
<td>090</td>
<td>Anneal Condition &quot;O&quot;</td>
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<tr>
<td>100</td>
<td>Deoxidize &amp; Soap Coat</td>
<td>1</td>
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<tr>
<td>110</td>
<td>Draw</td>
<td>1</td>
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<td>120</td>
<td>Trim</td>
<td>2</td>
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<td>130</td>
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<td>Solution Heat Treat T-4</td>
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<td>Artificial Age T-6</td>
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<td>170</td>
<td>Drill Vent Holes</td>
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<td>180</td>
<td>Head Turn</td>
<td>2</td>
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<tr>
<td>190</td>
<td>Spray Wash</td>
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</table>

1. REQUIRED TO MEET FACILITY DESIGN PRODUCTION RATE.
2. PERCENT RATE = 1.(NO GOOD PIECES(NO REWORK) /TOTAL PRODUCED) 100
3. PIECES/HR OR SHIFT, ETC.

EXHIBIT V
<table>
<thead>
<tr>
<th>OPER. NO.</th>
<th>OPERATION DESCRIPTION</th>
<th>QTY ON HAND</th>
<th>QTY IN TEST</th>
<th>OBSERVED AVAILABILITY</th>
<th>REJECT RATE</th>
<th>REQUIRED RATE</th>
<th>OBSERVED RATE</th>
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</thead>
<tbody>
<tr>
<td>200</td>
<td>Final Trim, Size &amp; Chamfer</td>
<td>2</td>
<td>2</td>
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<td>.974</td>
<td>8.2 P.P.M.</td>
<td>18.48</td>
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<td>210</td>
<td>Anodize</td>
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<tr>
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<td>Inspect Vent Holes</td>
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<td>1</td>
<td>.993</td>
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<td>8.2 P.P.M.</td>
<td>21.38</td>
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</table>

1. REQUIRED TO MEET FACILITY DESIGN PRODUCTION RATE.
2. PERCENT RATE = \[\frac{\text{NO GOOD PIECES}(\text{NO REWORK})}{\text{TOTAL PRODUCED}}\] × 100
3. PIECES/HR OR SHIFT, ETC.

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