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PROCESS ENERGY INVENTORY AT IOWA ARMY AMMUNITION PLANT

LOAD LINE 3

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US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
LARGE CALIBER
WEAPON SYSTEMS LABORATORY
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M106 projectile	Air compressor	

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

A comprehensive process energy audit was conducted at the Iowa Army Ammunition Plant, Load Line 3. The energy consumption baseline was determined for four production items: cartridges M106, M650E5, M17A1, and M337A1E1. This report includes a brief description of the production process for each item, corresponding process flow charts, and estimates of potential savings. The potential savings for production of all four items total $22,244 or 6680 M Btu of energy per year, a reduction over current consumption of 28%.

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INTRODUCTION

In the early 1950s, this nation's demand for petroleum began to outpace its supply. Consequently, it became necessary to import crude oil from foreign sources. This imbalance between internal supply and demand continued to increase and by 1973 nearly 30% of all domestic consumption was supplied by foreign imports. During that year, the Organization of Petroleum Exporting Countries (OPEC) imposed an embargo on crude oil shipments to the United States, causing severe hardships in both the industrial and private sectors. Even though the embargo was short-lived, it did have far reaching consequences; namely, (1) the rapid escalation of fuel prices and (2) the creation of a nationwide awareness that fuel supplies are very uncertain and subject to instant interruption. In spite of these warnings, the foreign oil dependency has been allowed to deteriorate to the point where nearly 50% of the United States requirements are now imported.

Because of the fuel situation, there is reason for concern that energy in appropriate quantities may not be available to meet future mobilization requirements at Army manufacturing and loading plants. Even if these requirements can be satisfied, it is certain that manufacturing costs will be adversely affected by rapidly escalating fuel prices. To insure that mobilization requirements can be met at an economically acceptable level, the need for a comprehensive energy conservation program became evident. MMT Project 4281, "Conservation of Energy at Army Ammunition Plants," was established to introduce advanced energy conservation technology into the process operations that take place at munitions plants.

PROJECT DESCRIPTION

This report describes the process energy inventory portion of project 4281 that was conducted at Iowa Army Ammunition Plant (IAAP), Middletown, Iowa, by Mason and Hanger-Silas Mason Co., Inc.

The objectives of this project were (1) to conduct a comprehensive process energy audit of one load line at IAAP and (2) to define potential process related, energy saving measures and projects. The load line chosen for this project was the IAAP line 3.

The production items audited were the 8-inch HE projectile M106; the warhead M17A1 (Nike Hercules); the 8-inch HE rocket-assisted (RA) projectile M650E5; and the 75-mm brass blank preparation process.

The process energy consumed in the Load, Assemble, and Pack (LAP) of the 8-inch HE projectile M106 totaled 10,847 M Btu per year at an annual production rate of 132,000 projectiles. This amounts to 82,174 Btu per projectile. This project determined that the more effective procedural change and capital investment projects could save approximately 2,100 M Btu per year. This would reduce

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the process energy consumption by 19.4% to 8,747 M Btu per year, or 66,265 Btu per shell.

The process energy consumed by the warhead M17A1 (Nike Hercules) totaled 569 M Btu per year at a production rate of 1200 warheads per year as produced at the IAAP. This amounts to 474,167 Btu per warhead. Potential savings of the more effective energy conservation projects would reduce the process energy consumption by approximately 390 M Btu per year or 68.5%. The new energy consumption of the production process would be 179 M Btu per year or 149,167 Btu per warhead.

Production of the 8-inch HE RA projectile M650E5 consumes energy at a rate of 4,715 M Btu per year at the current rate of 48,000 projectiles per year. At a mobilization rate of 120,000 per year, 9,483 M Btu would be consumed. This amounts to 98,229 Btu per projectile at standard production and 79,025 Btu per projectile at mobilization. The energy saving measures described in this report would result in a savings of 2,100 M Btu per year for this item. The new consumption would be 2,615 M Btu per year at normal production levels or 7,383 M Btu at mobilization rates. This amounts to 54,480 Btu per projectile at current production and 61,525 Btu per projectile at mobilization rates.

The 75-mm brass blank preparation process at IAAP consumes 63 M Btu per day at a daily production rate of 5,500 blanks. This amounts to 11,454 Btu per cartridge case. Due to the low energy consumption and irregularity of production on this item, the potential for significant process energy reduction was relatively small. Therefore, energy saving investigations were primarily directed toward the other three more energy-intensive production items. In addition to the potential direct process energy saving measures described in this report, 2,272 M Btu per year could be conserved by reduced building heat load depending on production schedules. Potential savings, from both the direct process energy savings measures and from reduced building heat load, are depicted in table 1.

DATA ACQUISITION METHODOLOGY

Steam

Steam data were obtained by measuring condensate with a tared bucket, scale and stopwatch. Test lines were taken off condensate lines as soon after the trap as possible. Attempts were made to measure each individual unit independently; however, in a few cases, units were clustered in order to obtain the desired data.

The bucket-and-scale method was used because it was believed that this method was more accurate than most steam meters and because the cost of installing steam meters at each measuring point would have been prohibitive.

Table 1. Potential energy savings

Production item	Present consumption (M Btu/yr)	Automatic control (M Btu/yr)	Process Insulation (M Btu/yr)	Potential consumption (M Btu/yr)	Potential reduction (%)
M106	10,847	1,540	230	8,747	19.4
M550E5 Standard	4,715	1,540	84	2,615	44.5
M650E5 Mobilization	9,483	1,540	210	7,383	22.1
M17A1 Nike Hercules	569	315	75	179	68.5

Building Heat Load Reduction

Recirculate air compressor waste heat ....380 M Btu/yr

Reclaim heat from high pressure traps..............................1,526 M Btu/yr

Recirculate heat in melt buildings....................................183 M Btu/yr

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Electricity

Electrical data was obtained using four different methods depending on certain situations:

1. A portable kWh meter was designed and built for utilization where possible. The meter was hooked in line with the particular machinery and monitored for a specific period of time. The number of production items processed through this machine was monitored and unit energy consumption was determined using this data.

2. An industrial analyzer was purchased for utilization where possible. The meter was hooked in line with the machinery and monitored. The meter reads kilowatts, volts, amps, and power factor. Using this data and engineering calculations, appropriate energy consumption figures were generated.

3. Where safety regulations prohibited the above methods, indirect methods were used. One method was to monitor process electrical load for an entire building. A clamp-on ammeter was used to determine the average current draw. With this and the line voltage information, calculations were made to determine energy consumption on a per-building basis. Item energy consumption was determined by use of this number and production item-per-day figures.

4. When none of the above methods was feasible, available utility consumption figures were used. Calculations were made to obtain unit energy consumption figures.

Air

An investigation into the possibility of individual air flow meters determined this method to be too costly; therefore, available manufacturers' air consumption data were used to generate the appropriate energy consumption figures.

Conversion Factors Used In This Report

Steam	– 1000 Btu/lb		
Electricity	– 3413 Btu/kWh		
Air*	– 9.8 Btu/ft^3		
M106	– Production	–	132,000/yr
	– Mobilization	–	N/A

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*Calculated from Gardner-Denver air compressor data using 344 ft^3 air/kWh and 3413 Btu/kWh.

M650	– Production	–	48,000/yr
	– Mobilization	–	120,000/yr
M17A1	– Production	–	1,200/yr
	– Mobilization	–	N/A
Blank	– Production	–	5,500/day
	– Mobilization	–	N/A

8-INCH HE PROJECTILE M106

Process Description

The M106 is an 8-inch projectile filled with approximately 36 pounds of TNT. Present facilities have a production capablity of 132,000 projectiles per year. No mobilization rate has been established.

The metal parts are received at the loading line storage building and are transferred to the receiving and painting building when needed. There they are depalletized, inspected, placed on transfer carts, and moved to the melt loading building.

TNT is received at the TNT service magazine and transferred to the TNT screening building as needed. The TNT is inspected and screeened before being transferred to the melt loading building.

Projectiles are preheated in an oven maintained at 125°F. TNT is melted on a 5 psig (228°F) steam heated melt grid. TNT is transferred to a Dopp kettle where it is mixed with unmelted TNT to the proper consistency for pouring (188°F). Approximately 36 pounds of TNT are poured into the projectiles and the projectiles are allowed to cool for a minimum of two hours.

The cooled projectiles are probed with a hot probe (220°F) to a depth of 15 inches to remove the cavitation formed in the casting during cooling. Melted TNT at 188°F is then poured into the hole left from probing and the projectiles are again allowed to cool. Following this, a second hot probe to a depth of five inches is performed, followed by a second add-pour.

When cooled, the projectiles are drilled and a liner is inserted for the supplementary charge.

The projectiles are x-rayed to check for defects. Accepted shells are transferred to the final assembly building. Defect shells are transferred to the melt building where they are sumped out and inserted in the process flow at the preheat oven stage.

The accepted shells are touch-up painted, weighed, and stenciled; the supplementary charge is inserted; and the lifting plug is assembled. The shells are then transferred to the post cyclic heating area where they are maintained

at 135° to 150°F for 12 to 18 hours, allowed to cool to not less than 70°F for 12 hours and reheated to 135° to 150°F for 12 to 18 hours. The shells are then shipped out or stored at the appropriate locations.

The above description of the manufacturing process was extracted from the following IAAP Standing Operating Procedures:

S.O.P. No. 674, Rev. 3 - Line 3 Service Magazines, Screening Building and 2nd and 3rd Floor Melt Tower Operations.

S.O.P. No. 704, Rev. 3 - Post Cyclic Heat, Projectiles and/or Warheads, Yard F.

S.O.P. No. 528, Rev. 4 - Load, Assemble, and Pack 8-Inch, HE, M106.

Energy Consumption

The process energy consumed in the LAP of the 8-inch HE projectile M106 totaled to 10,847 M Btu per year at an annual production rate of 132,000. This amounts to 82,174 Btu per projectile.

A breakdown of energy consumption by production step and form of energy is shown in figures 1 through 4.

GM, HE WARHEAD M17A1

Process Description

The M17A1 (Nike Hercules) is a missile warhead filled with approximately 650 pounds of H6 explosive. Present facilities (1980) have a production capability of 1200 warheads per year. No mobilization rate has been established.

The metal parts are received at the melt building. Other materials, including H6 explosive, are received at various buildings and transferred to the melt building when needed.

The H6 explosive is melted at 194°F and poured into pellet trays and allowed to cool. The empty warheads are weighed and then filled with water. The center of gravity is found and the warhead is prepared for loading.

The warhead is filled with a mixture of cooled H6 pellets and melted H6 explosive at 194°F. After a cooling period, the shrinkage cavity is filled with melted H6 and the warhead is again allowed to cool. Next, the warhead cover plate is attached and the warhead is transferred to the final assembly and ship-out building.

The loaded warhead is stenciled, booster assembled, and placed into the shipping container. The warhead is then shipped out.

RECEIVE TNT (3-06-2)

TRANSFER TNT TO 3-50 VIA PENDANT CONVEYOR

SCREEN TNT (3-50)

TRANSFER TNT TO 3-05-2 VIA PENDANT CONVEYOR

PREPARE TNT FOR POUR GRID MELT KETTLE, DOPP KETTLE, SYNTRON (3-05-2)

POUR TNT INTO PROJECTILES (3-05-2 BAY 'G')

MOVE PROJECTILES TO COOLING BAY VIA ELECTRIC TRACTOR

MOVE PROJECTILES TO COOLING BAY VIA ELECTRIC TRACTOR

MOVE TO 'X' BAYS FOR DRILLING, DRILL MOTOR, VACUUM

PAINT, WEIGH, STENCIL AND PALLETIZE INSERT SUPPLEMENTARY CHARGE

TRANSFER VIA TRAIN OR TRUCK TO YARD 'F'

PREHEAT (3-05-2)

AFTER COOLING PROBE

RETURN TO BAY 'G' FOR ADD-POUR

TRANSFER TO 3-10 FOR X-RAY

TRANSFER TO 3-12 VIA AUTO TRACTOR

POST CYCLIC HEATING

SHIP OUT OR TO STORAGE

RECEIVE PROJECTILE (3-01)

TRANSFER TO 3-04 VIA ELECTRIC TRACTOR

DEPALLETIZE, INSPECT & PLACE ON AUTO TRACTOR (3-04)

TRANSFER TO 3-05-2 VIA AUTO TRACTOR

AFTER WASHOUT TRANSFER TO 3-05-2

TRANSFER TO 3-05-1 FOR WASHOUT

REJECT

ACCEPT

TRANSFER PALLETS & LIFTING PLUGS

Figure 1. Process description--8-inch HE projectile M106

RECEIVE TNT
(3-06-2)

RECEIVE PROJECTILE
(3-01)

TRANSFER TNT TO
3-50 VIA PENDANT
CONVEYOR

PREPARE TNT FOR POUR
GRID MELT KETTLE,
DOPP KETTLE, SYNTRON
(3-05-2)   1,092

TRANSFER TO 3-04
VIA ELECTRIC TRACTOR

SCREEN TNT
(3-50)

POUR TNT INTO
PROJECTILES
(3-05-2 BAY 'G')

PREHEAT
(3-05-2)
984

DEPALLETIZE, INSPECT
& PLACE ON AUTO
TRACTOR (3-04)

TRANSFER TNT TO
3-05-2 VIA
PENDANT CONVEYOR

MOVE PROJECTILES TO
COOLING BAY VIA
ELECTRIC TRACTOR

AFTER COOLING
PROBE
792

TRANSFER TO 3-05-2
VIA AUTO TRACTOR

MOVE PROJECTILES TO
COOLING BAY VIA
ELECTRIC TRACTOR

RETURN TO BAY 'G'
FOR ADD-POUR
53

AFTER WASHOUT
TRANSFER TO
3-05-2

MOVE TO 'X' BAYS
FOR DRILLING, DRILL
MOTOR, VACUUM

TRANSFER TO 3-10
FOR X-RAY

REJECT

TRANSFER TO 3-05-1
FOR WASHOUT

ACCEPT

PAINT, WEIGH, STENCIL
AND PALLETIZE
INSERT SUPPLEMENTARY
CHARGE

TRANSFER TO 3-12
VIA AUTO TRACTOR

TRANSFER PALLETS
& LIFTING PLUGS

TRANSFER VIA TRAIN
OR TRUCK TO YARD 'F'

POST CYCLIC
HEATING
6500

NOTE:
STEAM CONSUMPTION IS GIVEN IN MBTU
BASED ON NORMAL PRODUCTION OF
132,000 PROJECTILES PER YEAR.

SHIP OUT OR
TO STORAGE

TOTAL CONSUMPTION= 9,421 MBTU

Figure 2. Yearly steam consumption--8-inch HE projectile M106

8

RECEIVE TNT
(3-06-2)

RECEIVE PROJECTILE
(3-01)
11

TRANSFER TNT TO
3-50 VIA PENDANT
CONVEYOR
19.8

PREPARE TNT FOR POUR
GRID MELT KETTLE,
DOPP KETTLE, SYNTRON
(3-05-2)

TRANSFER TO 3-04
VIA. ELECTRIC TRACTOR
11

SCREEN TNT
(3-50)

POUR TNT INTO
PROJECTILES
(3-05-2 BAY 'G')

PREHEAT
(3-05-2)

DEPALLETIZE, INSPECT
& PLACE ON AUTO
TRACTOR (3-04)

TRANSFER TNT TO
3-05-2 VIA
PENDANT CONVEYOR
19.8

MOVE PROJECTILES TO
COOLING BAY VIA.
ELECTRIC TRACTOR
11

AFTER COOLING
PROBE

TRANSFER TO 3-05-2
VIA. AUTO TRACTOR
11

ADDITIONAL ELECTRICITY
(BY BUILDING)

3-05-2 = 382.8 MBTU
3-05-1 = 435.6 MBTU
3-10 = 92.4 MBTU
X-RAY = 26.4 MBTU

MOVE PROJECTILES TO
COOLING BAY VIA.
ELECTRIC TRACTOR 11

RETURN TO BAY 'G'
FOR ADD-POUR
11

AFTER WASHOUT
TRANSFER TO
3-05-2
11

MOVE TO 'X' BAYS
FOR DRILLING, DRILL
MOTOR, VACUUM
11

TRANSFER TO 3-10
FOR X-RAY
11

REJECT

TRANSFER TO 3-05-1
FOR WASHOUT
11

ACCEPT

PAINT, WEIGH, STENCIL
AND PALLETIZE
INSERT SUPPLEMENTARY
CHARGE

TRANSFER TO 3-12
VIA. AUTO TRACTOR
11

TRANSFER PALLETS
& LIFTING PLUGS
11

TRANSFER VIA TRAIN
OR TRUCK TO YARD 'F'

POST CYCLIC
HEATING
36.3

NOTE:
ELECTRICAL CONSUMPTION IS GIVEN IN
MBTU BASED ON NORMAL PRODUCTION OF
132,000 PROJECTILES PER YEAR.

SHIP OUT OR
TO STORAGE

TOTAL CONSUMPTION = 1,138 MBTU

Figure 3.   Yearly electrical consumption--8-inch HE projectile M106

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RECEIVE TNT
(3-06-2)

TRANSFER TNT TO 3-50 VIA PENDANT CONVEYOR

SCREEN TNT
(3-50) 62

TRANSFER TNT TO 3-05-2 VIA PENDANT CONVEYOR

PREPARE TNT FOR POUR GRID MELT KETTLE, DOPP KETTLE, SYNTRON
(3-05-2) 31

POUR TNT INTO PROJECTILES
(3-05-2 BAY 'G')

MOVE PROJECTILES TO COOLING BAY VIA. ELECTRIC TRACTOR

MOVE PROJECTILES TO COOLING BAY VIA. ELECTRIC TRACTOR

MOVE TO 'X' BAYS FOR DRILLING, DRILL MOTOR, VACUUM 44

PAINT, WEIGH, STENCIL AND PALLETIZE INSERT SUPPLEMENTARY CHARGE 103

TRANSFER VIA TRAIN OR TRUCK TO YARD 'F'

PREHEAT
(3-05-2)

AFTER COOLING PROBE

RETURN TO BAY 'G' FOR ADD-POUR

TRANSFER TO 3-10 FOR X-RAY 24

TRANSFER TO 3-12 VIA. AUTO TRACTOR

POST CYCLIC HEATING

SHIP OUT OR TO STORAGE

RECEIVE PROJECTILE
(3-01)

TRANSFER TO 3-04 VIA ELECTRIC TRACTOR

DEPALLETIZE, INSPECT & PLACE ON AUTO TRACTOR (3-04) 24

TRANSFER TO 3-05-2 VIA. AUTO TRACTOR

AFTER WASHOUT TRANSFER TO 3-05-2

TRANSFER TO 3-05-1 FOR WASHOUT REJECT

TRANSFER PALLETS & LIFTING PLUGS

ACCEPT

NOTE:
AIR CONSUMPTION IS GIVEN IN MBTU BASED ON NORMAL PRODUCTION OF 132,000 PROJECTILES PER YEAR.

TOTAL CONSUMPTION = 288 MBTU

Figure 4. Yearly air consumption—8-inch HE projectile M106

10

The above description of the manufacturing process was extracted from the following IAAP Standing Operating Procedures:

S.O.P. No. 674, Rev. 3 - Line 3 Service Magazines, Screening Buildings and 2nd and 3rd Floor Melt Tower Operations.

S.O.P. No. 750, Rev. 1 - Load, Assemble, and Pack Warhead, GM, HE, M17A1.

Energy Consumption

The process energy consumed in the LAP of the GM HE warhead M17A1 totaled 569 M Btu per year at an annual production rate of 1200 warheads. This amounts to 474,167 Btu per warhead.

A breakdown of energy consumption by production step and form of energy is shown in figures 5 through 8.

8-INCH HE RA PROJECTILE M650E5

Process Description

The M650E5 is an 8-inch RA projectile filled with approximately 29 pounds of TNT. Facilities exist for a production capability of 48,000 projectiles per year and present mobilization plan of 120,000 per year.

The metal parts are received at the loading line storage building and transferred to the receiving and painting building when needed. There they are depalletized, inspected, placed on transfer carts, and moved to the melt loading building.

The TNT is received at the TNT service magazine and transferred to the TNT screening building when needed. the TNT is inspected and screened before being transferred to the melt loading building.

While the projectiles are placed in a preheat oven maintained at 125°F, the TNT is melted over a steam heated melt grid at 228°F and collected in a jacketed reservoir. The melted TNT is transferred to a Dopp kettle where it is mixed with unmelted TNT to the proper consistency for pouring (188°F).

Approximately 29 pounds of TNT are poured into the projectiles and the projectiles are allowed to cool for a minimum of two hours.

The cooled projectiles are probed with a hot probe to a depth of 15 inches. This step is intended to remove the cavity formed in the casting during cooling. Melted TNT is then poured into the hole left from probing and the projectiles are again allowed to cool. Following this, a second hot probe is performed to a depth of five inches, followed by a second add-pour.

RECEIVE & REST STORE
METAL PARTS
(3-05-1   BAY 'B')

RECEIVE, REST STORE
& TRANSFER EXPLOSIVES
(3-16-2)

CHARGE PELLET TRAYS
(3-05-1   BAY 'G')

RECEIVE PAINTS
& SOLVENTS
(3-03 & 3-12 BAY 'D')

COOL PELLETS & REMOVE
FROM TRAYS
(3-05-1   BAY 'X2')
WEIGH PELLETS

RECEIVE INERT
MATERIALS
(3-12 DOCK & BAY 'D')

WEIGH WARHEADS EMPTY
AND FILLED WITH WATER,
DRY WARHEADS
(3-05-1   BAY 'C')

TRANSFER TO
3-12

UNPACK WARHEAD
METAL PARTS
(3-12   BAY 'D')

POSITION TUBE
STABILIZER & FLANGE
COVER, (3-05-1   RAMP
BETWEEN BAYS 'D' & 'G')

REMOVE BODY
SECTION FROM
SHIPPING CONTAINER
(3-12   BAY 'D')

TRANSFER METAL PARTS
& EXPLOSIVES TO 3-05-1
& RECEIVE LOADED WAR-
HEADS FROM 3-05-1

LOAD WARHEADS
(3-05-1   BAYS 'A' & 'G')

STENCIL WARHEAD
& ASSEMBLE TO
BODY SECTION
(3-12   BAY 'D')

LEVEL FLANGE & FILL
CAVITY
(3-05-1   BAY 'B', 'C' or 'D')

ASSEMBLE BODY
SECTION IN
SHIPPING CONTAINER
(3-12   BAY 'D')

PLACE DESICCANT
& HUMIDITY INDICATOR
CARD & SECURE
CONTAINER COVER
(3-12   BAY 'D')

ASSEMBLE GASKET
& PLATE
(3-05-1   BAY 'C')

SECURE PAD TO
BOOSTER & WASHER
TO ADAPTER
(3-12)

TOUCH-UP & STENCIL
SHIPPING CONTAINER
(3-12   BAY 'D')

GAGE BOOSTER &
ASSEMBLE BOOSTERS,
ADAPTER, SNAP RETAINER
RING & HARNESS
(3-12   BAY 'D')

SHIP WARHEAD
FROM 3-12

Figure 5.   Process description--GM, HE warhead M17A1

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Figure 6. Yearly steam consumption—GM, HE warhead M17A1

RECEIVE & REST STORE METAL PARTS (3-05-1 BAY 'B')

CHARGE PELLET TRAYS (3-05-1 BAY 'G') (SEE NOTE 1)

COOL PELLETS & REMOVE FROM TRAYS (3-05-1 BAY 'X2') WEIGH PELLETS

WEIGH WARHEADS EMPTY AND FILLED WITH WATER, DRY WARHEADS (3-05-1 BAY 'C')

POSITION TUBE STABILIZER & FLANGE COVER, (3-05-1 RAMP BETWEEN BAYS 'D' & 'G')

LOAD WARHEADS (3-05-1 BAYS 'A' & 'G') (SEE NOTE 1)

LEVEL FLANGE & FILL CAVITY (3-05-1 BAY 'B' 'C' or 'D') (SEE NOTE 1)

ASSEMBLE GASKET & PLATE (3-05-1 BAY 'C')

TRANSFER TO 3-12

REMOVE BODY SECTION FROM SHIPPING CONTAINER (3-12 BAY 'D')

STENCIL WARHEAD & ASSEMBLE TO BODY SECTION (3-12 BAY 'D')

ASSEMBLE BODY SECTION IN SHIPPING CONTAINER (3-12 BAY 'D')

SECURE PAD TO BOOSTER & WASHER TO ADAPTER (3-12)

GAGE BOOSTER & ASSEMBLE BOOSTERS, ADAPTER, SNAP RETAINER RING & HARNESS (3-12 BAY 'D')

RECEIVE, REST STORE & TRANSFER EXPLOSIVES (3-16-2)

RECEIVE PAINTS & SOLVENTS (3-03 & 3-12 BAY 'D')

RECEIVE INERT MATERIALS (3-12 DOCK & BAY 'D')

UNPACK WARHEAD METAL PARTS (3-12 BAY 'D')

TRANSFER METAL PARTS & EXPLOSIVES TO 3-05-1 & RECEIVE LOADED WARHEADS FROM 3-05-1

PLACE DESICCANT & HUMIDITY INDICATOR CARD & SECURE CONTAINER COVER (3-12 BAY 'D')

TOUCH-UP & STENCIL SHIPPING CONTAINER (3-12 BAY 'D')

SHIP WARHEAD FROM 3-12

NOTES:
1. TOTAL MELT---497 MBTU / YR.
2. TOTAL CONSUMPTION IS BASED ON 1200 WARHEADS PER YEAR.
3. ALL FIGURES ARE IN MBTU

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RECEIVE & REST STORE
METAL PARTS
(3-05-1   BAY 'B')

CHARGE PELLET TRAYS
(3-05-1   BAY 'G')

COOL PELLETS & REMOVE
FROM TRAYS
(3-05-1   BAY 'X2')
WEIGH PELLETS

WEIGH WARHEADS EMPTY
AND FILLED WITH WATER,
DRY WARHEADS
(3-05-1   BAY 'C')

POSITION TUBE
STABILIZER & FLANGE
COVER, (3-05-1   RAMP
BETWEEN BAYS 'D' & 'G')

LOAD WARHEADS
(3-05-1   BAYS 'A' & 'G')

LEVEL FLANGE & FILL
CAVITY
(3-05-1   BAY 'B' 'C' or 'D')

ASSEMBLE GASKET
& PLATE
(3-05-1   BAY 'C')

TRANSFER TO
3-12

REMOVE BODY
SECTION FROM
SHIPPING CONTAINER
(3-12   BAY 'D')

STENCIL WARHEAD
& ASSEMBLE TO
BODY SECTION
(3-12   BAY 'D')

ASSEMBLE BODY
SECTION IN
SHIPPING CONTAINER
(3-12   BAY 'D')

SECURE PAD TO
BOOSTER & WASHER
TO ADAPTER
(3-12)

GAGE BOOSTER &
ASSEMBLE BOOSTERS,
ADAPTER, SNAP RETAINER
RING & HARNESS
(3-12   BAY 'D')

RECEIVE, REST STORE
& TRANSFER EXPLOSIVES
(3-16-2)

RECEIVE PAINTS
& SOLVENTS
(3-03 & 3-12 BAY 'D')

RECEIVE INERT
MATERIALS
(3-12 DOCK & BAY 'D')

UNPACK WARHEAD
METAL PARTS
(3-12   BAY 'D')

TRANSFER METAL PARTS
& EXPLOSIVES TO 3-05-1
& RECEIVE LOADED WAR-
HEADS FROM 3-05-1

PLACE DESICCANT
& HUMIDITY INDICATOR
CARD & SECURE
CONTAINER COVER
(3-12   BAY 'D')

TOUCH-UP & STENCIL
SHIPPING CONTAINER
(3-12   BAY 'D')

SHIP WARHEAD
FROM 3-12

ELECTRICAL CONSUMPTION
3-05-1 = 55 MBTU
:ARTS = 15 MBTU

NOTES:
1. TOTAL CONSUMPTION = 70 MBTU
2. TOTAL CONSUMPTION IS BASED ON
   1200 WARHEADS PER YEAR.
3. ALL FIGURES ARE IN MBTU.

Figure 7. Yearly electrical consumption----GM, HE warhead M17A1

Figure 8. Yearly air consumption--GM, HE warhead M17A1

The projectiles are x-rayed to check for defects. Accepted shells are transferred to the post cyclic heating preparation area. Defect shells are transferred to the melt building where they are sumped out and inserted in the process flow at the preheat oven stage.

The accepted projectiles are transferred to the post cyclic heating area where they are maintained at 135° to 150°F for 12 to 18 hours, allowed to cool to no less than 70°F, and reheated to 130 to 150°F for 12 to 18 hours. The shells are then returned to the final assembly building.

The rocket motor is attached to the loaded projectile and x-rayed. The accepted shells are then palletized and shipped to storage or off-plant.

The description of the manufacturing process was extracted from the following IAAP Standing Operating Procedures:

S.O.P. No. 674, Rev. 3 — Line 3 Service Magazines, Screening Building and 2nd and 3rd Floor Melt Tower Operations.

S.O.P. No. 704, Rev. 3 — Post Cyclic Heat — Projectiles and/or Warheads.

Energy Consumption

The process energy consumed in LAP of the 8-inch HE RA projectile M650E5 totaled 4,715 M Btu at a production rate of 48,000 per year. Planned mobilization production at 120,000 shells per year would consume 9,483 M Btu per year. This amounts to 98,229 Btu per shell at standard production and 79,025 Btu per shell at mobilization.

A breakdown of energy consumption by production step and form of energy is shown in figures 9 through 12.

75-mm BLANK CARTRIDGE M337A1E1

Process Description

The blanks analyzed were the 75-mm brass blanks. Production capability of approximately 5,500 units per day exists at the IAAP.

The process analyzed involved the following steps:

1. Remove primer.

2. Cut off to desired length.

3. Deburr and delaminac.

16
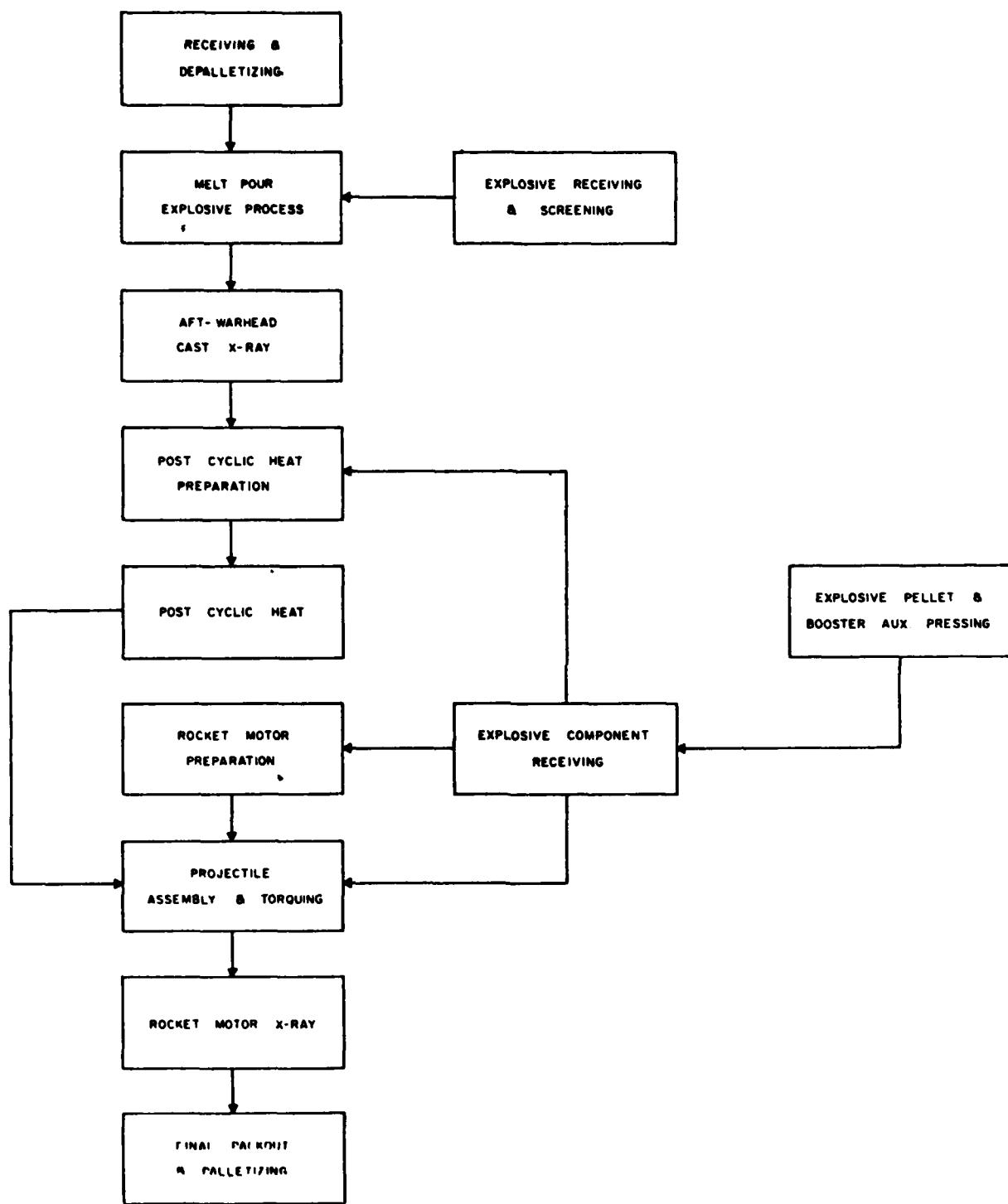
Figure 9. Process description--8-inch HE projectile M650E5

17

RECEIVING & DEPALLETIZING

MELT POUR EXPLOSIVE PROCESS [2025] 1734

EXPLOSIVE RECEIVING & SCREENING

AFT- WARHEAD CAST X-RAY

POST CYCLIC HEAT PREPARATION

POST CYCLIC HEAT [6000] 2400

EXPLOSIVE PELLET & BOOSTER AUX PRESSING

ROCKET MOTOR PREPARATION

EXPLOSIVE COMPONENT RECEIVING

PROJECTILE ASSEMBLY & TORQUING

ROCKET MOTOR X-RAY

FINAL PACKOUT & PALLETIZING

NOTES:

1. TOTAL CONSUMPTION (STANDARD PRODUCTION) = 4134 MBTU

2. TOTAL CONSUMPTION (MOBILIZATION) = 8025 MBTU

3. STANDARD PRODUCTION FIGURES ARE UNDERLINED, MOBILIZATION FIGURES ARE IN BRACKETS.

4. ALL FIGURES ARE GIVEN IN MBTU

5. STANDARD PRODUCTION FIGURES ARE BASED ON 48,000 PROJECTILES PER YEAR. MOBILIZATION FIGURES ARE BASED ON 120,000 PROJECTILES PER YEAR.

Figure 10. Yearly steam consumption--8-inch HE projectile M650E5

18
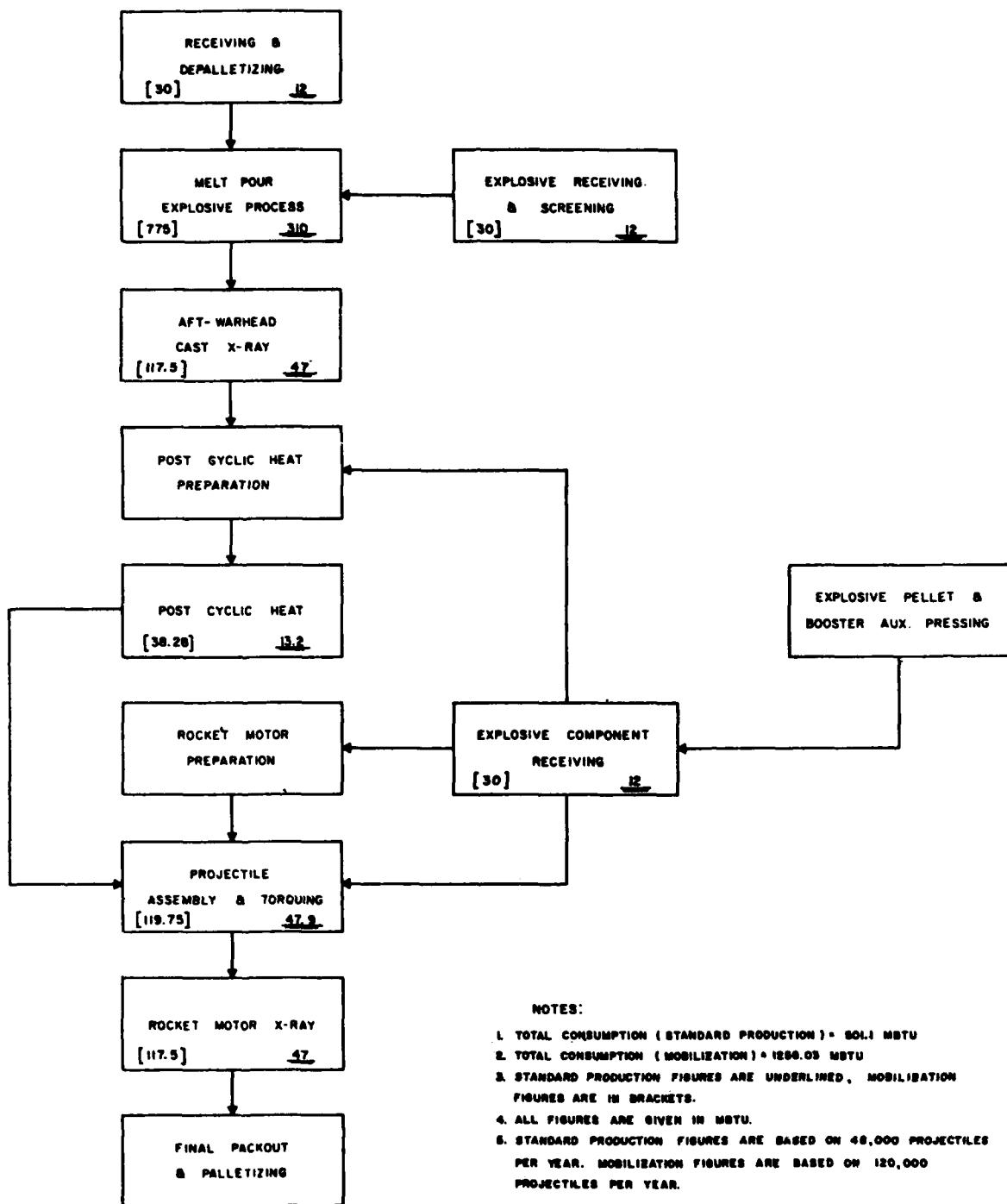
Figure 11. Yearly electrical consumption--8-inch HE projectile M650E5
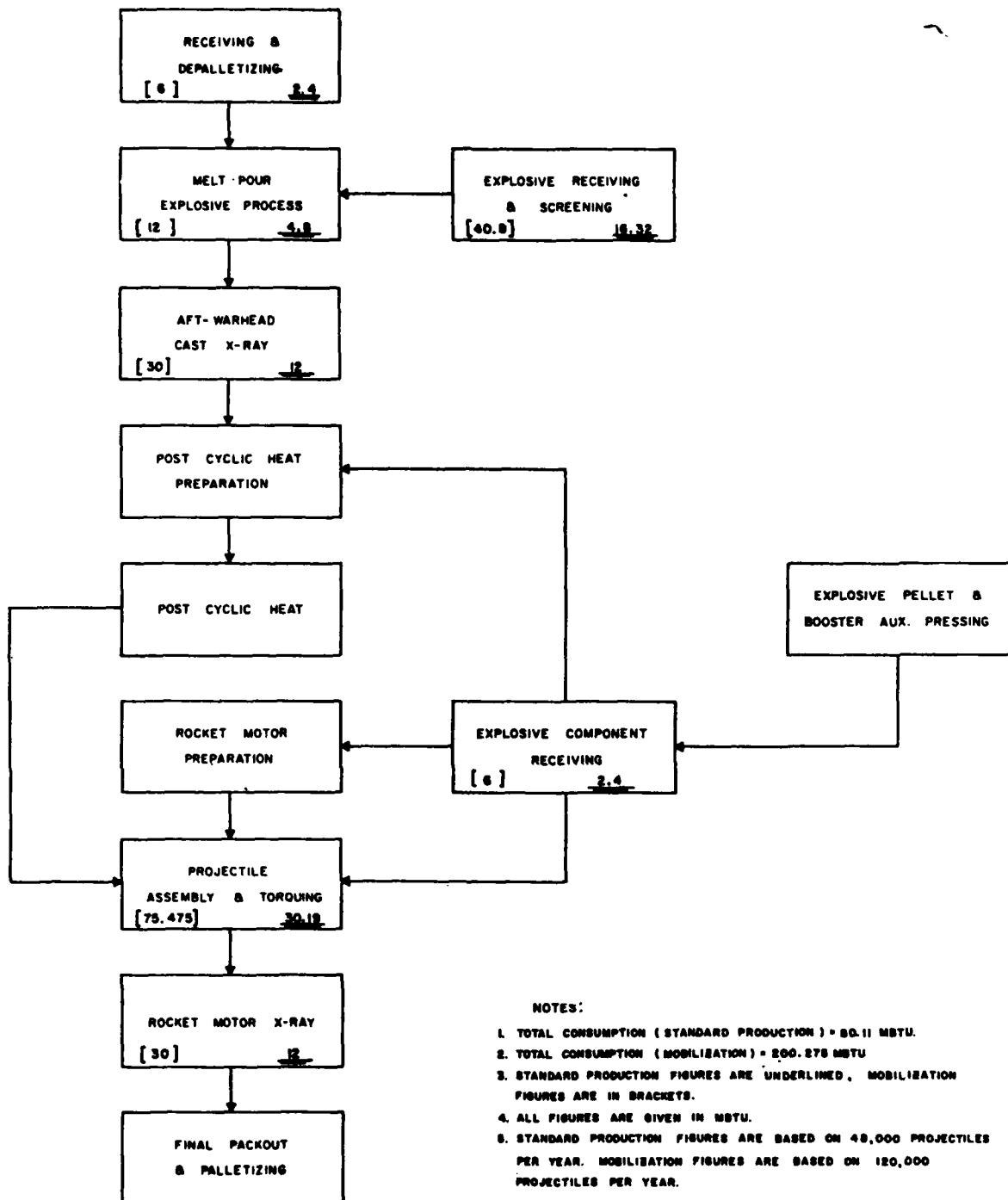
Figure 12. Yearly air consumption--8-inch HE projectile M650E5

4. Sandblast.

5. Degrease.

6. Clean chemically.

7. Palletize and ship out.

The above description of the manufacturing process was extracted from the following IAAP Standard Operating Procedure:

S.O.P. No. 543, Rev. 3 - Prepare Cartridge Cases for Assembly of Blank Ammunition.

This process includes only preparation of blank cartridge cases, not LAP, which will be included in a later study.

Energy Consumption

The blank preparation process will consume approximately 63 M Btu per day at a daily production rate of 5,500 blanks. This amounts to 11,454 Btu per cartridge case.

A breakdown of energy consumption by production step and form of energy is shown in figures 13 through 16.

ENERGY CONSERVATION OPPORTUNITIES

Air Compressor Waste Heat Utilization

A study was undertaken to determine the feasibility of utilizing waste heat generated by the main air compressors for line 3, building 3-83. There are three compressors, each one using an air-cooled heat exchanger located outside the building to cool both the compressor oil and the compressed air.

At line 3, there are only two areas where this application might be practical: building 3-83 and building 3-01. All other areas are too remote. Two possible methods for reclaiming this waste heat are:

1. Direct use of the warm air discharge from the heat exchanger

2. Installation of a "Q-pipe" or similar thermal recovery device in the warm air stream, thus utilizing the waste heat indirectly.

The second method was not considered practical due to the relatively low temperature (105°F maximum) of the warm air discharge and the loss involved in the use of a "Q-pipe" (typical efficiency 60% to 80%), coupled with the lack of

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RECEIVE BLANK
CARTRIDGE CASES
(3-01)

REMOVE FIRED
PRIMERS

SAW CARTRIDGE
CASES

DEBURR AND
DELAMINAC

SHOT BLAST
CASES

DEGREASE CASES

STEEL

BRASS

RECEIVE, TRANSFER
& STORE ACID
(3-03)

CLEAN STEEL
CARTRIDGE CASES

PAINT STEEL
CARTRIDGE CASES

CLEAN BRASS
CARTRIDGE CASES

REMOVE PRIMER INSERT
& INSPECT

DRAIN TANKS
& NEUTRALIZE ACID
PER 120 HRS

PALLETIZE

TRANSFER TO
800-191

Figure 13.   Process description—75-mm blank cartridge M337A1E1

22
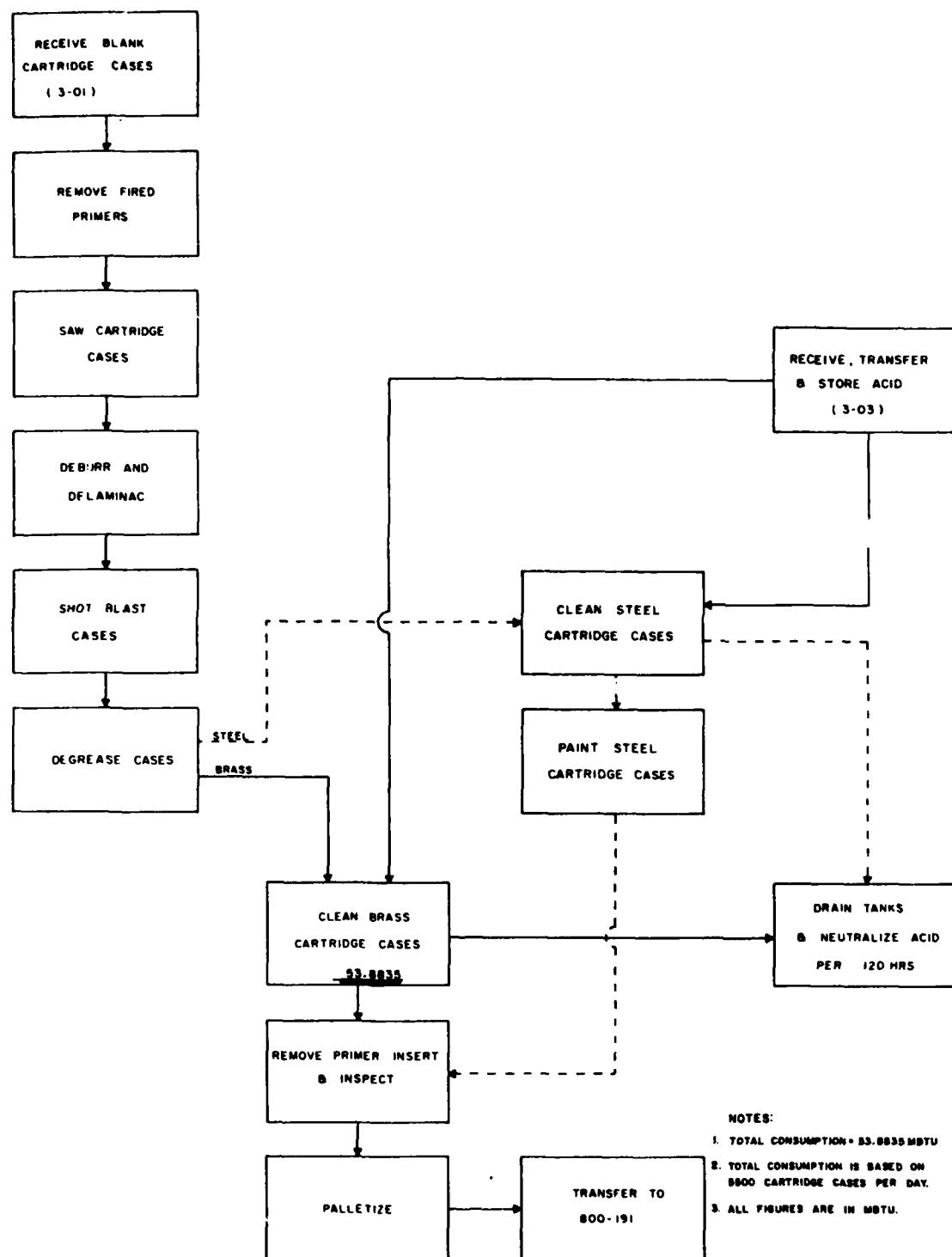
Figure 14. Daily steam consumption—75-mm blank cartridge M337A1E1

23
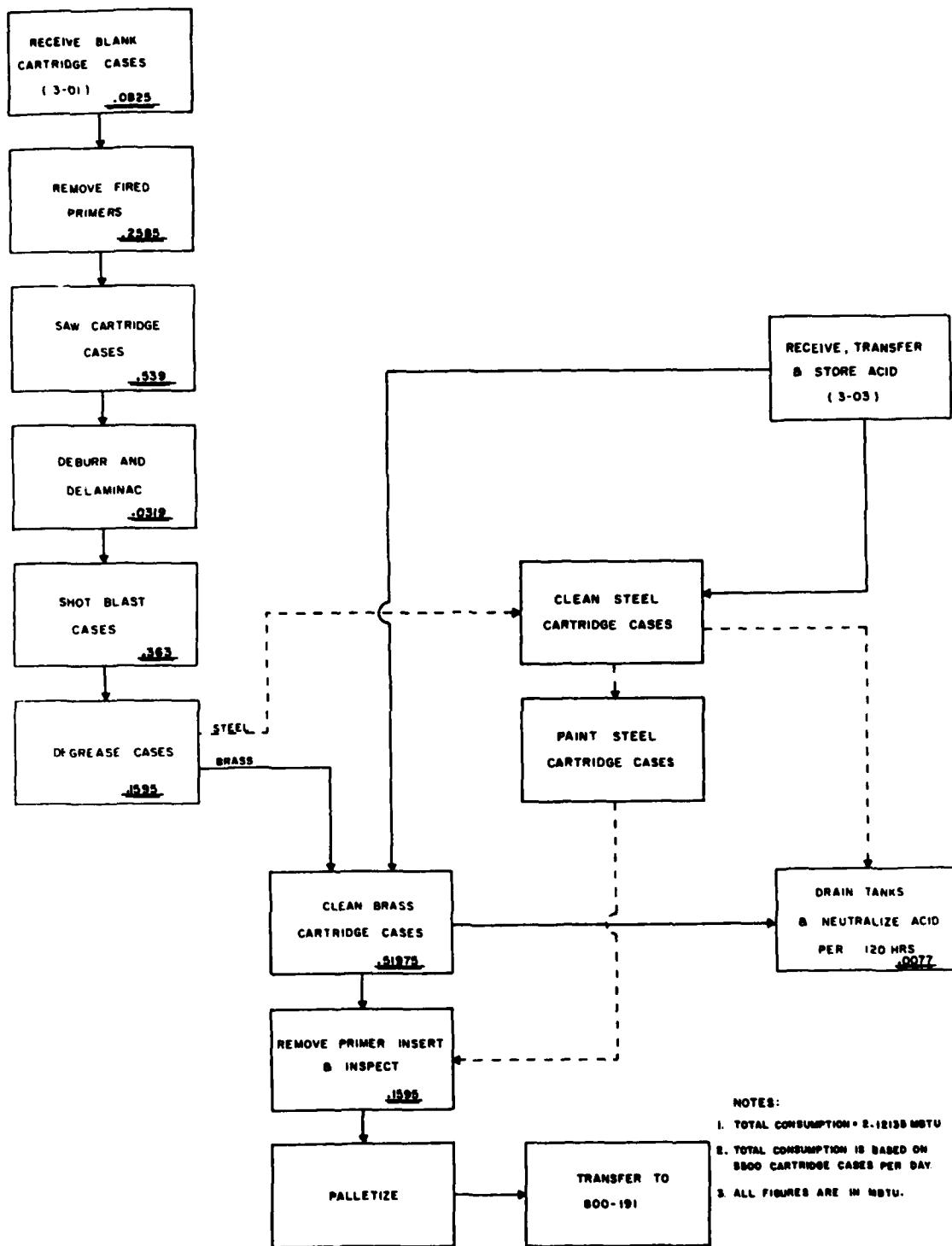
Figure 15. Daily electrical consumption—75-mm blank cartridge M337A1E1
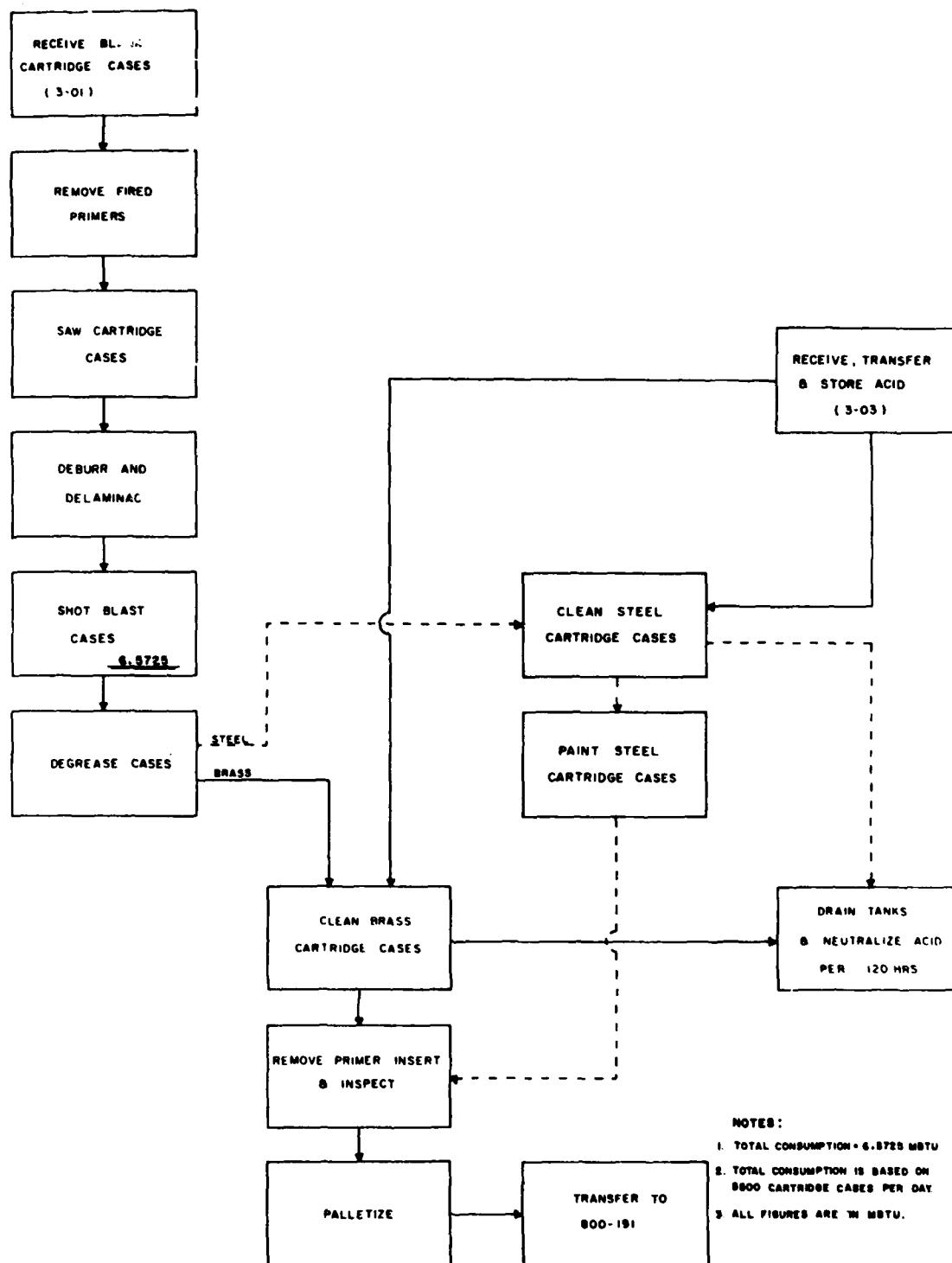
Figure 16. Daily air consumption—75-mm blank cartridge M337A1E1

a suitable process application nearby. Therefore, applications using the first method were studied in more detail. When the project is expanded to plant-wide application, possible use of the second method will be evaluated.

The simplest application would be the utilization of the waste heat to provide heating for building 3-83 itself. This could be accomplished by attaching ductwork to the heat exchanger to convey the warm air directly into the building. A bypass could be provided so that during warm weather, the warm air would be exhausted to the atmosphere, as is the current practice. An interlock with the existing building heating system would be provided to prevent temperatures from getting too low during times when the compressors are not running, or to provide supplemental heating if required.

A second possibility would be to use the compressor waste heat to provide make-up air for building 3-01. This could be accomplished by direct ducting, or by the purchase of an additional heat exchanger or exchangers. In the latter case, instead of ducting the warm air discharge directly to building 3-01, the additional heat exchanger(s) would be installed adjacent to building 3-01, with the oil and compressed air lines being piped to both units. During cool weather periods, oil and compressed air flow would be to the unit(s) adjacent to building 3-01. Warm air discharge would be blown directly into the building, with proper sound-deadening material provided as required. Warm weather bypass would be accomplished by diverting flow to the existing units with the warm air discharge going to atmosphere, as is now the case.

There are three compressors in building 3-83. One is a 200 hp unit; the others are identical 100 hp units. For the 200 hp unit, the cooling air flow rate through the oil/air cooler is 19,000 ft^3/min, whereas for the 100 hp units the flow rate is 8,000 ft^3/min. Thus, a maximum of 35,000 ft^3/min can be expected. However, current demand is such that one 100 hp unit is adequate to fill all compressed air needs (on rare occasions, a second 100 hp unit will be required in addition to the first). Therefore, we can only expect 8,000 ft^3/min to be available. The average discharge temperature is 93°F. The buildings in question (3-83 or 3-01) will be maintained at 65°F.

To allow for some degree of heat loss in the ductwork, a final delivered air temperature of 90°F is assumed. Thus, the amount of heat available for recovery is

$$Q = (1.09) (8,000 \text{ ft}^3/\text{min}) (90°F - 65°F) = 216,000 \text{ Btu/hr}$$

Prohibitive expense would be involved in attempting to use the waste heat to provide make-up air for building 3-01. This building is about 60 feet away from building 3-83 which would result in an impractical duct run. In addition, the duct would have to pass over a road between the two buildings, resulting in a higher than normal duct support expense. In the other case considered (purchasing an additional heat exchanger), support costs could be eliminated by routing the oil and air piping along with existing steam and air piping. However, the cost of the additional heat exchanger(s) would render this method impractical.

Costs involved in implementing the waste heat recovery technique for supplying building heat for building 3-83 would be minimal. Total installed cost for an automatic bypass system including pneumatic controls, dampers and distribution ductwork would be approximately $4,200. Design heat loss for building 3-83 is 182,313 Btu/hr. The 216,000 Btu/hr available from compressor waste heat recovery is more than enough to supply any building heating needs.

Building 3-83 is presently heated by unit heaters utilizing 5 psig steam. The amount of savings that can be realized by instituting the compressor waste heat recovery technique:

$\dfrac{Q}{h_{fg}}$ at 5 psig steam

Q: Design heat loss (Btu/hr)

h_{fg}: Latent heat of vaporization (Btu/lb)

$$\dfrac{182,313 \text{ Btu/hr}}{960.7 \text{ Btu/lb}} = 190 \text{ lb/hr}$$

Current cost of steam = $3.96/1000 lb

190 lb/hr x $3.96/1000 lb = $0.75/hr x 24 hr/day = $18.00/day

Therefore, a savings of $18.00/day can be realized by instituting compressor waste heat.

The amount of steam required for a typical heating season of approximately 6100 degree-days:

Q_D: Heat loss per degree temperature difference

$$Q_D = \dfrac{\text{Total design heat loss}}{(\text{inside design temperature}) - (\text{outside design temperature})}$$

$$= \dfrac{182.313 \text{ Btu/hr}}{(65°F)-(-15°F)} = 2279 \text{ Btu/hr °F}$$

Steam consumption $= \dfrac{Q_D \times (\text{degree days}) \times (24 \text{ hr/day})}{h_{fg}}$.

$$= \dfrac{(2279 \text{ Btu/hr °F}) (6100°F \text{ day}) (24 \text{ hr/day})}{960.7 \text{ Btu/lb}} = 347,294 \text{ lb/heating season}$$

Therefore, the cost of steam required for a typical heating season would be:

$$(347,294 \text{ lb}) \times \dfrac{\$3.96}{1000 \text{ lb}} = \$1375$$

This implies a payback period of:

$$\dfrac{\text{Cost}}{\text{Savings}} = \dfrac{\$4200}{\$1375/\text{yr}} = 3.05 \text{ yr}$$

In summary, the only practical way to utilize the air compressor waste heat at line 3 is to provide heat for the compressor building (building 3-83). As shown above, this could be done quite easily at a reasonable expense.

Reclaim Heat from High Pressure Steam Traps

An engineering study was made to determine the energy savings potential of utilizing hot condensate from high pressure steam traps. There are two melt buildings in each production line, each using a high pressure (150 psig) heat exchanger to heat water for building heat.

Taking the melt building 3-05-2 as an example, 5,776 M Btu is required for heating. An average heating season is approximately 5,088 hours. Condensate from 150 psig steam has a heat content of 339 Btu/lb. Since the condensate is presently not utilized, the maximum potential for savings would be:

$$h_{fg} \text{ at 150 psig} = 857.2 \text{ Btu/lb}$$

$$\frac{\text{Heating load}}{\text{Heating season}} = \frac{5776 \text{ M Btu}}{5088 \text{ hr}} = 1,135,220 \text{ Btu/hr}$$

$$\frac{1,135,220 \text{ Btu/hr}}{857.2 \text{ Btu/lb}} = 1,324 \text{ lb/hr}$$

$$\text{Efficiency} = 80\%$$

$$\frac{1324 \text{ lb/hr}}{0.80} = 1650 \text{ lb/hr}$$

$$1650 \text{ lb/hr} \times 339 \text{ Btu/lb} = 559,350 \text{ Btu/hr}$$

Maximum potential savings would equal:

$$559,350 \text{ Btu/hr} \times 5088 \text{ hr/yr} = 2,846 \text{ M Btu/hr}$$

Process steam (5 psig) could be supplemented by use of a flash tank and also a heat exchanger to recover the heat from the remaining condensate. A 150 psig to 5 psig flash tank has the capability to flash 14% of the hot condensate to 5 psig steam.

$$h_g \text{ at 5 psig} = 1156.4 \text{ Btu/lb}$$

$$1650 \text{ lb/hr} \times 0.14 = 231 \text{ lb/hr}$$

$$231 \text{ lb/hr} \times 1156.4 \text{ Btu/lb} = 267,128 \text{ Btu/hr}$$

The remaining condensate could be utilized in a heat exchanger to preheat incoming air or process water. The maximum heat available would be

$$559,350 \text{ Btu/hr} - 267,128 \text{ Btu/hr} = 292,222 \text{ Btu/hr}$$

A conservative estimate of the savings of this remaining heat would be 30,000 to 50,000 Btu/hr. Therefore, savings would total approximately 300,00 Btu/hr or 1,526 M Btu/yr (flash steam plus hot condensate recovery). With August 1980 steam costs of $3.33 per M Btu, a savings of $5,100 per year could be realized.

Costs involved in installing the flash tank, heat exchanger, and all necessary piping would be approximately $3,750. Therefore, this project could self-amortize in one heating season. Assuming 2,000 hr/yr of actual production time, this would equate to 534 M Btu/yr of direct process energy savings. The remainder of the savings would be realized in building heat savings.

Automatically Control Process Heat

To assure the heat producing equipment's being at the proper temperatuare at the beginning of a shift, steam must be left on during off-shift hours. This results in approximately 128 hr/wk of steam use when it is not required. The amount of steam per hour and per week consumed during non-use hours is:

	Lb/hr	Lb/wk
Preheat oven, 3-05-2 M106 M650E5	100	12,800
Grid melt unit, 3-05-2 M106 M650E5	35	4,480
Dopp kettle, 3-05-2 M106 M650E5	25	3,200
Steam probe, 3-05-2 M106 M650E5	35	4,480
Hot water probe, 3-05-1 M106 M650E5	50	6,400
Comp B - H6 melt kettle, 3-05-1 M17A1	50	6,400

Substantial energy could be saved by the use of a timer-controller to heat the equipment to the proper temperature by the beginning of a shift. The potential savings in pounds of steam per week and per year (assuming 85% of the non-shift steam could be saved and 50 weeks per year of production) is:

	Lb/week	Lb/year
M106	26,656	1,332,800
M650E5	26,656	1,332,800
M17A1	5,440	272,000

Using $3.96 per 1000 pounds of steam, the following savings could be realized per year:

	Savings ($)	Savings (M Btu)*
M106	5,300	1,540
M650E5	5,300	1,540
M17A1	1,100	315

*5 psig steam at 1156.4 Btu/lb.

The acquisition and installation costs of a timer-controller would vary greatly with the complexity of the system; however, the above numbers indicated that a system could be designed that could easily amortize.

Insulate Heat Producing Equipment and Piping

A significant amount of energy could be saved by devising a suitable method for insulating certain process equipment and piping. A large quantity of equipment such as melt kettles, melt grid units, volumetric loaders, etc., as well as steam jacketed explosives piping, steam piping, and hot water piping is currently not insulated. This results in high energy losses and concurrent uncomfortable conditions in certain locations. Thus, proper insulating techniques would result in dual benefits: energy savings and increased employee comfort.

There are some areas which would be extremely difficult, if not impossible, to insulate due to the irregularity of the surface. However, many areas still exist which can and should be insulated.

The major problems encountered in locating a suitable insulation relate to the nature of the equipment and to housekeeping techniques. Some of the equipment is irregularly shaped, consisting of combinations of curved and flat surfaces and having numerous protrusions and obstructions such as piping connections, inspection doors, varying mechanical devices and the like. This means that the insulation must be flexible and easy to work with. As to the housekeeping techniques, at regularly scheduled intervals everything is "washed down" with steam or hot water to eliminate buildup of explosives which have collected and/or condensed on various surfaces. Therefore, the insulation must be waterproof and cannot be absorptive.

Typical equipment surface temperatures were found to be in the range from 160°F to 243°F. Typical process piping surface temperatures were around 190°F to 240°F. Building heating system piping surface temperatures were 170°F to 180°F. Room temperatures were generally 90°F to 95°F (first floor of melt building), 90°F to 105°F (second floor of melt building), and 90°F to 95°F (third floor of melt building).

Since the majority of the process equipment had an average surface temperature of about 190°F, this temperature was selected as typical for this equipment in order to simplify and expedite calculations. Likewise, a surface temperature of 175°F was selected for use in all calculations involving the piping for the building's heating system. A surface temperature of 200°F was used in calculations relative to piping in the process. The calculations in this report then yield a good estimate of the magnitude of savings which would result from this type of insulation program.

Due to the large quantity of heated equipment and piping, it was felt that a room temperature of 65°F would be unattainable without using an excessive amount of insulation which would be bulky and expensive. Therefore, the desired room temperature was taken to be 80°F, a goal deemed attainable with a reasonable amount of insulation.

The thermal conductivity value for one of the insulation systems considered for use on this project was assumed to be representative and was used in the calculations for this report.

The results of the survey are presented in table 2. Energy savings are shown for a number of different insulation thicknesses. It is obvious that even with the application of only one inch of insulation, there is a tremendous energy saving potential.

The equations used in performing the calculations for this report are as follows:

1. Piping heat loss

$$\frac{Q}{L} = \frac{T_1 - T_a}{\frac{\ln\left(\frac{r_3}{r_2}\right)}{2k_{ins}} + \frac{1}{2 r_3 h_0}}$$

Where $\frac{Q}{L}$ = Heat loss per linear foot, Btu/hr-ft

T_1 = Pipe surface temperature, °F

T_a = Room air temperature, °F

r_2 = Pipe outside radius

r_3 = Insulation outside radius, = r_2 + insulation thickness

k_{ins} = Thermal conductivity of insulation, Btu/hr-ft °F

h_0 = Outside air film conductance, Btu/hr-ft^2 °F

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Table 2. Survey Results

Item	Heat loss without insulation (Btu/hr)	Insulation thickness (in.)	Heat loss with insulation (Btu/hr)	Energy savings (Btu/hr)	Cost of energy ($/yr)	Insulation cost ($)	Amortization period (yrs)
Process piping	227,100	1	53,790	173,310	1430	14,200	9.9
		1 1/2	43,120	183,980	1520		9.3
		2	36,920	190,180	1570		9.0
		2 1/2	32,870	194,230	1600		8.9
		3	29,990	197,110	1620		8.8
Heating system piping	259,300	1	70,290	189,010	1560	25,900	16.6
		1 1/2	56,800	202,500	•1670		15.5
		2	49,010	210,290	1730		15.0
		2 1/2	43,890	215,410	1780		14.6
		3	40,210	219,090	1800		14.4
Process equipment	88,900	1	13,850	75,050	620	3,400	5.5
		1 1/2	9,870	79,030	650		5.2
		2	7,660	81,240	670		5.1
		2 1/2	6,260	82,640	680		5.0
		3	5,300	83,600	690		4.9

2. Equipment heat loss

$$\frac{Q}{L} = \frac{T_1 - T_a}{\dfrac{X}{k_{ins}} + \dfrac{1}{h_0}}$$

Where $\dfrac{Q}{L}$ = Heat loss/sq ft surface area, $Btu/hr\text{-}ft^2$

T_1 = Surface temperature, $°F$

X^1 = Insulation thickness, in.

k_{ins} = Insulation thermal conductivity, $Btu\text{-}in./hr\text{-}ft^2\ °F$

3. Energy savings

Energy savings = (heat loss without insulation) - (heat loss with insulation)

4. Cost of energy saved (cost savings)

"Energy savings" figures were used to determine the amount of 5 psig steam required to produce that amount of heat.

$$M_s = \frac{Q}{h_{fg}}$$

Where M_s = Steam consumption, lb/hr

Q = Energy savings, Btu/hr

h_{fg} = Latent heat of vaporization at 5 psig steam, 960.7 BTU/lb

Cost per hour = M_s x $3.96/1000 lb
Cost per year = (cost per hour) x (2000 working hrs/year)

5. Amortization Period

$$\text{Amortization period} = \frac{\text{Insulation} \cdot \text{cost}}{\text{Cost of energy saved}}$$

Recirculate Melt Tower Air

As an alternative to insulating the high temperature piping and equipment in use at many locations, it was suggested that the hot room air might be exhausted to some area at a lower temperature. The intent here would be to cool the area containing the hot equipment while at the same time provide heating for the lower temperature area. During warm weather, a bypass system would be in operation so that the hot room air would be exhausted to atmosphere. This could be accomplished by installing fans along with ductwork and control systems similar to that described in the "Air Compressor Waste Heat Utilization" section of this project.

Under the current project which covers only the line 3 production area, there is no location where this concept can be practically applied. There are locations in the plant, however, where a recirculation system of this type may not only be workable, but advantageous. When the project is expanded to include the entire plant area, these locations will be studied in more detail.

For the present, we can make some preliminary calculations to determine the magnitude of energy savings possible by incorporating this type of recirculation system. Room temperatures on the second floor of a typical melt building during production operations hover around 100°F, with a total room volume of 18,600 ft^3. The heat loss, determined by the degree-day method, was found to be 130,950 Btu/hr. The heat gain from equipment and piping was calculated as 204,550 BTU/hr. Thus, there is 73,600 Btu/hr in excess heat available for recirculation from the second floor of a typical melt building.

The amount and cost of 5 psig steam necessary to produce this amount of heat can be calculated as follows:

$$M_s = \frac{73,600 \text{ Btu/hr}}{960.7 \text{ Btu/lb}} = 77 \text{ lb/hr}$$

$$\text{Cost} = 77 \text{ lb/hr} \times \frac{2000 \text{ working hr}}{\text{Year}} \times \frac{\$3.96}{1000 \text{ lb}} = \$610/\text{yr}$$

Therefore, we can only expect to save around \$610 each year per building, by recirculating hot room air in melt buildings.

As previously stated, there is no area under the current project scope where this proposal is practical. Therefore, recirculation cannot at present be considered a viable alternative to insulation of piping and equipment.

Additional Conservation Possibilities

Other conservation projects which have less potential, but which warrant further investigation at a later date are:

1. Motor controllers for electric and air motors

2. Power factor controllers for electric motors

3. Isolation of bays not in use

4. Insulate cooling bays and recirculate heat

CONCLUSIONS

As a result of the comprehensive process energy audit of ammunition load line 3 at IAAP, conclusions reached were:

1. Energy-use areas were delineated and associated energy data accumulated.

2. Potential energy savings measures amounting to $22,244 per year were defined and evaluated for present production rate. This savings represents a 28% reduction in process energy requirement.

3. Additional potential projects were identified that could result in energy savings.

RECOMMENDATIONS

As described in "Energy Conservation Opportunities," it is recommended that active consideration be given to:

1. The implementation of those energy saving projects which promise satisfactory payback under current operating level.

2. The initiation of additional investigations to define and implement those opportunities which cannot be characterized at this time (i.e., insulate heat producing equipment and piping, isolation of bays, etc.).

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ATTN: Construction Division
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ATTN: Construction Division
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215 North 17th Street
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  Kansas City
ATTN: Construction Division (2)
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Commander
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Commander
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Commander
Holston Army Ammunition Plant
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Indiana Army Ammunition Plant
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Commander
Lone Star Army Ammunition Plant
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Commander
Longhorn Army Ammunition Plant
ATTN: SARLO-O
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Commander
Louisiana Army Ammunition Plant
ATTN: SARLA-S
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Commander
McAlester Army Ammunition Plant
ATTN: SARMC-FD
McAlester, OK 74501

Commander
Milan Army Ammunition Plant
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Commander
Newport Army Ammunition Plant
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