First Article Inspection of BSU-33B/B Bomb Fins

Marc S. Pepi

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Weapons & Materials Research Directorate

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Abstract

A thorough examination of the manufacturing sequences involved in the fabrication of the BSU-33B/B bomb fins was performed by the U.S. Army Research Laboratory (ARL), Weapons and Materials Research Directorate (WMRD). The welding, zinc phosphate, and powder coating processes were evaluated with respect to the governing specifications, as was the finished product. With respect to the welding, the apparatus, procedures, and personnel all conformed to the governing requirements. The zinc phosphate process appeared suitable, as evidenced by the uniform coating on the First Article (FA) bomb fins. Also, coating weights of panels, which were run on the same production line as the FA bomb fins, met the governing requirement. The powder coating was applied according to the governing specification, and the physical attributes of the coating conformed to the requirements of this specification, with the exception of the fin wedges, which were slightly below the required thickness. Recommendations were offered as a result of this inspection.
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FIRST ARTICLE INSPECTION OF BSU-33B/B BOMB FINS

1. PURPOSE

The Naval Air Warfare Center (NAWC) requested the U.S. Army Research Laboratory (ARL) to provide technical support during a first article inspection (FAI) of BSU-33B/B bomb fins at Morris Tool and Die (MTD), Greeneville, Tennessee. ARL was asked to evaluate the welding, zinc phosphate, and powder coating processes, as well as the finished products. The recommendations listed are to provide completeness, rather than to indicate nonconformance.

2. CONCLUSIONS

2.1 Welding

MTD performed the welding operations for the BSU-33B/B in accordance with the governing specifications, and Mr. Scott Fawbush (the anticipated welder for the duration of the contract) was certified per MIL-STD-1595. The welding apparatus used by MTD also conformed to the governing requirements.

2.2 Zinc Phosphate

The five-stage spray zinc phosphate process at MTD conformed to the requirements of Federal specification TT-C-490. The coating weight and other stage measurements were all conducted in accordance with TT-C-490. Five fins subjected to the process while ARL representatives were present showed evidence of streaking and a minimal amount of white powder. MTD stated that this typically occurred to the first few fins which were coated with zinc phosphate and that once “warmed up,” the coating is continuous and free from defects. Test panels that were run with the FAI bomb fins showed no evidence of streaking or white powder and conformed to TT-C-490.

2.3 Powder Coating

MTD performed the powder coating operations for the BSU-33B/B in accordance with the governing specification, WSD-C-0181. The coating process and equipment were inspected by ARL personnel. The physical attributes, including thickness, of the dried coating all conformed to WSD-C-0181 for all parts of the fin assembly except the fin wedges, which were slightly under the average thickness requirement of 3.0 to 5.0 mils (2.4 mils). The powder used was “out of date” according to the shelf life requirement; however, MTD experienced no application...
difficulties, and ARL had no objections to its final characteristics. The powder was therefore determined to be adequate for the FAI as well as for the production of the bomb fins as long as application and appearance problems did not arise.

3. WELDING PROCESS

The BSU-33B/B bomb fins are welded in a number of locations, as summarized in Table 1.

Table 1

BSU-33B/B Weldments

<table>
<thead>
<tr>
<th>Part</th>
<th>Drawing Number</th>
<th>Weld Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spar Assembly, Conical Fin</td>
<td>2846770</td>
<td>MIL-W-12332</td>
</tr>
<tr>
<td>Ring, Adapter, Conical Fin</td>
<td>4902079</td>
<td>MIL-W-6873</td>
</tr>
<tr>
<td>Fin Assembly</td>
<td>923AS150</td>
<td>MIL-W-12332</td>
</tr>
<tr>
<td>Port, Fuze</td>
<td>923AS153</td>
<td>MIL-STD-2219</td>
</tr>
<tr>
<td>Skin, Conical Fin</td>
<td>923AS286</td>
<td>MIL-W-12332</td>
</tr>
<tr>
<td>Nut Assembly, Self-Locking</td>
<td>923AS292</td>
<td>MIL-W-6858</td>
</tr>
<tr>
<td>Fin Assembly, Bomb, BSU-33B/B</td>
<td>923AS641</td>
<td>MIL-STD-2219</td>
</tr>
</tbody>
</table>

ARL personnel witnessed pull testing performed on test coupons sectioned from the welded adapter ring (butt weld) and on the welded conical fin skin (seam weld). In addition, the welding apparatus was examined, as well as the MTD written weld procedures.

3.1 Pull Testing

Pull testing was performed on nine butt weld coupons sectioned from the adapter ring and on five seam weld coupons from the conical fin skin. The governing drawings required a pull load of 2,600 pounds per linear inch of coupon. This load was based upon a nominal carbon steel sheet thickness of 0.060 inch. However, the tolerance for this sheet is ±0.006 inch. Therefore, the thickness could range from 0.054 inch to 0.066 inch. With any variation from the nominal thickness (and width), the final pull load must be adjusted accordingly. This interpolation was deemed acceptable by both the Government representatives and the MTD representatives present at the FAI. The carbon steel sheet with which the conical fin skin was fabricated was 0.057 inch thick, as measured during the FAI. The 0.057-inch thickness was 95% of the nominal 0.060
thickness. Therefore, each actual load was divided by 0.95 to calculate the adjusted load. The actual load of coupon 3D was also divided by 0.75, since the width was only 0.75 inch, rather than the nominal 1.0 inch. Table 2 lists the actual loads attained during MTD testing with ARL personnel present, as well as the adjusted loads (with accompanying comments). Appendix A contains the actual loads attained during testing at MTD. Table 3 contains the results of testing performed by MTD before ARL arrived. Pull testing was performed on a Baldwin 120,000-pound capacity tension/compression machine, No. 040-1984, Model No. 12-H. The machine was calibrated on 31 January 1996 and was due for calibration 30 January 1997. The pull rate used was approximately the required 0.5 inch/minute. The pull rate was manually controlled and difficult to maintain at exactly the required rate, especially once yielding occurred.

Table 2

Weldment Coupon Pull Loads
Testing Witnessed by ARL

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Weld Type</th>
<th>Actual Load (lb)</th>
<th>Width (inch)</th>
<th>Thickness (inch)</th>
<th>Adjusted Load (lb)</th>
<th>Failure Location</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>1B</td>
<td>Butt</td>
<td>2630</td>
<td>1.0</td>
<td>0.057</td>
<td>2770</td>
<td>Parent</td>
<td>Retest*</td>
</tr>
<tr>
<td>2A</td>
<td>Butt</td>
<td>2580</td>
<td>1.0</td>
<td>0.057</td>
<td>2715</td>
<td>Parent</td>
<td>Retest*</td>
</tr>
<tr>
<td>2C</td>
<td>Butt</td>
<td>2550</td>
<td>1.0</td>
<td>0.057</td>
<td>2685</td>
<td>Parent</td>
<td></td>
</tr>
<tr>
<td>3A</td>
<td>Butt</td>
<td>2720</td>
<td>1.0</td>
<td>0.057</td>
<td>2865</td>
<td>Parent</td>
<td>~2.0&quot;/min</td>
</tr>
<tr>
<td>3B</td>
<td>Butt</td>
<td>2620</td>
<td>1.0</td>
<td>0.057</td>
<td>2760</td>
<td>Parent</td>
<td></td>
</tr>
<tr>
<td>3C</td>
<td>Butt</td>
<td>2620</td>
<td>1.0</td>
<td>0.057</td>
<td>2760</td>
<td>Parent</td>
<td></td>
</tr>
<tr>
<td>5A</td>
<td>Butt</td>
<td>2510</td>
<td>1.0</td>
<td>0.057</td>
<td>2640</td>
<td>Parent</td>
<td></td>
</tr>
<tr>
<td>5B</td>
<td>Butt</td>
<td>2615</td>
<td>1.0</td>
<td>0.057</td>
<td>2750</td>
<td>Parent</td>
<td></td>
</tr>
<tr>
<td>5C</td>
<td>Butt</td>
<td>2530</td>
<td>1.0</td>
<td>0.057</td>
<td>2665</td>
<td>Parent</td>
<td></td>
</tr>
<tr>
<td>4D</td>
<td>Seam</td>
<td>2650</td>
<td>1.0</td>
<td>0.057</td>
<td>2790</td>
<td>Parent</td>
<td></td>
</tr>
<tr>
<td>4E</td>
<td>Seam</td>
<td>2730</td>
<td>1.0</td>
<td>0.057</td>
<td>2875</td>
<td>Parent</td>
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</tr>
<tr>
<td>5D</td>
<td>Seam</td>
<td>2680</td>
<td>1.0</td>
<td>0.057</td>
<td>2820</td>
<td>Parent</td>
<td></td>
</tr>
<tr>
<td>5E</td>
<td>Seam</td>
<td>2740</td>
<td>1.0</td>
<td>0.057</td>
<td>2885</td>
<td>Parent</td>
<td></td>
</tr>
<tr>
<td>3D</td>
<td>Seam</td>
<td>2030</td>
<td>0.75</td>
<td>0.057</td>
<td>2850</td>
<td>Parent</td>
<td></td>
</tr>
</tbody>
</table>

* - Retested after grip slippage
Table 3
Weldment Coupon Pull Loads Testing Performed by MTD Before ARL Arrived

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Weld Type</th>
<th>Actual Load (lb)</th>
<th>Width (inch)</th>
<th>Thickness (inch)</th>
<th>Adjusted Load (lb)</th>
<th>Failure Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>Butt</td>
<td>2650</td>
<td>1.0</td>
<td>0.057</td>
<td>2790</td>
<td>Parent</td>
</tr>
<tr>
<td>1C</td>
<td>Butt</td>
<td>2620</td>
<td>1.0</td>
<td>0.057</td>
<td>2760</td>
<td>Parent</td>
</tr>
<tr>
<td>2B</td>
<td>Butt</td>
<td>2520</td>
<td>1.0</td>
<td>0.057</td>
<td>2655</td>
<td>Parent</td>
</tr>
<tr>
<td>4A</td>
<td>Butt</td>
<td>2630</td>
<td>1.0</td>
<td>0.057</td>
<td>2770</td>
<td>Parent</td>
</tr>
<tr>
<td>4B</td>
<td>Butt</td>
<td>2530</td>
<td>1.0</td>
<td>0.057</td>
<td>2665</td>
<td>Parent</td>
</tr>
<tr>
<td>4C</td>
<td>Butt</td>
<td>2630</td>
<td>1.0</td>
<td>0.057</td>
<td>2770</td>
<td>Parent</td>
</tr>
<tr>
<td>1D</td>
<td>Seam</td>
<td>2620</td>
<td>1.0</td>
<td>0.057</td>
<td>2760</td>
<td>Parent</td>
</tr>
<tr>
<td>1E</td>
<td>Seam</td>
<td>2570</td>
<td>1.0</td>
<td>0.057</td>
<td>2705</td>
<td>Parent</td>
</tr>
<tr>
<td>2D</td>
<td>Seam</td>
<td>2640</td>
<td>1.0</td>
<td>0.057</td>
<td>2780</td>
<td>Parent</td>
</tr>
<tr>
<td>2E</td>
<td>Seam</td>
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<td>1.0</td>
<td>0.057</td>
<td>2790</td>
<td>Parent</td>
</tr>
<tr>
<td>3E</td>
<td>Seam</td>
<td>2620</td>
<td>1.0</td>
<td>0.057</td>
<td>2760</td>
<td>Parent</td>
</tr>
</tbody>
</table>

3.2 Pull Testing Recommendations

1. It was observed that the grip faces used for testing were worn. This contributed to slippage during testing. These faces should be replaced to reduce slippage.

2. ARL recommended to Mr. Gary Kirk that specimens should be gripped closer to the weld to help avoid slippage. This technique was successful.

3. ARL also recommended conducting a series of tests in the future to assure that the 0.5-in./min pull rate was being achieved.

3.2.1 Welding Apparatus

A tour was conducted of the off-site MTD welding facility, which included inspection of the welding apparatus. Equipment included a resistance welding machine that was used to weld the ends of the fins, a subsequent Niagara 32-ton press which basically flattened each of the four fins in preparation for the projection welds, a Progressive welding machine which performed the conical fin skin seam weld, a T/W welding machine which was used to spot weld the spar assembly pieces (four total) together, an Allied spot welder used to join the self-locking nut assembly, and two Airco Dip-Pak 200-arc welding units used for the ring adapter weld and the
final welding of the fin to the conical skin. Each of the first four welding units inspected was equipped with an Entron 460V controller. Mock fins were subjected to the welding operation at each stage for ARL to witness.

3.2.2 Review of MTD MIL-W-12332 Resistance Weld Procedure

As shown in Table 1, the conical fin spar assembly, the fin assembly, and the conical fin skin are resistance welded in accordance with MIL-W-12332. The MTD welding procedures were compared to the major requirements of MIL-W-12332 for conformance:

- Paragraph 3.2: The welding procedure shall include
  a. Metal alloy composition
  b. Thickness range of the metal
  c. Weld time range
  d. Metal cleaning procedure
  e. Welding current range
  f. Roll spot or seam welding travel speed

- MTD: MTD provided ARL with a resistance welding manual for spot, projection and seam welding for low carbon steel, which was written in accordance with MIL-W-12332. This three-page manual listed the major requirements of MIL-W-12332. ARL was also provided with resistance weld procedures for eight different resistance welds on the BSU-33B/B bomb fin. The eight individual written procedures (see Appendix B) were BSU-33B/B specific and compared as follows:
  a. Metal alloy composition - Only type of material listed, not composition
  b. Thickness range of the metal - Conformance
  c. Weld time range - Conformance
  d. Metal cleaning procedure - Procedure says part shall be clean; no method
  e. Welding current range - Conformance
  f. Welding travel speed - None listed

- Paragraph 4.1: The maximum carbon content shall be less than 0.20%
  The maximum manganese content shall be less than 0.60%

- MTD: The maximum carbon content of components from the BSU-33B/B bomb fin is 0.10% and the maximum manganese content of components from the BSU-33B/B bomb fin is 0.50%. Both of these contents are within specification.
• Paragraph 5.1: The welding machine shall consist of the following:

   a. Suitable source of energy
   b. Suitable electrodes
   c. Means of adequately cooling the electrodes
   d. Means of reliably controlling the magnitude of the current, welding force, and the
time of current flow

• MTD:

   a. Suitable source of energy - Conformance
   b. Suitable electrodes - Conformance
   c. Means of adequately cooling the electrodes - Conformance
   d. Means of reliably controlling the magnitude of the current, welding force and the time of
current flow - Conformance

• Paragraphs 6.2 and 7.3.1: All welds shall be subject to visual inspection, and the outer surfaces of the welds shall be smooth and free of cracks, tip pickup, pits, metal expulsion and other defects.

• MTD: A total of six welded and unpainted fins were visually examined by ARL with no evidence of the aforementioned defects.

• Paragraph 6.3: The welded assembly or specimens shall be peel tested in accordance with paragraph 7.3.3.

• MTD: ARL was provided with the results of MTD peel testing of preproduction spot welds. The three spot welds failed at 3,700, 3,575, and 3,650 pounds, respectively, which conformed to the minimum requirement of 2,600 pounds. These results are listed in Appendix C. The MTD result sheet did not include the resultant nugget diameters as a result of this testing.

Recommendations Concerning MIL-W-12332:

1. MTD should include the “material composition” on the resistance welding procedure sheets.

2. MTD should include the “method of cleaning” on the resistance welding procedure sheets.

3. MTD should list the “roll spot or seam welding travel speed” requirement on the resistance welding procedure sheets.

4. MTD should include “nugget size” on the peel test result sheet.
3.2.3 Review of MTD MIL-STD-2219 Fusion Weld Procedure

As shown in Table 1, the fuze port and the fin assembly are fusion welded in accordance with MIL-STD-2219. The MTD welding procedures were compared to the major requirements of MIL-STD-2219 for conformance.

- Paragraph 1.2: Fusion welding shall be accomplished using flux cored arc welding (FCAW), gas metal arc welding (GMAW), gas tungsten arc welding (GTAW), oxyfuel welding (OFW), plasma arc welding (PAW), submerged arc welding (SAW), or shielded metal arc welding (SMAW).

- MTD: MTD uses the GMAW procedure for BSU-33B/B fusion weldments.

- Paragraph 3.1.2: Operators shall be qualified per MIL-STD-1595.

- MTD: ARL was provided with the MTD welder certification sheet (see Appendix D). Mr. Scott Fawbush was the certified welder and the anticipated welder for the duration of the BSU-33B/B contract. The certification showed that Mr. Fawbush’s specimens passed radiographic, magnetic particle, and visual inspection. The results of destructive testing of representative specimens welded by Mr. Fawbush met the required 2,600-pound pull force minimum (specimens F and G were 0.75 inch wide, and 0.057 inch thick for adjusted pull forces of 2,710 and 2,610 pounds, respectively). The certification sheet does not state that the welder was certified per MIL-STD-1595. However, when asked, MTD representatives stated that the qualification was per MIL-STD-1595.

- Paragraph 5.4.2.3: All Class B welds shall be radiographically inspected when specified on the drawing or in the contract.

- MTD: ARL was provided with the results of radiography performed by the Industrial NDT (nondestructive test) Company, a Liberty Technologies Inc. (see Appendix E). Test specimens, as well as bomb fin assemblies, were inspected. ARL also examined the radiographic films provided by the Industrial NDT Company and noted no nonconforming defects.

- Table 5-3: Minimum fillet weld sizes.

- MTD: The fillet weld sizes, as measured on the FAI bomb fins, met the minimum requirements of Table 5-3.

- Para 5.4.5.1: Any weldment with cracks in the base metal shall be rejected.
• MTD: Visual examination of the FAI bomb fins did not reveal any cracks in the weldments of the parent material.

3.2.4 Weld Depth of Penetration

A representative butt (Specimen 5B) and seam (Specimen 5E) weld pull test coupon were returned to ARL for examination of the penetration depth through metallography. The samples were sectioned, mounted, and metallographically prepared. The polished samples were etched with 1% nital in order to reveal the depth of penetration. Figures 1 and 2 show the butt and seam weld, respectively. The photomacrographs show an acceptable depth of penetration for each of the welds.

Recommendation concerning MIL-STD-2219:

1. MTD should ensure that the welder certification sheet states that the welder is certified per MIL-STD-1595.

Figure 1. Macrograph of the Butt Weld From Pull Test Specimen No. 5B. (The depth of penetration was acceptable; magnification 7.5x.)
4. ZINC PHOSPHATE PROCESS

The BSU-33B/B bomb fins were required to be coated with zinc phosphate per the governing drawings. Although MTD was not involved in an actual production run at the time of the FAI, Mr. Joe Morris, Jr., ran a total of five bomb fins through the system. The process began with the hand wiping of each fin with a solution of Intex Product No. 405L (major component: toluene) mixed 10% 405L with 90% water. The bomb fins were hung on a conveyor system with the adapter ring end up and fuze support down. The conveyor system ran at a rate of 3 feet per minute. The zinc phosphate process encompassed a five-stage spray system. The first stage was hot alkaline cleaning with EZE No. 330C, followed by an ambient temperature clean water rinse with continuous overflow. The third stage was zinc phosphate with EZE Nos. 176 and 8695, followed by another ambient temperature clean water rinse with continuous overflow. The final stage was the application of a rust-inhibitive rinse EZE No. 8828. The five fins showed some evidence of streaking and minimal white powder after emerging from the zinc phosphate process, which, according to Mr. Kirk, is typical of the first few parts that are treated with zinc phosphate. These fins also exhibited a very light gray coating. The fifth fin was darker and showed less streaking and white powder than the first fin, suggesting that the process was getting progressively better. Mr. Kirk assured ARL that parts exhibiting any white powder are not subsequently top coated and are removed from the line. ARL also examined 4- by 6-inch panels that were treated with zinc phosphate, along with the FAI bomb fins. These panels showed no evidence of streaking.
or white powder and were very uniform in color (dark gray). The MTD zinc phosphate procedure sheets and process were compared to the major requirements of TT-C-490:

• Paragraph 3.3a: Parts shall be free of oil, grease, dirt, scale, and foreign matter.

• MTD: The toluene hand wiping of the fins before the zinc phosphate process appeared to effectively eliminate foreign matter and welding smut from the fins.

• Paragraph 3.3b: Rinsing shall be performed to remove alkali or acid from the cleaning operation. The rinsing stations shall be tested for contaminants every 4 hours of production.

• MTD: Conformance.

• Paragraph 3.3c: Drying shall be the final stage of each cleaning process unless followed immediately by the Type I process.

• MTD: Parts are dried in a furnace at 285° to 310° F for approximately 10 minutes (310° F is optimal for the application of the powder coating). This drying stage immediately follows the five-stage zinc phosphate process.

• Paragraph 3.5.1a: Type I coatings shall be continuous.

• MTD: As mentioned previously, the first five fins that were treated with phosphate at the beginning of the day exhibited streaking and slight evidence of white powder; however, panels coated with the FAI fins (after the process had been running) conformed to Paragraph 3.5.1a.

• Paragraph 3.5.1c: The coating weight shall be tested at least every 4 hours of production.

• MTD: Conformance (see Appendix F for an example of the MTD panel coating weight test, as well as bath measurements).

• Paragraph 3.5.1d: Panels subjected to salt spray testing shall show no more than 1/8 inch creepage, blistering, or loss of adhesion from the scribe mark.

• MTD: The 1000-hour salt spray testing for the entire coating system (See Powder Coating Section) was in progress at the time of inspection. After approximately 600 hours of testing, only 1/16 inch creepage was noted from the scribe marks, and there was no evidence of blistering. It was anticipated that the panels would pass the requirements of Paragraph 3.5.1d.

• Paragraph 4.2.4.1: Total alkali contamination.

• MTD: Conformance.
• Paragraph 4.2.4.2: Total acid contamination.

• MTD: Conformance.

• Paragraph 4.2.6: Phosphate coating weights.

• MTD: The coating weight was measured in accordance with TT-C-490, and typical panel weights (as shown in Appendix F) showed conformance to Type I coating weights (150 to 500 mg/ft²).

• Paragraph 6.5: Required stages of the zinc phosphate process.

• MTD: MTD met the minimum stage requirement listed in TT-C-490 (Appendix G is a copy of MTD's zinc phosphate description of process):

   a. Stage 1: Cleaning
   b. Stage 2: Rinse (125° to 180° F) with constant overflow of fresh water.
   c. Stage 3: Zinc phosphate
   d. Stage 4: Water rinse with constant overflow
   e. Stage 5: Acidified rinse

4.1 Other Zinc Phosphate Comments

The temperature controls on the alkali cleaner bath (Stage 1), the zinc phosphate bath (Stage 3), and the sealer bath (Stage 5) had not been calibrated since 1991. Joseph Morris, Jr., indicated that the temperatures were periodically measured manually with a hand-held thermometer for conformance.

5. POWDER COATING PROCESS

The BSU-33B/B bomb fins are required to be powder coated per the governing specifications. MTD powder coated a total of five bomb fins for ARL to witness and inspect. The bomb fins came to the coating station immediately after the 285° to 310° F drying stage following the phosphating process. Because of the minimal cooling time before powder coating, the bomb fins were coated at an elevated temperature conducive to good coating adhesion and appearance. The powder coating station consisted of Nordson spray equipment, a powder collection booth, powder collection filters, reclamation receptacles, and Valspar Powder Code No. 1007A77. The oversprayed powder can be blown out of the collection filters and reused. The sprayed parts were then transferred to a baking oven where they were baked at 380° to
400°F for approximately 20 to 25 minutes, which was adequate to cure the powder. In the interest of time and money, only the most pertinent performance requirements were verified for conformance. They included salt spray resistance, flexibility, knife testing, and adhesion testing. ARL examined three final article bomb fins and five cured powder coated bomb fins and was provided with 10 powder coated panels to test further.

5.1 Salt Spray Resistance

• Paragraph 3.13: A cured film shall show undercutting of no more than 6.3 mm (0.25 inch) from the lines scored to base metal. There shall also be no blistering, wrinkling, or loss of adhesion of the coating nor any general surface corrosion or pitting.

• Paragraph 4.7.10: Two panels shall be exposed in accordance with American Society for Testing and Materials (ASTM) B 117.

• Paragraph 4.7.10: Exposure time shall be 1000 hours minimum (4.7.10).

• MTD: These panels passed this test at ARL. The 1000-hour salt spray testing was in progress at MTD at the time of inspection. After approximately 600 hours of testing, only 1/16 inch creepage was noted from the scribe marks, and there was no evidence of blistering. It was anticipated that the panel would pass the requirements of Paragraph 4.7.10.

5.2 Film Properties

• Paragraph 3.4: a. Coatings shall have a total dry film thickness for interior and exterior surfaces of 3 to 5 mils.

b. Coating shall be free of runs, sags, and streaks.

• MTD: The MTD technician had the ability to apply a total dry film thickness (DFT) of 3 to 5 mils. All parts with the exception of the fin wedges (2.4 mils DFT) met this requirement. The coating appearance conformed to the requirement.

<table>
<thead>
<tr>
<th>Triglycidyl Isocyanurate (TGIC) Area (mils)</th>
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<tbody>
<tr>
<td><strong>Average Thickness</strong></td>
</tr>
<tr>
<td>Fin</td>
</tr>
<tr>
<td>Door</td>
</tr>
<tr>
<td>Wedge</td>
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</table>

12
5.3 Flexibility

• Paragraph 3.6: The cured film shall show no cracking or loss of adhesion in the bend areas.

• Paragraph 4.6.3: Coating shall be 3 mils ±0.5 mil thick.

• Paragraph 4.7.3: Panels bent 180° over a 0.5-inch mandrel in accordance with ASTM-D-1737.

• MTD: Conformance.

5.4 Knife Test

• Paragraph 3.7: The cured film shall adhere tightly and not flake, crack, or powder from the metal. The cut shall show beveled edges.

• Paragraph 4.7.4: Perform on flat portion of flexibility panel; use standard knife at ~30° angle.

• Paragraph 4.7.4: Procedure in accordance with FED-STD-141, Method 6304.

• MTD: Conformance.

5.5 Adhesion

• Paragraph 3.8: The cured film shall show no lifting, flaking or other signs of loss of adhesion when tested.

• Paragraph 4.7.5: Two parallel scratches shall be made through the coating 1 inch apart, no less than 2 inches long, using a stylus on two panels.

• Paragraph 4.7.5: A 1-inch wide strip of masking tape in accordance with ASTM D 3652 shall be placed perpendicular to scratches. The tape shall be pressed down using two passes of a 5-pound rubber roller.

• Paragraph 4.7.5: The tape shall be removed in one abrupt motion, at 90° to each panel.

• MTD: Conformance.
5.6 Recommendations Concerning the Powder Coating Process

a. The average coating thickness on the fin wedges should be increased from the present 2.4 mils to the requirement of 3 to 5 mils.

b. Overall, the coating thickness measurements were on the low end of the required range. ARL noticed that the spacing between the fins should be increased to allow sufficient time to apply a 3.0- to 5.0-mil coating DFT. However, even with the very first bomb fin, the average coating DFT was just over 3.0 mils. This suggests that the technician barely has enough time to apply a 3.0-mil coating DFT before the bomb fin leaves the spray station at the present line speed rate of 3 ft/min.

c. Written procedures were provided to ARL for the powder coating process; however, no stipulation is made to qualify the spray technician to the process. Establishing tighter control methods of the spray process appears to be necessary.

d. While the Valspar powder product appeared satisfactory at the time of the FAI, it is recommended that in the future the shelf life requirement be followed.

6. IMPROVEMENTS MADE SINCE THE 15 TO 18 APRIL 1991 MK83 FAI

*1991: No written welding procedures had been established.
*1996: Welding procedures were available for both the fusion and resistance welding processes.

*1996: ARL was provided with the welder certification sheet, but the sheet failed to state that the welder was certified per MIL-STD-1595.

*1991: Grease was observed on parts subjected to the zinc phosphate process, the results of poor prior cleaning.
*1996: No signs of grease were noted on the five fins subjected to the zinc phosphate process, indicating adequate prior cleaning.

*1991: Streaking and white powder were noted on the parts during production.
*1996: Streaking and white powder were noted on parts subjected to the zinc phosphate process, but, as mentioned earlier, this was not a production run, and MTD assured ARL that this condition would have merited adjustment of the accelerator concentration, and that the parts would not have been top coated. Also, test panels subjected to the zinc phosphate process with the FAI fins showed no evidence of streaking or white powder.
1991: No temperature calibration was performed at the various stages of the zinc phosphate process.

1996: Although the temperature controls have not been calibrated since 1991, manual temperature measurement is performed by MTD personnel at the appropriate intervals.

1991: Bomb fins were allowed to collect dust and other shop debris before the primer and paint were applied.

1996: Bomb fins on an overhead lift proceed from the hand clean operation to the zinc phosphate process, to the dry-off furnace and subsequently directly to the powder coating booth, allowing essentially no lag time where foreign matter could possibly collect.
APPENDIX A

BSU-33 B/B FIN ASSEMBLY WELD TEST REPORT
BSU-33 B/B FIN ASSEMBLY WELD TEST REPORT

**Contract No:** DAAA09-98-C-0102  
**Drawing No:** 923A5641 REV. D, BSU.33 B/B FIN ASSEMBLY

**Date:** 11-27-96  
**Lot No:** First Article  
**Quantity:** 5

<table>
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<tr>
<th>Specimen Description</th>
<th>Actual Test Results - 2600 lb Force Minimum</th>
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<tr>
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<td>Unit 1</td>
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<tr>
<td>A Finskin to Adapter Ring</td>
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<tr>
<td>B Finskin to Adapter Ring</td>
<td>2630</td>
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<tr>
<td>C Finskin to Adapter Ring</td>
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</tr>
<tr>
<td>D Side Seam</td>
<td>2620</td>
</tr>
<tr>
<td>E Side Seam</td>
<td>2570</td>
</tr>
</tbody>
</table>

*Force Applied at 1/2"/Min*

**Figure 1:** Specimen 3 Places A, B, C  
**Figure 2:** Specimen 2 Places D, E

**Identify all specimens with unit No. and specimen No. (5A, 5B, 5C etc.)

**Pass/Fail**

**Inspector:**  
**Date:** 11-27-96

**Figure 3:** Site and location of seam weld specimens

**Figure 4:** Site and location of seam weld specimens

**Inspector:** Gary D. Kirk  
**Date:** 11-27-96
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APPENDIX B

RESISTANCE WELDING PROCEDURES
RESISTANCE WELDING PROCEDURES

DRAWING NO. 423 AS150

PART NAME Fin Assembly

DESCRIPTION OF WELD

Resistance Weld Spar to Fin, 4 Hits - 48 Projections.

MATERIAL USED

THICKEST PART .060 + .006
THINNEST PART .060 - .006
TYPE OF MATERIALS ASTM A1620

PROCESSED CONDITION OF MATERIAL TO BE WELDED CLEAN (FREE OF DIRT AND OIL)

WELDING SEQUENCE TIMING SCHEDULE

SQUEEZE TIME 82 MIN. SETTING 77 MAX. SETTING 87
WELD TIME 38 MIN. SETTING 33 MAX. SETTING 43
HOLD TIME 15 MIN. SETTING 10 MAX. SETTING 20
ELECTRODE FORCE (PSI on CYLINDER) 40
MIN. SETTING 30 MAX. SETTING 50
CURRENT SETTING 78 MIN. SETTING 73 MAX. SETTING 83
ELECTRODE USED Copper Electrode 4 x 6

MACHINE USED

________________________________________

23
RESISTANCE WELDING PROCEDURES

DRAWING NO. 923AS150

PART NAME Fin Assembly

DESCRIPTION OF WELD
Spot each fin at locations shown (8 spots total)

MATERIAL USED
THICKEST PART .060 + .006
THINNEST PART .060 - .006
TYPE OF MATERIALS ASTM A441
PROCESSED CONDITION OF MATERIAL TO BE WELDED Clean (Free of dirt and oils)

WELDING SEQUENCE TIMING SCHEDULE
SQUEEZE TIME 64 MIN. SETTING 59 MAX. SETTING 69
WELD TIME 43 MIN. SETTING 38 MAX. SETTING 48
HOLD TIME 30 MIN. SETTING 25 MAX. SETTING 35
ELECTRODE FORCE (PSI on CYLINDER) 25
MIN. SETTING 20 MAX. SETTING 30
CURRENT SETTING 50 MIN. SETTING 40 MAX. SETTING 60
ELECTRODE USED Copper Tipped Electrode .300 Dia.

MACHINE USED

24
RESISTANCE WELDING PROCEDURES

DRAWING NO. 923A5150

PART NAME Fin Assembly

DESCRIPTION OF WELD

Resistance weld four (4) fins per attached drawing.

WELD SPEED - 60"/MIN.

MATERIAL USED

THICKEST PART .060 + .006
THINNIEST PART .060 - .006

TYPE OF MATERIALS ASTM A1640

PROCESSED CONDITION OF MATERIAL TO BE WELDED Clean (free of dirt and oil)

WELDING SEQUENCE TIMING SCHEDULE

SQUEEZE TIME N/A MIN. SETTING MAX. SETTING

WELD TIME 8 HEAT 4 COOL MIN. SETTING 7 HEAT 3 COOL MAX. SETTING 2 HEAT

HOLD TIME N/A MIN. SETTING MAX. SETTING

ELECTRODE FORCE (PSI on CYLINDER) 70
MIN. SETTING 50 MAX. SETTING 90

CURRENT SETTING 58 MIN. SETTING 53 MAX. SETTING 63

ELECTRODE USED Copper wheel with 7/16 welding face

MACHINE USED

25
RESISTANCE WELDING PROCEDURES

DRAWING NO. 2846770
PART NAME SPAR ASSEMBLY, CONICAL FIN

DESCRIPTION OF WELD
RESISTANCE WELD 4 SPAR
SEGMENTS TOGETHER AT WELD
PROTENSIONS AS INDICATED ON
DRAWING (52 PLACES)

MATERIAL USED
THICKEST PART .060 ± .006
THINNEST PART .060 ± .006
TYPE OF MATERIALS
PROCESSED CONDITION OF MATERIAL TO BE WELDED CLEAN (FREE
OF DIRT AND OIL)

WELDING SEQUENCE TIMING SCHEDULE
SQUEEZE TIME 85 MIN. SETTING 80 MAX. SETTING 90
WELD TIME 33 MIN. SETTING 28 MAX. SETTING 38
HOLD TIME 10 MIN. SETTING 05 MAX. SETTING 15
ELECTRODE FORCE (PSI ON CYLINDER) 40
MIN. SETTING 30 MAX. SETTING 50
CURRENT SETTING 65 MIN. SETTING 60 MAX. SETTING 70
ELECTRODE USED

MACHINE USED
RESISTANCE WELDING PROCEDURES

DRAWING NO. 923AS275
PART NAME Wire Guide, Arming

DESCRIPTION OF WELD

Resistance Weld Wire Guide
To Skin I.A.W. Note #4.
Weld Per Drawing 923AS641
(See Diagram) →

MATERIAL USED
THICKEST PART .060 + .006
THINNEST PART .060 - .006
TYPE OF MATERIALS ASTM A1621
PROCESSED CONDITION OF MATERIAL TO BE WELDED Clean (Free
of Dirt and Oil)

WELDING SEQUENCE TIMING SCHEDULE
SQUEEZE TIME 64 MIN. SETTING 59 MAX. SETTING 69
WELD TIME 37 MIN. SETTING 32 MAX. SETTING 42
HOLD TIME 30 MIN. SETTING 25 MAX. SETTING 35
ELECTRODE FORCE (PSI on CYLINDER) 25
MIN. SETTING 20 MAX. SETTING 30
CURRENT SETTING 47 MIN. SETTING 42 MAX. SETTING 52
ELECTRODE USED Copper, Tipped Electrode .300 OIA.

MACHINE USED

27
RESISTANCE WELDING PROCEDURES

DRAWING NO. 923AS286

PART NAME SKIN, CONICAL FIN

DESCRIPTION OF WELD

SPOT SKINS TOGETHER AT BOTH ENDS AND MIDDLE PRIOR TO RESISTANCE WELDING (6 PLACES, 3 EACH SIDE)

MATERIAL USED

THICKEST PART .060 + .006
THINNEST PART .060 + .006

TYPE OF MATERIALS ASTM A/620

PROCESSED CONDITION OF MATERIAL TO BE WELDED CLEAN (FREE OF DIRT AND OIL)

WELDING SEQUENCE TIMING SCHEDULE

SQUEEZE TIME 84 MIN. SETTING 82 MAX. SETTING 86
WELD TIME 45 MIN. SETTING 40 MAX. SETTING 45
HOLD TIME 30 MIN. SETTING 30 MAX. SETTING 35

ELECTRODE FORCE (PSI on CYLINDER) 20

MIN. SETTING 10 MAX. SETTING 20
CURRENT SETTING 76 MIN. SETTING 72 MAX. SETTING 82
ELECTRODE USED COPPER TIPPED ELECTRODE .300 DIA.

MACHINE USED

28
RESISTANCE WELDING PROCEDURES

DRAWING NO. 923AS.286
PART NAME SKIN, CONICAL FIN
DESCRIPTION OF WELD
RESISTANCE WELD SKINS TOGETHER, BOTH SIDES (2 WELDS)

MATERIAL USED
THICKEST PART .060 + .006
THINNEST PART .060 - .006
TYPE OF MATERIALS ASTM A/620
PROCESSED CONDITION OF MATERIAL TO BE WELDED CLEAN (FREE OF DIRT AND OIL)

WELDING SEQUENCE TIMING SCHEDULE
SQUEEZE TIME N/A MIN. SETTING — MAX. SETTING —
WELD TIME 5 HEAT 5 COOL MIN. SETTING 4 HEAT 4 COOL MAX. SETTING 7 HEAT 2 COOL
HOLD TIME N/A MIN. SETTING — MAX. SETTING —
ELECTRODE FORCE (PSI on CYLINDER) 45
MIN. SETTING 40 MAX. SETTING 50
CURRENT SETTING 20 MIN. SETTING 20 MAX. SETTING 25
ELECTRODE USED COPPER WHEEL WITH 5/16 WELDING FACE.

MACHINE USED
RESISTANCE WELDING PROCEDURES

DRAWING NO. 923AS292

PART NAME: NUT ASSEMBLY, SELF-LOCKING

DESCRIPTION OF WELD:

PLACE NUT AND RETAINER IN SPECIAL HOLDING FIXTURE FOR ALIGNMENT AND RESISTANCE WELD.

MATERIAL USED:

THICKEST PART: 1.130
THINNEST PART: 0.60

TYPE OF MATERIAL: STAINLESS

PROCESSED CONDITION OF MATERIAL TO BE WELDED: CLEAN (FREE OF DIRT AND OIL)

WELDING SEQUENCE TIMING SCHEDULE:

SQUEEZE TIME: 30 MIN. SETTING 25 MAX. SETTING 35
WELD TIME: 52 MIN. SETTING 47 MAX. SETTING 57
HOLD TIME: 20 MIN. SETTING 15 MAX. SETTING 25

ELECTRODE FORCE (PSI on CYLINDER):

MIN. SETTING: 10 MAX. SETTING: 20

CURRENT SETTING: 50 MIN. SETTING 45 MAX. SETTING 55

ELECTRODE USED: COPPER TIPPED ELECTRODE .300 DIA.

MACHINE USED:

30
APPENDIX C

RESISTANCE WELD TEST RESULTS
**RESISTANCE WELD TEST RESULTS**

Part No. 138050C REV Description SKIN ASSEMBLY

**Type of Weld** — Spot ☑ Projection □ Seam □

**Tests Required**

- Visual ☑
- Macroscopic □
- Peal ☑
- Shear-Peel □
- Pull □

**Thickest Part** 0.090 **Thinnest Part** 0.075

**Minimum Nugget Size** 29

**Minimum Pull Test** N/A

**Minimum Width of Seam** N/A

**Description of Weld**

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<th>Pass Test</th>
<th>Test</th>
<th>Value</th>
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<td>3</td>
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Pass ☑ Fail □

**Signature** Joe C. Allen

**Date** 4/6/88
APPENDIX D

WELDER CERTIFICATION AND TEST REPORT FOR BSU-33 B/B
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WELDER CERTIFICATION AND TEST REPORT BSU-33 B/B

<table>
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<tr>
<th>Specimen Number</th>
<th>Minimum Force</th>
<th>Actual Force</th>
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<td>Adapter Ring to Fin Skin “A”</td>
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<td>Adapter Ring to Fin Skin “B”</td>
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<td>2770</td>
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<td>Adapter Ring to Fin Skin “C”</td>
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<td>2790</td>
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<td>Fin Skin to Fin Quarter “D”</td>
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<tr>
<td>Fin Skin to Fin Quarter “E”</td>
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<td>Fuze Support to Fin Qtr. “F”</td>
<td>“</td>
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<td>Fuze Support to Fin Qtr. “G”</td>
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<tr>
<td>Skin Support to Fin Skin “H”</td>
<td>Bend Test</td>
<td>Circle One: Pass</td>
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Force to be Applied at a rate of ½ inch per minute

Welder is Certified to weld BSU-33 B/B Conical Fin Assembly

Inspector’s Authorized Signature: [Signature]
Date: 11-27-96
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APPENDIX E

NDT EXAMINATION REPORT
MAGNETIC PARTICLE EXAMINATION REPORT

To: R. Smith
From: J. M. Smith
Date: 12-2-96

Project: MAGNETIC PARTICLE INSPECTION OF MK 83 CONICAL FIN ASSEMBLY CERTIFICATIONS

Contract No. or Purchase Order No.: 38653
INDT Job No.: 38653

Material: Cast Metal

Size: 2
No. of Pieces: 2
Type of Base Metal: Cast Metal
Type of Filter Material: Weld or N/A

Location: MTI, INC.
LlfigP-TM KCT, TN
System: MK 83 CERTIFICATION SPECIMENS

Acceptance Standards: MIL-STD-2219
Procedure: Q.C.B. 500

Type of Check:
- Initial Plate Edge
- In Process
- Back Gouge
- Root Pass
- Repair
- 24 Hr.
- 7 Day
- Final

Type of Inspection:
- Wet
- Dry
- Direct Contact
- Residual
- Circular
- AC Prod
- Yoke

MT Equipment/Model: PARKER DA 100
Surface Preparation Method: Wipe Clean
Inspection Medium/Color: WET FLUORESCENT
Demagnetization Method / Equipment: N/A

Reference: Summary

Results of Inspection

COPY TO: M. J. Smith
Requested By: J. M. Smith
Reported By (Technician): B. C. Lee

NOTICE:
THIS EXAMINATION REPORT IS A REPORT OF THE RESULTS OF THE NDT PROCEDURE ACTUALLY PERFORMED BY THIS COMPANY.
IT IS SUBJECT TO THE LIMITATIONS OF THE TEST WHICH WERE UTILIZED.
THIS REPORT, INDUSTRIAL NDT COMPANY DOES TESTED SPECIMEN.
<table>
<thead>
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<th>SERIAL</th>
<th>JOINT NUMBER</th>
<th>PENETRATOR SIZE</th>
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<th>PENETRATOR APPEARANCE</th>
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<th>PENETRATOR CONDITION</th>
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**NOTE:**

THIS EXAMINATION REPORT IS A REPORT OF THE RESULTS OF THE NDT PROCEDURES ACTUALLY PERFORMED BY THIS COMPANY. IT IS SUBJECT TO THE LIMITATIONS OF THE TESTING SPECIFICATIONS AND PROCEDURES WHICH WERE UTILIZED BY FURNISHING THIS REPORT. LIBERTY TECHNICAL SERVICES DOES NOT GUARANTEE ANY CONDITION OF THE TESTED SPECIMEN.
APPENDIX F

PHOSPHATE PROCESS CONTROL DATA SHEET
**MTD, INC. GREENEVILLE, TENNESSEE**
**PHOSPHATE PROCESS CONTROL DATA SHEET**
**PART NUMBER 923AS641 REV.G PART NAME 85U-73 B/B**
**CONTROL NUMBER FIRST ARTICLE OPERATOR IN CHARGE D.O. CONED**

<table>
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<tr>
<th>DATE/TIME</th>
<th>Alkaline (PH) Tank #1</th>
<th>Rinse (PH) Tank #2</th>
<th>Zinc Phosphate Concentration Tank #3</th>
<th>Zinc Phosphate Accelerator Tank #3</th>
<th>Rinse (PH) Tank #4</th>
<th>Rust Inhibiting Seal (PH) Tank #5</th>
<th>Test Panel Coating Weight</th>
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**DATE/TIME** | **Alkaline (PH) Tank #1** | **Rinse (PH) Tank #2** | **Zinc Phosphate Concentration Tank #3** | **Zinc Phosphate Accelerator Tank #3** | **Rinse (PH) Tank #4** | **Rust Inhibiting Seal (PH) Tank #5** | **Test Panel Coating Weight** | **Sample MG per Square Foot** |
APPENDIX G

PROCESS CONTROL FOR CLEANING AND METAL PREPARATION
TO CONFORM TO MIL-STD-171D
1. Scope

This process control covers the cleaning and pre-treatment of ferrous metals for the application of organic coatings (paint, varnish, lacquer, enamel and etc.) The process is designed to clean, apply a zinc phosphate coating and final rinse chromic acid sealer.

2. Description of Process

The following process will be utilized to conform to the requirements of TT-C-490C, Method III, Type I.

2.1 Equipment - The process equipment will consist of a five stage spray system as follows:

- **Stage 1** - Hot alkaline cleaning at 130-150°F for a minimum of 1 minute.

- **Stage 2** - Ambient temperature clean water rinse with continuous overflow with fresh water entering at the bottom of the tank for a min. of 30 sec.

- **Stage 3** - Application of zinc compound and zinc phosphate accelerator for 1 minute at 140-160°F.

- **Stage 4** - Ambient temperature clean water rinse with continuous overflow with fresh water entering at the bottom of the tank for a min. of 30 sec.

- **Stage 5** - Rust Preventative Rinse at 125-180°F with a pH of 8.5-9.0 for a minimum time of 30 seconds.

3. Chemicals to be Used

The chemicals to be utilized to comply with the requirements of TT-C-490C, Method III, Type I are set forth below.
Stage 1 - Alkaline Cleaning - EZE Product Number 83360 will be used in Stage 1 at a concentration of 3-5%. (See attached Product Data Bulletin.)

Stage 2 - Clean Water Rinse - Clean tap water will be used in Stage 2. Constant overflow will be maintained to avoid excessive contamination.

Stage 3 - Zinc Phosphate - EZE Product No. #176 (Zinc Compound) and EZE Product No. 8695 (Zinc Phosphate Accelerator) will be utilized in Stage 3. Concentrations of #176 will be 1-2% free acid and 15-20% total acid. The concentration of IPN8695 will be maintained at 1-2%. (See attached Product Bulletins.)

Stage 4 - Clean Water Rinse - Clean tap water will be used in Stage 4. Constant overflow will be maintained to avoid excessive contamination.

Stage 5 - Rust preventative Rinse - EZE Product 8228 (Rust Preventative Rinse) will be used in Stage 5. Concentration will be a pH of 8.5 to 9.0. (See attached Product Bulletin.)

4. Quality Assurance Procedures

This section of this procedures is to set for the quality assurance procedures and tests necessary to comply with specification TT-C-490C, Method III, Type I. Tests required are as follows and each series of test will be set forth under the Test Procedures Section of this Process Control Procedure.

a. Chemical tests on the 5 stage cleaning and phosphating system.
(b) Phosphate coating weight test.
(c) Film thickness of organic coating (where required).
(d) Film adhesion of organic coating (where required).
(e) Salt spray resistance (where required).

4.1 Chemical Tests on the (5) Stage Cleaning and Phosphating System

4.1.1 Stage 1 - Alkaline Cleaning - Following the final rinse at least 2 test specimens shall be dried and examined for rust, corrosion products and soils. Frequency of this examination shall be every four hours. If the specimens show signs of soils or corrosion products all products processed since the last examination shall be rejected and corrective action taken. After corrective action tests will resume at a frequency of one hour until there is no sign of corrosive products or soil. Testing frequency will then revert to two specimens each four hours.

Tests on Stage 1 chemical concentration will be run at a frequency of once for each 4 hours operation as per Test Procedure No. CS-1 of this Process Control Procedure. Frequency of tests as per CS-1 and disposing of Stage 1 chemicals will depend upon the nature of the soil, amount of soil and contaminants, and hours of operation after initial production runs. Fixed times will be established for testing and chemical maintenance. Results of tests will be recorded and records maintained on MTD Form No. 22.

4.1.2 Stage 2 - Clear Water Rinse - Tests for chemical contamination of Stage 2 will be performed at a frequency of once each 4 hours of operation as per Test Procedure CS-2. When the
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First Article Inspection of BSU-33B/B Bomb Fins

Pepi, M.S. (ARL)

U.S. Army Research Laboratory
Weapons & Materials Research Directorate
Aberdeen Proving Ground, MD 21010-5066

U.S. Army Research Laboratory
Weapons & Materials Research Directorate
Aberdeen Proving Ground, MD 21010-5066

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A thorough examination of the manufacturing sequences involved in the fabrication of the BSU-33B/B bomb fins was performed by the U.S. Army Research Laboratory (ARL), Weapons and Materials Research Directorate (WMRD). The welding, zinc phosphate, and powder coating processes were evaluated with respect to the governing specifications, as was the finished product. With respect to the welding, the apparatus, procedures, and personnel all conformed to the governing requirements. The zinc phosphate process appeared suitable, as evidenced by the uniform coating on the First Article (FA) bomb fins. Also, coating weights of panels, which were run in the same process as the FA bomb fins, met the governing requirement. The powder coating was applied according to the governing specification, and the physical attributes of the coating conformed to the requirements of this specification, with the exception of the fin wedges, which were slightly below the required thickness. Recommendations were offered as a result of this inspection.