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The production baseline was designed as a standard for evaluating existing MK82 bomb production facilities.

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Model Line
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A production baseline is a theoretical production line based on technical data package configurations and specifications. This report describes alternative methods and provides a recommended method for the production of metal part components and the assembly of the MK82 bomb body.

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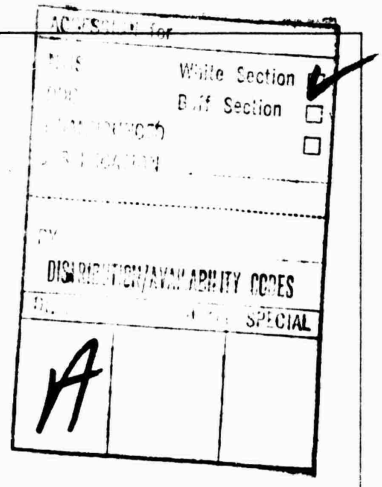

PRODUCTION BASELINE
MK82 BOMB BODY ASSEMBLY

REPORT NO. 78-13-R-1

Volume 1

ENGINEERING ASSESSMENT OF
PLANT EQUIPMENT PACKAGE (PEP) MODERNIZATION PROGRAM

Prepared for Project Manager
Munitions Production Base Modernization and Expansion

Administered by U.S. Army Armament Research and Development Command
Contract No. DAAK10-78-C-0020

July 1978

KAISER ENGINEERS
In Association with Stetter Associates, Inc.

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I. INTRODUCTION

The production baseline described herein is a theoretical munitions production line developed from technical data package configuration and specifications applicable to the manufacture of the MK82 bomb body assembly. This baseline reflects the best elements of current methods of manufacture utilized by existing producers, and it is limited to proven state-of-the-art production technology.

The production baseline includes industrial production equipment and critical support equipment only. Discussion of all other contributory factors is restricted to general comments.

When possible, examples of recommended equipment are included in the general discussions of each operation. An example cited should be considered neither as the only choice nor as an indication of any exclusion. The type of tooling used in the operations is included only when it affects equipment choice. Without specific costs and design data, any detailed discussion of tooling is of doubtful value.

The MK82 production baseline is designed to produce the following metal parts and assemblies:

1265394	Charging-tube fitting
1252606	Bomb-body adapter
1380547	Bomb casing
1212112	Single lug
1380230	Double lug
1239593	Forward fuze-liner assembly
4902493	Fuze-liner retainer
4902490	Aft fuze-liner assembly
4902487	Base plug

The remaining parts of the MK82 bomb body assembly are purchased from vendors specializing in the process required to produce the part. For example, part No. 251634, a fuze insert shipping plug made from plastic material, would be produced by a vendor with plastic molding capabilities.

II. PROCESS DESCRIPTION SUMMARY

Following this page are process description summaries that show the sequence of operations required to manufacture the components of the MK82 bomb body assembly. Equipment used to perform each operation, including any applicable alternate equipment, is also listed. Only industrial plant equipment (IPE) is specifically identified. Other plant equipment (OPE) is discussed only where necessary to identify the process requirements.

The operation numbers are four-digit characters indicating the numerical sequence of operations. Across from the operation number is a description of the operation, with the equipment listed below.

Under the operation sequence, a path shown by X's indicates steps of manufacture. If an alternate method of manufacture is available, it is shown as an alternate on the flow charts, Figure III-2 and Figure III-3.

For a detailed description of each operation, see section III, Analysis of Operations.

Gross capacities, production capabilities of the equipment designated for the operation, are shown in pieces per hour. These figures are not factored for downtime or delays. As an example, a press capable of cycling in 10 seconds (i.e., 6 cycles per minute) will have a gross capacity of 360 pieces per hour.

The drawing/specification of the MK82 bomb casing shows a hot-forge option to the seamless and seam-welded tubing. The MK82 production baseline report addresses both the forging and tubing processes, although the forging process appears not to be economical. The forging process demands presses (hammers) of both nigh tonnage and extra stroke length. The presses neither are readily available nor can they be specially manufactured within a reasonable lead time.

The following process description summaries are provided:

Table	Title
II-1	Casing (1380548)
II-2	Adapter Ring (1252606)
II-3	Base Plug (4902487)
II-4	Insert, Suspension Lug (1212112)
II-5	Forward Insert (1380230)

TABLE II-1
PROCESS DESCRIPTION SUMMARY
BODY ASSEMBLY (1380547)
MK82 MOD 1, 500-LB BOMB CASING
PEP MODERNIZATION PROGRAM

Oper No.	No. of Equip Alt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Forge	 Tube
1110	1	Handle Received Material	25	X	X
		Material handling equipment			
1120	4	Separate Lengths, Tube			X
		Saw, carbide tipped, 25 hp	60		
		Saw, band, 15 hp	36		
		Flame-cutting equipment	50		
		Cutoff machine, rotary, 60 hp	200		
1130	5	Separate Mults		X	
		Press 2,200 ton (cold shearing)	180		
		Saw, carbide tipped, 30 hp	40		
		Saw, band, 25 hp	20		
		Press, hydraulic, 100 ton (nick and break)	180		
		Flame-cutting equipment	50		
1140	3	Heat Mults		X	
		Heater induction,800 kW, 180 Hz, 2200 F	40		
		Rotary-hearth furnace, 2200 F	150		
		Continuous tunnel furnace,2200 F	180		

TABLE II-1 (cont)

Oper No.	No. of Equip Alt's	Operation Description / Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Forge	Tube
1150	1	Descale Mults		X	
		Cabinet, water jet	180		
1160	1	Cabbage		X	
		Press, hydraulic, 1,500 ton	120		
1170	1	Pierce		X	
		Press, hydraulic, 1,250 ton	120		
1180	1	First Draw		X	
		Press, hydraulic, 600 ton	120		
1190	1	Draw and Pierce Base		X	
		Press, hydraulic, 600 ton	120		
1200	1	Cool		X	
		Tunnel	200		
1210	1	Descale ID		X	
		Cabinet	120		
1220	1	Descale OD		X	
		Cabinet, abrasive cleaning	120		

TABLE II-1 (cont)

Oper No.	No. of Equip Alt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Forge	Tube
1230	1	Trim Nose and Base Ends		X	
		Lathe, chucking, automatic, 50 hp	60		
1240	1	Pre-form Nose		X	X
		Press, hydraulic, 500 ton	180		
1250	1	Pre-form Nose and Base Ends			X
		Press, hydraulic, 500 ton	180		
1260	1	Heat Nose End		X	X
		Heater, induction, 500 kW, 180 Hz, 1400 F	180		
1270	1	Form Nose		X	X
		Press, hydraulic, 500 ton	180		
1280	1	Heat Base End		X	
		Heater, induction, 500 kW, 180 Hz, 1400 F	180		
1290	1	Form Base		X	
		Press, hydraulic, 500 ton	180		
1300	1	Machine Nose		X	
		Lathe, chucking, automatic, 30 hp	60		

TABLE II-1 (cont)

Oper No.	No. of Equip A'lt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Forge	Tube
1310	1	Machine Base Lathe, chucking, automatic, 30 hp	60	X	X
1320	1	Machine, Nose and Base Way type, 40 hp, dual head (Alternate to Oper Nos. 1300 and 1310)	60	X	X
1330	1	Machine Base Lathe, automatic, chucking, 30 hp	60	X	
1340	1	Cut Lug & Charging Holes Cutting machine, flame	30	X	X
1350	1	Weld Lug and Charging Adapter Welding machine, arc, automatic	50	X	X
1360	1	Weld Adapter Ring Welding machine, arc, automatic	60		X
1370	2	Heat Treat and Temper Heater, induction, 3,000 kW, 180 Hz, 1650 F	120	X	X
		Furnace, gas, 1650 F	170	X	X

TABLE II-1 (cont)

Oper No.	No. of Equip Alt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Forge	Tube
1380	1	Blast Clean Roto-blast unit	120	X	X
1390	1	Check Hardness Hardness tester	180	X	X
1400	1	Bore, Face, Thread Nose Lathe, turret, automatic, 30 hp	25	X	X
1410	1	Bore, Face, Thread Base Lathe, turret, automatic, 30 hp	25	X	X
1420	1	Drill and Tap Lifting and Charging Holes Drill press, multistation	65	X	X
1430	1	Drill 16 Holes, Base End Drill press, multihead	100	X	X
1440	1	Drill and Tap Nose Hole Drill press	200	X	X
1450	1	Drill 16 Holes, Base End, and Drill Nose End	100	X	X
		Drill press, multispindle (Alternate to Oper Nos. 1430 and 1440)	100	X	X

TABLE II-1 (cont)

Oper No.	No. of Equip Alt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Forge	 Tube
1460	1	Test Lifting Lug Adapter Special test equipment	150	X	X
1470	1	Pressure Test Body Special test equipment	150	X	X
1480	1	Stamp Identification	200	X	X
1490	1	Phosphate Treat Chemical line	200	X	X
1500	1	Paint Exterior Paint Equipment	200	X	X

TABLE II-2
PROCESS DESCRIPTION SUMMARY
ADAPTER RING (1252606)
MK82 MOD 1, 500-LB BOMB CASING
PEP MODERNIZATION PROGRAM

Oper No.	No. of Equip Alt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Cup
2110	1	Handle Received Material Material handling equipment		X
2120	3	Separate Mults Press, shear, 1,000 ton Saw, carbide tipped, 30 hp Saw, band, 25 hp	 180 120 60	X
2130	3	Heat Mult Heater, induction, 400 kW, 180 Hz, 2200 F Furnace, rotary hearth, gas, 2200 F Furnace, tunnel, continuous, 2200 F		X
2140	1	Descale Tumbler, squirrel cage	250	X
2150	1	Forge Complete Press, mechanical, 2,000 ton, 12-inch stroke	225	X

TABLE II-2 (cont)

Oper No.	No. of Equip Alt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Cup
2160	1	Descale Blast-cleaning equipment	250	X
2170	1	Ring Roll Machine, special, rolling	60	X
2180	1	Machine Inside and Outside Diameters Lathe, six-spindle, automatic, chucking, 30 hp	200	X
2190	1	Clean Degreaser, vapor	700	X

TABLE II-3
PROCESS DESCRIPTION SUMMARY
BASE PLUG (4902487)
MK82 MOD 1, 500-LB BOMB CASING
PEP MODERNIZATION PROGRAM

Oper No.	No. of Equip Alt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Cup
3110	1	Handle Received Material Material handling equipment		X
3120	3	Separate Mults		X
		Press, shear, 1,000 ton	180	
		Saw, carbide tipped, 30 hp	120	
		Saw, band, 25 hp	60	
3130	3	Heat Mult		X
		Heater, induction, 150 kW, 180 Hz, 2200 F	200	
		Furnace, rotary hearth, gas, 2200 F		
		Furnace, tunnel, continuous	300	
3140	1	Descale		X
		Tumbler, squirrel cage	250	
3150	1	Forge Complete	225	X
		Press, mehcanical, 2,000 ton, 12 inch stroke		

TABLE II-3 (Cont)

Oper No.	No. of Equip Alt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Cup
3160	1	Descale Blast-cleaning equipment	250	X
3175	1	Machine Inside and Outside Diameters Lathe, six-spindle, automatic chucking, 30 hp	200	X
3180	1	Machine Complete Lathe, bar, automatic, four-spindle, 30 hp	240	X
3190	1	Drill and Tap Six Holes Multiple drill head and shuttle fixture	180	X
3200	1	Stamp Identification Marking machine	350	X
3210	1	Clean Degreaser, vapor	2,000	X

TABLE II-4
PROCESS DESCRIPTION SUMMARY
INSERT, SUSPENSION LUG (1212112)
MK82 MOD 1, 500-LB BOMB CASING
PEP MODERNIZATION PROGRAM

Oper No.	No. of Equip Alt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Cup
4110	1	Handle Received Material Material handling equipment		X
4120	3	Separate Mults		X
		Press, shear, 350 ton	270	
		Saw, carbide tipped, 25 hp	180	
		Saw, band, 15 hp	120	
4130	3	Heat Mult		X
		Heater, induction, 50 kW, 180 Hz, 2200 F	150	
		Furnace, rotary hearth, gas, 2200 F	200	
		Furnace,tunnel, continuous, 2200 F	250	
4140	1	Perform and Restrike Press, mechanical, 500 ton, 6-inch stroke	200	X
4160	1	Descale Blast-cleaning equipment	400	X
4170	1	Clean Degreaser, vapor	2,000	X

TABLE II-5
PROCESS DESCRIPTION SUMMARY
FORWARD INSERT (1380230)
MK82 MOD 1, 500-LB BOMB
PEP MODERNIZATION PROGRAM

Oper No.	No. of Equip Alt's	Operation Description Equipment Description	Gross Capacity Pieces/h	Operation Sequence Hot Cup
5110	1	Handle Received Material Material handling equipment		X
5120	3	Separate Mults Press, shear, 350 ton Saw, carbide tipped, 25 hp Saw, band, 15 hp	 180 120 60	X
5130	3	Heat Mult Heater, induction 250 kW, 180 Hz, 2200 F Furnace, rotary hearth, gas, 2200 F Furnace, tunnel, continuous, 2200 F	 150 200 250	X
5140	1	Descale Tumbler, squirrel cage	 220	X
5150	1	Preform and Restrike Press, mechanical, 500 ton, 6-inch stroke		X
5160	1	Descale Blast-cleaning equipment	 250	X
5170	1	Clean Degreaser, vapor	 1,500	X

III. ANALYSIS OF OPERATIONS

A. CASING, BOMB, MK82 MOD 1 (1380548)

This section provides an analysis of operations for the production of the casing for the 500-pound MK82 Mod 1 bomb. Details of the body assembly are shown in Figure III-1. The flow chart depicting the sequence of operations is shown in Figure III-2.

Material - Carbon steel, seamless extruded tube/seam welded plate
- Carbon steel, forging quality

1. Operation 1110 - Handle Billets/Tubes

Equipment - Standard cranes, hoists, and transfer equipment

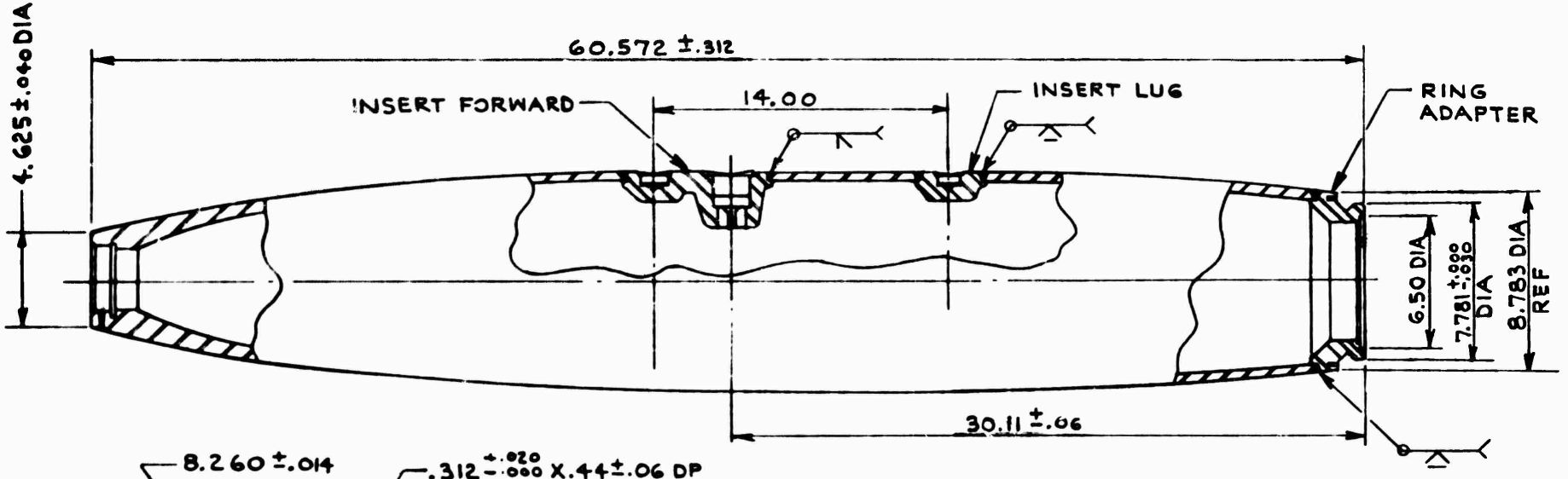
The handling of steel billets/tubes is not a step in the production process, but the materials handling problem must be anticipated in any line designed for high-tonnage consumption of steel billets/tubes. The operations that must be considered are discussed below.

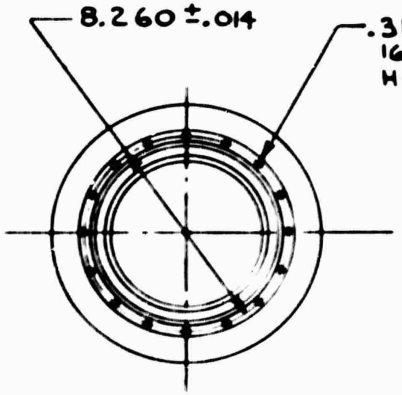
a. Receiving Bulk Stock

This operation includes moving rolling stock and trailers and stacking material in the storage areas. Overhead cranes, forklifts, and jib cranes are used to unload the stock. The stacking is arranged to assure material traceability.

Receiving inspection is completed before a lot becomes available for processing. If the material's supplier certification is acceptable, a verification of quantity, either by weight or by length, is accomplished without extra handling.

b. Movement of Billets/Tubes from Bulk Storage to First Process Station, 8-1/2-Inch RCS, 5,500 lb Each/10-3/4-Inch OD, .425-Inch Wall, 2,400 lb





END VIEW

FIGURE III-1
CASING, BOMB, GENERAL PURPOSE, 500 POUND
MK 82 MOD 1, EMPTY
PART No. 1380547

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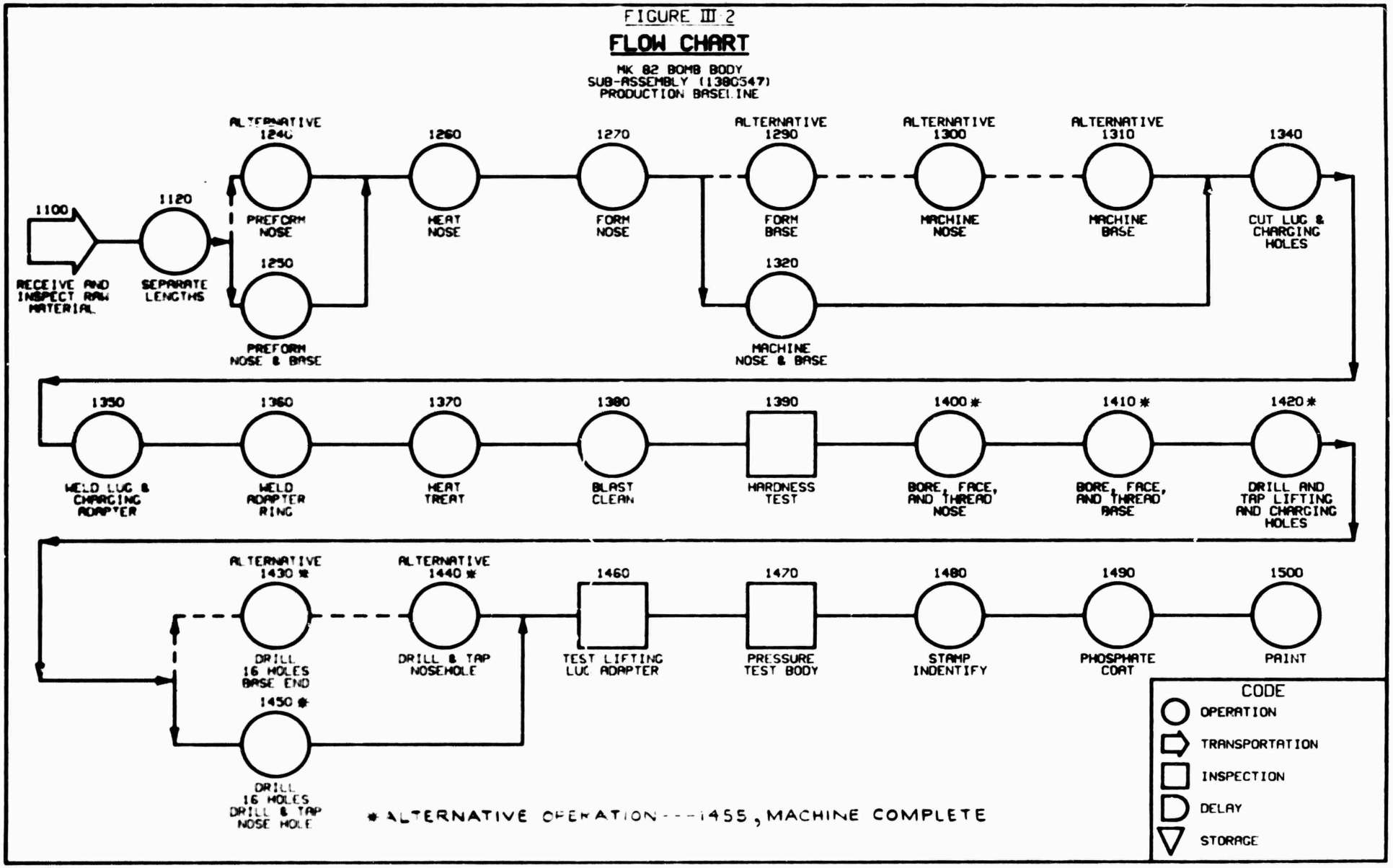
FIGURE III 2

FLOW CHART

MK 82 BOMB BODY
SUB-ASSEMBLY (1380547)
PRODUCTION BASELINE



* ALTERNATIVE OPERATION---1455, MACHINE COMPLETE

This operation includes:

- o Separating stock into single billets/lengths. Special handling equipment such as magnets, hooks, grapples, slings, and hoists are needed.

- o Continuously processing individual billets/lengths through weighing devices, metallurgical scanning, and physical measuring devices. This activity is required to develop the correct mult/length weight to be generated at the billet/tube separation operation. A computerized system to scan weight and length is the preferred control system. Although the system does not increase the yield per billet/tube, it assures the cutting of mults to the required weight/length.

- o Moving billet/length through separation operation. This activity involves controlling the alignment and progression of the billet/length and handling the rejects. Included are any additional functions, such as multiple-racking saw-trim requirements and a possible laydown or holding requirement.

An example of the proper equipment to use is a Shepard-Niles 25-ton bridge crane.

2. Operation 1120 - Separate Lengths, Tube

Equipment alternatives:
- Saw, carbide tipped, 24 inch, 25 hp (sawing)
- Saw, band, 16 inch, 15 hp (sawing)
- Flame cutting equipment
- Cutoff machine, rotary, 60 hp

a. Circular Saw

Carbide-tipped circular saws produce precision lengths.

An example of the proper equipment to use is a Heller Gebrueder SSH 630, circular saw, 25 hp.

b. Band Saw

The band saw, although less accurate, is less expensive than a circular saw. The band sawing process is slow, compared with the forging rate; therefore, materials handling provisions must be developed for multiple machines.

An example of the proper equipment to use is a Do-All Automatic C70, band saw, 15 hp.

c. Flame Cutting

Flame cutting equipment can be used with an automated rotating device and materials handling equipment.

An example of the proper equipment to use is an H&M Pipe Cutting & Beveling #2, with a machine torch adapted for synthetic fuel.

d. Rotary Cutting

The tube is cut off to the required length, while chamfers are generated on the outside diameter. This method eliminates end deburring.

An example of the proper equipment to use is a Stamet Co. SD24450, lathe, automatic, 95-r/min spindle, 60 hp.

3. Operation 1130 - Separate Mults, Forging

Equipment alternatives:

- Press, 2,200 ton (cold shearing)
- Saw, carbide tipped, 24 inch, 30 hp (sawing)
- Saw, band, 16 inch, 25 hp (sawing)
- Press, 1,000 ton, and torch (nick and break)
- Flame cutting equipment

The weighing of each mult is an integral part of this operation.

a. Cold Shear

The 2,200-ton shear press requires automatic feed, clamp, and eject attachments. The press may be in the production line to minimize materials handling and traceability problems, but the press can be off-line if facilities dictate.

An example of the proper equipment to use is a Buffalo Billet Shear, 2,200 ton.

b. Circular Saw

Carbide-tipped circular saws produce precision mult.

Abrasive cutting, even done wet, is not approved. Experience has shown that trapped abrasive causes excessive tool wear during forging.

An example of the proper equipment tc use is a Heller Gebrueder SSH 630, circular saw, 25 hp.

c. Band Saw

The band saw, although less accurate, is less expensive than a circular saw. The band-sawing process is slow, compared with the forging rate; therefore, materials handling provisions must be developed for multiple machines.

An example of the proper equipment to use is a Do-All Automatic C70, band saw, 15 hp.

d. Nick and Break

This process is based on the concentration of a stress called the nick in the cold billet, followed by a cold-breaking operation.

An example of the proper equipment to use is a Production Machinery Division U.S. Industry Press, Mechanical, Vertical, Straight Sided KS11000-42, 1,000 ton and Arcair 62-001, Electrode 1/4 - 3/4.

e. Flame Cutting

Flame cutting is not recommended, because it is slow and wasteful of material. It may also affect the metallurgy of the mult.

4. Operation 1140 - Heat Mult, Forging

Equipment alternatives:
- Heater, induction, 2200 F, 5000 kW, 180 Hz
- Rotary-hearth furnace,gas, 2200 F
- Continuous-tunnel furnace, gas, 2200 F, 8-1/2-inch RCS

This step is required for the hot-cup, hot-draw process. Time at temperature should be long enough to assure uniform heating, but excessive soak time should be avoided, because of the high degree of scaling that occurs in gas furnaces with natural atmosphere.

Examples of the proper equipment to use are:

a. Tocco induction heating in-line system with multicoil stations for sequential heating, 2200 F.

b. Flinn and Dreffein Inc., rotary hearth, gas fired, 2200 F.

c. Lindburg Bros. Co., T-slot oven, open flame, gas fired, 2200 F.

5. Operation 1150 - Descale Mult, Forging

Equipment - Cabinet, water-jet automatic feed

The removal of scale from hot mults prior to forging is accomplished by water jets. Water pressures of 1,200 to 2,200 lbf/in^2 and flow rates of 1/2 to 2 gal/s normally are used. Power feeding of the hot mults is done by chain conveyor or pusher.

This equipment is normally custom-made to incorporate handling as well as descaling equipment.

An example of the proper equipment to use is a Pangborn Div. of Carborundum Co. ES421, descaling machine, 7-1/2 hp.

6. Operation 1160 - Cabbage, Forging

Equipment - Press, hydraulic, 1,500 ton, 48-inch stroke

In the cabbage step, the heated square mult is shaped into a round die. Once the mult is sized, the pierce operation accomplishes the first major movement of metal, with or without reheating.

An example of the proper equipment to use is a Verson Allsteel Press 1500HDI-76T, 1,500 ton, 48-inch stroke.

7. Operation 1170 - Pierce, Forging

Equipment - Press, hydraulic, 1,250 ton, 60-inch stroke

The pierce step is a hot-working process that uses a backward extrusion technique to form the sized mult into an intermediate hollow length. The uniformity of metal flow determines the effectiveness of the succeeding forging operations in attaining overall dimensional accuracy and a high level of quality.

An example of the proper equipment to use is a Verson Allsteel Press 1250 HD1-84T, 60-inch stroke.

8. Operation 1180 - First Draw, Forging

Equipment - Press, hydraulic, 600 ton, 144-inch stroke

The casing is hot-drawn, and the wall thickness is reduced as the casing is extended through rings and over a mandrel.

An example of the proper equipment to use is a Bliss Co. press, horizontal, special, 600 ton, 144-inch stroke.

9. Operation 1190 - Draw and Pierce Base, Forging

Equipment - Press, hydraulic, 600 ton, 144-inch stroke

The bomb casing is open at both ends. It is now hot-drawn to length, and during the same stroke, the end is pierced.

An example of the proper equipment to use is a Bliss Co. press, horizontal, special, 600 ton, 144-inch stroke

10. Operation 1200 - Cool

Equipment - Tunnel, cooling

High carbon steels have mechanical properties sensitive to the rate at which the steel is cooled from forging temperatures. To produce the best metallurgical structure for subsequent machining operations, the cooling must be slow. Slower cooling introduces fewer thermal stresses and less warpage.

An example of the proper equipment to use is a Selas Corp. tunnel, four stage, special.

11. Operation 1210 - Descale Inside Surface, Forging

Equipment - Cabinet, abrasive cleaning, 75 hp

The descaling by abrasive cleaning is necessary prior to subsequent machining and forming operations.

An example of the proper equipment to use is a Wheelabrator-Frye, 42D393, blast-cleaning machine.

12. Operation 1220 - Descale Outer Surface, Forging

Equipment - Cabinet, shot blast, automatic feed, 75 hp

The removal of scale from the forging is accomplished by propelling steel shot at high velocity against the surface while the forging is being conveyed on skewed and tapered rolls. This exposes all of the surface to the scaling media.

An example of the proper equipment to use is a Wheelabrator-Frye, 42D393, blast-cleaning machine.

13. Operation 1230 - Trim & Turn Nose and Base Ends, Forging

Equipment - Way-type machine, single station, double ended horizontal, boring, 50 hp

This operation prepares the forging for the nosing operations.

An example of the proper equipment to use is a machine made by Heald Machine Co., 442A, 80-inch-long table, 50 hp.

14. Operation 1240 - Pre-form Nose End

Equipment - Press, hydraulic, 500 ton, 36-inch stroke

Preforming the nose is a combination of reducing the diameter of the nose end and upsetting the tube end to increase the wall thickness.

An example of the proper equipment to use is a Verson Allsteel Press 500HDI-48T, 500 ton, 36-inch stroke.

15. Operation 1250 - Pre-form Nose and Base End, Tube

Equipment - Press, hydraulic, 600 ton, 48-inch stroke

The preforming of the nose and the forming of the base may be combined when using tubing.

An example of the proper equipment to use is a Verson Allsteel Press 600HDI-66T, 600 ton, 48-inch stroke.

16. Operation 1260 - Heat Nose End

Equipment - Heater, induction, 1400 F, 500 kW, 180 Hz

The nose end of the casing requires heating prior to the nosing operation. A convenient heating method is induction heating ranging from 1200 F to 1400 F.

An example of the proper equipment to use is a Westinghouse Electric induction coil.

17. Operation 1270 - Form Nose

Equipment - Press, hydraulic, 500 ton, 36-inch stroke

Forming the nose is a combination of reducing the diameter of the nose and upsetting the end to increase the wall thickness to meet the required length for the fuze liner wall.

An example of the proper equipment to use is a Verson Allsteel Press 500HDI-48T.

18. Operation 1280 - Heat Base End, Forging

Equipment - Heater, induction, 1400 F, 500 kW, 180 Hz

To form the base end of the casing from a forging requires prior heating. This operation may not be required for casing made from tubing.

An example of the proper equipment to use is a General Electric Co. induction coil.

19. Operation 1290 - Form Base End

Equipment - Press, hydraulic, 500 ton, 36-inch stroke

The diameter of the base end is reduced when it is formed. The wall is to be thickened only slightly. In the case of the forged casing, the ring adapter No. 1252606 is formed in this operation.

An example of the proper equipment to use is a Verson Allsteel Press 500HDI-48T.

20. Operation 1300 - Rough-Machine Nose End

Equipment - Lathe, automatic, chucking, 12-inch swing,
72-inch centers, 30 hp

The nose end of the casing is rough-bored, counter-bored, and faced.

An example of the proper equipment to use is a Lodge & Shipley Co., Profiturn 50, automatic lathe, 12-inch swing, 72-inch centers.

21. Operation 1310 - Machine Base End, Tube

Equipment - Lathe, automatic, chucking, 12-inch swing, 72-inch centers, 30 hp

The base end is cut off, a bore is made for the ring adapter, and the outside and inside end are chamfered for welding.

An example of the proper equipment to use is a Lodge & Shipley Co., Profiturn 50, automatic lathe, 12-inch swing, 72-inch centers, 30 hp.

22. Operation 1320 - Machine Nose and Base End, Tube (Alternate)

Equipment - Way-type machine, single station, double ended, horizontal, boring, 50 hp

Operations 1300 and 1310 are combined on one double end machine, where the nose and base ends are machined simultaneously.

An example of the proper equipment to use is a machine made by Heald Machine Co., 442A, 80-inch-long table, 50 hp.

23. Operation 1330 - Rough Machine Base - Adapter Ring, Forging

Equipment - Lathe, automatic chucking, 12-inch swing, 72-inch centers, 30 hp

This operation is used for the adapter ring as forged with the casing. The base is bored, faced, and cut for a relief groove, and the adapter section is turned.

An example of the proper equipment to use is a Lodge & Shipley Co., Profiturn 50, automatic lathe, 12-inch swing, 72-inch stroke, 30 hp.

24. Operation 1340 - Flame Cut Lug and Charging Tube Adapter Holes

Equipment alternatives:

- Two automatic machine torches
- Two 500-600 A power supplies
- Special cradling and fixturing machine base

The bomb body is conveyed into the special flame-cutting machine. The body is aligned and positioned. The two torches can be guided either mechanically by templates or by a numerically controlled device to follow the required cutting pattern.

An example of the proper equipment to use is a Linde Division, Union Carbide Co., CM-56 with CW-45 cutting torches.

25. Operation 1350 - Weld Lug and Charging Adapters

Equipment alternatives:

- Two automatic machine torches, gas shielded with flux-cored wire
- Two 500-600 A 100 percent duty-cycle power supply
- Special cradling and fixturing machine base

The bomb-body sub-assembly is conveyed into the special welding machine, where the lug and the adapter are installed facing up. The body is aligned and positioned. The two torches can be guided either mechanically by templates or by a numerically controlled device to follow the required weld pattern.

An example of the proper equipment to use is a Linde Division of Union Carbide Co., VI600 welding power supply, SWM-23 wire feeder, ST-5 water-cooled machine torch.

26. Operation 1360 - Weld Ring, Adapter, Tubing

Equipment - Automatic machine torch with arc-length sensor, gas shielded with flux-cored welding wire
- 500 - 600 A 100 percent duty-cycle power supply
- Special cradling and fixturing machine base

The bomb-body sub-assembly is conveyed into the special welding machine. The bomb body is affixed in place. The arc is then started, while the bomb body rotates 360 degrees for a one pass weld.

An example of the proper equipment to use is a Linde Division of Union Carbide Co. VI-600 welding power supply, SWM-23 wire feeder, ST-5 water-cooled machine torch.

27. Operation 1370 - Heat Treat and Temper

Equipment alternatives:

- Heater, induction, 1550 F to 1650 F, 3000 kW, 180 Hz or
- Furnace, gas, 1550 F to 1650 F; hardening and
- Furnace, gas, 750 F to 950 F; tempering

The strength of the case is achieved by heating and quenching. Furnace or induction heating is used to heat at 1550 F to 1650 F. Quenching should be by immersion in an agitated bath. The case is tempered at 950 F in an atmosphere-controlled draw furnace.

An example of the proper equipment to use is a special heat-treat and temper system made by Flinn & Dreffein Engineering Co., special.

28. Operation 1380 - Blast Clean ID and OD

Equipment - Roto-blast unit

All scale is blast-cleaned from inside and outside surfaces.

An example of the proper equipment to use is a Wheelabrator & Frye Co., 42D393, blast-cleaning machine.

29. Operation 1390 - Check Hardness

Equipment - Hardness tester, brinnel, automatic

The hardness required by specifications is checked.

An example of the proper equipment to use is a Rockwell Corp., 5JR, hardness tester.

30. Operation 1400 - Bore, Face, Thread Nose End

Equipment - Lathe, turret, automatic 12-inch swing, 72 inch centers, 30 hp

This is a standard machining operation.

An example of the proper equipment to use is a Warner-Swasey, automatic lathe, 12-inch swing, 72-inch centers, 30 hp.

31. Operation 1410 - Bore, Face, Thread, Machine Base End

Equipment - Lathe, turret, automatic 12-inch swing, 72-inch centers, 30 hp

This is a standard machining operation.

An example of the proper equipment to use is a Lodge & Shipley Profiturn 50, automatic lathe, 12-inch swing, 72-inch centers, 30 hp.

32. Operation 1420 - Step Drill and Tap Lifting Holes and Charging Hole

Equipment - Drill press, tapping multistation, 2-1/4-inch capacity

This is a standard machining operation.

An example of the proper equipment to use is a Barnes multispindle drill press, special.

33. Operation 1430 - Drill and Countersink 16 Holes Base End

Equipment - Drill press, multispindle, 3/8 capacity

This is a standard machining operation.

An example of the proper equipment to use is a Barnes multispindle, horizontal drill press, special.

34. Operation 1440 - Drill Countersink & Tap Nose Lock Hole

Equipment - Drill press, tapping, 3/8 capacity

This is a standard machining operation.

An example of the proper equipment to use is a Zagar, Inc., Special.

35. Operation 1450 - Drill 16 Holes, Base End and Drill and Tap Nose End

Equipment - Drill press, multispindle, 2 units, horizontal

This operation finish-machines the casing in one setup. Operations 33 and 34, on the other hand, require two setups.

An example of the proper equipment to use is a Barnes multispindle, horizontal drill press, 15 hp.

36. Operation 1455 - Machine Complete

Equipment - Special transfer-and-shuttle type with turning, boring, drilling and threading heads, and attachments

This alternate operation reduces the handling and extensive setups (outlined in the preceding steps, starting with Operation 1400 to Operation 1450) which relate to conventional equipment and processes.

An example of the proper equipment to use is a specially designed and built transfer-and-shuttle turning machine.

37. Operation 1460 - Test Lifting Lug Adapter

Equipment - Special test machine

The required push-and-pull test shown in the drawing is conducted.

An example of the proper equipment to use is special test equipment manufactured to dictated parameters.

38. Operation 1470 - Pressure-Test Bomb Body

Equipment - Special test equipment

The required pressure test shown in the drawing is conducted.

An example of the proper equipment to use is special test equipment manufactured to dictated parameters.

39. Operation 1480 - Stamp Identification

Equipment - Machine, stamping, rotary, 5 hp

The stamping is performed on a horizontal rotating fixture. At this time, the nomenclature, date of manufacture, lot number, and contractor's identification are imprinted.

An example of the proper equipment to use is a James H. Matthews Co. Marking Machine N2201.

40. Operation 1490 - Phosphate Treat

Equipment - Chemical line (multistage spray/dip system)

Foreign particles are removed, and the surface is prepared for subsequent painting.

An example of the proper equipment to use is a five-stage phosphatizer made by Litton Unit Handling Systems.

41. Operation 1500 - Paint Exterior

Equipment - Paint spraying machine, automatic, electrostatic

Except for the threads, both the inside and outside surfaces are painted.

An example of the proper equipment to use is be a special unit made by Binks Manufacturing Co.

B. RING, ADAPTER, BOMB BODY (1252606)

This section contains a detailed analysis of operations for the production of the adapter ring. The flow chart depicting the sequence of operations is shown in figure III-3.

Material - Carbon steel with yield strength 40,000 lbf/in^2 and tensile strength 70,000 lbf/in^2, forging quality

1. Operation 2110 - Handle Billet

Equipment - Standard cranes, hoists, and forklift trucks

The handling of steel billets is not a step in the production process, but the materials handling problem must be anticipated in any line designed for high-tonnage consumption of steel billets. How these operations must be considered, is discussed below.

a. Receiving Billets

This operation includes moving rolling stock and trailers and stacking material in the storage areas. Overhead cranes, forklifts, and jib cranes are used to unload the stock. The stacking is arranged to assure material traceability.

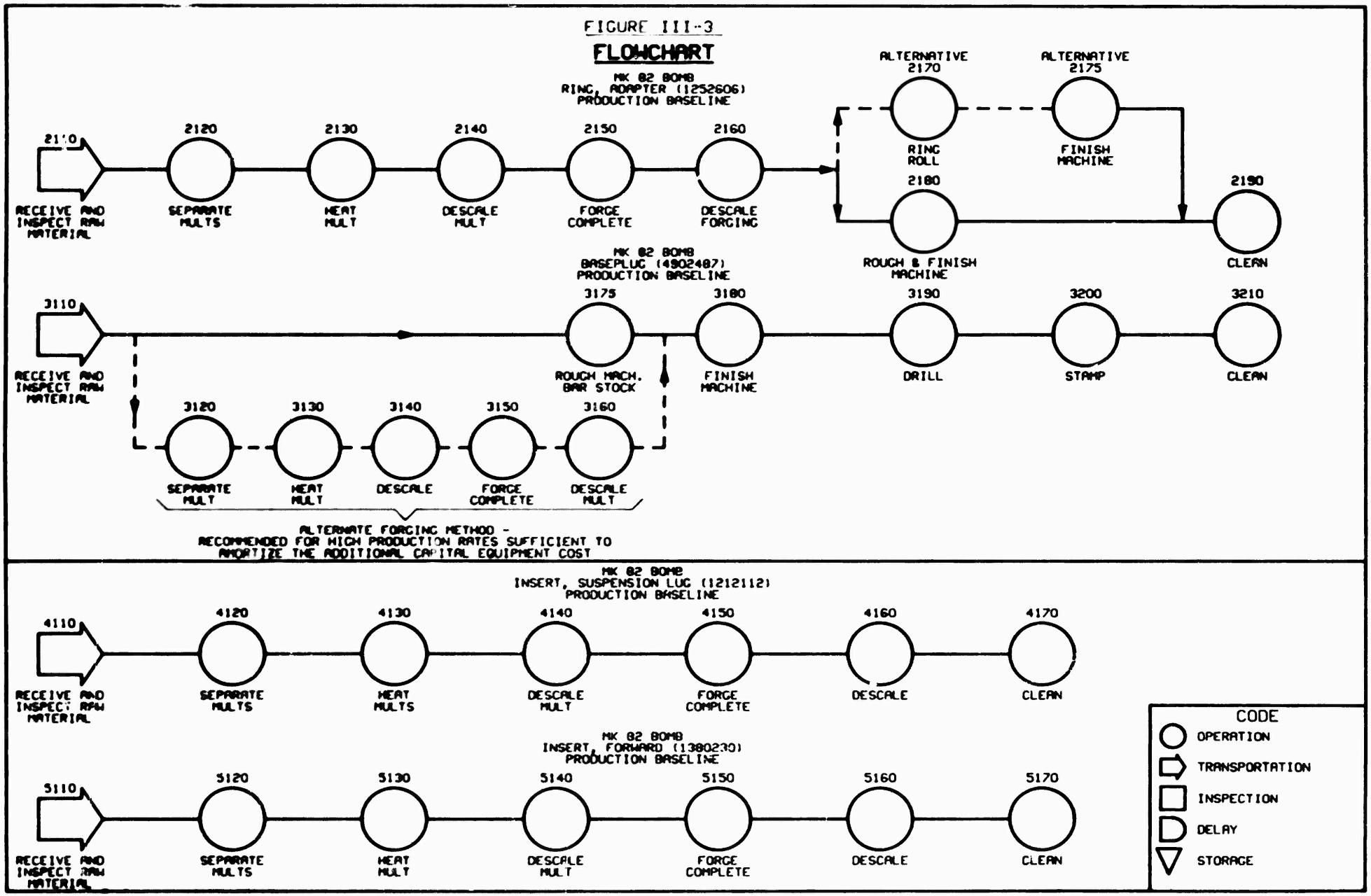
Receiving inspection must be completed before a lot becomes available for processing. If the material's supplier certification is acceptable, a verification of quantity, either by weight or by length, can be accomplished without extra handling.

b. Movement of Billets From Storage to First Process Station 5-inch RCS, 1,700-lb-Each Billet

This operation includes the movement of stock to the sawing or shearing operation of the billet preceding the first processing step.

FIGURE III-3

FLOWCHART



Examples of the proper types of equipment to use are a Shepard-Niles 25-ton bridge crane and a Clark 2-ton forklift truck.

2. Operation 2120 - Separate Mults

Equipment alternatives:
- Shearing machine, 1,000 ton (cold shearing)
- Saw, carbide tipped, 24 inch, 30 hp (sawing)
- Saw, band, 16 inch, 25 hp (sawing)

a. Cold Shear

The 1,000 ton shearing machine requires automatic feed, clamp, and eject attachments. The press may be in the production line to minimize materials handling and traceability problems or be off-line if facilities dictate.

An example of the proper equipment to use is a Buffalo Forge Co., shearing machine, 5-5/8-inch bar, model 13.

b. Circular Saw

Carbide tipped circular saws produce precision mult.

Abrasive cutting, even done wet, is not approved. Experience has shown that trapped abrasive causes excessive tool wear during forging.

An example of the proper equipment to use is a Heller Gebrueder cut-off machine, circular saw blade, manual, model No. SSH630.

c. Band Saw

Although a band saw is less accurate, it is less expensive than a circular saw. The band-sawing process is slow, compared with the forging rate; therefore, materials handling provisions must be developed for multiple machines.

An example of the proper equipment to use is a Do-All cut-off machine, automatic feed, horizontal, model No. P16M.

3. Operation 2130 - Heat Mult

Equipment alternatives:
- Heater, induction, 2200 F, 400 kW, 180 Hz
- Rotary-hearth furnace, 2200 F
- Continuous tunnel furnace, 2200 F

Induction heating is the preferable method since the heating is normally fast enough to prevent scaling of the mult. If furnace heating is used, the furnaces should have dual fuel burners.

Examples of the proper equipment to use are:

a. Tocco induction-heating in-line system with multicoil stations for sequential heating, 2200 F.

b. Flinn and Dreffein Inc., rotary hearth, gas-fired, 2200 F.

c. Lindburg Bros. Co. T-slot oven, open flame, gas-fired, 2200 F.

4. Operation 2140 - Descale

Equipment - Squirrel-cage tumbler

The mults are placed in a squirrel-cage tumbler to remove the scale formed from exposure to the atmosphere. This operation normally is not necessary, if induction heating is used.

Typically, the squirrel-cage tumbler is custom designed and made for the part being tumbled.

5. Operation 2150 - Pancake, Pre-form, Punch, and Restrike

Equipment - Press, mechanical, 2,000 ton, 10-inch stroke

The part is forged in a three-stage die with one part in each stage at a time.

An example of the proper equipment to use is a National Machinery Co. Maxipress 2000, mechanical.

6. Operation 2160 - Descale

Equipment - Blast-clean and finishing machine, horizontal

During this operation, forging scale is removed by tumble blasting.

An example of the proper equipment to use is a Pangborn Corporation blast-cleaning machine, endless-belt barrel type, model 15GN3.

7. Operation 2170 - Ring Roll

Equipment - Ring rolling-machine, 10-inch diameter x 3-inch capacity

This operation enlarges and rough-rolls the adapter ring outer and inner contour to expedite machining and conserve material. This operation can be eliminated, if the ring adapter was forged to rough size at Operation No. 2150.

An example of the proper equipment to use is a Wagner-Dortmund, KFRWT-630, four-mandrel, ring rolling mill.

8. Operation 2175 - Rough and Finish Machine

Equipment - Lathe, six-spindle, automatic chucking, 10-inch capacity

The forging is rough-and-finish machined without being ring rolled.

An example of the proper equipment to use is a National Acme Co. RPA6 automatic chucker, 30 hp.

9. Operation 2180 - Machine Ends and Outside

Equipment - Lathe, six-spindle, automatic chucking, 10-inch capacity

The inside surface is forged to size. Machining is required on the ends and the outside contour.

An example of the proper equipment to use is a National Acme Co. automatic chucker, 30 hp, model RPA6.

10. Operation 2190 - Clean

Equipment - Vapor degreaser

This is a standard cleaning process to prepare for welding.

This equipment is classified as "other production equipment."

An example of the proper equipment to use is a Baron-Blakeslee, model 1019.

C. PLUG, BASE, BOMB BODY (4902487)

This section contains a detailed analysis of operations for the production of the base plug. The flow chart depicting the sequence of operations is shown in figure III-3.

Material - Carbon steel with yield strength 40,000 lbf/in^2 and tensile strength 70,000 lbf/in^2, forging quality
- Carbon steel with yield strength 40,000 lbf/in^2 and tensile strength 70,000 lbf/in^2 bar stock

1. Operation 3110 - Handle Bar/Billet

Equipment - Standard cranes, hoists, and forklift trucks

The handling of steel bar/billet is not a step in the production process, but the materials handling problem must be anticipated in any line designed for high-tonnage consumption of steel bar/billets. The operations to be considered are discussed below.

a. Receiving Bulk Stock

This operation includes moving rolling stock and trailers and stacking material in the storage areas. Overhead cranes, forklifts, and jib cranes will be used to unload the stock. The stacking is arranged to assure material traceability.

Receiving inspection must be completed before a lot becomes available for processing. If the material's supplier certification is acceptable, a verification of the quantity, either by weight or by length, can be accomplished without extra handling.

b. Movement of Bar/Billets From Storage to First Process Station, 4-inch, 1,100-lb-Each Billet and 6-1/2-inch, 2,200-lb-Each Bar

This operation includes the movement of stock to the sawing or shearing operation to produce forgings for the first machining operation.

An example of the proper equipment to use is a Shepard-Niles 25-ton bridge crane and a Clark 2-ton forklift truck.

2. Operation 3120 - Separate Mults

Equipment alternatives:

- Shearing machine, 1,000 ton (cold shearing)
- Saw, carbide tipped, 24 inch, 30 hp (sawing)
- Saw, band, 16 inch, 25 hp (sawing)

a. Cold Shear

The 1,000-ton shearing machine requires automatic feed, clamp, and eject attachments. The press can either be in the production line to minimize materials handling and traceability problems or be off-line if facilities dictate.

An example of the proper equipment to use is a Buffalo Forge Co., shearing machine, bar, model 13.

b. Circular Saw

Carbide-tipped circular saws are used to produce precision mult.

Abrasive cutting, even done wet, is not approved. Experience has shown that trapped abrasive causes excessive tool wear during forging.

An example of the proper equipment to use is a Heller Gebrueder cut-off machine, circular-saw blade, manual, model No. SSH630.

c. Band Saw

The band saw is less accurate but, less expensive than a circular saw. The band-sawing process is slow, compared with the forging rate; therefore, materials handling provisions must be developed for multiple machines.

An example of the proper equipment to use is a Do-All cut-off machine, automatic feed, horizontal, model No. P16M.

3. Operation 3130 - Heat Mult

Equipment alternatives:
- Heater, induction, 2200 F, 150 kW, 180 Hz
- Rotary hearth furnace, 2200 F
- Continuous tunnel furnace, 2200 F, 3,000

Induction heating is the preferable method, since the heating normally is fast enough to prevent scaling of the mult. If furnace heating is used, the furnaces should have dual-fuel burners.

Examples of the proper equipment to use are:

a. Tocco induction heating in-line system with multicoil stations for sequential heating, 2200 F.

b. Flinn and Dreffein Inc., rotary hearth, gas-fired 2200 F.

c. Lindburg Bros. Co. T-slot oven, open flame, gas-fired, 2200 F.

4. Operation 3140 - Descale, Mult

Equipment - Squirrel-cage tumbler

The mults are placed in a squirrel-cage tumbler to remove the scale generated by exposure to the atmosphere. This operation normally is not necessary, if induction heating is used.

Typically, the squirrel-cage tumbler is custom designed and made for the part being tumbled.

5. Operation 3150 - Pancake, Pre-form, Punch, and Restrike

Equipment - Press, mechanical, 2,000 ton, 12-inch stroke

The part is forged in a three-stage die, with one part in each stage at a time.

An example of the proper equipment to use is a National Machinery Co. Maxipress 2000.

6. Operation 3160 - Descale

Equipment - Blast clean and finish machine, horizontal

The forging scale is removed by tumble blasting.

An example of the proper equipment to use is a Pangborn Corporation endless belt barrel type, model 15GN3 blast-cleaning machine.

7. Operation 3175 - Machine Inside and Outside Diameters, Bar Stock

Equipment - Lathe, four-spindle, automatic bar, 7-3/4-inch capacity

Machining is required on the inside and outside diameter.

An example of the proper equipment to use is the National Acme Co. RB-4.

8. Operation 3180 - Thread Outside Diameter and Face, Bar Stock/Forging

Equipment - Lathe, chucking, horizontal, six spindle, automatic, 8-inch capacity

Machine complete except for drilled and tapped holes in face.

An example of the proper equipment to use is the National Acme Co. 30 hp, model RA6, automatic chucking lathe.

9. Operation 3190 - Drill and Tap Six Holes

Equipment - Drill press, 2 spindle, 3/4 cap.

Six holes are drilled and tapped with the index fixture and multiple-drill head.

An example of the proper equipment to use is a Leland Gifford Co., drilling machine, manual, model 2LMS-26.

10. Operation 3200 - Mark

Equipment - Marking machine, reciprocating die, semiautomatic feed, mechanical power

The required part number is marked.

An example of the proper equipment to use is a Noble and Westbrook marking machine, model 245.

11. Operation 3210 - Clean

Equipment - Vapor degreaser

This is a standard cleaning process.

This equipment is classified as "other production equipment."

An example of the proper equipment to use is a Baron-Blakeslee, model 1019.

D. INSERT, SUSPENSION LUG (1212112)

This section contains an analysis of operations required for the production of the suspension-lug insert. The flow chart depicting the sequence of operations is shown in figure III-3.

Material - Carbon steel with yield strength 40,000 lbf/in^2 and tensile strength 70,000 lbf/in^2, forging quality

1. Operation 4110 - Handle Bar/Forgings

Equipment - Standard cranes, hoists, and forklift trucks

Although the handling of steel bar/forgings is not a step in the production process, the materials handling problem must be anticipated in any line designed for high-tonnage consumption of steel bar/forgings. The operations to be considered are discussed below.

a. Receiving Bar Stock/Forgings

This operation includes moving rolling stock and trailers, and stacking material in the storage areas. The unloading activity will utilize overhead cranes, forklifts, and jib cranes. The stacking is arranged to assure material traceability.

Receiving inspection must be completed before a lot becomes available for processing. If a material's supplier certification is acceptable, a verification of quantity, either by weight or by length, can be accomplished without extra handling.

b. Movement of Bar/Forgings from Storage to First Process Station

This operation includes the movement of raw material to the sawing or shearing operation for forgings to the first machining operation.

Examples of the proper equipment to use are the Shepard-Niles 25-ton bridge crane and a Clark 2-ton forklift truck.

2. Operation 4120 - Separate Mults

Equipment alternatives:
- Press, shear, 350 ton (cold shearing)
- Saw, carbide tipped, 24 inch, 30 hp (sawing)
- Saw, band, 16 inch, 25 hp (sawing)

a. Cold Shear

The 350-ton shear press requires automatic feed, clamp, and eject attachments. The press can either be in the production line to minimize materials handling and traceability problems or be off-line if facilities dictate.

An example of the proper equipment to use is a Buffalo Forge Co., shearing machine, 5-inch bar, model 12.

b. Circular Saw

Carbide-tipped circular saws produce precision mult.

Abrasive cutting, even done wet, is not approved. Experience has shown that trapped abrasive causes excessive tool wear during forging.

An example of the proper equipment to use is a Heller Gebrueder cut-off machine, circular-saw blade, manual, model No. SSH630.

c. Band Saw

The band saw, although less accurate, is less expensive than a circular saw. The band-sawing process is slow, compared with the forging rate; therefore, materials handling provisions must be developed for multiple machines.

An example of the proper equipment to use is a Do-All cut-off machine, automatic feed, horizontal, model No. C70.

3. Operation 4130 - Heat Mult

Equipment alternatives:
- Heater, induction, 2200 F, 250 kW, 180 Hz
- Rotary hearth furnace, 2200 F
- Continuous tunnel furnace, 2200 F

Induction heating is the preferable method, since the heating is normally fast enough to prevent scaling of the mult. If furnace heating is used, the furnaces should have dual-fuel burners.

Examples of the proper equipment to use are:

a. Tocco induction heating in-line system with multicoil stations for sequential capacity, 2200 F

b. Flinn and Dreffein Inc. rotary hearth, gas-fired, 2200 F

c. Lindburg Bros. Co. T-Slot Oven, open flame, gas-fired, 2200 F.

4. Operation 4140 - Descale

Equipment - Squirrel-cage tumbler

The heated mults are placed in a squirrel-cage tumbler to remove scale. This operation normally is not necessary, if induction heating is used.

Typically, the squirrel-cage tumbler is custom-designed and made for the part being tumbled.

5. Operation 4150 - Pre-form and Restrike

Equipment - Press, mechanical, vertical, straight sided, single crank, 500 ton, 6-inch stroke

The part is forged in a three-stage die, with one part in each stage at a time.

An example of the proper equipment to use is a National Machinery Co. Maxipress 2000 mechanical press, model No. 500.

6. Operation 4160 - Descale

Equipment - Blast-clean and finish machine, horizontal endless-belt barrel type

The forging scale is removed by tumble blasting.

An example of the proper equipment to use is a Pangborn Corporation 15GN3 Blast Cleaning Machine.

7. Operation 4170 - Clean

Equipment - Vapor degreaser

This is a standard cleaning process to prepare for welding.

This equipment is classified as "other production equipment."

E. INSERT, FORWARD (1380230)

This section contains an analysis of operations required for the production of the forward insert. The flow chart depicting the sequence of operations is shown in Figure III-3.

1. Operation 5110 - Handle Bar/Forgings

Equipment - Standard cranes, hoists, and forklift trucks

The handling of steel bar/forgings is not a step in the production process, but the materials handling problem must be anticipated in any line of this type, that is designed for high tonnage consumption of steel bar/forgings. These operations must be considered, as discussed below.

a. Receiving Bar Stock/Forgings

This operation includes moving rolling stock and trailers and stacking of material in the storage areas. The unloading activity utilizes overhead cranes, forklifts, and jib cranes. The stacking is arranged to assure material traceability.

Receiving inspection is completed before a lot becomes available for processing. If a material's supplier certification is acceptable, a verification of quantity, either by weight or by length, can be accomplished without extra handling.

b. Movement of Bar/Forgings from Storage to First Process Station

This operation includes the movement of raw material to the sawing or shearing operation for forgings to the first machining operation.

Examples of the proper equipment to use are a Shepard-Niles 15-ton bridge crane and a Clark 2-ton forklift truck.

2. Operation 5120 - Separate Mults

Equipment alternatives:

- Press, shear, 500 ton (cold shearing)
- Saw, carbide tipped, 24 inch, 30 hp (sawing)
- Saw, band, 16 inch, 25 hp (sawing)

a. Cold Shear

The 350-ton shear press requires automatic feed, clamp, and eject attachments. The press may either be in the production line to minimize materials handling and traceability problems or be off-line if facilities dictate.

An example of the proper equipment to use is a Buffalo Forge Co., Shearing Machine, 5-inch bar, model 12.

b. Circular Saw

Carbide tipped circular saws produce precision mult.

Abrasive cutting, even done wet, is not approved. Experience has shown that trapped abrasive causes excessive tool wear during forging.

An example of the proper equipment to use is a Heller Gebrueder cut-off machine, circular-saw blade, manual, model No. SSH630.

c. Band Saw

The band saw, although less accurate, is less expensive than a circular saw. The band sawing process is slow, compared with the forging rate; therefore, materials handling provisions must be developed for multiple machines.

An example of the proper equipment to use is a Do-All cut-off machine, automatic feed, horizontal, model No. C70.

3. Operation 5130 - Heat Mult

Equipment alternatives:
- Heater, induction, 2200 F, 250 kW, 180 Hz
- Rotary-hearth furnace, 2200 F
- Continuous-tunnel furnace, 2200 F

Induction heating is the preferable method, since the heating is normally fast enough to prevent scaling of the mult. If furnace heating is used, the furnaces should have dual-fuel burners.

Example of the proper equipment to use are:

a. Tocco induction heating in-line system with multicoil stations for sequential heating, 2200 F

b. Flinn and Dreffein Inc. Rotary Hearth, gas-fired, 2200 F

c. Lindberg Bros. T-Slot Oven, open flame, gas-fired, 2200 F

4. Operation 5140 - Descale

Equipment - Squirrel cage tumbler

Heated mults are placed in a squirrel-cage tumbler to remove scale. This operation normally is not necessary, if induction heating is used.

Typically, the squirrel-cage tumbler is custom designed and made for the part being tumbled.

5. Operation 5150 - Pre-form and Restrike

Equipment - Press, mechanical, vertical, straight sided, single crank, 500 ton, 6-inch stroke

The part is forged in a three-stage die with one part in each stage at a time.

An example of the proper equipment to use is a National Machinery Co. Mechanical Press, model No. 500.

6. Operation 5160 - Descale

Equipment - Blast-clean and finish machine, horizontal, endless-belt barrel type

The forging scale is removed by tumble blasting.

An example of the proper equipment to use is a Pangborn Corporation 15GN3.

7. Operation 5170 - Clean

Equipment - Vapor degreaser

This is a standard cleaning process to prepare for welding.

This equipment is classified as "other production equipment."

F. RETAINER, FUZE LINER (4902493)

The following section contains a detailed analysis of operations for the production of the fuze-liner piece parts and assembly.

Material - Carbon-Steel Tube, 5-inch OD x 3-1/4-inch ID, MIL-T-16343

1. Operation 6110 - Handle Tube

Equipment - Standard cranes, hoists, and forklift trucks

The handling of steel bar is not a step in the production process, but the material handling problem must be anticipated in any line designed for high-tonnage consumption of steel bar. The operations to be considered are discussed below.

a. Receiving Tube Stock

This operation includes moving rolling stock and trailer and stacking material in the storage areas. The unloading activity will utilizes overhead cranes, forklifts and jib cranes. The stacking is arranged to assure material traceability.

Receiving inspection is completed before a lot becomes available for processing. If the material's supplier certification is acceptable, a verification of the quantity, either by weight or by length, can be accomplished without extra handling.

b. Movement of Tube from Storage to First Process Station

This operation includes the movement of stock to the first machining operation.

Examples of the proper equipment to use are a Shepard-Niles 25-ton bridge crane and a Clark 2-ton forklift truck.

2. Operation 6120 - Machine Complete and Cut Off

Equipment - Lathe, bar, horizontal, four spindle, automatic
5-inch dia bar

The machining is complete except for drilled holes in the face.

An example of the proper equipment to use is a National Acme Co. automatic bar lathe, four spindle, model RB4, 5-1/8-inch dia bar.

3. Operation 6130 - Drill Two Holes

Equipment - Drill press, two spindle

The index fixture is used to drill two holes.

An example of the proper equipment to use is a Leland Gifford Drilling Machine, model 2LMS-26.

4. Operation 6140 - Clean

Equipment - Vapor degreaser

This is a standard cleaning process.

The equipment is classified as "other production equipment."

G. FUZE LINER, AFT (4902490)

1. Operation 7110 - Receive Raw Material

Equipment - Forklift and hoist

This standard operation, which is used in all processes, requires standard material handling equipment.

2. Operation 7120 - Handle Coil Strip, Bar & Tube

Equipment - Standard cranes, hoists, and transfer equipment

Handling of material is not a step in the production process but materials handling must be anticipated in a line designed for high utilization of coil strip and bar. Handling of the material is accomplished by standard equipment such as overhead hoists, conveyors, hooks, slings, and lift trucks. No example of specific equipment or manufacturer is required, because the equipment used is standard to the metal-working industry.

H. CANISTER - ITEM 1, PART OF (4902490)

Material - Steel, (CRDQ) QQ-S-698 (.072 thick)

1. Operation 7130 - Blank and Form

Equipment - Press, straight sided, mechanical, 230 ton, 15-inch stroke, coil-stock reel, straightener, lubricator, and scrap chopper

The stock is pulled from the reel through the straightener and lubricator into a five-station die. The die stations include blanking, three draws and a punch at the last draw station, and trim to length. The unused strip is chopped to facilitate scrap removal from the press area.

An example of the proper equipment to use is a Bliss 5S, mechanical, vertical, straight sided, double-action press.

2. Operation 7140 - Degrease

Equipment - Degreaser, conveyorized

Parts are received from the previous operation, loaded onto racks with the large open end down, and conveyed through the degreaser unit to remove all contaminants.

An example of the proper equipment to use is a Baron-Blakeslee Degreaser, 1019, type TH-LL-V.

I. COLLAR - ITEM 2, PART OF (4902490)

Material - Steel tubing, type 1, MIL-T-16343

1. Operation 8110 - Turn Complete

Equipment - Lathe, horizontal, six-spindle automatic, 4-inch diameter bar, 30 hp

Parts are produced from lengths of tubing by a standard machining operation. All parts are complete except for the inside diameter which must be .12 inches smaller in each part. This material is removed after welding in Operation 4010. The machine production rate is based on double-tooling the machine, thus two finished parts are produced with each cycle of the machine.

An example of the proper equipment to use is a Cone-Blanchard Machine Co., automatic screw machine, model SZ, six-spindle.

2. Operation 8120 - Deburr

Equipment - Finishing machine, vibratory type, circular bowl, 20-cubic-ft capacity with automatic washer and unloader

All burrs and sharp edges are removed by the abrasive media and the vibratory motion.

An example of the proper equipment to use is a Sweco Inc., model FM20, finishing machine.

3. Operation 8130 - Degrease

Equipment - Degreaser, conveyorized

Parts are loaded into racks and conveyed through the degreaser unit to remove all contaminants.

A typical example of the proper types of equipment to use would a Baron-Blakeslee Degreaser, type TH-LL-V, model 1019.

J. SLEEVE, FUZE LINER (4902492)

Material - Steel, AISI 1025, 1024, or 1022

1. Operation 9110 - Machine Complete

Equipment - Lathe, bar, horizontal, six-spindle automatic, 1-5/8-inch dia bar, 30 hp

Standard machining practices are used to produce a finished part with each cycle of the machine.

An example of the proper equipment to use is a Cone-Blanchard Machine Co. automatic screw machine SW, 30 hp.

2. Operation 9120 - Degrease

Equipment - Degreaser, conveyorized

Parts are loaded on racks and conveyed through the cleaning cycle to remove contaminants.

An example of the proper equipment to use is a Baron-Blakeslee, type TH-LL-V, model 1019.

K. FUZE LINER, AFT (4902490)

1. Operation 10110 - Friction Weld (Inertia Weld) Collar to Canister

Equipment - Friction welding machine, special with automatic load and unload

Parts are automatically loaded in the machine and joined by the friction weld process which consists of one part rotated at a controlled r/min while the other part, restrained from turning, is forced against the rotating part. The heat generated by the rotation and the force or forging action created a weld without filler materials, fluxes, or shielding gases, Only a narrow heat zone is required.

An example of the proper equipment to use is a Manufacturing Technology Inc., 180-B Inertia Welding Machine.

2. Operation 10120 - Machine Weld Flash

Equipment - Lathe, automatic chucking, 3-inch dia bar, 10 hp

This is a standard machining operation which includes back-boring the flash on the inside diameter of the collar and plunge-cutting the external flash from the part.

An example of the proper equipment to use is a Warner & Swasey OAC, 4410 Automatic Turret Lathe, 3-inch bar, 10 hp.

3. Operation 10130 - Degrease

Equipment - Degreaser, conveyorized

Parts with flange down are loaded on racks and conveyed through the degreaser unit to remove all contaminants.

An example of the proper equipment to use is a Baron-Blakeslee, type TH-LL-V, model 1019.

4. Operation 10140 - Magnetic Particle Inspection

Equipment - Magnetic particle inspection, magnaflux

To determine imperfections, parts are inspected by standard procedure.

An example of the proper equipment to use is a Magnaflux Corporation model H720 with a No. SB1416 de-magnetizer.

L. FUZE LINER ASSEMBLY (4902494), AFT

1. Operation 11110 - Friction-Weld (Inertia Weld) Sleeve to Canister Sub-Assembly

Equipment - Friction welding machine, special with automatic load and unload

Parts are automatically loaded in the machine and joined by the friction-weld process. One part is rotated at a controlled r/min and the other part, restrained from turning, is forced against the rotating part. The heat generated by the rotation and the force or forging action creates a weld without filler materials, fluxes, or shielding gases. There is also a narrow heat zone.

An example of the proper equipment to use is a Manufacturing Technology Inc. model 90-B Inertia Welder.

2. Operation 11120 - Zinc Plate

Equipment - Zinc plating machine, automatic, return type, continuous 12

Parts are racked and processed automatically through the plating machine. Loading and unloading is manual.

An example of the proper equipment to use is a Udylite Co., Division of OXY Finishing Corp., Custom Zinc Plating Machine.

M. FUZE LINER, FORWARD (1239593)

1. Operation 12110 - Receive Raw Material

Equipment - Forklift and hoist

This standard operation used in all processes requires standard material handling equipment.

2. Operation 12120 - Handle Coil Strip, Bar and Tube

Equipment - Standard cranes, hoists and transfer equipment

Although it is not a step in the production process, materials handling must be anticipated in a line designed for high utilizatin of coil strip and bar. The handling is accomplished by standard equipment, such as overhead hoists, conveyors, hooks, slings, and lift trucks.

No specific equipment or manufacturer is required, because the equipment used is standard to the metal-working industry.

N. CANISTER - ITEM 1, PART OF (1239593)

Material - Steel (CRDQ) QQ-S-698 (072 THK)

1. Operation 12130 - Blank and Form

Equipment - Press, straight sided, mechanical, 230 ton, 15-inch stroke, coil-stock reel, straightener, lubricator, and scrap chopper

The stock is pulled from the reel, through the straightener and the lubricator into a five-station die. The die stations include blanking, three draws (with a punch at the last draw station), and trim to length. The unused strip is chopped to facilitate scrap removal from the press area.

An example of the proper equipment to use is be a Bliss 5S, mechanical, vertical, straight sided, double action press.

2. Operation 12140 - Degrease

Equipment - Degreaser, conveyorized

Parts received from the previous operation, are loaded with the large open end down onto racks and conveyed through the degreaser unit to remove all contaminants.

An example of the proper equipment to use is a Baron-Blakeslee Degreaser, 1019, type TH-LL-V.

0. COLLAR - ITEM 2, PART OF (1239593)

Material - Steel tubing, type 1 MIL-T-16343

1. Operation 13110 - Turn Complete

Equipment - Lathe, horizontal, six-spindle automatic, 4-inch dia bar, 30 hp

Parts are produced from lengths of tubing by standard machining operations. All parts are complete except for the inside diameter, which must be .12 inches smaller on each part. This material is removed after welding in Operation 4010. The machine production rate is based on double-tooling the machine, thus two finished parts are produced with each cycle of the machine.

An example of the proper equipment to use is a Cone-Blanchard Machine Co., automatic screw machine, model SZ, six spindle.

2. Operation 13120 - Deburr

Equipment - Finishing machine, vibratory type, circular bowl, 20-cubic ft capacity with automatic washer and unloader

All burrs and sharp edges are removed by the abrasive media and the vibratory motion.

An example of the proper equipment to use is a Sweco Inc., model FM20, finishing machine.

3. Operation 13130 - Degrease

Equipment - Degreaser, conveyorized

Parts are loaded into racks and conveyed through the degreaser unit to remove all contaminants.

An example of the proper equipment to use is a Baron-Blakeslee Degreaser, type TH-LL-V, model 1019.

P. SLEEVE, FUZE LINER (4902492)

Material - Steel, AIS 1025, 1024, or 1022

1. Operation 14110 - Machine Complete

Equipment - Lathe, bar, horizontal, six-spindle automatic, 1-5/8-inch dia bar, 30 hp

Standard machining practices are used to produce a finished part with each cycle of the machine.

An example of the proper equipment to use is a Cone-Blanchard Machine Co. automatic screw machine, SW, 30 hp.

2. Operation 14120 - Degrease

Equipment - Degreaser, conveyorized

Parts are loaded on racks and conveyed through the cleaning cycle for removal of contaminants.

A typical piece of equipment to use is a Baron-Blakeslee, type TH-LL-V, model 1019.

Q. FUZE LINER, FWD (1239593)

1. Operation 15110 - Friction Weld (Inertia Weld) Collar to Canister

Equipment - Friction-welding machine - custom built automatic load and unload

Parts are automatically loaded in the machine and joined by the friction-weld process. One part is rotated part rotated at a controlled r/min and the other part, restrained from turning, is forced against the rotating part. The heat generated by the rotation and the force or forging action create a weld without filler materials, fluxes, or shielding gases. Only a narrow heat zone is required.

An example of the proper equipment to use is a Manufacturing Technology Inc., 180-B Inertial Welding Machine.

2. Operation 15120 - Machine Weld Flash

Equipment - Lathe, automatic chucking, 3-inch dia bar, 10 hp

This is a standard machining operation which includes back boring the flash on the inside diameter of the collar and then plunge-cutting the external flash from the part.

An example of the proper equipment to use is a Warner & Swasey OAC, 4410 automatic turret lathe, 3-inch bar, 10 hp.

3. Operation 15130 - Degrease

Equipment - Degreaser, conveyorized, liquid-vapor-liquid type

Parts are loaded with flange down on racks and conveyed through the degreaser unit to remove all contaminants.

An example of the proper equipment to use is a Baron-Blakeslee, type TH-LL-V, model 1019.

4. Operation 15140 - Magnetic-Particle

Equipment - Magnetic particle inspection, magnaflux

Parts are inspected by standard procedure to determine imperfections.

An example of the proper equipment to use is a Magnaflux Corporation machine, model H720 with a No. SB1416 de-magnetizer.

R. FUZE LINER ASSEMBLY (4902495), FWD

1. Operation 16110 - Friction Weld (Inertia-Weld) Sleeve to Canister Sub-assembly

Equipment - Friction welding machine, custom built with automatic load and unload

Parts are automatically loaded in the machine and joined by the friction-weld process. One part is rotated at a controlled r/min and the other part, restrained from turning, is forced against the rotating part. The heat generated by the rotation and the force or forging action creates a weld without filler materials, fluxes, or shielding gases. Only a narrow heat zone is required.

An example of the proper equipment to use is a Manufacturing Technology Inc. model 90-B inertia welder.

2. Operation 16120 - Zinc Plate

Equipment - Zinc plating machine, automatic, return type, continuous 12

Parts are racked and automatically processed through the plating machine. Loading and unloading is manual.

An example of the proper equipment to use is a Udylite Co., Division of OXY Finishing Corp., Custom Zinc Plating Machine.

S. BODY ASSEMBLY, BOMB, GENERAL PURPOSE (1380545)

This section contains an analysis of operations required for the body assembly shown in Figure III-4. The flow chart depicting the assembly of the bomb is shown in Figure III-5.

1. Operation 17110 - Complete

Equipment - Special tube expander air activated
- Special air activated assembly holding fixture
- 100 candle power light source

The bomb body is secured in the special air activated assembly holding fixture. This procedure is necessary to hold the body in a fixed position to allow ease of assembly of charging tubes, fuze liners, plugs, and rings. The fixture should be so designed as to allow vertical, horizontal, and rotary movement of the body for the various assembly operations. The operator can manipulate the body without leaving the assembly station. Tools, and parts to be assembled, should be located for easy access in the assembly work station. The expansion tools should be located to allow for their efficient use. The use of balance suspension equipment is recommended.

The assembly station must have a light source capable of providing 100 candle power of light inside the bomb body cavity without impairing the vision of the operator looking into the interior of the body.

The light is required to adequately view the holes in the charge inserts for ease of installation of the charge tubes, and to inspect the interior of the cavity for possible damage to the bituminous protective coating.

The bomb body will be processed into the assembly station by conveyor and moved out to the next operation the same way.

Detailed assembly steps are performed as follows:

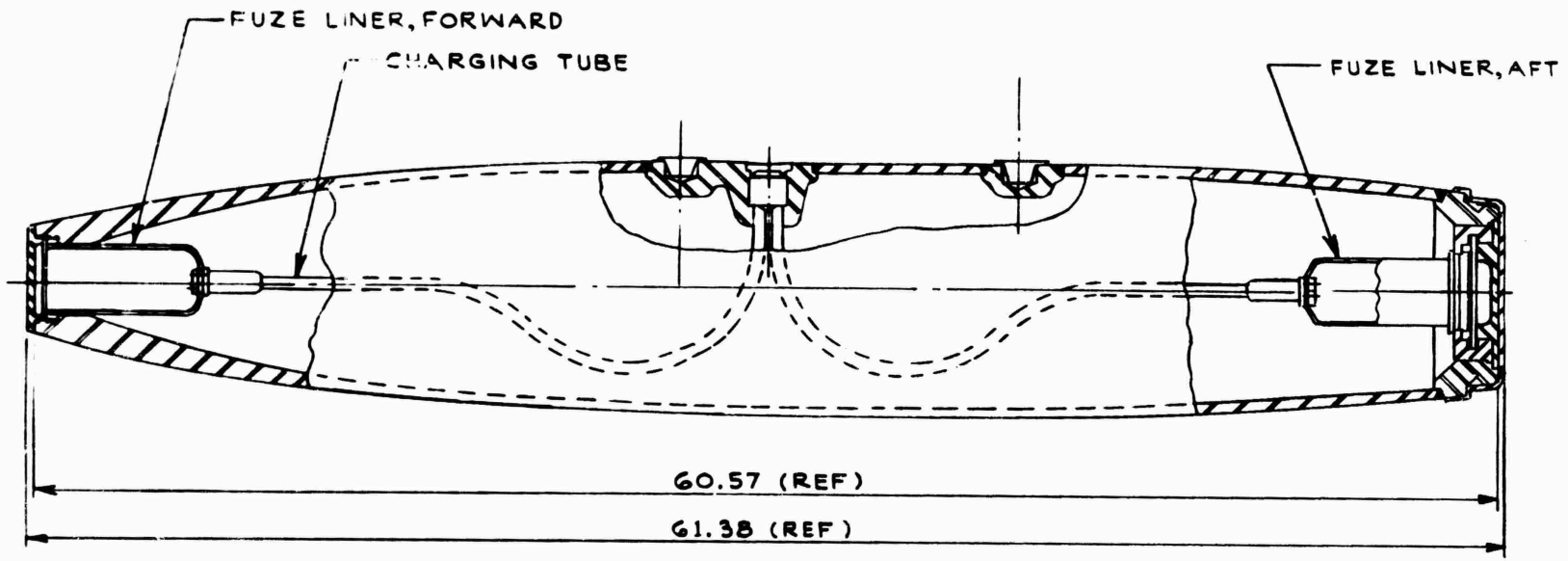


FIGURE III-4
BODY ASSY, BOMB, GENERAL
PURPOSE, 500 POUND
MK 82 MOD 1, EMPTY
PART No. 1380545

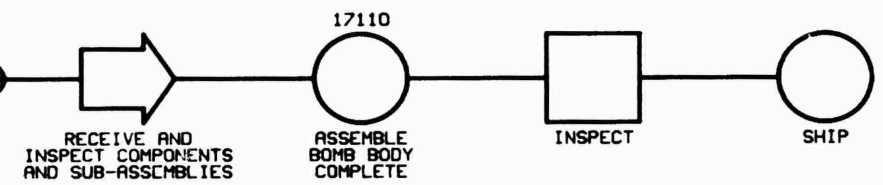
KAISER ENGINEERS
OAKLAND, CALIFORNIA

FIGURE III [illegible]

FLOW CHART

MK 82 BOMB BODY ASSEMBLY (1380545)
PRODUCTION BASELINE

FITTING, CHARGING TUBE	(1265394)
FUZE LINER, FORWARD	(1239593)
FUZE LINER, AFT	(4902490)
PLUG, BASE	(4902487)
RETAINER, FUZE LINER	(4902493)
GASKET	(1123625)
NUT, FITTING, CHARGING TUBE	(1123646)
TUBE, CHARGING	(1212113)
CLIP, RETAINING, NUT, CHARGING	(1212120)
WASHER, LOCK, INTERNAL TOOTH	(1252629)
PLUG, SHIPPING, NOSE AND BASE	(2518425)
PLUG, TAPERED	(4902068)
SET SCREW, FULL-DOG POINT	(4902485)
PLUG, SHIPPING, INSERT, FUZE, CHARGING	(2518634)
CLIP, RETAINING	(4902489)
SLEEVE, FUZE LINER	(4902492)
SET SCREW, KNURLED CUP POINT	(MS51964-69)
CAP SCREW	(MS16997-76)
WASHER, LOCK	(MS35338-45)
PACKING	(AN6230815)



CODE
- OPERATION
- TRANSPORTATION
- INSPECTION
- DELAY
- STORAGE

a. Install Forward and Aft Charging Tubes

The forward charge tube is manually inserted into the boss on the forward insert. (Care is taken to assure the forward most boss is used, and the rear one is to receive the aft charging tube.) The tube is aligned in the proper position to mate with the forward and aft fuze wells, which are installed in the next operation. The position of the tubes in relation to the bosses is critical. Care must be taken to assure that the tubes are fully inserted into the bosses. The tubes must bottom-out against the flanges at the bottom of the holes.

The joint must be pressure tight after expansion. A seal compound is suggested if needed to assure proper sealing of the joints.

Should the compound be used, it must be applied just prior to the insertion of the tubes into the bosses.

b. Form Joints of Forward and Aft Charging Tubes

To form an air-tight joint an air-activated expansion tool is used to expand the steel tubing into the coupling.

The inside diameter of the tube must remain open throughout the entire length of the tube.

Both ends of the forward charging tube are expanded in this operation. The depth of insertion of the expansion tool into the charge tube varies at each end. The operator must take care to insert the tool to the proper depth before expanding the joints. Improper use of the special expansion tool could cause permanent damage to all parts (bomb body, charging tube, and fuze well assembly).

c. Assemble Forward Fuze Liner in Bomb Body

The fuze liner is threaded and must be carefully screwed into place. The threads are coated with an antiseize compound before the fuze liner is inserted into the bomb body.

Care must also be taken to assure the proper alignment of the forward charge tube with the coupling that is at the rear of the fuze liner. The two parts must slip together as the fuze well is screwed into position. The flange on the fuze well is later coated with a bituminous coating compound, MIL-C-450.

The thin coating ensures proper sealing of the two parts and prevents leakage and exposure of the explosives used in the bomb.

The fuze liner should be torqued to 200 ft-lb.

The depth of penetration of the charging tube into the fuze liner flange must be inspected. Care is required to make the tubes conform to the drawing specifications.

d. Install Aft Fuze Liner

Slip the aft fuze well flange onto the aft charging tube. The position of the aft fuze well is critical, and the relationship of the base plug must be properly maintained prior to expanding the joints of the charge tube.

Care must also be taken to assure the proper alignment of the aft charge tube and the coupling at the rear of the fuze liner. The two parts must slip together as the fuze well is screwed into position.

The flange on the fuze well is to be coated with a thin layer of a bituminous coating compound MIL-C-450 to ensure the proper sealing of the two parts and to prevent leakage and exposure of the explosives used in the bomb.

The depth of penetration of the charging tube into the fuze liner flange must be inspected.

e. Form Joints of Forward and Aft Charging Tube

An air activated expansion tool is used to expand the steel tubing into the coupling to form an air tight joint to withstand the mechanical force associated with the application.

The inside diameter of the tube must remain open throughout the length of the tube.

f. Inspect Cavity

The entire interior surface of the body cavity, the charging tubes, and the fuze wells is inspected for any damage to the coating compound.

Special attention should be given to the fuze well coupling/charge tube joints and the charge tube insert and tubes.

Any exposed surface is coated with the bituminous coating compound MIL-C-450.

In addition, any other foreign material trapped in the cavity is removed.

g. Install Base Plug

The threads of the base plug are coated with an antiseize compound according to MIL-A-907.

The base plug is screwed into the bomb body ring adapter. Care is required to properly align the aft fuze well with the base plug.

The base plug is then torqued to 200 ft-lb.

The seat of the fuze well that mates with the base plug is applied with a thin coating of bituminous compound MIL-C-450.

i. Install Aft Fuze-Liner Retainer

The aft fuze-well retainer is screwed into place by attaching it to the aft fuze-well assembly.

Prior to assembly, the threads are coated with antiseize compound required by MIL-A-907.

The retainer is torqued to 200 ft-lb/min.

The screw is not installed in this procedure. The set screw is shipped separately with each finished bomb body assembly. It is clearly identified and packaged.

j. Move Completed Assembly to Next Operation

The completed bomb assembly is released from the assembly fixture and taken away on a conveyor. The assembly station is now clear for the next unit.

IV. RECOMMENDED PRODUCTION BASELINE FOR THE MK82 MOD 1, 500-LB BOMB BODY ASSEMBLY

The recommended production baseline for the MK82 bomb body assembly is summarized in Tables IV-1, 2, 3, 4, and 5 by operation number. The recommended process and equipment are based on the findings of the PEP modernization study. The rationale and assumptions used in preparing the baseline are discussed below.

The lack of an assigned production rate required the arbitrary establishment of a gross capacity production rate as a basis for quantifying the equipment requirements. Capacity can be altered by adding and deleting equipment for each operation.

The technical data package indicates the casing may be formed by the hot forging process or by using seamless or welded-seam tubing. The MK82 production baseline analysis addresses both the forging and tubing processes. The forging process does not appear to be economical in that the forging process will require presses of high tonnage with exceptionally long strokes. Presses of this type are not available in existing equipment inventories, nor are they of the design and size that can be manufactured within a reasonable leadtime. Therefore, the baseline processes and equipment are planned and designed to use steel tubing to produce the bomb casing.

The initial evaluation of the manufacturing requirements considered all feasible methods for producing the MK82 piece parts. In some instances, this evaluation led to the identification and evaluation of the alternate production equipment/methods discussed earlier in this report.

Operations for which alternate methods were discussed are listed below along with the rationale for selecting the process shown in the recommended baseline.

- Table IV-1, Bomb Casing, Operation 1120 - (Separate Lengths of Tube). The four methods investigated for this operation were band sawing, circle sawing, flame cutting, and rotary cutting. Rotary cutting is the most efficient means of performing this operation. This method, which produces a clean, accurate parting of the tube section at a gross rate of 200 pieces/h is much faster than the other methods and does not result in any material loss to saw or torch kerf. Moreover, the roll cutters generate a chamfer on the outside diameter of the tube ends and thereby eliminate the need for deburring.

- Table IV-2, Adapter Ring, Operation No. 2120 - (Separate Mults). Three methods were considered for this operation. They included cold shearing and types of metal sawing (circle and band). Cold shearing is the most productive and accurate method. Moveover, this method generates appreciable material savings by eliminating saw kerf.

- Table IV-2, Adapter Ring, Operation 2130 - (Heat Mult). The induction heater was chosen over the rotary hearth or through-feed furnace processes. Although the productivity of the induction heater is less than the continuous furnces, there is a termendous energy savings due to the localized heat control and startup/shutdown response. This method also minimizes soak time and consequently produces less surface scale and related material loss.

- Table IV .. Insert Suspension Lug, Operation No. 4120 - (Separate Mults). Three methods were considered for this operation. They included cold shearing and two types of metal sawing (circle and band). Cold shearing is the most productive and accurate method. Moreover, this method generates appreciable material savings by eliminating saw kerf.

- Table IV-5, Forward Insert, Operation No. 5130 - (Heat Mult). Induction heating was selected over the rotary hearth and tunnel furnaces. This choice was based on energy savings resulting from the startup/shutdown response time, localized heat zone control, material savings from reduced surface scaling, and elimination of subsequent descaling operations.

RECOMMENDED MANUFACTURING PROCESS: ANALYSIS OF OPERATIONS

A. CASING, BOMB, MK82 MOD 1 (1380548)

The recommended sequence of manufacture is summarized in Table IV-1. The operation numbers are the same as those shown in Section III.

1. Operation 1110 - Handle Tubes

   Equipment - Standard cranes, hoists, and transfer equipment

   An example of the proper equipment to use is a Shepard-Niles 25 ton bridge crane.

2. Operation 1120 - Separate Lengths, Tube

   Equipment - Cutoff machine, rotary, 60 hp

   d. Rotary Cutting

      The tube is cut to the required length while chamfers are generated on the outside diameter. This method eliminates end deburring.

      An example of the proper equipment to use is a Stamet Co. model S024450, lathe, automatic, 95 r/min spindle, 60 hp.

3. Operation 1250 - Pre-form Nose and Base End, Tube

   Equipment - Press, hydraulic, 600 ton, 48-inch stroke

   An example of the proper equipment to use is a Verson Allsteel Press model 600HDI-66T, 600 ton, 48-inch stroke.

4. Operation 1260 - Heat Nose End

Equipment - Heater, induction , 1400 F, 500 kW, 180 Hz

An example of the proper equipment to use is a Westinghouse Electric induction heater.

5. Operation 1270 - Form Nose

Equipment - Press, hydraulic, 500 ton, 36-inch stroke

An example of the proper equipment to use is a Verson Allsteel Press model 500 HDI-48T.

6. Operation 1310 - Machine Base End, Tube

Equipment - Lathe, automatic, chucking 12-inch swing, 72-inch centers, 30 hp

An example of the proper equipment to use is a Warner-Swasey automatic lathe, 12-inch swing, 72-inch centers, 30 hp.

7. Operation 1320 - Machine Nose and Base End, Tube

Equipment - Way-type machine, single station, double ended, horizontal, boring, 50 hp

An example of the proper equipment to use is a machine made by Heald Machine Co., model 442A, 80-inch-long table, 50 hp.

8. Operation 1340 - Flame Cut Lug and Charging Tube Adapter Holes

Equipment - Two automatic machine torches
- Two 500 to 600-A power supplies
- Special cradling and fixturing machine base

An example of the proper equipment to use is a Linde Division of Union Carbide Co., model CM-56 with CW-45 cutting torch.

9. Operation 1350 - Weld Lug and Charging Adapters

Equipment - Two automatic machine torches, gas shielded with flux cored wire
- Two 500 to 600-A 100-percent duty-cycle power supply
- Special cradling and fixturing machine base

An example of the proper equipment to use is a Linde Division of Union Carbide Co. model VI-600 welding power supply, SWM-23 wire feeder, ST-5 water-cooled machine torch.

10. Operation 1360 - Weld Ring Adapter

Equipment - Automatic machine torch, arc-length sensor, gas shielded, flux-cored welding wire
- 500 to 600-A 100-percent duty-cycle power supply
- special cradling and fixturing machine base

An example of the proper equipment to use is a Linde Division of Union Carbide Co. model VI-600 welding power supply, SWM-23 wire feeder, ST-5 water-cooled machine torch.

11. Operation 1370 - Heat Treat and Temper

Equipment - Furnace, gas, 1550 F to 1650 F

An example of the proper equipment to use is a Flinn & Dreffein Engineering Co. heat-treat and temper system, special model

12. Operation 1380 - Blast-clean ID and OD

Equipment - Roto-blast unit

An example of the proper equipment to use is a Wheelabrator & Frye Co., model 42D393, blast-cleaning machine.

13. Operation 1390 - Check Hardness

Equipment - Hardness tester, brinnel, automatic

An example of the proper equipment to use is a Rockwell Corp., model 5JR, hardness tester

14. Operation 1400 - Bore, Face, and Thread Nose End

Equipment - Lathe, turret, automatic 12-inch swing, 72-inch centers, 30 hp

An example of the proper equipment to use is a Warner-Swasey, automatic lathe, 12-inch swing, 72-inch centers, 30 hp.

15. Operation 1410 - Bore, Face, Thread,, and Machine Base End

Equipment - Lathe, turret, automatic 12-inch swing, 72-inch centers, 30 hp

An example of the proper equipment to use is a Warner-Swasey, automatic lathe, 12-inch swing, 72-inch centers, 30 hp.

16. Operation 1420 - Step Drill and Tap Lifting Holes and Charging Hole

Equipment - Drill press, tapping multistation, 2-1/4 inch capacity

An example of the proper equipment to use is a Barnes multispindle drill press, special.

17. Operation 1450 - Drill 16 Holes, Base End and Drill, and Tap Nose End

Equipment - Drill press, multispindle, two units, horizontal

An example of the proper equipment to use is a Barnes multispindle horizontal drill press, 15 hp.

18. Operation 1460 - Test Lifting Lug Adapter

Equipment - Special test machine

An example of the proper equipment to use is a special test equipment manufactured to dictated parameters.

19. Operation 1470 - Pressure-test Bomb Body

Equipment - Special test equipment

An example of the proper equipment to use is a special test equipment manufactured to dictated parameters.

20. Operation 1480 - Stamp Identification

Equipment - Stamping machine, rotary, 5 hp

An example of the proper equipment to use is a James H. Matthews Co., Marking Machine N2201.

21. Operation 1490 - Phosphate Treat

Equipment - Chemical line, multistage spray-dip system

An example of the proper equipment to use is a Litton five stage phosphatizer.

22. Operation 1500 - Paint Exterior

Equipment - Paint spraying machine, automatic, electrostatic

An example of the proper equipment to use is a Binks Manufacturing Co. special unit.

B. RING, ADAPTER, BOMB BODY (1252606)

Material - Carbon steel with yield strength 40,000 lbf/in^2 and tensile strength 70,000 lbf/in^2, forging quality

1. Operation 2110 - Handle Billet

Equipment - Standard cranes, hoists, and forklift trucks

An example of the proper equipment to use is a Shepard-Niles 25-ton bridge crane and a Clark 2-ton forklift truck.

2. Operation 2120 - Separate Mults

Equipment - Press, shear, 1,000 ton

An example of the proper equipment to use is a Buffalo Forge Co., shearing machine, 5-5/8 inch bar, model 13.

3. Operation 2130 - Heat Mult

Equipment - Heater, induction, 400 kW, 180 Hz, 2200 F

An example of the proper type of equipment to use is a Tocco induction heating in-line system with multicoil stations for sequential heating, 2200 F.

4. Operation 2150 - Forge Complete

Equipment - Press, mechanical, 2,000 ton, 10-inch stroke

An example of the proper type of equipment to use is a National Machinery Co., Maxipress 2000, mechanical.

5. Operation 2160 - Descale

Equipment - Blast-clean and finishing machine

An example of the proper type of equipment to use is a Pangborn Corporation blast-cleaning machine, endless-belt barrel type, model 15GN3.

6. Operation 2180 - Rough and Finish Machine

Equipment - Lathe, six-spindle, automatic chucking, 10-inch capacity

An example of the proper equipment to use is a National Acme Co., model RPA6 automatic chucker, 30 hp.

7. Operation 2190 - Clean

Equipment - Vapor degreaser

An example of the proper equipment to use is a Baron Blakeslee, model 1019.

C. PLUG, BASE, BOMB BODY (4902487)

Material - Carbon steel with yield strength 40,000 lbf/in^2 and tensile strength 70,000 lbf/in^2, bar stock

1. Operation 3110 - Handle Bar Stock

Equipment - Standard cranes, hoists, and forklift trucks

Examples of the proper equipment to use is a Shepard-Niles 25-ton bridge crane and a Clark 2-ton forklift truck.

2. Operation 3175 - Machine Inside and Outside Diameters

Equipment - Lathe, automatic chucker, four-spindle

An example of the proper equipment to ute is a National Acme model RA-4 four-spindle automatic, bar-type, horizontal turning machine.

3. Operation 3180 - Thread Outside Diameter and Face

Equipment - Lathe, automatic chucker, six-spindle

An example of the proper equipment to use is a National Acme Co. automatic chucker, 30 hp, model RPA6.

4. Operation 3190 - Drill and Tap Six Holes

Equipment - Drill press, 2-spindle, 3/4-inch capacity

An example of the proper equipment to use is a Leland Gifford Co., drilling machine, manual, model 2LMS-26.

5. Operation 3200 - Stamp Identification

Equipment - Marking machine, reciprocating die, semiautomatic feed, mechanical power

An example of the proper equipment to use is a Noble and Westbrook marking machine, model 245.

6. Operation 3210 - Clean

Equipment - Vapor degreaser

An example of the proper equipment to use is a Baron Blakeslee, model 1019.

D. INSERT, SUSPENSION LUG (1212112)

Material - Carbon steel with yield strength 40,000 lbf/in^2 and tensile strength 70,000 lbf/in^2, forging quality

1. Operation 4110 - Handle Bar

Equipment - Standard cranes, hoists, and forklift trucks

Examples of the proper equipment to use is a Shepard-Niles 25-ton bridge crane and a Clark 2-ton forklift truck.

2. Operation 4120 - Separate Mults

Equipment - Shear press, 350 ton

An example of the proper equipment to use is a Buffalo Forge Co., shearing machine, 5-inch bar, model 12.

3. Operation 4130 - Heat Mult

Equipment - Heater, induction, 2200 F, 50 kW, 180 Hz

An example of the proper equipment to use is a Tocco induction heating in-line system with multicoil stations for sequential capacity, 2200 F.

4. Operation 4150 - Pre-form and Restrike

Equipment - Press, mechanical, vertical, straight-sided, single crank, 500 ton, 6-inch stroke

An example of the proper equipment to use is a National Machinery Co., Maxipress 2000 mechanical press, model No. 500.

5. Operation 4160 - Descale

Equipment - Blast-clean and finish machine

An example of the proper equipment to use is a Pangborn Corporation model 15GN3 blast-cleaning machine

6. Operation 4170 - Clean

Equipment - Vapor degreaser

This equipment is classified as other production equipment.

E. INSERT, FORWARD (1380230)

Material - Carbon steel with yield strength 40,000 lbf/in^2 and tensile strength 70,000 lbf/in^2 forging quality

1. Operation 5110 - Handle Bar Stock

Equipment - Standard cranes, hoists, and forklift trucks

Examples of the proper equipment to use is a Shepard-Niles 15-ton bridge crane and a Clark 2-ton forklift truck.

2. Operation 5120 - Separate Mults

Equipment - Press, shear, 350 ton

An example of the proper equipment to use is a Buffalo Forge Co., shearing machine, 5-inch bar, model 12.

3. Operation 5130 - Heat Mult

Equipment - Heater, induction, 2200 F, 250 kW, 180 Hz

An example of the proper equipment to use ia a Tocco induction heating in-line system with multicoil stations for sequential heating, 2200 F.

4. Operation 5150 - Pre-form and Restrike

Equipment - Press, mechanical, vertical, straight-sided, single crank, 500 ton, 6-inch stroke

An example of the proper equipment to use is a National Machinery Co., mechanical press, model No. 500.

5. Operation 5160 - Descale

Equipment - Blast-clean and finish machine

An example of the proper equipment to use is a Pangborn Corporation model 15GN3.

6. Operation 5170 - Clean

Equipment - Vapor degreaser

This equipment is classified as "other production equipment."

TABLE IV-1
RECOMMENDED SEQUENCE OF MANUFACTURE
PROCESS DESCRIPTION SUMMARY
MK82 MOD 1, 500-LB BOMB, CASING (1380548)
TUBE METHOD
BASIS, 50 PIECES/H ASSIGNED OUTPUT RATE

Oper No.	Equipment Required	Operation Description Equipment Description	Gross Capacity Pieces/h	Equipment Est Cost, $
1110	As Required	Handle Received Material Materials handling equipment	50	N/A
1120	1	Separate Lengths, Tube Cutoff machine, rotary, 60 hp	200	241,000
1250	1	Pre-form Nose and Base Ends Press, hydraulic, 500 ton	180	300,000
1260	1	Heat Nose End Heater, induction, 500 kW, 180 Hz, 1400 F	180	175,000
1270	1	Form Nose Press, hydraulic, 500 ton	180	300,000
1310	1	Machine Base End, Tube Lathe, automatic, 30 hp	80	290,000
1320	1	Machine Nose and Base End, Tube Way-type, 50 hp, dual head	60	250,000

TABLE IV-1 (Cont)

Oper No.	Equipment Required	Operation Description Equipment Description	Gross Capacity Pieces/h	Equipment Est Cost, $
1340	2	Cut Lug and Charging Holes Flame cutting machine	60	34,000
1350	1	Weld Lug and Charging Adapter Welding machine, arc, automatic	50	28,000
1360	1	Weld Adapter Ring, Tubing Welding machine, arc, automatic	60	18,000
1370	1	Heat Treat and Temper Furnace, gas, 1600 F	170	475,000
	1	Tempering furnace, ga , 950 F	105	237,000
1380	1	Blast-Clean ID and OD Roto-blast unit	120	82,000
1390	1	Check Hardness Hardness tester	180	2,000
1400	2	Bore, Face, Thread Nose End Lathe, turret, automatic, 30 hp	50	220,000
1410	1	Bore, Face, Thread Base Lathe, turret, automatic, 30 hp	50	220,000
1420	1	Drill and Tap Lifting & Charging Holes	65	300,000

TABLE IV-1 (Cont)

Oper No.	Equipment Required	Operation Description Equipment Description	Gross Capacity Pieces/h	Equipment Est Cost, $
1450	1	Drill 16 Holes Base End & Drill & Tap Nose End Drill press, multispindle	100	250,000
1460	1 1	Test Lifting Lug Adapter Special test equipment	150	30,000
1470	1	Pressure-Test Body Speical test equipment	150	25,000
1480	1	Stamp Identification Marking machine	300	17,000
1490	1	Phosphate Treat Chemical line	200	225,000
1500	1	Paint Equipment	200	31,000
			SUBTOTAL	3,750,000

TABLE IV-2
RECOMMENDED SEQUENCE OF MANUFACTURE
PROCESS DESCRIPTION SUMMARY
ADAPTER RING (1252606)
MK82 MOD 1, 500-LB BOMB
HOT CUP METHOD
BASIS, 50 PIECES/H ASSIGNED OUTPUT RATE

Oper No.	Equipment Required	Operation Description Equipment Description	Gross Capacity Pieces/h	Equipment Est Cost, $
2110	As Required	Handle Received Material Materials handling equipment	50	N/A
2120	1	Separate Mults Press, shear, 1,000 ton	180	430,000
2130	1	Heat Mult Heater, induction, 400 kW, 180 Hz, 2200 F	200	150,000
2150	1	Forge Complete Press, mechanical, 2,000 ton, 12-inch stroke	225	700,000
2160	1	Descale Blast cleaning equipment	250	60,000
2180	1	Machine Inside and Outside Diameters Bore and Face Lathe, six-spindle, automatic, chucking, 30 hp	200	178,000
2190	1	Clean Degreaser, vapor	700	27,000
			SUBTOTAL	1,545,000

TABLE IV-3
RECOMMENDED SEQUENCE OF MANUFACTURE
PROCESS DESCRIPTION SUMMARY
BASE PLUG (4902487)
MK82 MOD 1, 500-LB BOMB
BAR STOCK METHOD
BASIS, 50 PIECES/H ASSIGNED OUTPUT RATE

Oper No.	Equipment Required	Operation Description Equipment Description	Gross Capacity Pieces/h	Equipment Est Cost, $
3110	As Required	Handle Received Material, Bar Stock Materials handling equipment		N/A
3175	1	Machine Inside and Outside Diameters and Cut Off Lathe, four-spindle, automatic bar machine	50	414,000
3180	1	Thread Outside Diameter and Face Lathe, automatic, chucking, six-spindle, 8-inch capacity	120	178,000
3190	1	Drill and Tap Six Holes Multiple drill head and shuttle fixture	180	75,000
3200	1	Stamp Identification Marking machine	350	12,000
3210	1	Clean Degreaser, vapor	2,000	27,000
			SUBTOTAL	706,000

TABLE IV-4
RECOMMENDED SEQUENCE OF MANUFACTURE
PROCESS DESCRIPTION SUMMARY
INSERT, SUSPENSION LUG (1212112)
MK82 MOD 1, 500-LB BOMB
HOT CUP METHOD
BASIS, 50 PIECES/H ASSIGNED OUTPUT RATE

Oper No.	Equipment Required	Operation Description Equipment Description	Gross Capacity Pieces/h	Equipment Est Cost, $
4110	As Required	Handle Received Material Materials handling equipment		N/A
4120	1	Separate Mults Press, shear, 350 ton	270	430,000
4130	1	Heat Mult Heater, induction 50 kW, 180 Hz, 2200 F	150	60,000
4150	1	Preform and Restrike Press, mechanical, 500 ton, 6-inch stroke	200	250,000
4160	1	Descale Blast-cleaning equipment	400	59,000
4170	1	Clean Degreaser, vapor	2,000	27,000
			SUBTOTAL	826,000

TABLE IV-5
RECOMMENDED SEQUENCE OF MANUFACTURE
PROCESS DESCRIPTION SUMMARY
INSERT, FORWARD (1380230)
MK82 MOD 1, 500-LB BOMB
HOT CUP METHOD
BASIS, 50 PIECES/H ASSIGNED OUTPUT RATE

Oper No.	Equipment Required	Operation Description Equipment Description	Gross Capacity Pieces/h	Equipment Est Cost, $
5110	As Required	Handle Received Material Materials handling equipment		N/A
5120	1	Separate Mults Press, shear, 350 ton	180	430,000
5130	1	Heat Mult Heater, induction, 250 kW, 180 Hz, 2200 F	150	150,000
5150	1	Perform and Restrike Press, mehcanical, 500 ton, 6-ich stroke	200	250,000
5160	1	Descale Blast-cleaning equipment	250	59,000
5170	1	Clean Degreaser, vapor	1,500	27,000
			SUBTOTAL	916,000

TABLE IV-6
RECOMMENDED PRODUCTION BASELINE FOR
MK82 MOD 1, 500-LB BOMB BODY ASSEMBLY
ESTIMATED EQUIPMENT COST SUMMARY

Reference Table	Component	Part No.	Qty of IPE	Estimated Cost,$
IV-1	Casing	1380548	24	3,750,000
IV-2	Adapter Ring	1252606	6	1,545,000
IV-3	Base Plug	4902487	5	706,000
IV-4	Insert, Suspension Lug	1212112	5	826,000
IV-5	Insert, Forward	1380230	5	916,000
			TOTAL	7,743,000