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ARCSL-TR-80015

WHITE PHOSPHORUS DRY FILL LINE

by

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August 1980

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
Chemical Systems Laboratory
Aberdeen Proving Ground, Maryland 21010

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An MMT project was conducted to provide a semi-automatic prototype WP dry fill line at Pine Bluff Arsenal by modification and improvement of existing equipment. The line was designed to fill the 105-mm M60 projectile, the 81-mm M375 projectile, the 60-mm M302 projectile, and the 2.75-inch M156 warhead. The line was successfully operated with the 105-mm M60 and the 2.75-inch M156. Tests were not conducted with the 60-mm and 81-mm munitions because components were not available. The WP dry fill line provides a safe, extremely accurate system for production rate filling of munitions with WP. It also reduces air and water pollution by more than 97% over that experienced with the dip fill system.

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PREFACE

The work described in this report was authorized under MMT Project 5761274, WP Dry Fill Line. The work was started in September 1976 and completed in December 1978.

Acknowledgments

The authors express their appreciation to the following Pine Bluff Arsenal employees for their contribution to this project:

Mr. B. J. Miller, design of height of fill station
Mr. B. T. Armstrong, control system design
Mr. Jackie Smedley, instrumentation
Mr. Tom Wooley, machine-shop work

They would also like to thank all the personnel in the Maintenance Division, Pine Bluff Arsenal, whose excellent efforts made the success of this project possible.

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WHITE PHOSPHORUS DRY FILL LINE

I. INTRODUCTION.

A. Objective.

The objective of MMT Project 5761274, WP Dry Fill Line, was to provide a semi-automatic prototype white phosphorus (WP) dry fill line which would fill the 105-mm M60 projectile, the 81-mm M375 projectile, the 60-mm M302 projectile, and the 2.75-inch M156 warhead as shown in figure 1. This was accomplished by modification and improvement of existing equipment on the WP dry fill line at Pine Bluff Arsenal (PBA). The line was then tested with the 105-mm M60 projectile and the 2.75-inch M156 warhead. This report describes the equipment, the test program, and the test results which were obtained.

B. Background.

The original WP dry fill line was designed, fabricated, and installed by FMC Corporation, Santa Clara, California, under contract DAAA15-69-C-0727. After installation at PBA, the contractor attempted without success to run the line. The contract was eventually terminated and the Government then attempted to start up the line, also without success. This effort was terminated and an ad hoc engineering team was formed to conduct an engineering study of the dry fill line problems. The team concluded that all major stations on the line required major modification or redesign or both.

During attempts to start the line, the filling nozzles proved very unreliable. Drippage occurred after munition removal and nozzles sticking in the open position resulted in WP running into the cabinet and causing a fire. Because the filling nozzles form the heart of the dry fill system, a program to rework and test the contractor nozzles was initiated. About the same time, a volumetric filling process was developed by Mr. Harold McKinney, PBA.[1] A decision was made to include the volumetric fill method in the test program. The results of this testing are reported elsewhere.[2] As a result of this test program, it was recommended that the volumetric filling concept be utilized in a redesign of the WP dry fill line.

MMT project 5751274 was then initiated to redesign the fill station to incorporate the volumetric concept and perform minor modifications to the other stations and conveyor system so that a test program could be conducted. A total of approximately 3500 105-mm M60 projectiles was filled with WP during this test program. The results of the project are reported in a previous publication[3] in which it is concluded that the volumetric system provides a rapid accurate method for filling production WP. Based on the results of that work, project 5761274 was initiated to provide a modernized semi-automated production filling line for the four WP munitions.

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[1] McKinney, Harold, Route 4, Box 404, Pine Bluff, Arkansas. United States Patent 4,002,268, Volumetric Filling System.

[2] Stewart, Frank M. Munitions Division, Chemical Systems Laboratory. Evaluation of Nozzles for Dry Filling WP Munitions. Unpublished Report. 29 August 1974.

[3] Stewart, Frank M., and McKinney, Harold D. WP Dry Fill Line, MMT Project 5751274. Pine Bluff Arsenal. Final Report. March 1976.

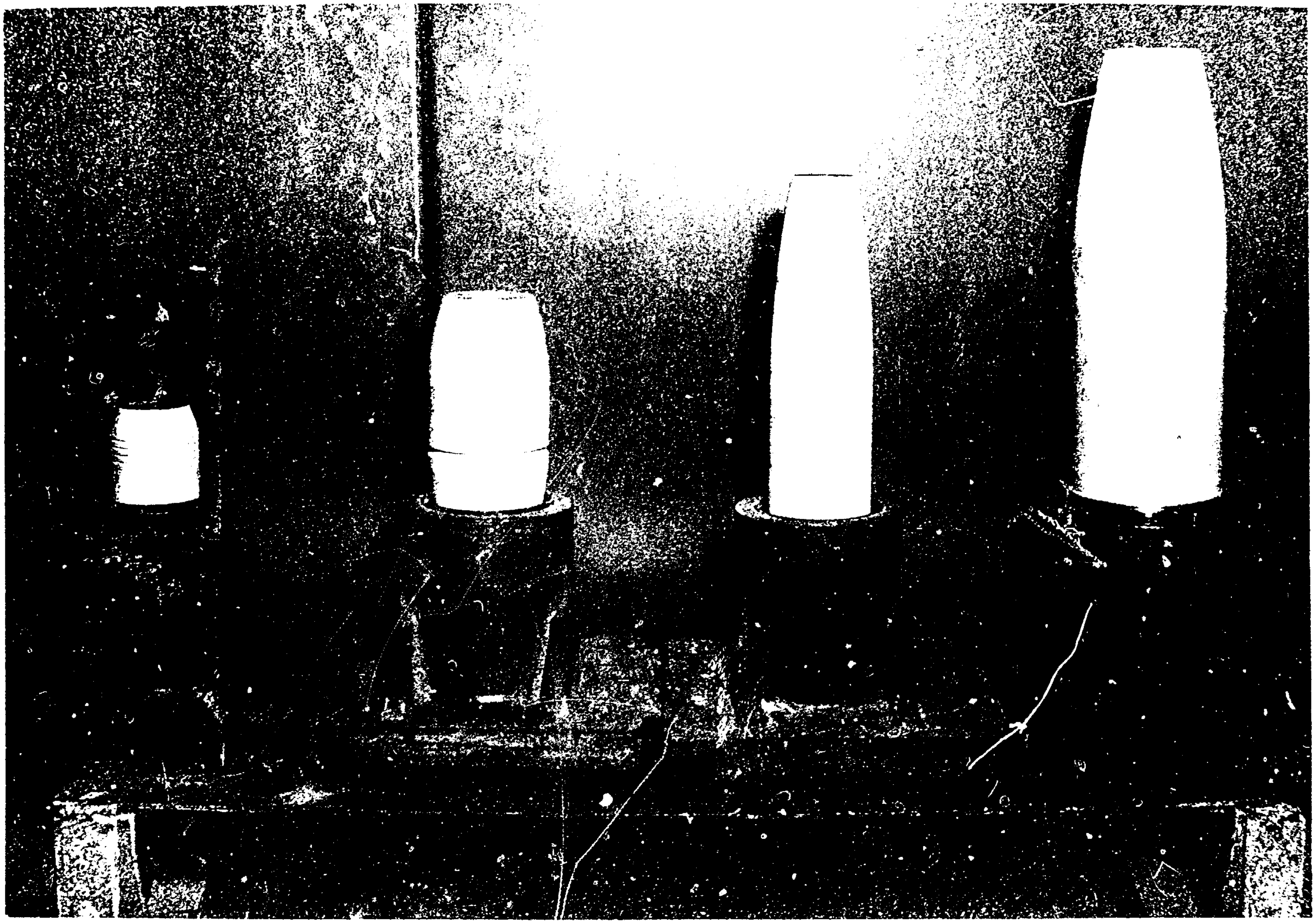

Figure 1. WP Munitions: 60-mm M302 Projectile, 81-mm M375 Projectile, 2.75-Inch M156 Warhead, and 105-mm M60 Projectile

II. EQUIPMENT DESCRIPTION.

The schematic diagram, figure 2, shows the relative location of equipment and stations on the WP dry fill line. The work performed on MMT project 5761274 was confined to the stations shown within the shaded area in figure 2. The conveyor systems, WP tanks, inert gas generator, and WP supply systems were utilized as they existed except for minor modifications where required to make them operational. This report describes the complete line, the stations which were designed and built under this project, and the supporting systems which were inherited from previous efforts. The original volumetric fill system tested under project 5751274 and improvements to the volumetric system made under project 5761274 have been previously described.[4]

A. Manual Loading Station and Crossover Conveyor.

1. Dust covers and plastic nose cups are removed from empty munitions prior to delivery to the front or loading end of the WP dry fill line.

2. Empty munitions on 4- by 4-ft pallets are located on a gravity roller section (three pallet limit) at the loading end of the dry fill line.

3. An operator lifts empty munitions from pallets located on the gravity roller conveyor and places them in an empty filling line pallet, which is held in position by an automatic pallet stop, figure 3.

4. After the munition is placed in the filling line pallet, the munition and pallet releases automatically and the charged pallet is transferred by a stainless steel slat conveyor to a 90° transfer point. At the same time the charged pallet is released, another empty pallet is positioned at the loading station.

5. The charged pallet is automatically pushed onto the filling line conveyor from the 90° transfer point, figure 4.

6. The munition and pallet is then carried by a dc variable-speed conveyor to the automatic vacuum-purge station, figure 5.

B. Automatic Vacuum-Purge Station (Computer-Controlled).

The automatic vacuum-purge station consists of the following interconnected items of equipment: four-station gating stop, two electric eyes for count in and count out, station mounting frame, four vacuum-purge station nozzles operated by pneumatic cylinders, an approximately 30-gallon vacuum surge tank, one 3-hp mechanical (Stokes) vacuum pump, automatic control valves, pipeline accessories, and a four-munition preaccumulator stop system. Operation is as follows:

[4] McKinney, Harold, Davenport, Larry, and Erickson, Merlin. Design Considerations for a Semi-Automatic White Phosphorus Munitions Production Line. Paper presented at the 1978 Annual Meeting of the Load, Assemble, and Pack Section, Ammunition Technology Division, American Defense Preparedness Association, held at the Naval Amphibious Base, Coronado, California, 29-30 March 1978.

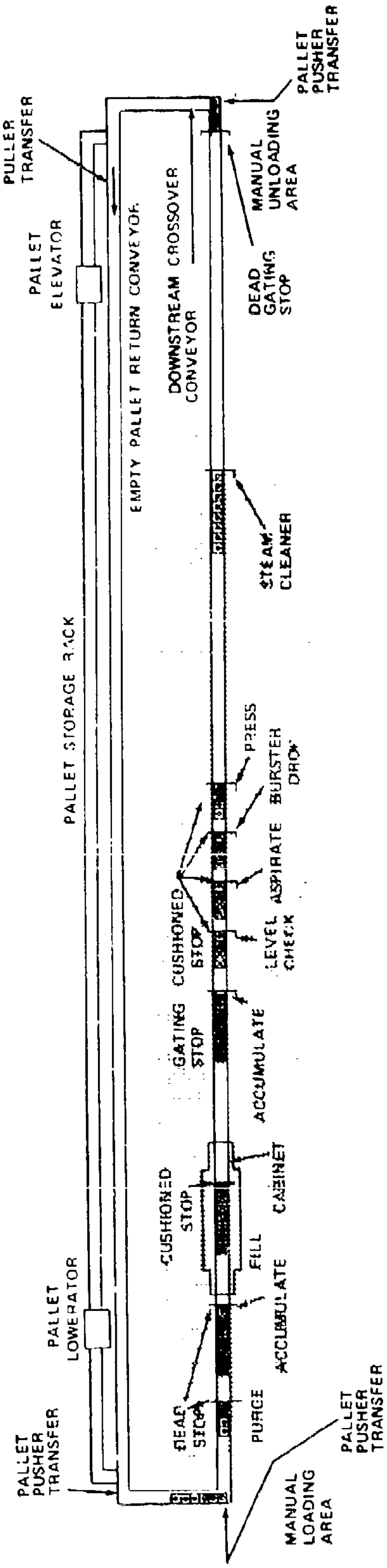

Figure 2. WP Dry Filling Line Layout

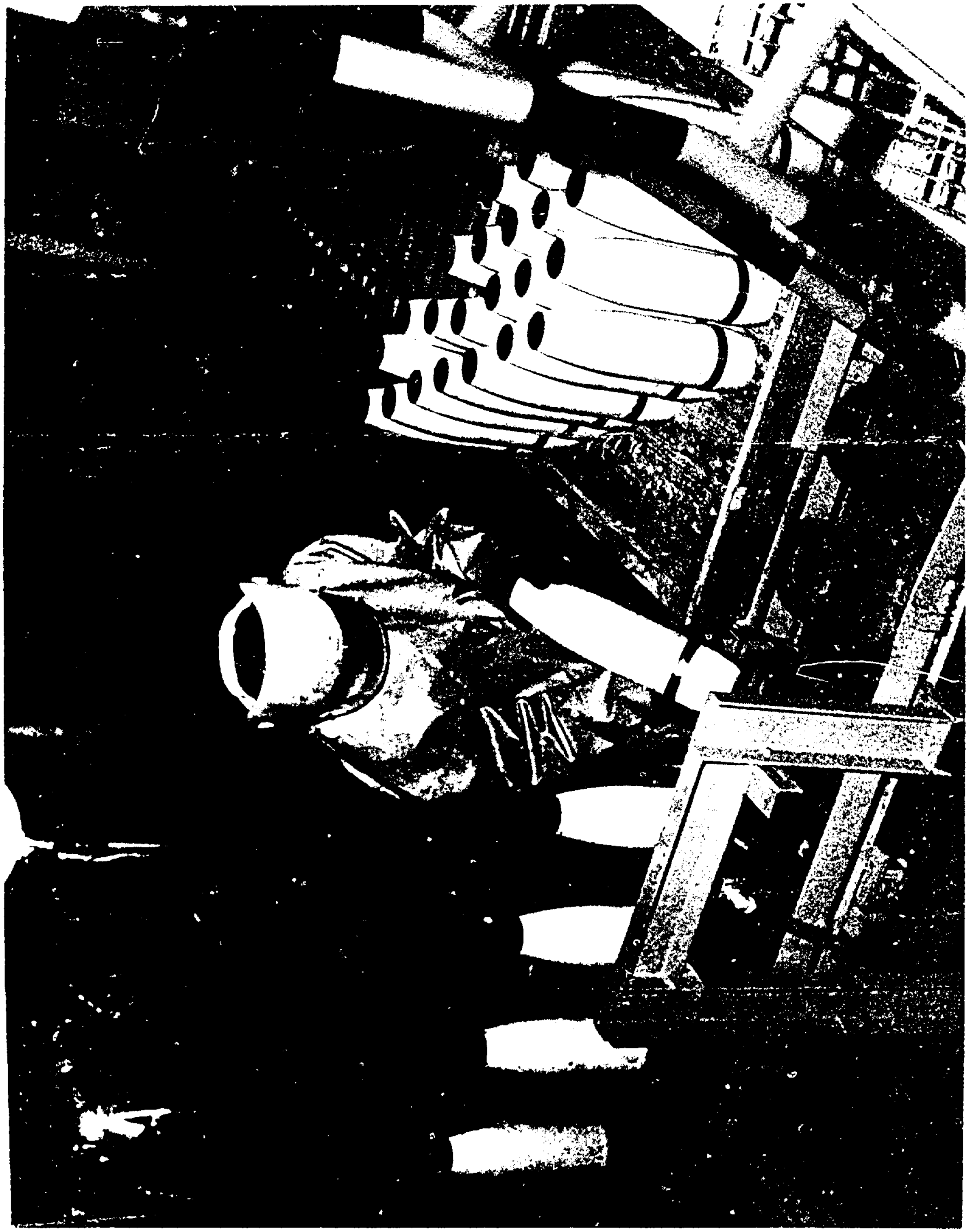

Figure 3. Manual Loading Station

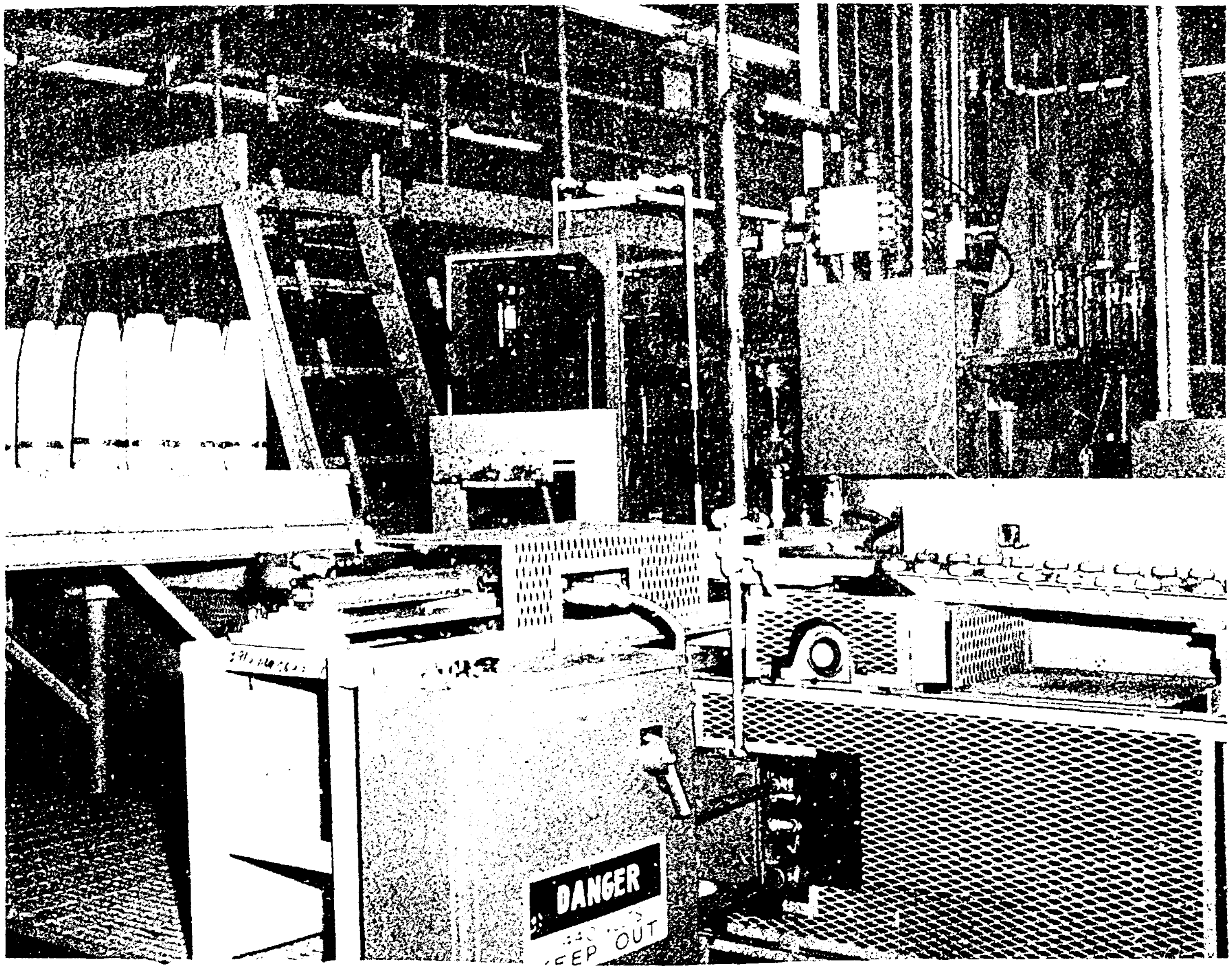

Figure 4. Filling Pallet and 90° Transfer Point

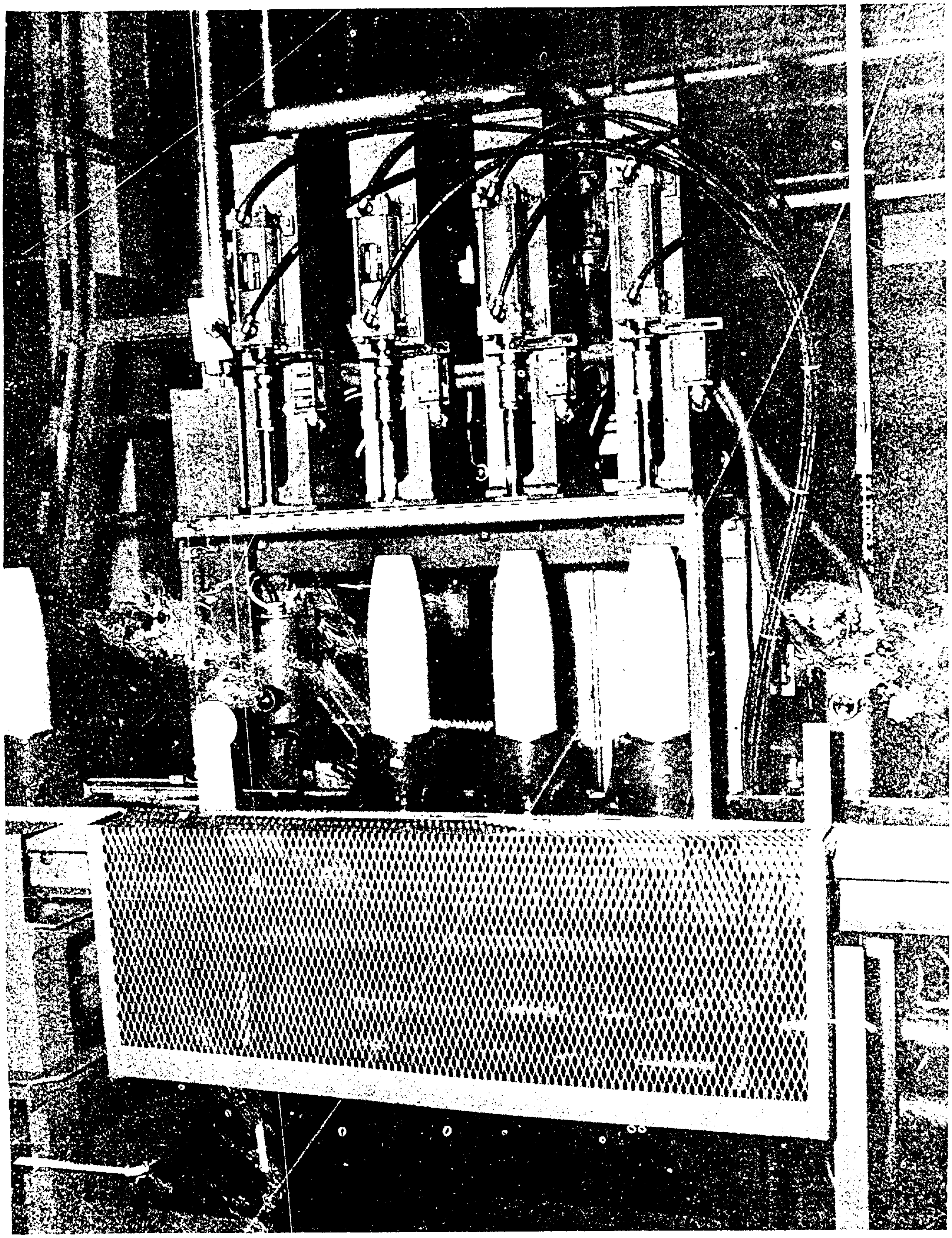

Figure 5. Automatic Vacuum-Purge Station (Receiving Munitions)

Four munitions are released from the preaccumulator station into the vacuum-purge station. The first counter registers four munitions in the station. Four pneumatic cylinders push the four station nozzles down until a rubber seal compresses between the nozzle and nose of the empty munition providing a vacuum tight seal, figure 6. A pneumatically-operated three-way ball valve opens connecting the munitions to the vacuum surge tank which is maintained at 28 inHg by constant operation of the Stokes vacuum pump. This action evacuates the munition cavity to 28 inHg in a fraction of a second. After a dwell time of 2 seconds or less, the pneumatically-operated three-way valve closes and the munition is then subjected to pressurized (15 psig) inert gas (CO_2 and N_2) which fills the previously evacuated munition cavity – dwell time is 2 seconds or less. The nozzle then retracts and the station stops drop, allowing the four inert gas-filled munitions to leave this station. The second counter registers the four munitions as they leave the station and resets the station stops at a count of four. Munitions from this station travel to the filling station preaccumulator section.

C. Automatic-Filling-Station Preaccumulator Section (Computer-Operated).

The automatic filling preaccumulator station (figure 7) is a gating stop station that counts (electric eye) in eight munitions and then locks up the station so that no additional munitions enter until the train of eight munitions is released. The munitions are released from this station upon demand of the WP filling station.

D. Process and Utility Service Control Panel.

The process and utility service control panel (figure 8), which is located in front of the filling station preaccumulator, controls all electrical, pneumatic, water, hydraulic, and process service. It also has a graphic flow panel for processing WP and serves as a manual override fo computerized station functions.

E. Volumetric Cylinder and Filling Nozzle Storage Case.

The volumetric cylinder and filling nozzle storage display case (figure 9) provides accessibility for volumetric cylinders and filling nozzles, not in use on the filling machine, and eliminates lost time due to misplaced tooling during changeover. The volumetric cylinders are designed for, from top to bottom, the 60-mm M302 projectile, the 81-mm M375 projectile, and the 2.75-inch M156 warhead. The nozzle set is for the M302 projectile and the M156 warhead.

F. Automatic WP Filling Station (Computer-Operated).

The automatic WP filling station (figure 10) consists of eight filling nozzles and volumetric dispensers and eight pneumatically-operated air cylinders for activating the filling nozzles, a hydraulically-operated drip pan, two electric-eye counters, a hydraulically-operated pallet and munition lift assembly, eight munition alignment devices, a pneumatically-operated pallet stop, an inert gas cabinet enclosure, an elevated WP filling tank, a lower WP supply tank, a WP circulating pump mounted on the supply tank, a 60-hp hydraulic unit, and connecting electrical controls service and operating piping systems. After eight munitions are counted into

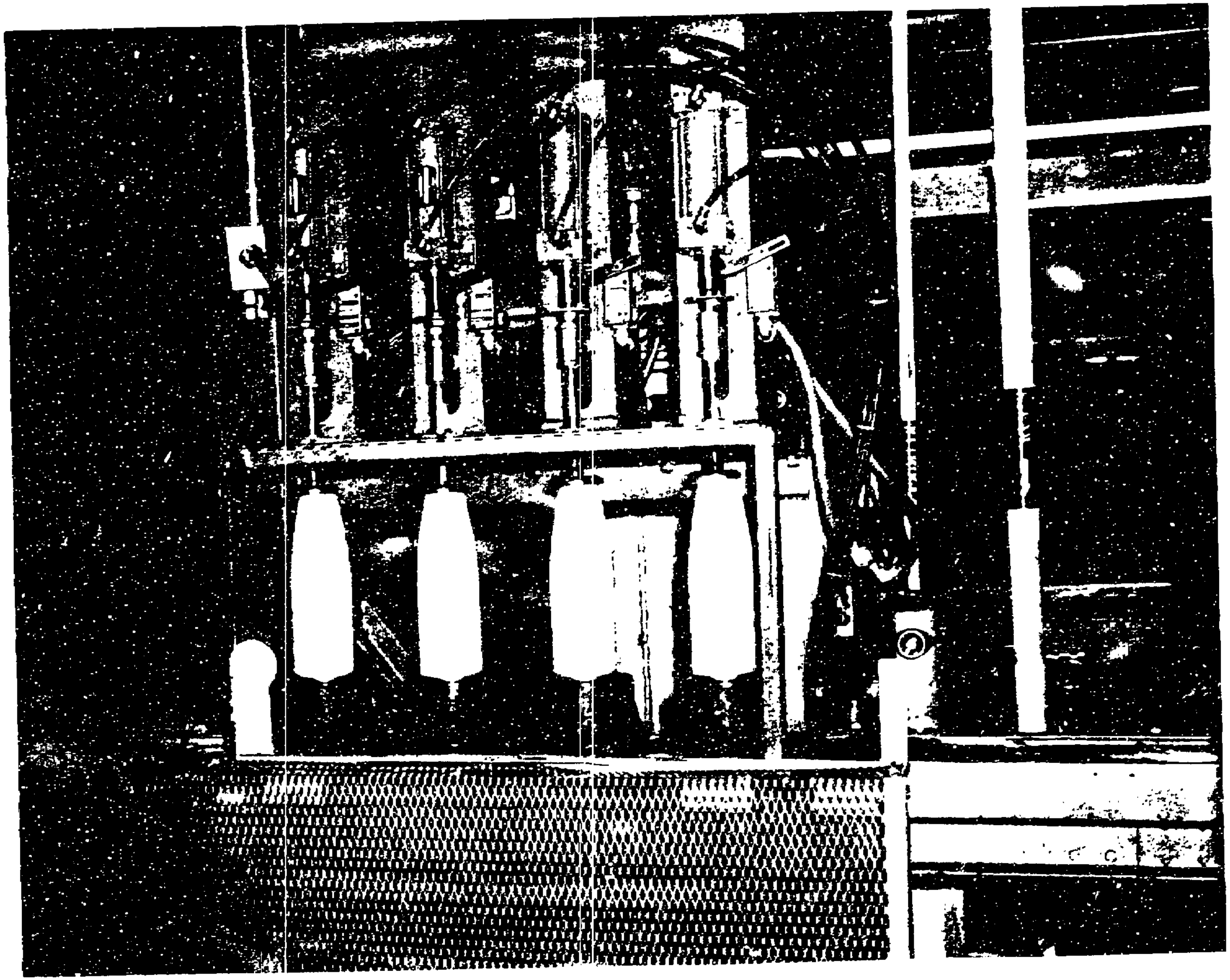

Figure 6. Automatic Vacuum-Purge Station (Processing Munitions)

Figure 7. Automatic Filling Preaccumulator Station

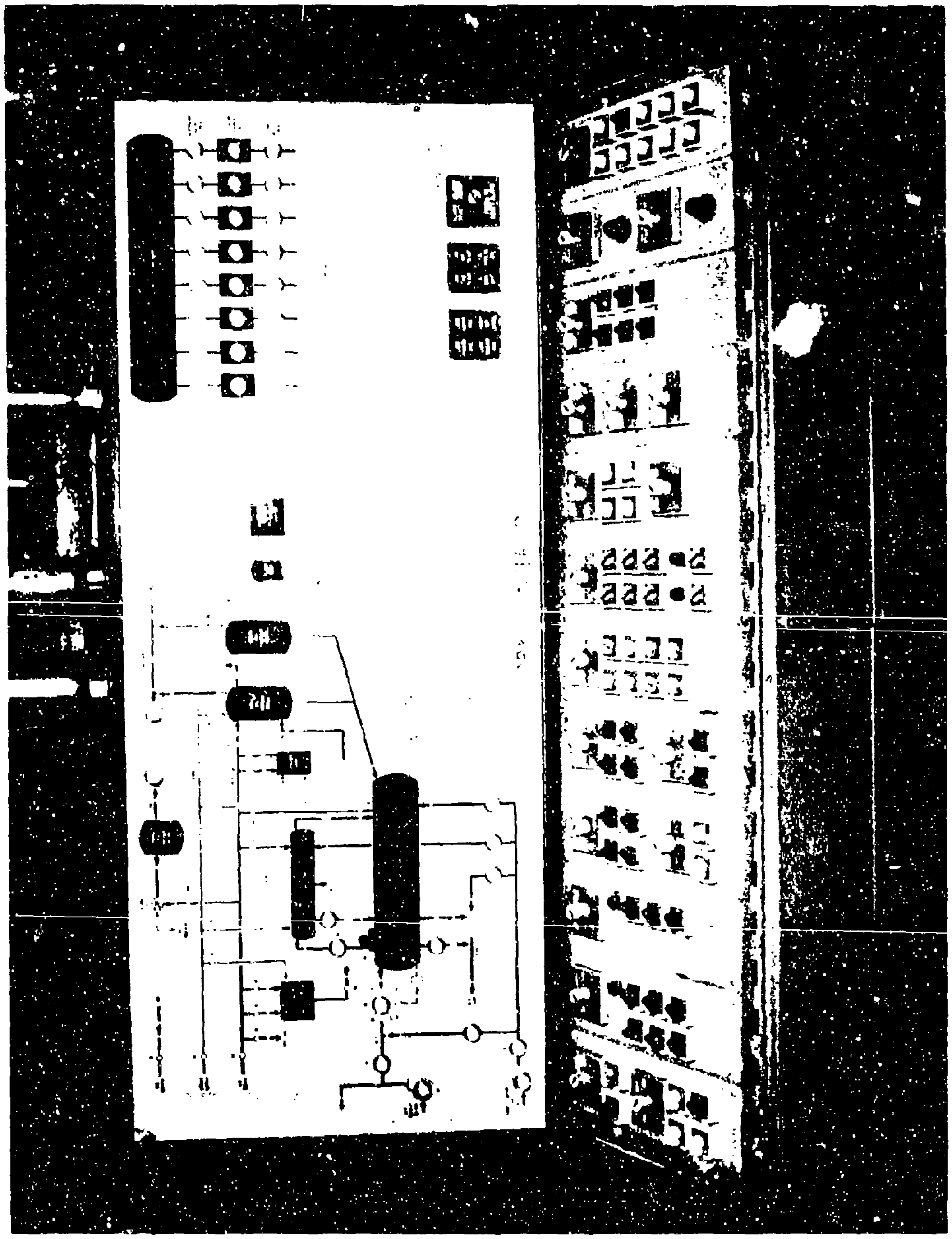

Figure 8. *Process and Utility Service Control Panel*

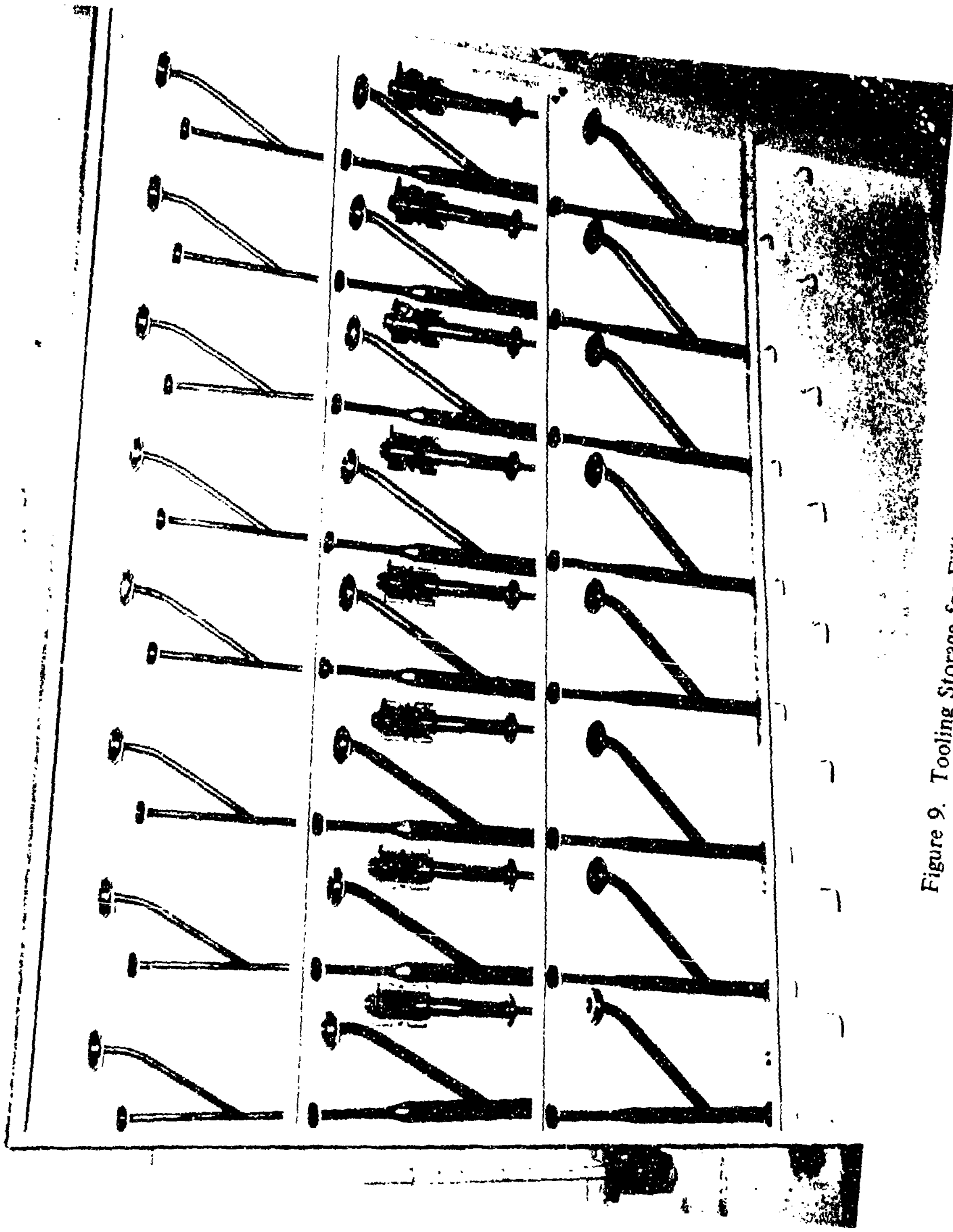

Figure 9. Tooling Storage for Filing Station

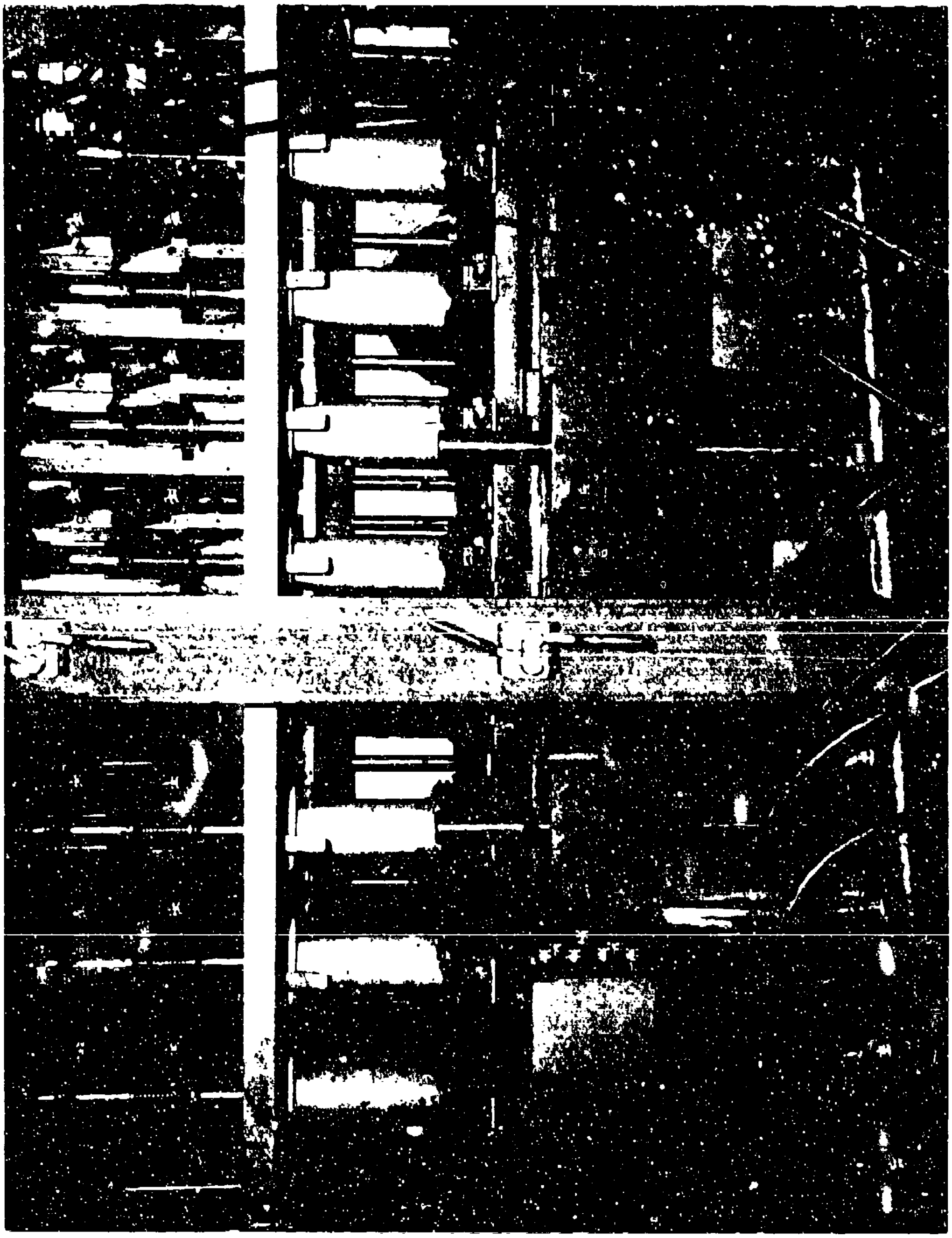

Figure 10. Automatic White Phosphorus Filling Station (Ready for Filling)

the filling station, the eight pallets and munitions are lifted 4 inches above the slat conveyor. At the termination of the lift, the filling nozzles are lowered into the cavity of the empty munition; a spring-loaded flange on the nozzle compresses upon contact with the top of the munition thereby opening a filling port on the nozzle which has penetrated to a depth below the munition burster casing adapter, figure 11. The volumetric dispenser, figure 12, which consists of an adjustable volumetric cylinder, a pneumatically-operated filling valve, and reservoir valve, then opens the filling valve for an automatically-timed sequence that dispenses the premeasured volume of WP for the munition being filled. The filling valve then closes and the reservoir valve opens for a timed interval recharging the volumetric dispenser. The lift mechanism then lowers the filled munitions and pallets to the slat conveyor. The drip pan extends to catch any WP drippage from the filling nozzles. Then the filling station pallet stops and the train of eight munitions and pallets is released to the height-of-fill station preaccumulator and gating station.

G. Automatic Height-of-Fill Preaccumulator and Gating Station (Computer-Operated).

The automatic height-of-fill preaccumulator and gating station (figure 13) consists of a cushioned gating stop system which prevents WP from spilling out of the filled munitions and releases trains of four munitions and pallets out of the station to the height-of-fill operation. This station has a capacity of 12 munitions and pallets and dispenses four munition units to the height-of-fill station upon demand by that station. This station is enclosed by an inert gas-filled tunnel between the filling station cabinet and the height of fill and aspirator cabinet.

H. Automatic Height-of-Fill Check Station (Computer Operated).

The automatic height-of-fill check station[5] (figure 14) checks munitions for acceptable height of fill, low height-of-fill reject, and high height-of-fill reject. The station is enclosed by an inert gas cabinet and contains the following items of equipment: four height-of-fill check units containing two tip-sensitive thermocouple probes each, four pneumatically-operated air cylinders for vertical movement of the four height-of-fill units, and a cushioned stop and platform unit to reduce high-impact stops of filled munitions. After four munitions are in place, height-of-fill check nozzles are pushed down into the filled munitions until a nozzle flange contacts the top of the shell which stops further movement of the nozzle. In this position, the tip-sensitive thermocouple probes are located at the proper depth to correctly determine height-of-fill condition of the munition. After the height-of-fill nozzle retracts, the munitions are released and the data for the filled condition of the munition are temporarily stored in the line computer. This information is transferred to the aspiration station for correction of high fills and to the burster drop station for removal of underfilled munitions.

I. Automatic Munition Aspiration Station (Computer-Operated).

A train of four munitions released from the height-of-fill station enters the aspirator station (figure 15) and is stopped (provided one or more of the filled munitions are overfilled or if the burster drop station is occupied). If munitions are overfilled, the computer directs the

[5] Miller, Billy J. WP Munitions Height of Fill System Utilizing Thermocouples. Technical paper presented at the Quality Controls in Loading and Assembly Processes Meeting of the American Defense Preparedness Association held at Yorktown Navy Weapons Station, Yorktown, Virginia, 21-22 March 1979.

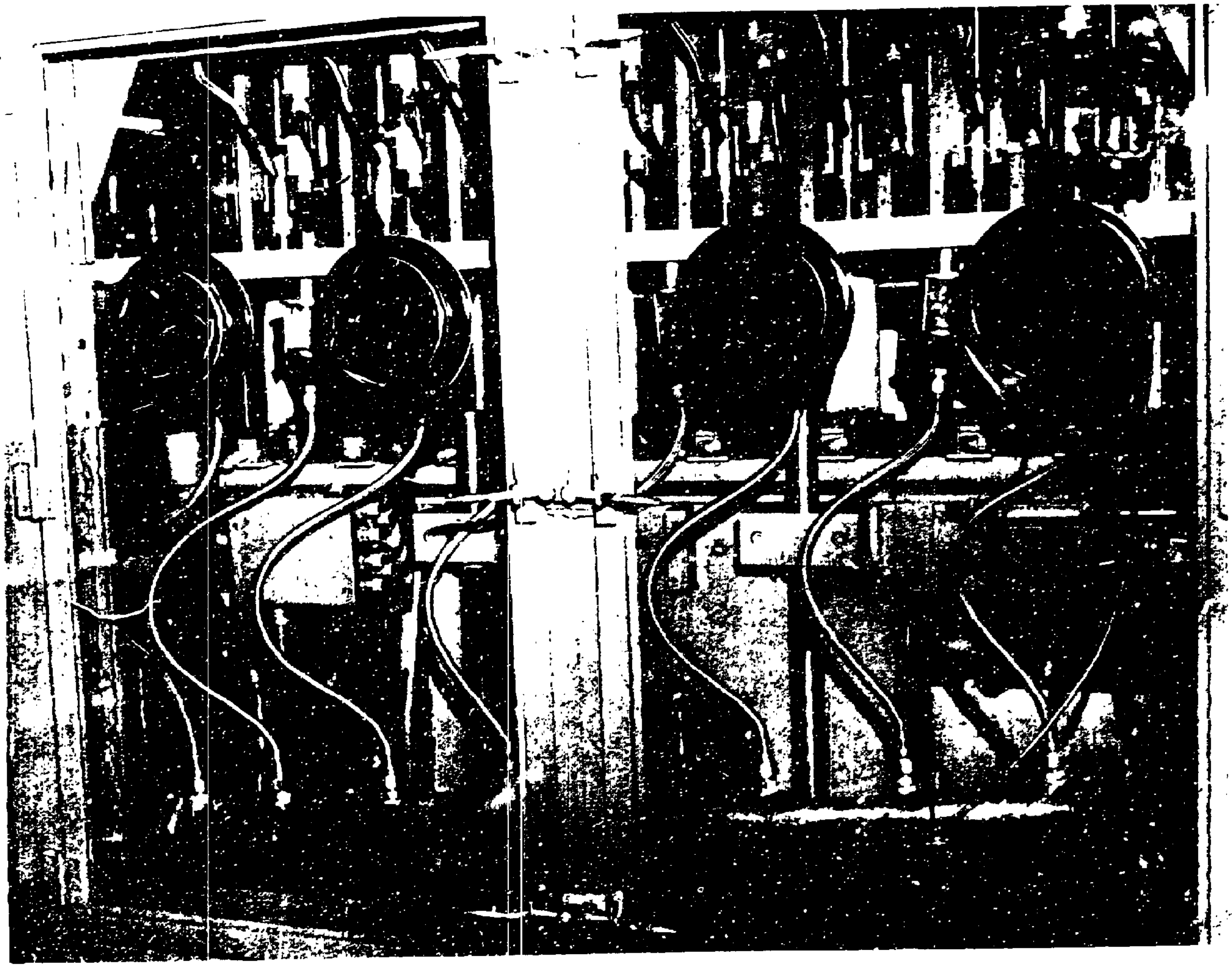

Figure 11. Automatic White Phosphorus Filling Station (Filling in Process)

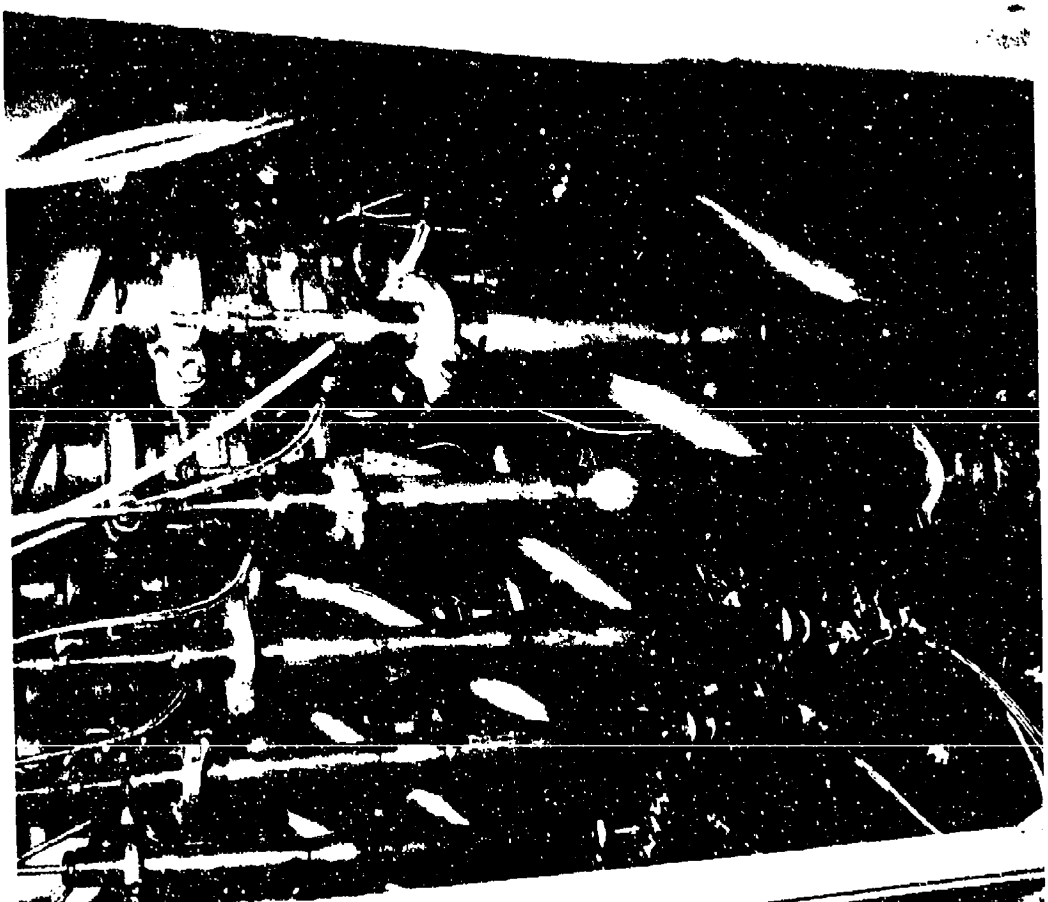

Figure 12. Automatic Volumetric Filling Dispensers

Figure 13. Automatic Height-of-Fill Preaccumulator Station

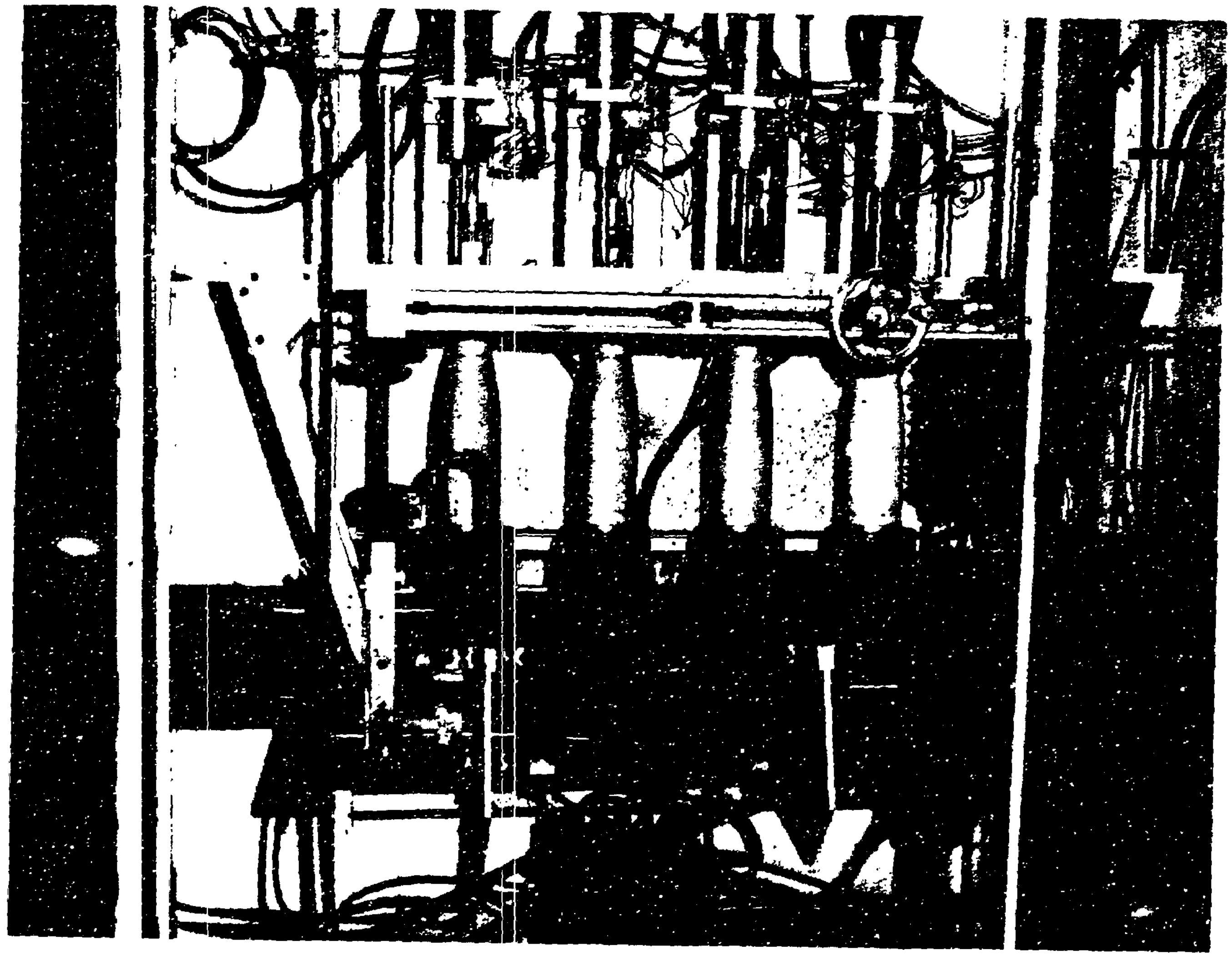

Figure 14. Automatic Height-of-Fill Check Station

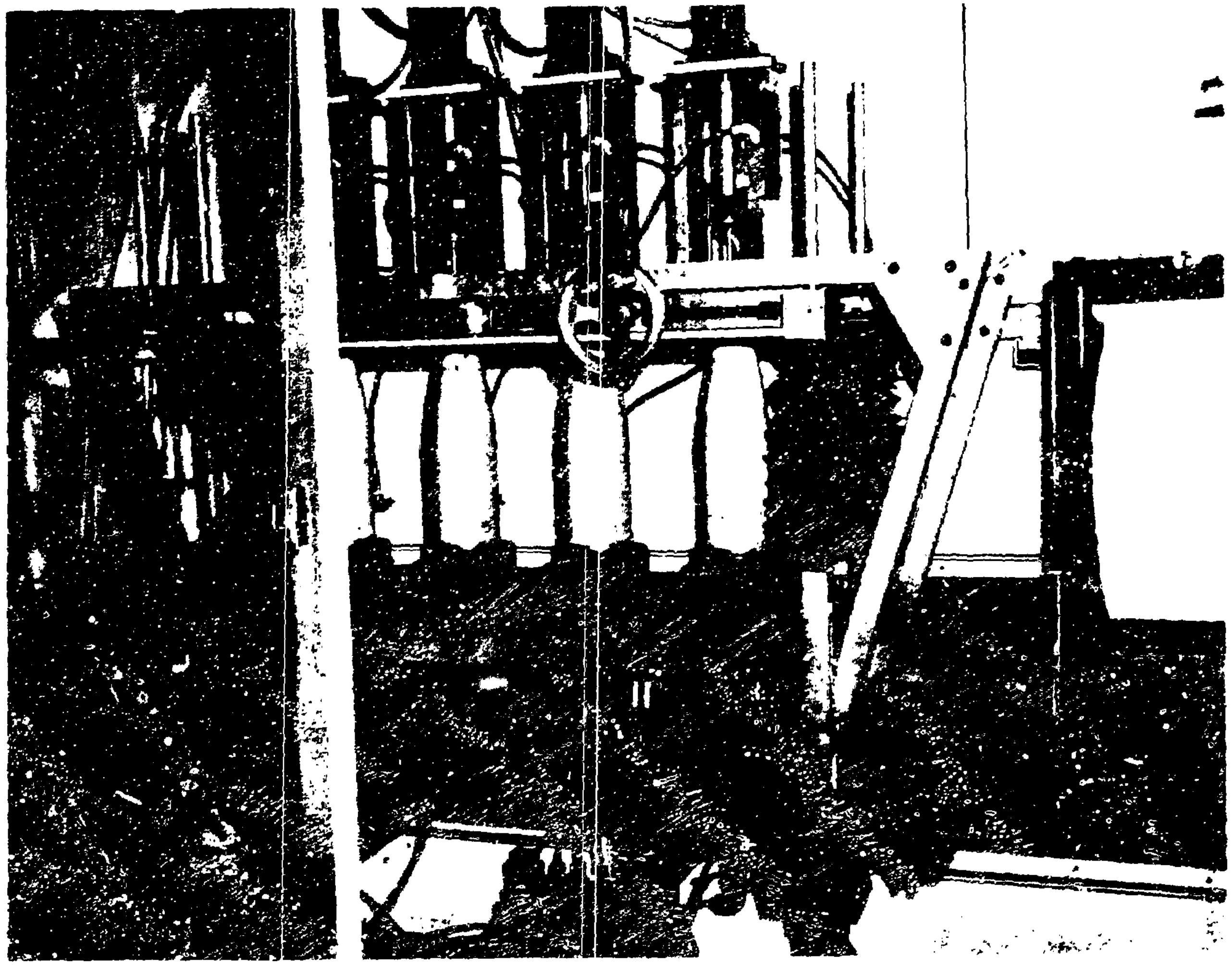

Figure 15. Automatic Munition Aspiration Station

aspiration station to stop the train of four munitions and to aspirate the excess WP from the munition or munitions. If no correction is indicated and the burster drop station is not occupied, the munitions pass through the aspirator station. This station consists of an adjustable platform mounted with four aspirator nozzles and four pneumatically-operated cylinders that move the nozzles up and down for the aspiration cycle. The platform is mounted to a cushioned stop system that reduces the impact between pallets and stop pins. The aspirator circuit includes a Kemp water seal vacuum pump that operates at 25 inHg vacuum and a 30-gallon vacuum surge and WP collection tank as well as jacketed aspirator piping, control valves, and other accessories. Munitions requiring height-of-fill correction are stopped in the station. The appropriate nozzle or nozzles are pushed down into the overfilled munition or munitions until the nozzle flange meets the top of the munition. The vacuum aspirator valve opens for a timed interval and then WP is aspirated out of the shell through the nozzle until the nozzle suction part is above the WP level in the munition and then liquid aspiration stops. After a timed interval, the aspirator valve closes, the nozzles retract, and the train of four munitions is released to the burster drop station.

J. Manual Burster Casing Drop Station.

The manually-operated burster casing drop station (figure 16) consists of a cushioned stop system, an electric eye counter, and a manual release button for station stops. A train of four munitions or pallets is received from the aspirator station, and an operator manually inserts the burster casings into the filled munitions. The operator then releases the munitions to the preaccumulator for the burster casing press station. Low fills encountered at this station are identified by indicating lights above the reject munition; operation of the indicating light alerts the operator of a low fill and the operator then removes the shell and places it in a barrel of water.

K. Automatic Preaccumulator for the Burster Casing Press (Computer-Operated).

The automatic preaccumulator for the burster casing press consists of a cushioned stop system that holds back a train of four filled munitions (with dropped burster casings), if the burster press is occupied; otherwise, the munitions pass through this station.

L. Automatic Burster Casing Press Station (Computer-Operated).

The automatic burster casing press station (figure 17) consists of a press frame work with an automatic elevator system for press height adjustment for the various shells produced on the line, a munitions-pallets lift mechanism for lifting four munitions-pallets ¼-inch above the slat conveyor, four 6-inch-diameter by 6-inch stroke hydraulic press ram cylinders, a 25-hp 1000 psig hydraulic unit, munition-pallet stop and control valves, counters (electric eye), piping, and accessories. The press station stops all trains of four munitions and raises the munitions ¼-inch off the slat conveyor, and the press rams push down inside the nose of the shell and press (metal interference displacement) the burster casing into the munition burster housing. After a 2-second dwell time, the munitions are released to the preaccumulator for the steam-dry air cleaner.

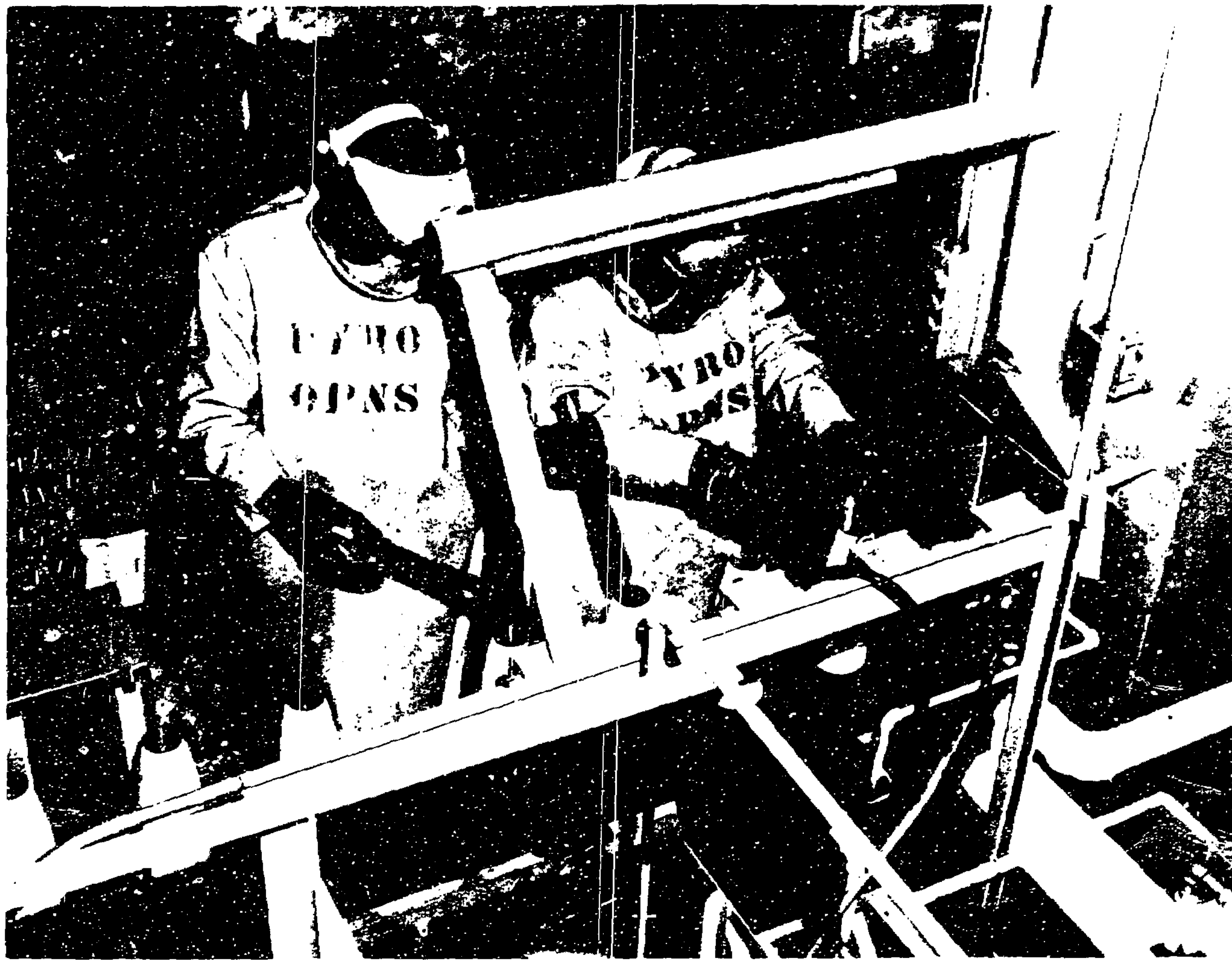

Figure 16. Manual Burster Drop Station

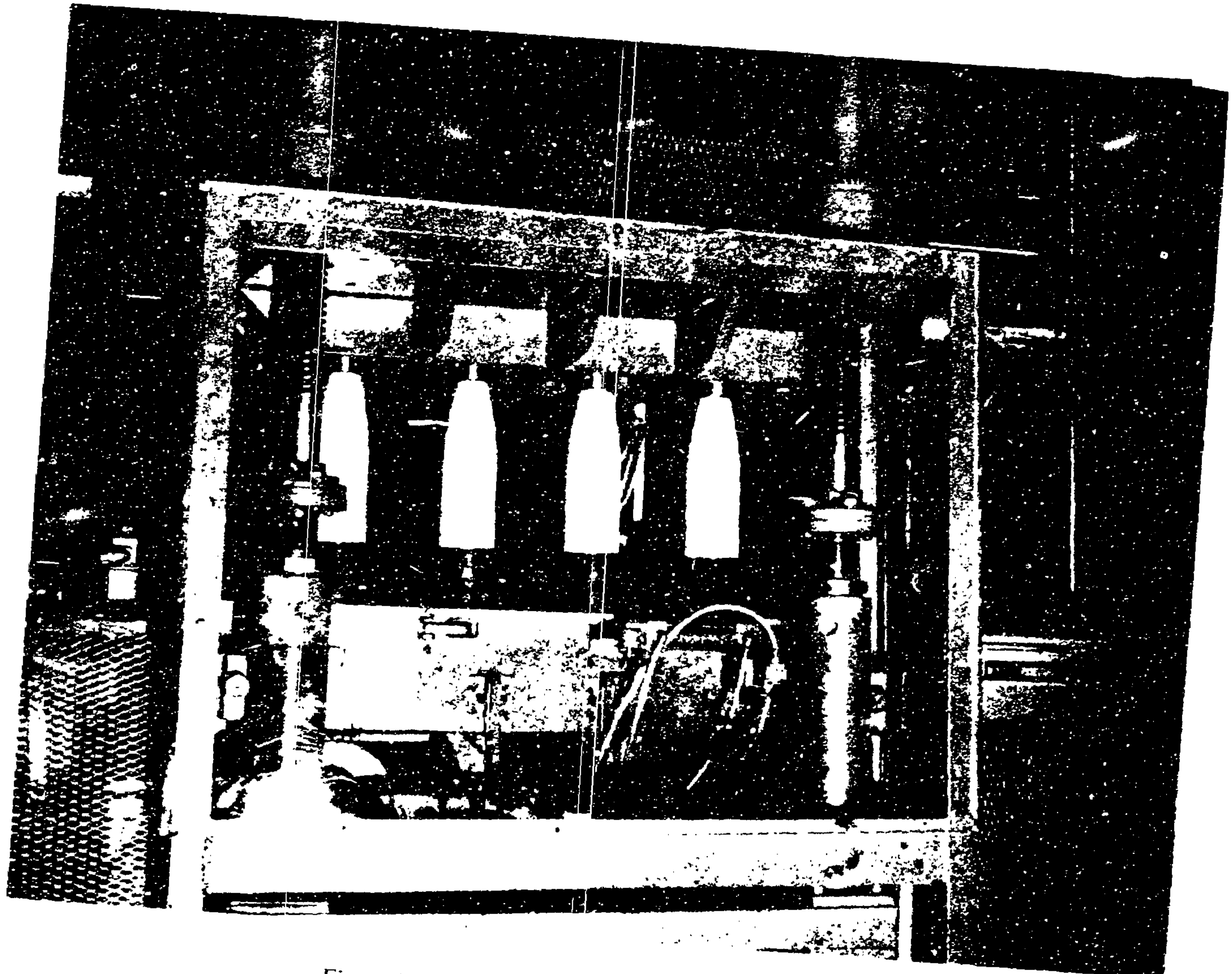

Figure 17. Automatic Burster Casing Press Station

M. Automatic Preaccumulator and Gating Stop Station for the Steam-Dry Air Cleaning Station (Computer-Operator).

The automatic preaccumulator and gating stop station (figure 18) accumulates eight munitions-pallets and releases them upon demand by the steam-dry air cleaning station. The station consists of a dead-stop eight-munition gating device and electric eye counters.

N. Automatic Steam-Dry Air Munitions Cleaning Station (Computer-Operated).

The automatic steam-dry air munitions cleaning station (figure 19) consists of a mounting frame work for all equipment, a pallet stop, eight cleaning nozzles with pneumatically-operated cylinders, eight alignment fixtures, a hydraulic lift device for lifting pallets and munitions 4 inches above the slat conveyor, a 10-hp hydraulic unit, electric eye counters, control valves, piping, and accessories. When the station clears, the preaccumulator releases a train of eight munitions-pallets into the steam-dry air cleaning station. The munitions-pallets are stopped in the station and raised 4 inches above the slat-type conveyor into munition alignment devices. The cleaning nozzle penetrates into the threaded portion of the munition and makes a pressure-tight connection between the nozzle and the top of the filled munition. Steam valves then open for a timed interval blowing live steam through the nozzle into the threaded mouth end of the munition and back through the nozzle to a vented expansion tank. The steam valve closes and a dry-air valve opens for a timed interval forcing air into the nose of the munition and then back through another port in the nozzle to the vented expansion tank. The steam removes cosmoline from the female threads in the nose of the munition as well as any WP contamination. The air blows condensate and any remaining residue out of the nose end of the munition. The air dries the nose end of the munition also. The air valve closes, the lift mechanism drops the munitions-pallets to the slat conveyor, the station stop opens, and the munitions travel out of the station to the munition removal station.

O. Manual Munitions Removal Station.

The manual munitions removal station (figure 20) consists of space for eight munitions-pallets and a two munition-pallet gating stop. A train of eight munitions-pallets travels from the cleaning station to the unloading station. Two pallets are held in the unloading gating stop until the operator removes the two munitions and then the two empty pallets are released automatically to return to the munition loading station at the front of the line. When the two empty pallets are released, two more munition-filled pallets are conveyed into the munition unloading station gating stop. The operator manually removes the shells from the munitions-pallets and places them on a conveyor that feeds an automatic zoning scale. After zoning, the munitions are stacked into metal pallets for oven testing.

P. Empty-Pallet Storage-Rack Station.

The empty-pallet storage-rack station contains storage racks for pallets for seven different munitions, one elevator for loading empty pallets on the racks, and one for unloading pallets for line use. The station has one conveyor that feeds the loading elevator and one conveyor to remove pallets from the unloading elevator. These conveyors are interfaced to the WP dry-fill-line return conveyor for loading and unloading of pallets from the dry fill return conveyor.

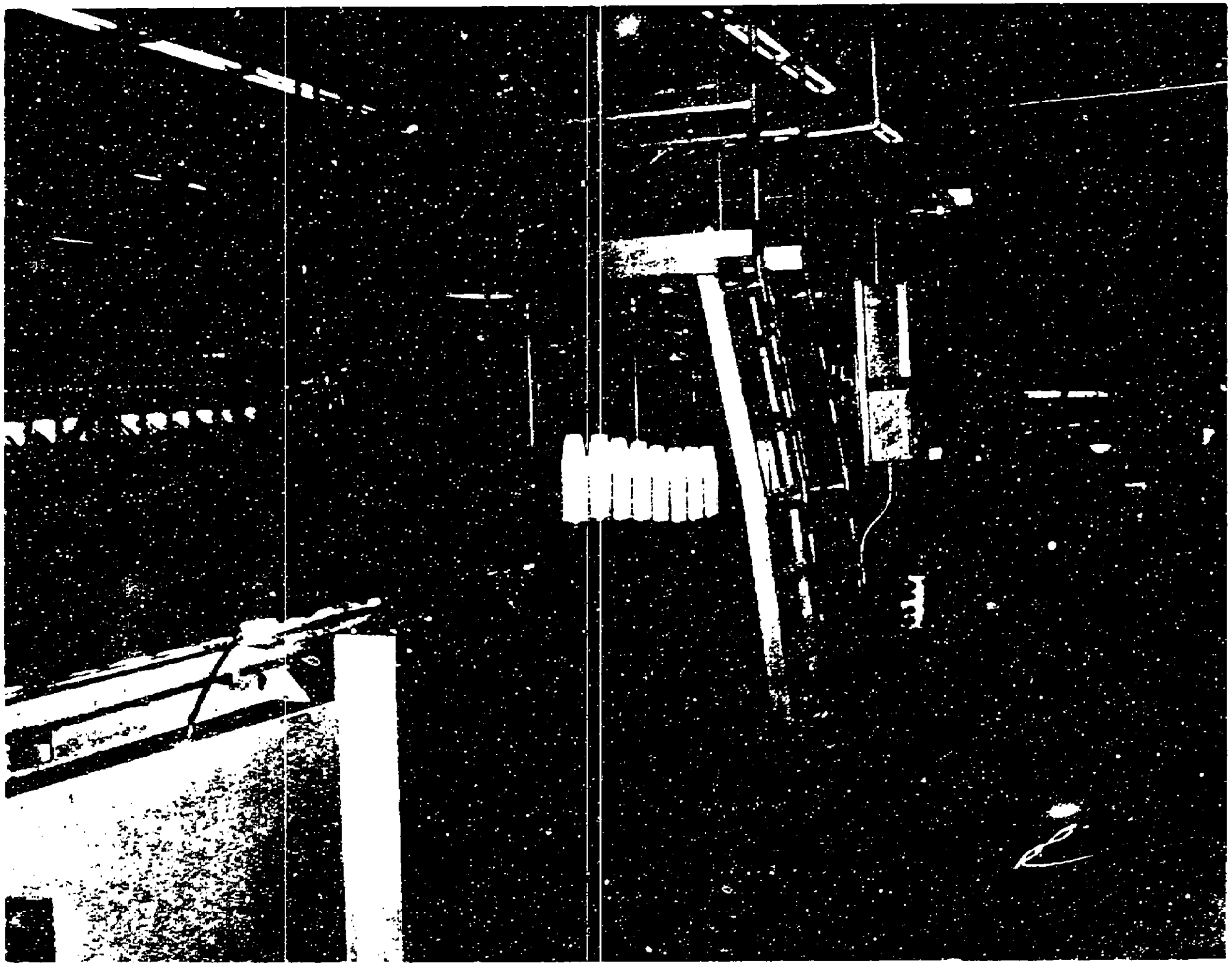

Figure 18. Preaccumulator for Munitions Cleaning Station

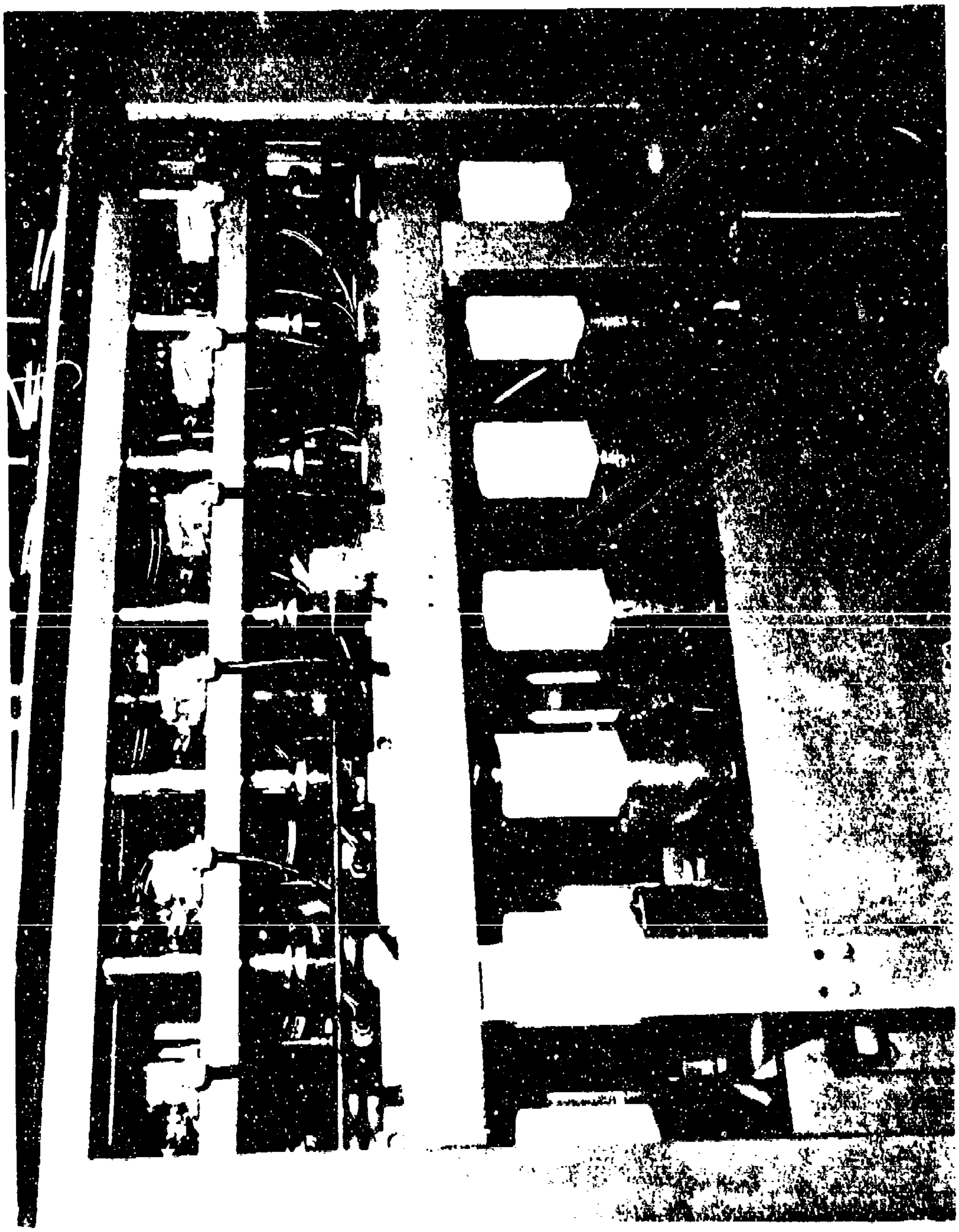

Figure 19. Automatic Cleaning Station

Figure 20. Manual Munitions Removal Station

Q. Production-Line Conveyors.

1. Munition-Loading Conveyor.

No. A. Stainless steel slat-type conveyor, ac drive, 60 fpm.

2. Filling and Closure Conveyors.

No. B. Stainless steel slat-type conveyor, dc drive, 0-60 fpm.

No. C. Stainless steel slat-type conveyor, dc drive, 0-60 fpm.

No. D. Stainless steel slat-type conveyor, ac drive, 60 fpm.

3. Return Conveyors.

No. E. Stainless steel slat-type conveyor, ac drive, 60 fpm.

No. F. Belt-driven roller conveyor, ac drive, 90 fpm.

No. G. Belt-driven roller conveyor, ac drive, 90 fpm.

No. H. Stainless steel slat-type conveyor, ac drive, 90 fpm.

R. Computer (Process Controller).

The Texas Instruments Company Model No. 5TI process controller (figure 21) has been utilized to control input and output signals from isolated station switches for sequential control of all in-line production stations.

III. TEST OPERATIONS.

A. Phase I.

Dry cycling of the line started on 21 October 1977 and was concluded on 24 October 1977. The line was shut down to correct mechanical and electrical deficiencies that were identified during this period. The most significant problem identified during the dry cycling operation was the two dc motor driven units for the filling-line conveyors. One of the units was 3 hp; and one, 5 hp. The control packages for these units were reversed during installation causing the 5-hp unit to kick out under load. This was corrected by wiring the motors to the correct motor controls.

B. Phase II.

Training was conducted for PBA line operators the week of 25 November 1977 and calibration tests with water were accomplished during the period from 27 November to 9 December 1977. The calibration results for all four volumetric cylinder sizes are presented in tables 1 through 4. The acceptance ranges (as established by PBA Quality Assurance) for the munitions compared to the maximum standard deviation of the volumetric cylinders are as follows:

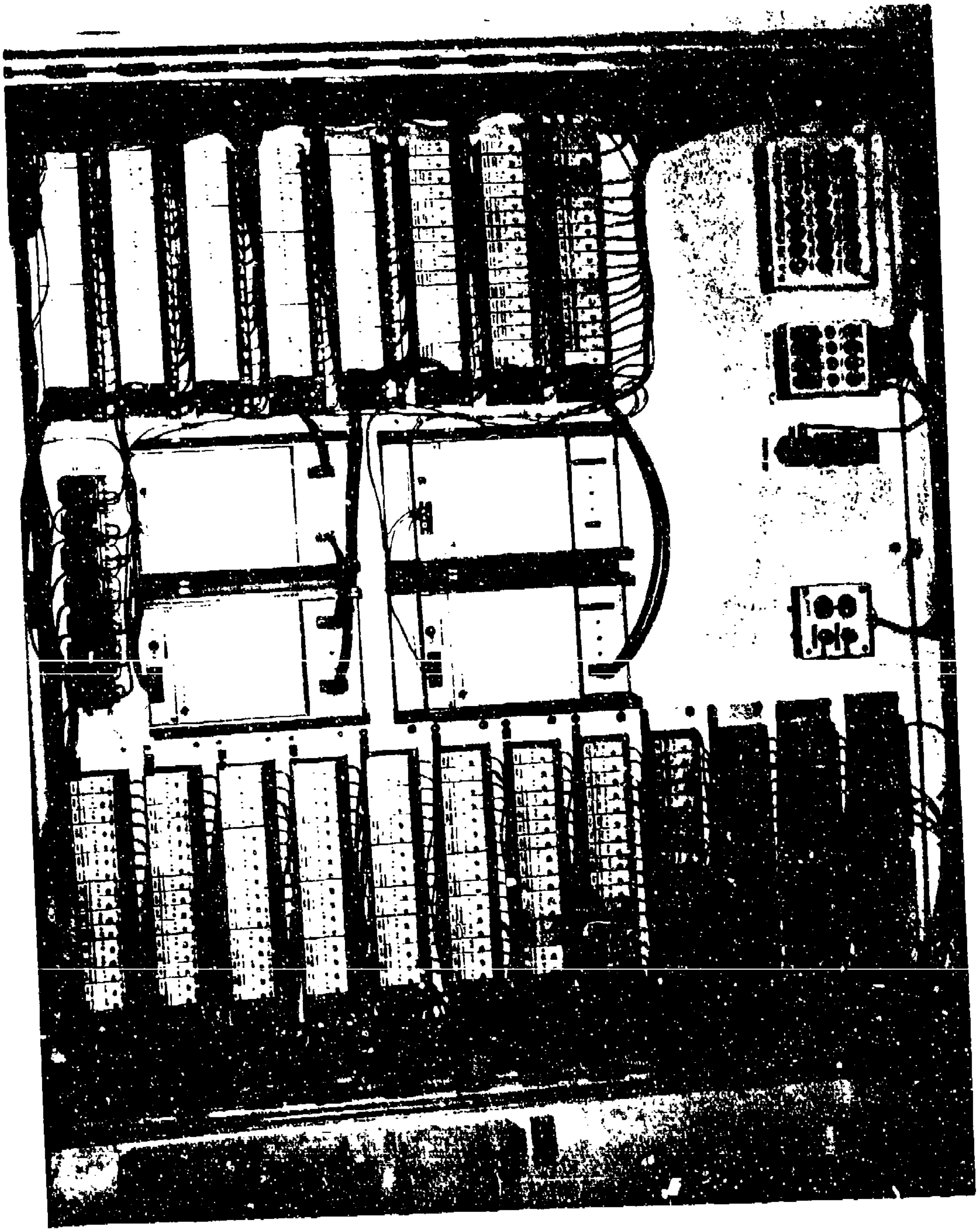

Figure 21. Process Controller (Computer)

Munition	Acceptance volume		Volumetric cylinder, maximum standard deviation
	Low	High	
	ml	ml	ml
105-mm M60 projectile	1003	1060	1.763
2.75-inch M156 warhead	548	560	1.111
60-mm M302 projectile	191	200	1.101
81-mm M375 projectile	434	461	1.284

These data clearly show that, if a volumetric cylinder is set at mid-range of the acceptance volumes, the probability of a fill falling outside the acceptance range is essentially zero. The worst case is the 60-mm M302 projectile, which has a range from the mid-point of ±4 standard deviations. This results in a probability of approximately 0.0002 that a fill will be outside the acceptance limits.

Table 1. Volumetric Chamber Certification for 105-mm M60 Projectile

Sample No.	Volume							
	Nozzle number							
	1	2	3	4	5	6	7	8
	ml							
1	1033.9	1035.5	1034.3	1034.7	1035.9	1034.8	1035.4	1036.7
2	1035.9	1034.6	1033.6	1035.2	1033.9	1034.1	1034.3	1035.2
3	1036.9	1037.3	1037.3	1034.7	1034.8	1034.9	1034.7	1036.8
4	1035.5	1035.1	1035.1	1035.9	1034.1	1035.3	1034.6	1036.6
5	1036.4	1037.5	1037.5	1034.4	1033.4	1034.8	1033.5	1034.6
Mean	1035.72	1036.0	1035.56	1034.98	1034.42	1034.78	1034.5	1035.98
Standard deviation	1.145	1.319	1.763	0.589	0.968	0.432	0.689	1.011

C. Phase III.

1. 105-mm M60 Projectiles.

The preoperational survey team was convened on 6 December 1977, and a WP test run of 500 105-mm M60 projectiles was scheduled. A total of 232 105-mm M60 WP rounds was filled on the WP dry fill line on 7 December 1977. Operation was interrupted because of numerous mechanical and control problems. Another attempt to fill 105-mm M60 rounds was stopped on 8 December 1977 because of microswitch failures in the fill cabinet and control-associated problems.

Mechanical and control problems were corrected by 16 December 1977, but a computer component failure resulted in loss of the program and operations were suspended. The defective component was shipped to Texas Instruments Company for repair.

Table 2. Volumetric Chamber Certification for 2.75-Inch M156 Warhead

Sample No.	Volume							
	Nozzle number							
	1	2	3	4	5	6	7	8
	ml							
1	556.6	559.4	556.2	556.2	554.1	553.1	554.2	555.9
2	559.6	560.4	557.3	558.2	554.5	554.9	554.2	555.9
3	559.3	560.4	557.1	558.2	553.7	555.3	554.4	554.9
4	559.0	559.5	556.8	557.2	553.9	552.8	553.4	555.2
5	558.4	560.5	556.9	557.9	554.1	552.7	554.4	556.5
6	558.5	559.3	556.2	558.2	553.7	552.5	554.0	556.1
7	558.7	560.3	556.2	559.3	554.5	552.2	554.1	556.0
8	558.4	559.3	556.2	557.6	554.6	552.5	554.5	555.3
9	558.4	560.2	556.4	558.6	553.1	553.8	554.0	556.0
10	558.4	560.1	556.5	557.6	553.8	552.4	555.0	555.1
11	557.7	560.2	555.6	557.6	554.1	552.0	554.0	555.8
12	558.8	561.6	555.2	558.2	554.1	551.8	553.8	555.1
13	558.5	561.3	555.5	557.8	553.2	552.2	553.8	555.5
14	557.5	559.3	555.4	557.0	554.4	552.0	553.7	557.5
15	558.1	561.0	555.0	557.0	553.7	551.3	554.3	557.0
16	558.9	559.2	555.4	557.4	553.9	551.7	553.3	557.1
17	557.3	559.4	555.6	557.1	553.2	551.9	553.1	557.3
18	556.8	559.9	555.2	557.4	553.2	551.7	553.5	556.2
19	555.7	559.8	555.8	557.4	553.9	552.1	553.2	555.7
20	558.4	559.6	556.1	557.5	553.1	550.7	553.6	555.7
Mean	558.15	560.035	556.03	557.67	553.84	552.48	553.925	555.99
Standard deviation	0.962	0.698	0.670	0.672	0.483	1.111	0.488	0.757

Table 3. Volumetric Chamber Certification for 81-mm M375 Projectile

Sample No.	Volume							
	Nozzle number							
	1	2	3	4	5	6	7	8
	ml							
1	448.7	445.5	449.0	446.9	447.3	448.3	446.1	446.5
2	448.4	446.5	449.5	450.3	448.2	448.7	448.6	446.5
3	448.7	445.2	449.5	449.3	447.1	448.7	448.0	448.8
4	448.7	446.1	450.6	448.3	448.1	448.5	448.3	448.5
5	447.6	445.8	449.0	448.3	447.5	447.9	449.8	448.5
6	447.6	446.3	448.6	448.1	447.7	448.4	446.8	447.3
7	448.7	445.5	450.6	447.6	450.3	447.8	447.4	448.4
8	447.9	445.2	450.4	446.8	448.0	447.9	448.2	448.2
9	447.0	445.9	447.4	447.0	447.7	446.9	447.2	448.6
10	448.0	445.7	447.9	447.6	447.9	448.3	447.3	446.8
11	448.3	445.2	447.3	448.1	448.1	447.5	447.0	446.7
12	448.5	444.8	449.5	446.1	447.8	447.0	447.8	446.6
13	448.2	445.1	447.5	446.3	447.7	447.4	446.0	447.9
14	447.0	445.5	447.6	447.6	447.4	447.2	447.4	447.6
15	448.4	445.1	447.3	447.8	446.8	450.5	447.9	448.6
16	447.9	444.3	450.6	447.4	446.8	448.4	447.6	446.5
17	447.1	444.1	447.3	448.5	446.9	447.3	446.2	447.5
18		444.5	447.3	447.0	448.5	446.3	447.0	447.5
19		444.4	447.5	446.8	445.6	447.1	447.6	447.5
20		444.4	447.5	446.9	447.0	446.1	447.2	447.4
Mean	448.04	445.26	448.60	447.64	447.62	447.81	447.47	447.60
Standard deviation	0.601	0.688	1.284	1.012	0.912	0.989	0.896	0.808

Table 4. Volumetric Chamber Certification for 60-mm M302 Projectile

Sample No.	Volume: Nozzle number 1	2	3	4	5	6	7	8
	ml							
1	195.6	194.6	195.3	195.2	195.6	195.7	194.2	192.5
2	194.6	195.6	195.7	198.0	195.1	196.4	194.8	194.3
3	195.6	195.6	195.3	194.9	196.1	195.0	193.4	193.3
4	194.8	195.9	195.3	195.9	195.1	195.3	194.0	193.8
5	193.3	196.1	195.6	195.2	194.7	195.7	194.7	193.9
6	195.1	195.8	194.6	196.7	193.9	194.0	193.4	193.6
7	194.4	194.6	195.9	195.2	195.4	195.3	193.4	193.9
8	194.4	194.3	194.9	196.9	194.9	194.3	195.2	193.9
9	195.5	194.6	194.6	195.9	195.6	196.3	194.2	193.3
10	195.8	194.9	195.7	194.3	195.3	195.5	193.7	192.7
11	193.2	196.9	194.7	195.0	195.6	194.5	193.4	194.8
12	195.2	195.7	194.9	194.0	194.9	195.5	193.8	194.0
13	194.2	192.9	193.9	193.9	196.4	195.5	193.3	194.3
14	195.2	194.0	195.4	195.9	195.2	194.1	192.5	194.3
15	192.0	195.9	195.9	195.7	193.1	194.8	195.2	193.1
16	195.0	196.1	194.7	195.2	195.4	194.7	194.1	193.8
17	195.0	197.1	194.9	195.2	194.9	195.2	194.1	193.3
18	194.1	196.0	195.4	195.5	194.4	196.1	194.5	192.2
19	192.1	195.3	195.5	196.1	194.2	195.3	193.8	192.9
20	193.7	195.6	194.2	194.4	195.7	195.0	194.0	194.3
Mean	194.44	195.375	195.12	195.455	195.075	195.21	193.985	193.61
Standard deviation	1.101	0.998	0.557	1.000	0.762	0.677	0.677	0.684

The Texas Instruments Company repaired the defective component and returned it to PBA on 9 January 1978. The computer was reprogrammed and the line operations were initiated. A total of 433 105-mm M60 WP rounds was filled with WP on 2 February 1978. Filling operations were stopped after the following problems occurred:

a. Filling pallet hangup in fill station caused by operator error; pallet was placed on the line backwards. To prevent this, pallet orientation is being emphasized in operator training.

b. Bent probes in height-of-fill station resulting from operator error in item a.

c. Bent drip pan in the filling station caused by operator error described in item a.

d. Filling line conveyor motor overload resulting from pallet backup caused by operator error described in item a.

The problems listed above caused short interruptions but were corrected and operations continued until WP solidified in the WP supply piping. This solidification occurred when an operator shut off the valve supplying WP to the dry-fill-line storage tank. The interruption of WP flow conditions allowed the WP in the supply line to solidify.

Thawing of the solidified WP in supply lines was hampered by cold weather. Thawing operations included attempts at circulating hot phossy water in the lines and spraying hot water on the external surfaces of the supply pipes. Several ruptures occurred at flanged connections because improper use of hot water spray on the WP supply line resulted in hydraulic expansion of WP in the frozen lines.

A total of 1040 105-mm M60 projectiles was filled on 17 February 1978. The filling accuracy was outstanding. Additional mechanical and electrical deficiencies were identified for correction before the next run.

Filling operations for the 105-mm M60 WP round were resumed on 15 March 1978. A total of 1683 rounds was filled on 15 March, 3504 rounds were filled on 16 March, and 2530 rounds were filled on the final day of filling of 105-mm M60 WP munitions. Problems encountered during 15, 16, and 17 March runs were poor temperature control of WP in underground storage supply tanks, an alignment problem in the filling station, and overloading and other conveyor problems.

A total of 9422 105-mm M60 rounds was filled on the WP dry fill line with only one reject. Table 5 represents some of the height-of-fill data taken by quality control during production of the M60 projectile. These data demonstrate the accuracy of the volumetric filling process and verify the calibration results and the conclusions that the probability of a fill falling outside the acceptance limits is essentially zero.

2. 2.75-Inch M156 Rocket, WP.

The WP dry fill line was changed over to the 2.75-inch M156 rocket warhead on 20 March 1978. Filling of the 2.75-inch WP rocket commenced 22 March 1978. Overflowing of WP on munition external surfaces occurred. The problem appeared to be a result of trapped gas in munitions caused by the high liquid flow rates. Operations were suspended to research the problem.

Sample No.	Height of fill							
	Nozzle 1	Nozzle 2	Nozzle 3	Nozzle 4	Nozzle 5	Nozzle 6	Nozzle 7	Nozzle 8
1	0.450	0.450	0.425	0.425	0.400	0.450	0.450	0.450
2	0.450	0.450	0.425	0.425	0.400	0.400	0.350	0.475
3	0.450	0.425	0.425	0.450	0.425	0.450	0.450	0.500
4	0.450	0.375	0.400	0.375	0.450	0.450	0.450	0.450
5	0.400	0.375	0.400	0.450	0.400	0.450	0.450	0.490
6	0.425	0.450	0.425	0.450	0.425	0.400	0.460	0.425
7	0.425	0.475	0.425	0.450	0.425	0.400	0.460	0.475
8	0.475	0.450	0.450	0.450	0.425	0.450	0.475	0.475
9	0.450	0.400	0.425	0.450	0.425	0.425	0.450	0.400
10	0.500	0.425	0.400	0.500	0.450	0.400	0.450	0.450
11	0.425	0.400	0.425	0.450	0.425	0.500	0.475	0.475
12	0.475	0.425	0.450	0.450	0.400	0.425	0.425	0.475
13	0.450	0.450	0.450	0.425	0.425	0.475	0.450	0.500
14	0.450	0.500	0.450	0.425	0.450	0.500	0.475	0.475
15	0.450	0.475	0.475	0.425	0.425	0.475	0.425	0.475
16	0.450	0.425	0.425	0.450	0.425	0.425	0.425	0.425
17	0.500	0.450	0.450	0.450	0.450	0.450	0.475	0.475
18	0.500	0.500	0.500	0.450	0.450	0.500	0.450	0.500
19	0.500	0.500	0.450	0.500	0.475	0.400	0.450	0.425
20	0.425	0.450	0.500	0.450	0.450	0.425	0.500	0.450
Mean	0.455	0.4425	0.4388	0.445	0.430	0.4425	0.4498	0.4633
Standard deviation	0.029	0.037	0.029	0.026	0.021	0.0345	0.030	0.028
Low fill	0.500	0.500	0.500	0.500	0.475	0.500	0.500	0.500
High fill	0.425	0.375	0.400	0.375	0.400	0.400	0.350	0.400

*All data measured are inches from the bottom of the nose adapter. Acceptance range is 0.1875 (high) to 0.6875 (low) as shown in figure 22.

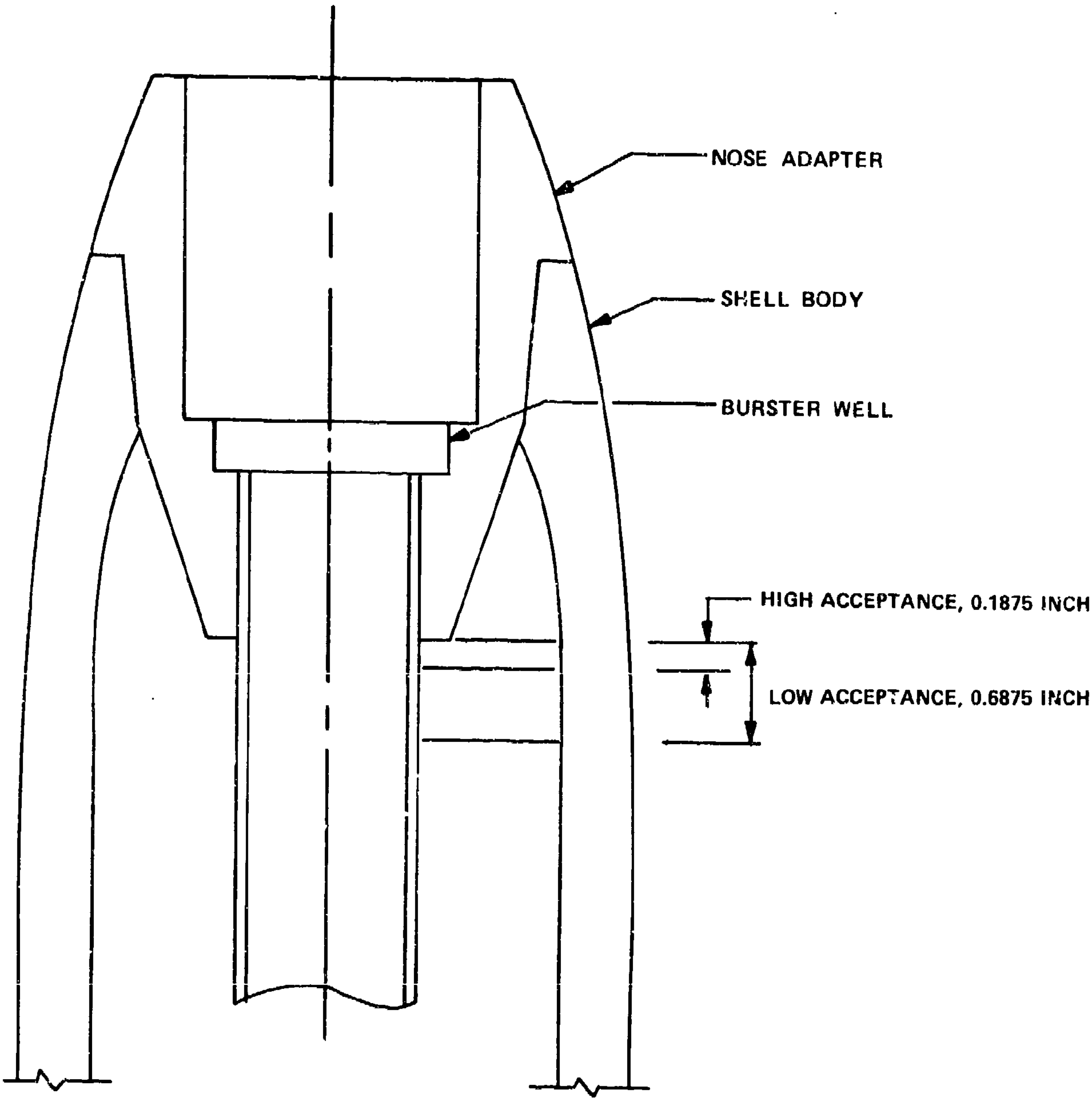

Figure 22. 105-mm M60 Projectile Height of Fill

A ¼-inch-diameter orifice was placed in the flexible filling hose of each filling nozzle to slow the flow rate of WP into the shell cavities. This correction eliminated the overflow problem.

One thousand seventy-three 2.75-inch M156 rockets were filled with WP on 24 April, 3069 2.75-inch M156 rockets were filled on 25 April, and 6431 2.75-inch M156 rockets were filled on 26 April.

Seven hundred seventy-nine 2.75-inch M156 rockets were filled on 27 April, 4712 were filled on 28 April, and 1800 were filled on 3 May. The run on 27 April was stopped because of problems with WP supply temperature control. Problems during 2.75-inch rocket production were misalignment of pallets and munitions in the filling station, inadequate temperature control of supply WP, and operator errors.

Filling results were excellent for the 2.75-inch M156 rocket production. A total of 17,864 rounds was filled and closed with only one reject. Table 6 represents some of the height-of-fill data for the M156 2.75-inch warhead production. These data verify the calibration and show that the volumetric filling system can handle a munition with a tight filling acceptance range. The probability of a fill falling outside the acceptance range is again essentially zero.

3. Survey Report of Test Operations.

After completion of these operations, a preoperational survey report was prepared by the survey team. A copy of this report is included as the appendix. The preoperational survey team concluded that the WP dry fill line was acceptable for production operations after a few minor corrections were made. The team also made recommendations for improvements in operation as follows: (1) strengthen fill-station stops, (2) provide adequate munition cleaning, (3) improve conveyor systems, and (4) provide adequate temperature control in the WP supply.

IV. DISCUSSION OF TEST RESULTS.

Although the line was successfully operated, there were a number of problems, especially with the WP supply system and the conveyor system. The problems were poor refill control of the line supply tank (corrected), WP solidification in supply lines during production stoppage, poor temperature control of the WP coming in from the outside storage tanks, and limited capacity of the line supply tank. There were numerous problems with the conveyor system, most resulting from the fact that the slat conveyor belts and drives are inadequate for the loads seen with production rates and especially if a delay results in the accumulation of a large number of pallets on one conveyor section. The return roller and belt conveyor will not handle an adequate number of pallets for production, especially during startup and shutdown of operations. An additional problem is the difficulty experienced by the operator's loading and unloading the line at production rates.

The problems which occurred with the equipment installed by this project were munition contamination, primarily a result of the burster insertion operation; lack of positive

Table 6. Height-of-Fill Data, 2.75-Inch M156 Warhead*

Sample No.	Height of fill							
	Nozzle 1	Nozzle 2	Nozzle 3	Nozzle 4	Nozzle 5	Nozzle 6	Nozzle 7	Nozzle 8
1	0.22	0.15	0.18	0.10	0.12	0.10	0.10	0.17
2	0.25	0.16	0.16	0.10	0.13	0.14	0.13	0.17
3	0.20	0.10	0.18	0.09	0.06	0.10	0.18	0.13
4	0.25	0.10	0.12	0.13	0.10	0.09	0.17	0.16
5	0.27	0.12	0.20	0.10	0.15	0.20	0.12	0.18
6	0.19	0.10	0.10	0.07	0.15	0.18	0.15	0.15
7	0.25	0.12	0.20	0.15	0.12	0.16	0.15	0.15
8	0.23	0.15	0.23	0.16	0.15	0.08	0.24	0.18
9	0.19	0.10	0.15	0.10	0.20	0.07	0.16	0.17
10	0.22	0.10	0.12	0.10	0.14	0.12	0.20	0.14
Mean	0.227	0.120	0.164	0.110	0.132	0.124	0.160	0.160
Standard deviation	0.0270	0.0245	0.0417	0.0279	0.0368	0.0443	0.0406	0.0120
High fill	0.19	0.10	0.10	0.07	0.06	0.07	0.10	0.13
Low fill	0.27	0.16	0.23	0.16	0.20	0.20	0.24	0.18

* Acceptance range is: high acceptance, 0; low acceptance, 0.3125. All heights are measured in inches from the high acceptance point on the inspection gage as shown in figure 23.

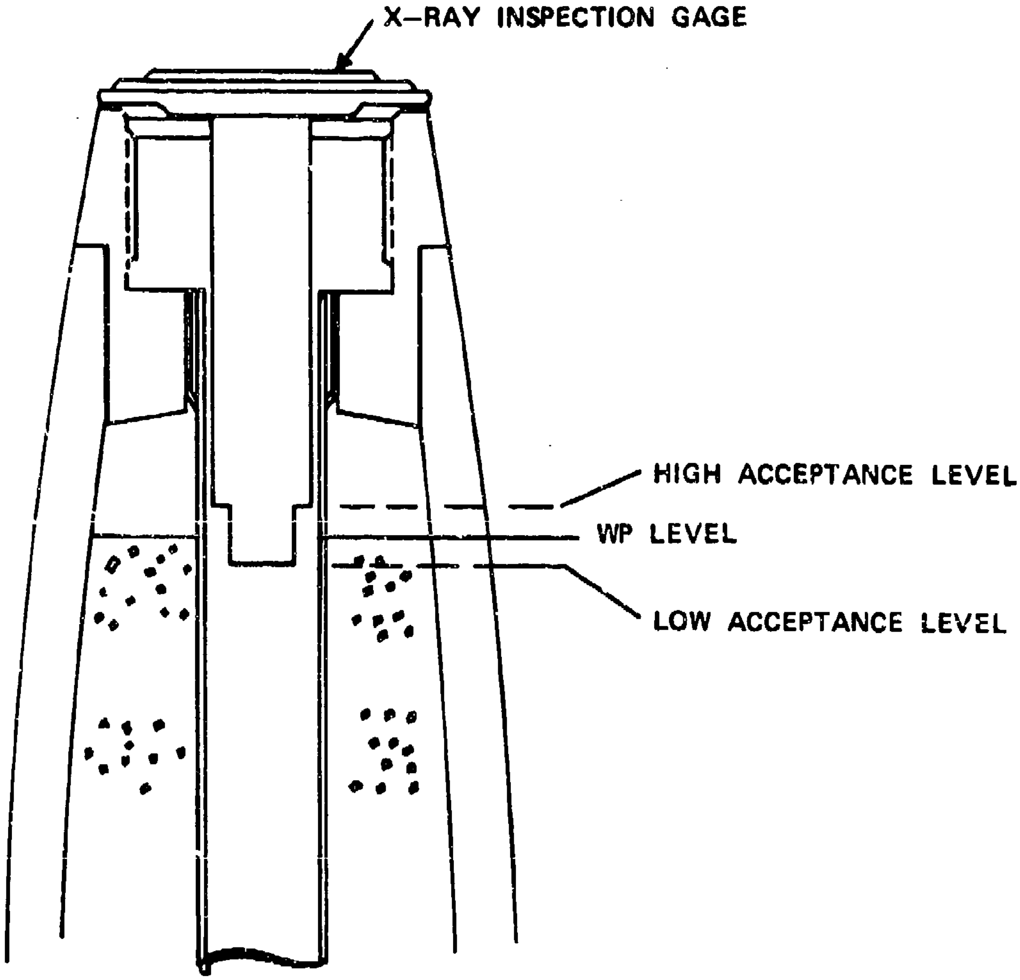

Figure 23. 2.75-Inch M156 Warhead Filling Data

manual control during production stoppages; poor pallet alignment in the fill station; solidification of WP in munitions on the conveyor line during production stoppages; and failure of the steam cleaner to remove WP contamination.

Because of these problems, a number of recommendations were made. These recommendations and actions planned or completed (if known at this time) are as follows:

Recommendation	Action
1. Utilize the WP dry fill line in all future productions of the 105-mm M60 projectile, the 2.75-inch M156 warhead, the 81-mm M375 projectile, and the 60-mm M302 projectile.	Accomplished. Current PBA plans are to utilize line for production of these items.
2. Replace the entire conveyor system by a dependable, nonoverloading conveying system because the existing conveyor system was severely overloaded and accounted for more than 75% of the downtime of the entire line.	A task for the Production Support and Equipment Replacement Program (PS&ER) was prepared for submission.
3. Provide a munitions cleaning station that will adequately remove WP contamination from the threaded nose area of WP-filled munitions.	A PS&ER task was submitted for FY 82.
4. Provide a larger WP supply tank at the filling station with a minimum capacity for 4 hours of operation. This change would shorten startup and shutdown time and improve the process operation.	No action to date.
5. Replace existing flanged and steam-traced WP supply lines with hot water jacketed lines connected with Cherry Burrell flange fittings. This would eliminate WP freezeups in the lines and problems associated with blown flange gaskets.	No action to date.
6. Modify the line control system to provide more positive manual control of line functions. This change is necessary for line setup and it provides an emergency operational capability during problems or station malfunctions.	PS&ER task was submitted for FY 82.
7. Install a temperature control system on the outside WP storage tanks which will maintain a WP temperature within a range of ±10°F.	Accomplished; control system installed.
8. Provide a heat source in the height-of-fill accumulator tunnel to prevent WP solidification in the event problems result in holding munitions in this area.	PS&ER task was submitted for FY 82.
9. Provide an improved method for loading and unloading the line.	No action to date.
10. Begin design of new lines to replace the existing dip fill lines as soon as possible.	This will be initiated when requirements for new lines are established.
11. Repair the filling station stops to prevent pallet misalignment.	Accomplished; pallet stops were repaired and strengthened.

V. CONCLUSIONS.

Completion of this project successfully culminates a more than 20-year effort by the US Army to establish a production method for dry filling of munitions with white phosphorus. The volumetric WP prototype filling line which was installed at Pine Bluff Arsenal provides the following benefits:

1. Reduces water and air polution by more than 97% over that experienced with the dip fill method.

2. Provides a high rate production method for filling WP that is much more accurate than any previous production filling system.

3. Munitions filled on the dry fill line are seldom contaminated with WP and this contamination is very slight when compared to the gross contamination experienced with dip filling.

4. Operation of the dry fill line provides much safer conditions for production operators than operation of the dip fill lines.

5. This project provides a production prototype system and the experience and knowledge to design and build other WP lines that will be safe, dependable, and economical.

APPENDIX

REPORT OF PREOPERATIONAL SURVEY OF THE WP DRY FILLING LINE PINE BLUFF ARSENAL

1. A preoperational survey of the WP dry fill line was conducted in accordance with PBA Reg 70-1 and SAREA Reg 700-6. Test operations were conducted from December 1977 to March 1978. A total of 9,422 105 mm M60 projectiles and 17,864 2.75-Inch M156 warheads were produced as shown in incl 1. The preoperational survey team members are listed in incl 2.

2. The preoperational survey team observed the test operations and provided the input for the preoperational survey checklist, incl 3. The problem areas indicated on the checklist have been addressed as noted by the footnotes for each noted shortcoming or deficiency.

3. The following problems were noted and should be corrected prior to subsequent operation:

a. Install adequate exhaust ventilation at the burster drop station.

b. Check labels on control switches to assure that they are readable.

c. Post material and personnel limits in accordance with AMCR 385-100.

d. Install two fire blankets at the specified locations near the jump tanks.

e. Correct all shortcomings as marked by Foot-note 2 on attached checklist.

4. The preoperational survey team also noted additional problems which should be addressed when funds are available. These problems will not prevent production operation, but their correction will improve line operation. They are as follows:

a. Strengthen fill station stops.

b. Correct the tendency of the height of fill station to short cycle.

c. Approximately 20 percent of the munitions were observed to have WP contamination. The steam cleaning station, while effective in removing the cosmoline from the fuze thread area did not significantly affect the WP contamination. It is recommended that a degreasing operation be provided to either clean contaminated munitions or to clean all munitions whichever is more cost effective.

d. A number of problems occurred with the pallet return conveyor. It is recommended that it be improved so that it will adequately handle the loads seen at a full production rate. A section of slat conveyor adequate to handle all pallets during startup and shutdown would improve line efficiency.

e. A large variation in the temperature of the WP supplied from the outside tanks was noted. A method of controlling the temperature more closely is recommended.

5. The preoperational survey for the WP dry fill line with the 105 mm M60 projectile and the 2.75-inch M156 warhead has been completed. It is the conclusion of the preoperational survey team that the WP dry fill line should be utilized for subsequent production operations with these munitions after the actions requested in para 3 are completed. A fill test program for the 60 mm M302 and the 81 mm M375 should be incorporated into the startup of the next production with these munitions. The recommendations contained in para 4 should be addressed as funds are available.

Merlin L. Erickson

3 Incl
as

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Director, Engineering & Technology
Pine Bluff Arsenal

APPROVED:

Robert K. Rolen 13 July 78
Commander, Pine Bluff Arsenal

Inclosure 1
WP Dry Fill Line
Test Operations

7 Dec	232	105 mm M60
3 Feb	433	105 mm M60
17 Feb	1040	105 mm M60
15 Mar	1683	105 mm M60
16 Mar	3504	105 mm M60
17 Mar	2530	105 mm M60
Total	9422	
24 Apr	1073	2.75-Inch M156
25 Apr	3069	2.75-Inch M156
26 Apr	6431	2.75-Inch M156
27 Apr	779	2.75-Inch M156
28 Apr	4712	2.75-Inch M156
3 May	1800	2.75-Inch M156
Total	17,864	

PREOPERATIONAL SURVEY WP DRY FILL LINE
TEAM MEMBERS

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PREOPERATIONAL SURVEY CHECKLIST
MMT PROJECT 5761274
WP DRY FILL LINE

PROCESS

	SATISFACTORY YES	SATISFACTORY NO	SHORTCOMING	DEFICIENCY
1. Process Flow Design:				
a. Evaluate process flow design for desired functions	X			
b. All items labeled to include direction of flow	X			
2. Equipment Design:				
a. Evaluate equipment design to determine suitability for specific operations	X			
b. Check for devices to indicate malfunctions and operation of the device	X			
c. Check human engineering aspects of equipment (for example, decible levels, pollutants, etc.).		X 1	Hearing protection required.	
d. Check equipment for conformance with all required codes and standards		X 2	Cover off accumulator cab. exhaust fan motor. Air regulator bowl covers off above aspirator cabinet.	
e. Degree of operational control - ease of maintenance, location of controls and manual systems	X			
3. Equipment Installation Inspection:				
a. All equipment mounted securely		X 1	Drive motor on pallet return conveyor.	
b. Electrical grounding	X			
c. Clearance and alignment	X			
d. Plumbing connections	X			
e. Electrical wiring		X 2	Open conduit & junction boxes above line.	
f. Necessary guards, railings, shields, catwalks, etc.		X 2	Center plexiglass panel on aspirator cabinet does not fit tight.	

1 Appropriate corrective action has been taken and the problem is resolved.
2 To be corrected prior to subsequent operations.

PREOPERATIONAL SURVEY CHECKLIST
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PROCESS

	SATISFACTORY YES	SATISFACTORY NO	SHORTCOMING	DEFICIENCY
g. Adequacy of ventilating system - dust collection or fume scrubbing		X [3]	Install exhaust hood above burster drop station & at entrance to fill cabinet.	
h. Necessary insulation on pipes, ducts, tanks, etc		X [1]	Repair/replace WP line insulation.	
i. Proper labeling of all pipes, tanks, ducts, bins, conveyors, etc.	X			
j. Determine if all required equipment has been painted properly	X			
k. Proper rotation of all motors	X			
l. All utility pressures and voltages	X			
m. Proper functioning of safety valves, switches, and fire protection systems	X			
n. Correct type and condition of flooring	X			
o. Adequacy of space for materials & handling equipment storage & operation		X [2]	Shorten conveyor at shell take off point to provide operator exit space.	
p. Adequacy of housekeeping in the area	X		Limited room for transportation & storage of bursters.	
q. Proper use of material handling equipment	X			
r. Availability of required spare parts	X			
s. Availability of maintenance equipment	X			
4. Instrumentation and Controls:				
a. All recorders, indicators, alarms, etc. for proper functioning	X			
b. All control panels and switches for proper operation and labeling	X			

[3] An exhaust vent was installed, however, subsequent operations showed that the ventilation rate was not adequate. A vent which has a higher air flow rate will have to be installed.

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PROCESS

	SATISFACTORY YES	SATISFACTORY NO	SHORTCOMING	DEFICIENCY
c. All monitoring systems (visual, audio, chemical)	X			
d. Inter- and intra- facility communications	X			
e. Determine if instruments have been calibrated and dated	X			
f. All instrumentation and controls clearly labeled		X 4	Control switch labels are small and hard to read	
5. Standard Operating Procedure and QA and QC Procedures:				
a. Easily understood	X			
b. Clearly defined sequence of operation	X			
c. Adequacy of instructions		X 2		Operation #6 not consistent with work being performed
d. Review and determine that there are no conflicts between SOP, quality assurance (QA), quality control (QC), procedures and the actual equipment and personnel training	X			
e. Posted in operating area		X 2	Post at each work station.	
6. Emergency Procedure:				
Evaluate all emergency procedures for adequacy and clearness	X			
7. Operator Training:				
a. Check for adequacy and effectiveness to include emergency situations	X			
b. Interrogate individual operators as to their functions, and items being produced, safety problems, etc. (Include supervisor and line foreman).				

4 This will be incorporated into future design efforts. All labels will be checked prior to production operation to assure that they are readable.

PREOPERATIONAL SURVEY CHECKLIST
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WP DRY FILL LINE

PROCESS

	SATISFACTORY		SHORTCOMING	DEFICIENCY
	YES	NO		
8. Product:				
Evaluate product to determine if it meets all necessary criteria found in technical data-package (TDP) and other applicable documents (per product specification)	X			
9. Environmental Controls:				
a. Does plant effluent levels conform to that cited in the assessment statement or environmental impact statement (EIS)?				
b. Is equipment operating effectively and efficiently?	X			
10. Check personnel facilities for Industrial Hygiene Standards:				
a. Change rooms	X			
b. Wash and shower facilities	X			
c. Ingress and egress	X			
d. Noise level		X 1	Noise level 85-90 db-all stations. Hearing protection reqd. Post & enforce.	
e. Lighting	X		More light needed in cabinets would be helpful.	
f. Comfort	X			
g. Work space	X			

PREOPERATIONAL SURVEY CHECKLIST
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SAFETY

	SATISFACTORY YES	SATISFACTORY NO	SHORTCOMING	DEFICIENCY
1. Coverage of operations by operating procedures. Adequacy of operating procedures.	X			
2. Personnel training:				
a. Familiarity of operators with the facility and equipment		X [5]	personnel were transferred to opn who had not been through training program.	
b. Familiarity of operators with operating procedures		X [5]		
c. Proficiency of operators in the plant operation	X			
3. Safety equipment:				
a. Adequacy of fire suppression systems	X			
b. Provision for respiratory protection where required	N/A			
c. Adequacy of protective clothing	X			
4. Material and personnel limits have been established and posted for the various operating areas		X [6]	Contained in opn directive but not posted.	
5. Procedures for equipment maintenance method used to assure that equipment is safe before turning over to maintenance personnel	X			
6. Certification of hoisting and lifting devices	N/A			
7. Accessibility of valves, controls and gauges; have provision made so that these can be viewed by the operator	X			
8. Compliance with Occupational Safety Health Act standards and practices by personnel equipment	X			

[5] Operater familiarity w/equipment & operating procedures will improve as additional production runs are made.
[6] Signs will be posted in accordance with the requirements of AMCR 385-100.

PREOPERATIONAL SURVEY CHECKLIST
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SAFETY

	SATISFACTORY YES	SATISFACTORY NO	SHORTCOMING	DEFICIENCY
9. Check to see if supervision has established high standards for housekeeping and are maintaing them; for example, adequate waste containers, provision for storage of protective equipment, provision for routine clean up, etc.	X			
10. Posting and familiarity of personnel with emergency procedures such as fire evacuation plan, etc.	X			
11. Methods of disposing of wastes		X 2	Need container for dispensing of burster casing containers.	
12. Emergency Equipment:				
a. Emergency showers	X			
b. Emergency vehicle	NA			
c. First aid kits	NA			
d. Aid station	NA			
e. Fire facilities:				
(1) Fire extinguishers	X			
(2) Hose		X 2	Provide hose racks (2)	
(3) Alarms	X			
(4) Blankets		X 2	Install 2 fire blankets, one near fill station & one between burster insertion & munition unloading stations.	
(5) Clothing	X			
(6) Fire fighting equipment and personnel	X			
f. Masks and respirators	NA			

PREOPERATIONAL SURVEY CHECKLIST
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WP DRY FILL LINE

FACILITY/BUILDING

	SATISFACTORY YES	SATISFACTORY NO	SHORTCOMING	DEFICIENCY
1. Structural Characteristics:				
a. Walls include mislocated holes, corrosion of metal, and joints.	X			
b. Roof includes mislocated holes, corrosion of metal, and joints	X			
c. Insulation	X			
d. Floors, grounding, and joints	X			
e. Doors, grounding, stops, positioning, corrosion of metal, locks, and handles	X			
f. Proper position of facilities, drinking fountain, washrooms, etc.	X			
2. Piping:				
a. Check color coding of pipes	X			
b. Check for proper symbols on pipes	X			
c. Check sprinkler system	X			
d. Check for proper clearance of pipes	X			
e. Size	X			
f. Proper supports	X			
g. Proper type pipe	X			
3. Electrical:				
a. Check for proper power at all outlets	X			
b. Check lighting both interior and exterior	X			
c. Check color coding of outlets	X			

PREOPERATIONAL SURVEY CHECKLIST
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WP DRY FILL LINE

FACILITY/BUILDING

	SATISFACTORY YES	SATISFACTORY NO	SHORTCOMING	DEFICIENCY
d. Check electrical panel boxes including fusing	X			
e. Check electrical cover plates	X			
f. Check all grounding	X			
4. Exterior:				
Check lighting protection system	NA			
5. General Housekeeping				

PREOPERATIONAL SURVEY CHECKLIST
MMT PROJECT 5761274
WP DRY FILL LINE

QUALITY ASSURANCE

	SATISFACTORY YES	SATISFACTORY NO	SHORTCOMING	DEFICIENCY
SECTION I - GENERAL				
1. Does Quality Assurance Office have copy of complete technical data package?				
a. Drawing list	X			
b. Information exchange list	NA			
c. Item drawings	X			
d. Inspection Equipment drawings Standard gage.	X			
e. Specifications	X			
2. Has Quality Surety Office evaluated and approved above plan?	X			
3. Is plan considered adequate?	X			
SECTION II - ACCEPTANCE INSPECTION OPERATIONS				
1. Is written verification plan of inspection available?	X			
a. Are all defects of the item specification covered in plan?	X			
(1) AQL's accurate?	X			
(2) Applicable drawings listed?	X			
(3) Gage numbers listed?	X			
(4) Sampling plan specified?	X			
b. Are all "Tests" listed in plan?	X			
(1) Sample size listed?	X			
(2) Test procedure?	X			
(3) Test equipment adequate?	X			

PREOPERATIONAL SURVEY CHECKLIST
MMT PROJECT 5761274
WP DRY FILL LINE

QUALITY ASSURANCE

	SATISFACTORY YES	SATISFACTORY NO	SHORTCOMING	DEFICIENCY
(4) Test conducted by qualified person?	X			
(5) Results interpreted properly?	X			
2. Are inspection stations properly located in manufacturing area?	X			
3. Is a flow chart available listing inspection stations and inspection performed at each station?	X			
4. Are all necessary drawings, specifications, written instructions, gages, forms, etc., available at each inspection station?	X			
5. Does the inspector at the station understand the following?				
a. Sampling tables used?	X			
b. Sampling plan used?	X			
c. Function and use of gages?	X			
d. Interpretation of results?	X			
e. Use of standard measuring equipment?	X			
f. Reading of drawings?	X			
6. Are areas used to hold nonconforming material properly controlled?	X			
7. Is the Quality Surety Office's method, gage, and frequency of inspection adequate?	X			

PREOPERATIONAL SURVEY CHECKLIST
MMT PROJECT 5761274
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QUALITY ASSURANCE

	SATISFACTORY YES	SATISFACTORY NO	SHORTCOMING	DEFICIENCY
SECTION III. SYSTEM VERIFICATION				
1. Does the Quality Surety Office have a procedure for system verification?	X			
SECTION IV. INSPECTION EQUIPMENT				
a. Has all inspection equipment been approved? Standard Gages	X			
b. Is all inspection equipment available?	X			
(1) If not, how is inspection being performed?				
(2) Are any inspections being omitted because of lack of inspection equipment?				
c. Has calibration system been established?	X			
SECTION V. PERSONNEL				
1. Number of Quality Surety Inspectors assigned to item 2.5				
a. Does Quality Surety Office consider this an adequate staff?	X			
b. Is staff considered adequate?	X			
2. Number of Arsenal QC inspectors assigned 3.5				
SECTION VI. MISCELLANEOUS				
1. Is receiving inspection procedures considered adequate?	X			
2. Are repair and/or rework procedures written and approved?	X			

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