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RESTRICTED DATA

PROJECT HISTORY

of

Line I Operations
Contract W-49-010-ORD-68

at

IOWA ORDNANCE PLANT

January 1, 1947 - July 1, 1954

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Operating Contractor

SILAS MASON COMPANY, INC.
ENGINEERS AND CONTRACTORS
BURLINGTON, IOWA

October 1954

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I. INTRODUCTION

Since 1947 the Silas Mason Company has held a contract (W-49-010-ORD-68) for designing, constructing and operating a facility at the Iowa Ordnance Plant for the purpose of supplying high explosive components of various nuclear weapons. It is the purpose of this Project History to record the initial rehabilitation, construction and activation together with later expansion of the facilities of Line I and the production of the MK 4, MK 5, MK 6, MK 7, MK 12 and Cobra bomb components.

The history begins with the selection of Line I, at Iowa Ordnance Plant as the location for the first mass production of explosive components for nuclear weapons and continues through seven years of activity in the nuclear weapons field. Rare is the individual who works with these devices who is not enthralled with their power and proud of his part in the program. A chronological tabulation of events in the construction and operation of the plant can only indicate that both Government and Contractor organizations were imbued with some fervor to be able to successfully carry out the crash programs that history depicts. It is the purpose here to recognize their efforts by a brief summary of their accomplishments as follows:

1. Within twenty-six hours of a completion date, set twelve months before, a modern operating plant to

manufacture high explosive components for nuclear weapons was installed on the site of an artillery load line.

2. Notwithstanding coexistent construction and production operations, an overall accident frequency of 1.6 for over 10 million man-hours, almost five times better than accident frequencies of industry at large, was achieved.

3. A consistent trend of producing a high quality product at decreasing costs has been in evidence since the beginning of operations. Moreover, even with decreased costs, all high explosive components were submitted as Grade I material. This material almost without exception has been of a higher quality than the minimum demanded by the Los Alamos Scientific Laboratories, authors of the specifications.

II. PROJECT DESIGN AND CONSTRUCTION

As a result of survey by the Atomic Energy Commission in cooperation with the Ammunition Branch, Industrial Division, Office of Chief of Ordnance, it was decided that Line I, Iowa Ordnance Plant at Burlington, Iowa should be the site for the proposed plant because of the existing available facilities, the favorable characteristics and availability of labor and the central United States geographic location.

During the early summer of 1947, Silas Mason Company entered into a contract with the Ordnance Department to assist in the design and engineering, to perform the construction and to operate a facility for the purpose of supplying the Atomic Energy Commission with explosive components of a nuclear weapon.

Black and Veatch, Consultants and Engineers of Kansas City, Missouri, made the original report to the Atomic Energy Commission and the firm was engaged as Architect-Engineer. Construction was under the supervision of the Corps of Engineers, Missouri Division of the Omaha District.

Dr. B. H. Sage at California Institute of Technology and Naval Ordnance Test Station was chosen as Process Consultant. The facilities under his direction at the NOTS, Salt Wells Pilot Plant, were used as pilot installation for purposes of design criteria, operating data, training of personnel, equipment specifications and similar considerations.

The contractors and agencies whose activities as individuals or groups were coordinated by direct liaison, were directed and supervised by an agent of the Military Application Branch of the Atomic Energy Commission. Since security was considered of prime importance, the relationships of the above were considered secret.

Time allowed to complete the engineering and construction of the project, to a stage permitting production, was only twelve months.

DESIGN CRITERIA AND PROGRAM

A general rule was established that only proven methods and equipment would be used in the initial phase of construction and operation. The criteria which governed the necessary design and modification of Line I at IOP were as follows:

1. The plant was designed with a capacity of Bravo Yankee Delta MK 3 acceptable Grade I explosive units completed per month.

2. Existing buildings and building services at Line I were to be utilized to the fullest extent, wherever possible.

3. The climate at IOP is very different from the climate at either NOTS or Los Alamos. Winter temperatures at IOP are as much as 20°F. colder than NOTS and 10°F. colder than Los Alamos. The humidity at IOP is higher for longer periods than at either NOTS or Los Alamos, even though the summer dry bulb temperatures are substantially the same. Average sunshine is less at IOP than at either NOTS or Los Alamos. This somewhat extreme variation in weather conditions was considered cause for much concern. As a result air conditioning was thought necessary at

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strategic operating points so as to more nearly duplicate the weather at NOTS and thereby assure acceptable product without the introduction of process unknowns.

4. Inasmuch as the IOP is located near major rivers and since considerable quantities of waste material which would contaminate these rivers was to be discharged from the plant, consideration was given to the elimination of the contaminants.

5. In the processes which generate either fumes or dust, it was decided that local ventilation systems would be used instead of the general ventilation principle used at NOTS, and all such fumes and dust would be passed through approved "wet" type collectors.

6. In order to save time and construction costs, the floors in the buildings within the line were left as they were and cleaned with mops or squeegee instead of by the elaborate gutter and sluicing systems used at NOTS.

7. Since it was necessary to test-fire standard samples of the product for quality control and ballistic data, and since no nearby range or proving ground was available, it was decided that a firing area would be provided within the IOP area so as to decrease the time and expense necessary to obtain pertinent information prior to shipment of the product. In this connection, the proximity of villages, farm houses and the like was cause for concern over claims and damages resulting from the blasts. Therefore, it was decided that preliminary testing for blast effects would be carried out prior to the final selection of a site for test firing.

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8. Data furnished in "Report on Casting Plant" by Black and Veatch was supplemented by later data from actual NOTS operation.

9. Isoceraunic charts indicated that Iowa has a lower frequency of electrical storms than Los Alamos but a higher one than NOTS. Moreover, the frequency of electrical storms is lower in Iowa than in certain other locations in which explosive plants have operated successfully. Therefore, it was considered that normal lightning protection as required by the Ordnance Safety Manual would be adequate.

10. Because of the dispersion required in explosive manufacturing operations, because of the greater extremes of weather conditions prevailing in Iowa and in view of the fragility of the product, it was decided that transporting of the product through the various stages of manufacture should be through ramps and corridors, which would be conditioned in such a fashion as to prevent severe thermal shock. It was, therefore, decided that the existing ramps at IOP would be further insulated and heated and that new ramps as required would be constructed in a similar fashion.

11. In view of the short time available, it was decided to scale up the pilot operations at NOTS and to use, wherever practicable, duplicate equipment, equipment design, equipment installation and instrumentation with the minimum modifications necessary to adapt the various systems to building arrangements at IOP.

12. To save time, the activities of the various agencies

and individuals concerned were coordinated into a planning committee. Membership was composed of representatives from California Institute of Technology, Naval Ordnance Test Station, Silas Mason Company and Black and Veatch. The efforts of this committee were directed toward an early selection of detailed design criteria, which would facilitate the design, selection of equipment, specifications and purchase.

13. NOTS was to furnish certain equipment for which they had developed sources of supply to save design and procurement time and to enhance security.

ACTIVATION AND CONSTRUCTION

Engineering and purchasing offices were established at Shreveport, Louisiana by the Silas Mason Company for security reasons. Meanwhile, at the site of the work, Burlington, Iowa, a field organization was assembled which consisted of construction forces, field engineers and a pertinent fiscal establishment.

Since Silas Mason Company felt the initial estimates were too qualitative, it was necessary to prepare a detailed estimate of costs of construction prior to the beginning of any work. This was done in order that more realistic figures be available for the necessary contract negotiations. Along with this estimate, certain fundamental technical criteria had to be agreed upon, prior to any suggestions from the planning committee.

Before receiving the detailed drawings necessary for construction, the forces and plant facilities were assembled. Various tests, such as nature and adequacy of water, power, soils and demolition work - where modifications to structures and facilities were necessary - were commenced. Although this work was started early in the fall of 1947, it was not fully effective for several months of the late fall construction season, because no detailed drawings were available. Since, as is outlined above, approval or comment by all parties listed, plus Ordnance Safety approval, was necessary before construction could commence, considerable time was required before a drawing was finally issued to the field. For these reasons little construction work was accomplished prior to January, 1948. This winter work required extensive and costly preparation, and attention was given to such items as excavation, concrete pouring and curing incidental to new footings, barricades, walls and similar concrete structures.

The work was started so soon after the end of World War II that many materials and much equipment were not readily available. In view of shortages and long delivery schedules, it was found necessary to demolish existing government installations at Weldon Springs Ordnance Works and to reuse a portion of the material such as pipe and fittings. It was not deemed advisable for security reasons to use AEC influence to rush delivery of materials or equipment.

Phase I construction contemplated the completion of those items essential to meeting the starting date. Design fell behind the construction pace and in view of the lag in drawing issue, part of the design load was transferred from Black and Veatch to Silas Mason Company and NOTS, i.e., Silas Mason Company was to assist materially in design of handling equipment, to completely design all jigs, fixtures, gages and cutters and to furnish complete design and drawings for both the burning ground and the test fire areas. The melt kettle installations along with related piping, power and instrumentation were to be copied from NOTS drawings with the minimum of changes absolutely essential to fit IOP arrangement.

The product desired at the end of Phase I construction was a limited number of Baratols. Since previous experience at NOTS indicated a low yield for Baratol - pieces which are required before Overcasts can be made - the Baratol production appeared to have the logical priority, therefore, emphasis was put on items of construction necessary to Baratol manufacture. These items were as follows:

1. Shops. Carpenter shop facilities were necessary to manufacture temporary handling boxes, tables and equipment for use prior to delivery of permanent equipment. Machine shop equipment was necessary to manufacture fixtures, cutters and gages.

2. Laboratories. Particle size control laboratory in barium nitrate preparation and minimum facilities in central control laboratory for sampling and analyzing finished Baratols were required for start-up.

3. Material Preparation. Any item which was installed as a single unit and one-half of all equipment which was installed in duplicate was required.

4. Material Handling. Such conveyors and equipment as were available and substitutes for permanent equipment which was not available.

5. Melt. Since the 500-pound kettles furnished by NOTS were not expected by the starting date, temporary "candy" kettles similar to those used at Los Alamos were installed with the minimum utilities necessary for operations.

6. Cast and Cool. Four bays in Building 1-05-1 were designated for Baratols. The circulating systems in these bays together with essential utilities and equipment were given first priority. An expeditor was assigned the duties of either borrowing or acquiring enough Baratol molds to start on schedule. However, certain control instruments and electrical equipment was necessary and accordingly, plans were made to start manually if instrument panels did not arrive on schedule.

7. Machining. Machines, cutters, jigs, fixtures and gages necessary to coring, sawing and finish machining of Baratols, along with necessary services and utilities were required.

8. Gammagraph and Radiograph. The gammagraph facilities were essentially complete soon after start-up.

9. Rest Houses. A minimum of one rest house was necessary in which to rest and temperature condition the material in

various stages of completion.

10. Utilities. Consideration was given to the various utilities as follows:

Air - A survey of the existing compressed air supply indicated that only the addition of stand-by instrument air capacity was necessary.

Steam - The preliminary estimate made by Silas Mason Company indicated that additional process and heating steam capacity was necessary, however, any work on additional steam capacity was with-held for future consideration.

Water - Preliminary work indicated an adequate water supply if recovery equipment, such as cooling towers, were used extensively.

Electric Power - The installed capacity of the IOP central station appeared adequate - unless all bomb, shell and miscellaneous lines at IOP were activated for full production.

Sewage - Existing sanitary sewage facilities were adequate but storm sewers and process waste disposal were given further consideration.

11. Test Firing. Minimum equipment essential to meet safety requirements was required soon after start-up.

12. Burning Ground. Sufficient and proper facilities necessary to meet safety requirements and to dispose of scrap material was required.

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13. Storage. Raw material and finished product storage

Shops (Building 1-01). The original plans for this building contemplated that it be used for administrative offices. However, it was decided that for safety considerations and since office space was available in the main administration building at IOP, that Building 1-01 would be used exclusively for shops. Administrative offices were then located in the main IOP administration building and the line offices in Building 1-04.

Box manufacture was contemplated in the carpenter shop which was equipped with conventional sawdust and shaving removal and collecting equipment. Box painting was provided with a water curtain collector so as to preclude the escape of vapors or fumes which might enter the air conditioning system of an explosive building. Approved hoods and exhaust systems were provided at welding and blacksmith shops. Air conditioning was installed in tool and gage shop to preclude condensation of moisture and subsequent corrosion of tools and gages. Standard construction and maintenance equipment was installed in the various shops. The sheet metal, carpenter, electric, pipe and machine shops were located in Building 1-01 and the tool and gage and the instrument shops in Building 1-04.

All shops in general were equipped to handle a larger volume of work than is necessary for routine maintenance, but the reserve capacity has been justified many times in shortening delays and equipment downtimes, especially during emergencies.

Laboratories. It was necessary that the control laboratory

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in Building 1-60 be essentially complete so that preparation of barium nitrate could properly proceed. This was doubly necessary in view of the last minute change from MK 3 to MK 4 design. Before the plant was finished, the MK 3 was declared obsolete and production was required on the MK 4. The equipment in this laboratory consisted of roller-analyzers, an aquatrator, Fisher subsieve sizers, Ro-tap shakers, and necessary equipment for quantitative analysis.

The central control laboratory in Building 1-04 was complete only so far as necessary to support Baratol production. The sample preparation and crusher Building 1-03 - where explosive cast samples are crushed - was activated to include two cabinet units and two hand-operated hydraulic jacks. These jacks initially were operated manually since some of the basic equipment was of long delivery. Also, crusher installations when tested, proved inadequate and it was necessary for Silas Mason Company to redesign the installation. To supplement laboratory services, a small solvent storage building was needed which was located and erected just east of Building 1-04. A large underground gas installation for bunsen burner service was also designed, however, installation was cancelled in favor of a bottled gas system, serviced by a local distributor. The laboratory was equipped with essential equipment for necessary qualitative and quantitative analyses of the product.

Material Preparation. Since the first item of production was Baratols, emphasis was placed on essential items of equipment necessary for Baratol material preparation. The barium nitrate preparation building itself was a new building, arrangement of which was specified by NOTS and designed by Black and Veatch. Since dry barium nitrate was required (20 per cent relative humidity), such features as special vapor barriers and dehumidification equipment were included in the building design. This new building was constructed on the site from which Building 1-08-2 was removed and was designated as Building 1-60. In general, it was arranged with a full basement, full first floor, with approximately one-half of the first floor area covered by a second story. The greatest portion of the process equipment was concentrated on the first floor with the utilities such as air conditioning equipment, steam, water, electric supply and elevator operating equipment in the basement. This arrangement made the first floor extremely crowded whereas the second floor and the basement had considerable vacancies. A large portion of the equipment necessary for barium nitrate preparation was of long delivery which in turn necessitated the elimination of all non-essential items, and a substitution of temporary equipment where the item could not be eliminated. A can drying oven was proposed and facilities arranged for incorporation of this oven within the final building, but since it was impossible to calculate an immediate need for the oven, it was not available for initial operation. A large heated holding oven was proposed, but was eliminated

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during the initial phase because of non-availability of materials and shortage of construction time. Since the vacuum dryers would not be available initially, a surplus ammonium nitrate dryer was temporarily installed for this operation. Also, the original design for the dryers specified the use of a hot air blower which would pass hot dry air through the material thereby removing moisture. This item was objected to by Silas Mason Company and in view of satisfactory tests at NOTS, a Stokes vacuum dryer was purchased for this purpose. A spare vacuum pump was borrowed from one of the melt installations until a replacement pump could be obtained. It was necessary, because of long delivery dates of properly enclosed electric items, to install equipment such as one double cone blender, one mikro-pulverizer, dryer and screens with temporary wiring. Instrumentation was of a very temporary nature and consisted of the minimum essential tachometers, thermometers and gages necessary to maintain quality control.

Kathabar equipment purchased for air conditioning was specified to maintain a relative humidity of 20 per cent, based on 100 per cent outside air, with no summertime temperature control. The installation of this equipment was not complete for initial operations.

TNT required in Baratol preparation was temporarily stored in Building 1-06-1 and was inspected in Building 1-50 where few additional facilities were required. Nitro-cellulose and stearoxyacetic acid were temporarily stored in Building 1-06-1

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and were tested in the 1-04 Laboratory.

Material Handling. Considerable footage of Alvey-Ferguson trolley conveyor was available within lines at IOP. This equipment with modified pendants was installed to connect material preparation facilities, i.e., Buildings 1-06-1, 1-06-2, 1-08-1 and 1-60 with the transfer building, 1-50. From Building 1-50 similar conveyors were installed to supply the raw materials to the melt buildings. Since the insulated cans and containers were not obtained in time for start-up, temporary cans and explosive packing boxes were utilized to the fullest extent. The carriers for finished products and the necessary fork trucks for transportation were not available, so temporary facilities were provided in the form of standard available push carts for transporting the finished material to and from the various stages of the operation.

Melt. The designs and layout specified the use of special 500-pound melt kettles which had been developed and procured by NOTS and shipped to IOP. The utilities and services required for these kettles made the installation of elaborate instrumentation necessary. Although the utility arrangement installed at NOTS was untried, it was to be copied except for minor changes necessary to fit the IOP buildings and arrangement. Numerous errors were apparent after inspection of the drawings, so conferences were arranged among NOTS, Silas Mason Company, Black and Veatch and AEC personnel to

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reach an early and satisfactory clarification. Since the decision to use this special NOTS equipment was delayed, it was recognized that even if the Architect-Engineer and the Contractor should attempt a more simplified design, the equipment would not be available by start-up date. Further, since the design and procurement of the special kettles by NOTS did not proceed as rapidly as planned, it became apparent that temporary kettles would be necessary. It was decided that the equipment used by Los Alamos in the form of "candy" kettles, which could be set up readily and on which considerable operating data was available, would be satisfactory for start-up. In view of the low first cost, revisions were made into the systems to use these "candy" kettles at atmospheric pressure even though the permanent NOTS type kettles, installed later, were vacuum kettles.

The utilities necessary to operate the kettles were located in underground equipment rooms between the two melt buildings. The melt buildings were designated as Buildings 1-05-1 and 1-05-2 and the equipment rooms as 1-05-1E and 1-05-2E. In view of the volume of equipment involved and in some cases, of special delivery schedules, it was again necessary to install a minimum of equipment consistent with safe operations.

Kettle vacuum installation, kettle hydraulic drive and operating equipment, fume removal system, and heating and ventilating units could not be scheduled for delivery in

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time for erection prior to start of operations. Likewise, a decision had not been reached as to the extent or nature of kettle deluge and fire-fighting equipment prior to Baratol production. It was then decided that: (1) emphasis would be placed on the installation of facilities necessary for operation in two of the four kettle bays in Building 1-05-1, the bays that were initially designated for Baratol production, and (2) the necessary minimum permanent and temporary air, electric and steam services be provided for operation of the temporary "candy" kettles.

Cast and Cool. One of the items delegated to NOTS for procurement was molds. Tests conducted at NOTS indicated that better results could be obtained by the use of aluminum molds instead of those formerly used which, were constructed of cerrotru. Therefore, it was decided that molds for IOP would be aluminum, also, since these items were classified, it was thought desirable to utilize existing sources and then merely re-ship the equipment to IOP from NOTS. However, the last minute change from MK 3 to MK 4 delayed the procurement of these molds to such an extent that it was doubtful that IOP would receive sufficient molds in time for start-up. In addition to a special expedition assigned to rush the procurement of the molds, an inspector was dispatched to the subcontracting company to inspect and accept the Baratol molds.

Much of the discussion on design and difficulty with material procurement involved the special mixing valves, service posts and instrumentation in the casting and cooling bays. These mixing valves consisted of a perforated tube within which a piston was positioned by a conventional power house "operator". The "operator" in turn was controlled by a time cycle controller with a cam which controlled the position of the set point for various water temperatures throughout the cooling cycle. This mixing valve was designed by Black and Veatch, manufactured in Silas Mason Company shops and assembled with the purchased "operators" and controllers in the respective operating bays. A temporary by-pass station for each necessary controller was built and operated manually until automatic control instruments could be obtained and installed. The operation of this entire assembly of equipment was predicated upon known data for the MK 3 Baratol. With the advent of the MK 4, this particular arrangement of automatically controlled equipment was of questionable value since little or no data was available pertaining to the changes in cycles and techniques which the MK 4 made necessary. However, the design had proceeded too far, and since much of the equipment had been installed, the work was completed with the expectancy that applicable cycles would be developed.

Another matter of considerable cost and discussion was the type of connections to be used between molds and service posts. A Hansen fitting had been used with varying degrees of

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success at Los Alamos. The procurement of proper rubber hose for use between molds and service posts was delegated to Goodyear Tire and Rubber Company with very good results. This hose successfully withstood the high temperature, the high air pressure, the various water connections and 30 inches of mercury vacuum.

Just before start-up, a major change in desired capacity dictated that a new steam plant be built. This change also required revision of the equipment rooms which housed the heat exchangers, mixing tanks, mixing valves, electric power panels and pumping equipment necessary to supply the various services to the casting and cooling bays.

Since initial operations with the "candy" kettle was at atmospheric pressure, considerable effort was exerted toward the use of transport kettles for evacuating molten explosive. This required reasonably complete installation of vacuum pump houses before start-up. The lines leading to and from the service posts were provided with filters to eliminate the possibility of any explosive material collecting inside the pump, and at the same time, to provide free and sufficient ventilation preventing the oily exhaust from contaminating other buildings and rooms. It was felt advisable that these vacuum house buildings be located separately from the main equipment and utility room to prevent the contact of explosive materials with the hot rotating, reciprocating and spark producing equipment.

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satisfactory demonstration that this combination of equipment would be entirely satisfactory was achieved. Purchase was then initiated.

Another matter which served as a fundamental criterion in the operation of the machining bays was the use of a water coolant. The coolant had three purposes; (1) to prevent over-heating of the cutter blades, (2) to remove chips by floatation, and (3) to maintain the casting at a constant temperature during machining. It had been found that sudden changes in temperature produced considerable cracking in previous and subsequent operations.

The machining bays designated for Baratol operations were located in Building 1-10. Therefore, these bays were equipped with heavily barricaded walls and light blow-out vents toward the outside along with the necessary utilities in the form of coolant water, hydraulic, electric and pneumatic services. All of these services were installed in a basement equipment room beneath the machining bays and were expedited to be complete soon after start-up date. For these machining operations, it was necessary to fabricate in Silas Mason Company shops the necessary jigs, fixtures and gages. This equipment was all designed and manufactured by Silas Mason Company, using where possible the experience of NOTS. The completion of this task was prolonged because of the change from MK 3 to MK 4 Baratol shape.

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Another item which was handled as a machining item was that of sawing and coring standard samples of cast Baratols for inspection by the laboratory to determine densities and compositions.

Gammagraph and Radiograph. Gammagraph and radiograph facilities were required for inspection operations and for accumulation of data from which adjustments could be made where necessary in production procedures. Since the initial operation was Baratol production, the gammagraph facility, utilizing a radium source, was given first priority. The facilities required consisted essentially of adequate shielding and safety devices for protection of personnel, and the various utilities such as power, light, heat and ventilation necessary for the functioning of the building. The shape of the building, eventually designated as 1-73, was under discussion from the beginning. The gammagraph portion evolved as a cube shaped building instead of the originally planned cylindrical building. As in most instances, construction could not be completed because of the late delivery of air conditioning equipment and certain electrical safety devices. No radiation detecting devices were provided since it was considered that safety devices carried by the individuals would be adequate. However, later it appeared desirable to provide a detecting device which would instantaneously indicate the intensity level of radiation.

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X-Ray facilities were not required until the second phase of production, so minimum construction in the form of shielding, utilities, and temporary controls was provided for one x-ray bay. This equipment was located in Building 1-12 to be used in an emergency and for the purpose of training personnel.

Rest Houses. Rest houses designated as Buildings 1-71, 1-72, 1-74, 1-75, and 1-76 were erected to the west of the main Buildings 1-10 and 1-12. These were to serve as flow regulators so as to smooth the production line operation and at the same time to allow for the curing of the various explosive components for a sufficient period to assure that thermal stresses were relieved. These buildings were barricaded and located at proper quantity distances from each other. In general the design was that of Navy type storage igloos in which the roof was of light construction to vent any possible explosion. For purposes of initial operations, construction of one rest house was expedited, and in this connection it was substantially complete with the exception of air conditioning equipment scheduled to arrive after start-up.

Utilities. After extensive surveys by Silas Mason Company, the existing facilities for the necessary utilities of compressed air, steam, water, electric power and sewage were considered adequate for start-up, however, additions were contemplated as follows:

Compressed Air - The existing compressed air plant, located in power house Building 1-02, was considered to be of sufficient capacity to operate the entire line requirements which included utility air, air to operate cylinders, motors, doors, and the like, and air to operate instruments. In the case of the latter because of dependability required, it was decided that stand-by compressor capacity would be required to operate instruments in the event of failure at the main plant. These stand-by instrument air compressors were to be installed in all cases as close as possible to the air requirement, near the instrument panel. Since this was a stand-by installation, it was not completed for initial start-up.

Steam - During a preliminary survey for preparing a construction estimate, Silas Mason Company determined that additional steam producing capacity was necessary for Line I, however, this item was held in abeyance inasmuch as the existing capacity in Building 1-02 augmented by steam delivered from the main generating station could satisfy the requirements for start-up. However, planning and procurement were started to provide the necessary additional process and heating steam required. This necessitated extensive modification to outside steam distribution piping and only those portions of the layout which were essential to the heating of operating Buildings, were expedited. Furthermore, since the preliminary design for the steam generating plant required that all condensate be returned to the plant, changes were made to facilities, piping, controls and the like.

Water - Preliminary studies indicated that the existing central water supply and treatment plant was entirely adequate providing water recovery equipment, such as cooling towers, would be installed when water consumption was high. For this reason, cooling towers were located at Buildings 1-10, 1-12 and 1-60 to provide cool water for air conditioning utilities, and at 1-05-1 and 1-05-2 a double cooling tower was installed to provide the necessary cool water for process operation. At other smaller air conditioning installations, such as 1-04 and 1-01, evaporative coolers were used. Since the water as discharged by the treatment plant was considered satisfactory for most uses, no water treatment equipment in power houses and circulating systems was installed initially.

Electric Power - It was determined that the central generating station at IOP had sufficient generating capacity to provide all the power necessary to Line I operations. However, in view of the high cost and hazard incidental to Line I operations, a study was made to consider the feasibility of providing stand-by power facilities.

This was not required for initial operations. At the same time, in view of the inadequacy of the remote switching equipment at the main power plant, changes were instituted by the local Post Engineer to correct the deficiencies. The work required for initial operations consisted of the construction necessary to accommodate the shift in power requirements and was given first priority for both outside and inside distribution and switching equipment.

Sewage - A preliminary survey of Line I and surrounding facilities indicated that the existing installed sanitary and storm sewage disposal facilities were entirely adequate. No system or equipment, however, was in evidence which would provide a satisfactory means to dispose of contaminated waste other than by burning, and since large quantities of the waste material would be wet from machining coolant, kettle washdown and the like, a study was made of the necessary facilities to safely dispose of this material. In this connection, the Architect-Engineer proposed clarifiers to sludge out heavy particles of the waste and dispose of them by means of tanks trucked to the burning ground. The diluted effluent from the clarifiers was discharged through a system of ditches into an impounding reservoir which retained the contaminated material until periods of high rainfall, at which times the reservoir was dumped. Thus, the effluent was diluted safely to prevent undue contamination of down stream water.

Test Firing. Manufacturing procedures required that samples of castings be fired and records kept which would indicate the uniformity of the product and conformity to the required specifications. For this purpose the test fire area followed a pattern quite similar to the installation at NOTS.

It was determined from a preliminary survey that possible damage to surrounding property might result from the blasts. In order to select the best site possible, inasmuch as no other nearby firing facilities were available, it was decided that a number of explosive charges would be detonated during varying weather conditions and at various locations and a test made in nearby houses, villages and buildings to determine the intensity of the blasts. These data were necessary to ascertain whether or not the level of intensity was sufficient to damage buildings and other structures. These tests revealed that practically zero ground shock was transmitted, which eliminated the possibility of damage claims from this type shock. The tests further indicated that the predominating cause of damage would be shock transmitted through the air and could on occasion, in case a condition of resonance prevailed, cause slight damage to nearby structures. Based on the data of these tests, along with the experience of test fire personnel from NOTS, two firing test sites were selected to be designated as the North Firing Site and the South Firing Site. It was thought that two sites would be necessary inasmuch as the weather conditions at IOP were quite different from those at other locations and inclement weather might possibly prevent firing for considerable periods. Thus, when weather permitted, the accumulated test fire samples would be rapidly fired at both sites.

The only fundamental difference between NOTS and IOP in the arrangement of the firing sites was in connection with additional utilities required to overcome the weather extremes. However, it was thought desirable to improve one facility - the actual firing point. At NOTS this firing point was a slab of armour plate placed on a wood cribbing. Such an installation required considerable maintenance and the use of heavy machinery to relocate the armour plate as the firing progressed. At Los Alamos the stand which held the piece to be fired was merely placed on a gravel mound. In the wintertime the ground becomes quite muddy at IOP and it was thought that it would be advantageous to provide a more durable firing point. However, since accurate data on this subject was lacking and since the various proposals, such as, firing within a cubicle or on a liquid support, were all rejected it was decided initially to support the firing plate on a wood cribbing, which could be fairly easily repaired, and to support the cribbing on a substantial concrete foundation.

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Since the work on the firing site did not have to be complete by start-up date, but had to be in operating condition approximately one month later, it was decided that for initial tests some of the first castings would be sent to NOTS for overcast and test fire to determine if IOP processes and procedures were proper and correct.

Because of the proximity of the test fire area administration buildings to the blasts, these were designed to resist the forces resulting from the blasts in a fashion very similar to the procedures used in localities where earthquakes prevail.

Special septic tanks and drain fields were installed for the following reasons: (1) the existing nearby installation was inadequate to accommodate the sewage, (2) no provision in existing installations would properly dispose of the waste from the photographic laboratories, and (3) the drainage area in which the buildings were located discharged into the reservoir which serves as the water supply for the entire IOP reservation.

The roads within this part of the reservation did not properly serve the area and for this reason both new roads involving extensive excavation and a new bridge were contemplated. It was necessary to have the road and outside work substantially complete at start-up so as to avoid winter construction.

<u>Burning Ground</u>. The burning ground was the facility designated to dispose of all waste explosive material by

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placing the scrap Composition B, residual castings and reject raw material in a shallow open pit, and igniting the material from a remote shelter by means of a small blasting machine. For this facility, it was only necessary to erect (1) a small magazine to contain the material safely until burning could be accomplished, (2) a firing shelter, (3) a small administrative office, and (4) adequate water connections for fire protection from grass fires and for wetting down the burning pit. It was necessary that this installation be substantially complete prior to start-up. Access roads and drainage were provided as required. The location of the various units within the burning ground facility provided for adequate safety distances should an explosion result.

Storage. The explosive materials necessary to the operation were handled in standard containers and were stored in an existing igloo storage yard which was designated as Yard C. Inasmuch as nearly all the materials would be transported by rail, and since the yard was both adequately equipped and available, very little work was necessary to utilize the storage facilities other than meeting security requirements.

Since the finished castings were of classified shapes, Yard G, an easily secured area, was selected for storage. Because the space was available, seven igloos were used to conveniently spread the backlog of castings which would normally build up prior to their proper selection and matching.

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This yard was accessible by motor vehicles only and required that shipments made by rail must behandled by truck to the rail loading point. Security requirements dictated that additional fencing, and fence lighting along with radio communication to the guard station was necessary. The completion of this work was designated as necessary for start-up. Initially all manufactured explosive items were shipped to another site for final assembly.

CONSTRUCTION WITH OPERATIONS IN PROGRESS

As outlined previously, certain construction requirements were necessary before initial operations could commence. Construction was further complicated by the late delivery of numerous items and, as has been mentioned, it was necessary to provide temporary facilities in the nature of both equipment and controls. An additional cause for delay was the fact that it was extremely difficult for the Architect-Engineer to furnish working drawings far enough in advance of construction to permit Silas Mason Company to establish and maintain a long range schedule. As stated previously, the time allotted for revising and constructing facilities to a point where production could commence was only twelve months. Also, the facility at IOP was planned and built from a pilot operation and was the first large scale production plant. Because of this, numerous design errors were apparent which required revision by the Architect-Engineer and Silas Mason

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Company. However, even with the difficulties, operations were commenced twenty-six hours after the date and hour promised the Atomic Energy Commission.

With the beginning of operations, which required the use of classified equipment and techniques, it was necessary to prevent uncleared construction workers from entering the locations where these operations were in progress. This was done by installing both protective and security barricades of a temporary nature. Further it was necessary to sectionalize all equipment and installations in such a fashion that one-half of the equipment could operate while the other half was being installed. At the same time, as the operators began their training and as the techniques and procedures became firm, acceptable products were being delivered. It was then necessary to meet the increased production demand by the start-up of the remaining facilities, utilities and equipment. This required in some instances that the equipment be operated prior to satisfactory shake-down. Operations of this nature which were started before adequate check and shake-down could be completed, required greater than normal maintenance and in some instances it was necessary to entirely remove and redesign the installation, as in the case of kettle hydraulic systems. This situation was further aggrevated by the use of salvaged material (the demolition of the Weldon Springs Ordnance Works provided the bulk of piping, drainage and fire alarm supplies installed at IOP), which required considerable cleaning, de-scaling and other processing before proper functioning could be obtained. In all instances the production operation was given priority and the construction schedule was adjusted to conform. Under this plan, since one-half of the facilities in Building 1-05-1 were in use, Building 1-05-2 was released to construction for full time work as operations progressed. Later as it became necessary to produce Outer Components and still later Inner Components, it was necessary for operations to shift to the most nearly completed 1-05-2 building and thus permit construction personnel to re-enter 1-05-1 and install such equipment as had arrived. The remaining facilities, equipment and utilities were thus installed throughout the line with the construction forces shuttling over and around operations. Outside work which included electrical power, water, sewage and contaminated water installations proceeded in the same fashion. Naturally, the cost of such construction operations was materially greater than operations which would permit continuous work in one location. However, satisfaction was derived from the fact that all promised schedules were met.

The work outlined above was carried on until January 1, 1949, at which time an inspection indicated that the bulk of the work was substantially complete, and action was taken to relieve the Corps of Engineers and the Architect-Engineer of any further responsibilities. The remaining work was completed by Silas Mason Company Engineering and Maintenance

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forces. All [illegible] cleanup and a short [illegible] contracting was completed by [illegible]

In March, 1949, it was decided [illegible] operations would be conducted at IOP. [illegible] and selection of Line I at IOP was based on [illegible] assembly operations would possibly be done there [illegible] the only line at IOP which includes a large process [illegible] building and a magazine, (Building 1-13 and Building [illegible] Three proposals were made to the Commission relative to [illegible] facilities. These were as follows: (1) the use of the [illegible] in Line I, (2) partial use of these buildings and partial [illegible] facilities, or (3) completely new assembly building and faci[illegible] On the basis of the cost and the time required to complete [illegible] work, the Commission decided to use existing buildings in Line [illegible] Contracts were modified and extended and the work commenced [illegible] June, 1949. The design, engineering and construction of this facility was done by Silas Mason Company forces, using criteria obtained from Sandia Base and following the recommendation of Garret L. Schuyler, Rear Admiral, USN (RET), whose services were suggested to the contractor. Considerable departure was permitted from the designs previously employed in remodeling the other portions of Line I, in view of the different hazards and the different nature of the work to be done. At the same time, in order to reduce expense, the entire top floor of Buildings 1-13 and 1-15 was removed so as to reduce the height of barricades and thereby save construction time. In all instances involving equipment for this assembly facility, the simplest design and the minimum equipment was used. This enabled Silas Mason Company to procure and install on schedule all of the elements of the facility so that on the date set for the operations, a complete installation was furnished the operators. Thus, completed assemblies were being delivered within a week.

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III. INITIAL PRODUCTION OPERATION

Silas Mason Company production supervisor personnel entered a training program in May 1948, at the Naval Ordnance Test Station, China Lake, California. These supervisors after training at NOTS in turn trained Silas Mason Company operators during the initial operations at the Iowa Ordnance Plant. Engineering observers had been visiting the pilot installation at NOTS for some time to gain information concerning construction features previous to that time.

In general, the training program at NOTS was very successful in acquainting the production supervisors with the operation and with the pilot plant methods but did have three drawbacks: the operation at NOTS was devoted to MK 3 castings; because of overly rigid security regulations, the trainees were not allowed to participate in all necessary phases of their future work; Pilot Plant methods were not always applicable to production line operation.

Initial operations at Iowa began with the Slow Component (Baratol) only. This component was chosen for several reasons: the Baratol forms part of the Outer Component, therefore, it was necessary to produce acceptable Baratols before acceptable Outer Components could be made; the Baratol was considered to be the most difficult component to produce and therefore, required more operator training; the raw material preparation for this component was complicated and critical, and again operator training time was needed; the facilities required in the unfinished south end of the line were less extensive.

Because of the late delivery of much of the equipment, it was necessary to make a number of temporary installations. The buildings used were as follows:

Building 1-01. All the shops were in use on both construction and operation jobs.

Building 1-04. The 1-04 laboratory was partially complete and was used for the necessary control analyses. The remainder of the building was under construction.

Building 1-05-1. This building was divided by a barricade the north half was used for production while construction continued in the south half. The NOTS type 500 pound kettles had not been delivered and temporary "candy" kettles were used for melting. These kettles had no provision for evacuation of the melt. The transport kettles had not been received either, and it was therefore necessary to pour the melt by using rubber buckets.

Building 1-06-1 & 2. These buildings were used for the line storage of raw materials.

Building 1-10. This building was complete to the point where it could be utilized for Baratol machining, repair, and inspection on one shift. Machining coolant water equipment was not complete so a domestic type water heater was temporarily installed to furnish tempered coolant water. Construction continued on the other shifts.

Building 1-50. This building was used for explosive raw material inspection and conveyor routing.

Building 1-60. The operation of this building was essential to any production of Baratol castings and at least one unit of each piece of processing equipment was required in this operation. The equipment was wired with temporary wiring and an ammonium nitrate cooler was used in place of the Stokes Dryer, which had not been received. The dehumidifier was not in operation. This building was operated on two shifts while construction continued on the third shift.

PRODUCTION OF MK 4

The operation was hampered by the fact that the pilot plant at NOTS had devoted almost all its effort to the production of MK 3 castings with very little experience on MK 4. Since the Silas Mason Company's efforts were directed to MK 4 production, there was no background of verified procedures from the training site in certain important phases of the work. In addition, specific equipment which was to be furnished by NOTS had not yet been received.

It was originally planned that the methods developed by NOTS were to be followed as closely as possible, but because of the difficulties cited in the previous pargraph, this did not prove feasible. It was therefore necessary to develop new methods applicable to the equipment and location of IOP.

The first castings produced were almost all physical and radiographic rejects. These castings were made primarily to shake-down equipment and acquaint the production operators with the material to be handled. Thirty-one batches, containing three Baratols each, were made before producing castings, a majority of which were acceptable to physical inspection. The density remained low, since high density material could not be made without evacuation of the melt.

During the last week in October 1948, melting and casting operations were transferred to Building 1-05-2 and on November 2, production of Outer components was started. Despite the prediction by the process consultant that acceptable components would not be produced for six months, surprisingly little difficulty was encountered inspectionwise from either a physical or radiographic point of view. Acceptable castings were produced from the very beginning, and while physical inspection rejects continued for some time they were not as numerous as had been anticipated.

The move to the second melt building (1-05-2) and the use of the vacuum kettles reduced the radiographic Baratol rejects to a point where efforts could be concentrated on ballistic performance.

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December 1948, January and most of February 1949 were spent in a concentrated effort to bring the ballistic quality of the Baratol and Outer Components within specifications. Efforts to improve the physical quality of these castings were carried on at the same time. By the middle of February, the prime effort met with some success and by March, the acceptance rate on Baratol castings was over 95 per cent and was over 85 per cent on Outer castings. This is to be compared with the 50 per cent acceptance rate estimated by the Consultant and Architect-Engineer. The monthly Grade I yield for the entire MK 4 Program is shown on Figure 1, page 49. The development of instructions and methods leading to this high quality was greatly advanced by the assistance rendered by representatives from the Los Alamos Scientific Laboratory and the whole-hearted cooperation given by that station.

One of the major reasons for the highly successful Baratol development at IOP was a change of concept different from that advanced by NOTS. Cooling cycle and barium nitrate particle size originally were adapted from NOTS operations and it was apparent that these procedures were not applicable to IOP processes because of a high density barium nitrate segregation or "powder" area in the center of the casting. The basic difference in thinking revolved around procedures supplied by NOTS which would allow a pour to settle completely in the mold before beginning the cooling period. Silas Mason personnel felt that controlled cooling would prevent excessive settling and would

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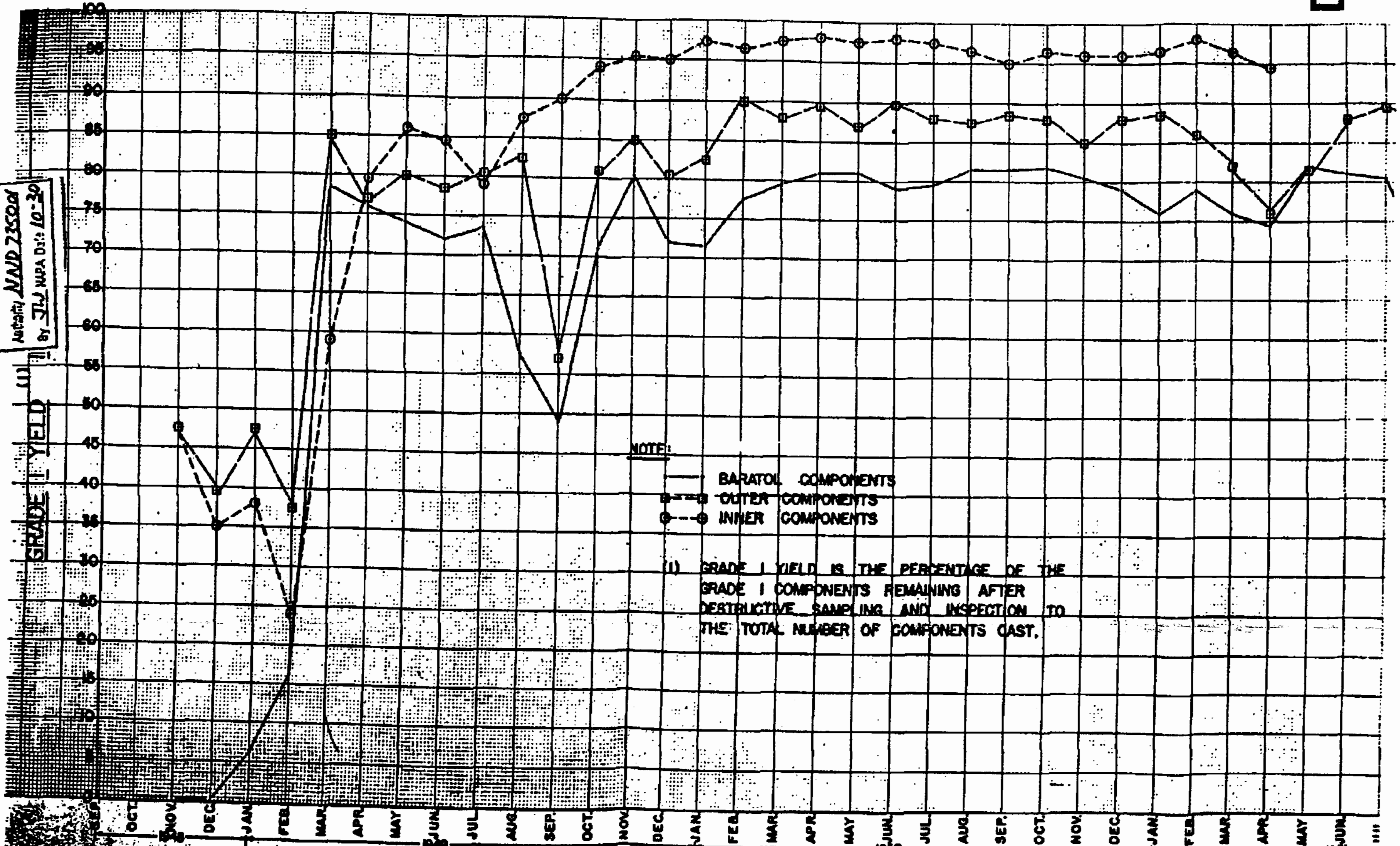

FIGURE I. MONTHLY GRADE I YIELD – MK 4 PROGRAM yield a more uniform casting. Los Alamos personnel concurred with this reasoning. By revising the cooling cycle and adjusting the barium nitrate grind to lower the melt viscosity, this "powder" area was raised into the riser. Work was then concentrated on reducing the length of the cooling cycle and stablizing the melt viscosity. The cycle was shortened to approximately one-third of the original time with the result that composition and density spreads throughout the casting were reduced and considerably more control of the final Baratol composition was obtained. This was a big step toward the production of ballistically acceptable Baratols. The soundness of this concept is attested to by the graph of firing results contained on Figure 2, page 51, and by the fact that later production of the same Baratol was made with closer ballistic specifications.

Production of Inner Components was initiated on November 5, 1948. Difficulty was immediately encountered with cracking and density. By the end of March 1949, a successful procedure had been devised. From that time, the acceptance of Inner Components increased to over 95 per cent and remained at that level to the end of the MK 4 Program.

From March until the beginning of the 1950 Fiscal Year, quality of all components continued to increase and production rates continued to rise. In June, Baratol and Outer production was returned to Building 1-05-1, now complete with the vacuum

SECRET

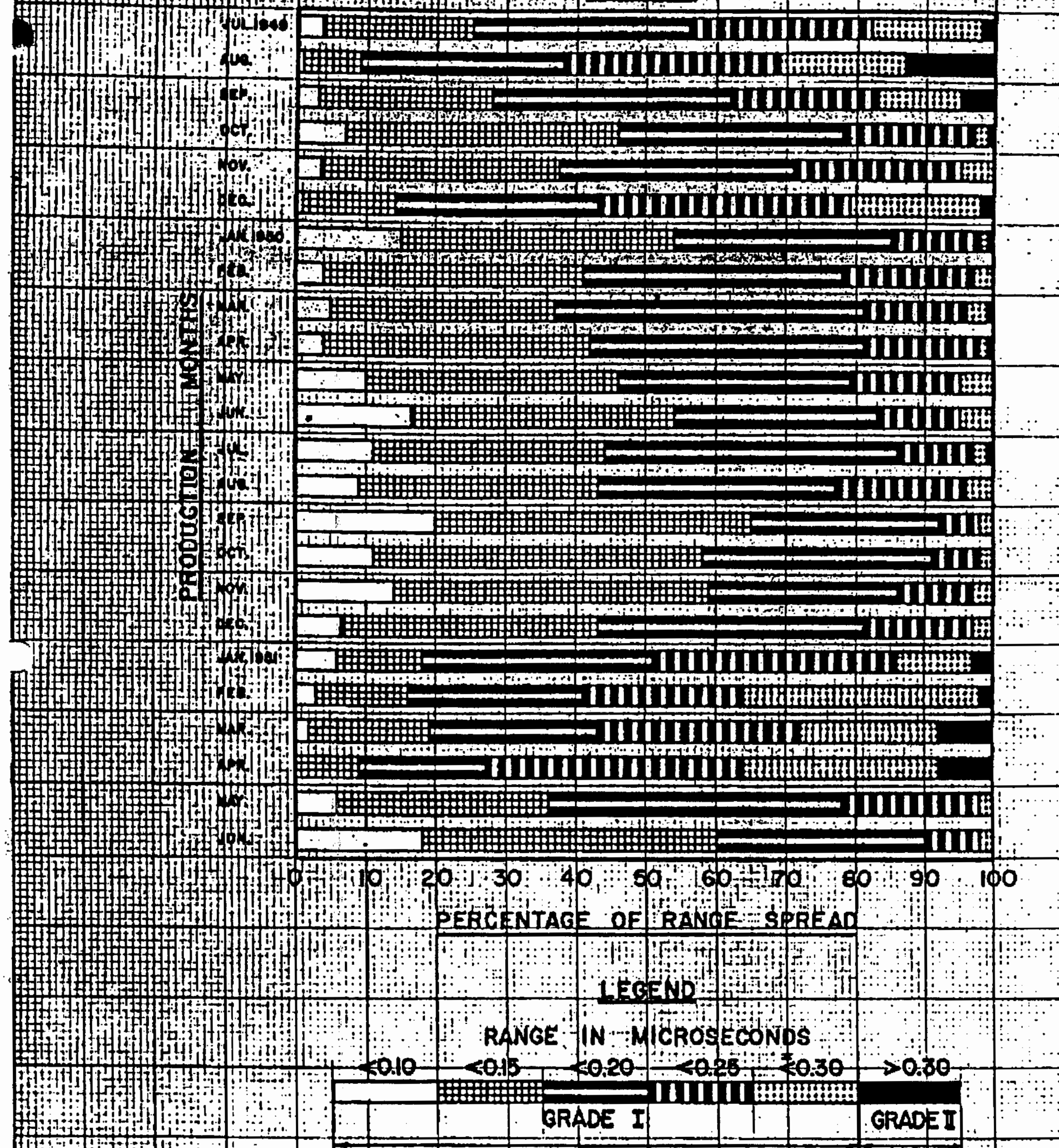

FIGURE 2 BARATOL RANGE SPREAD – BATCH PROOF FIRING MK 4 PROGRAM

SECRET

melt kettles. At this time, only nine months after the beginning of operations, quality and production had reached a level well above that anticipated.

On July 1, 1949, construction was virtually complete and all buildings were in full operation. The few remaining construction and installation jobs were carried out by the maintenance forces without hampering production operations.

In August 1949, the quality of Baratols, followed by Outers, dropped sharply. This lapse of quality was inexplicable until it was realized that the contour of the MK 4 Baratol as modified at NOTS, was predicated upon a relatively non-uniform component, i.e., one with high density and composition spreads, and that Silas Mason Company Baratols with almost complete uniformity were in essence "too good". It was necessary to increase the overall percentage of barium nitrate in the castings to allow for this contour.

In November 1949, a short riser Baratol was developed. This reduced the amount of raw material required per batch and permitted the melting of a complete "batch" in one melt kettle instead of the two formerly required. By this action both the material and labor cost on Baratols was substantially reduced.

By January 1950, additives, ortho and para nitrotoluene, were introduced as a crack preventative measure in Outer and Inner Components. Development of correct additive percentages and addition to Composition B melts was accomplished during January and February. Cracks which previously had been reduced by using Kimpac around molds and castings to buffer the effect of changes in room temperature on the cooling rate, were appearing in the Outer Components. A mixture of ortho and para nitrotoluene added to the Composition B melts essentially eliminated the cracks. Outer acceptance during February 1950, was the highest on record for production operations at this site, and yields of 85 to 90 per cent, even after destructive sampling, continued for this component essentially throughout the remainder of the program.

During January 1950, warpage on the bottom curvature of the Baratol dropped yields due to very close tolerance specifications. Apparently quality would not be affected by increasing the tolerance, and since the problem lay in the TNT raw material itself, the difficulty was corrected, with specification changes, and the castings were usable in Grade I units. Baratol acceptance returned to approximately 80 per cent and continued at that percentage throughout 1950.

With the Outer acceptance remaining around 88 per cent, efforts were being concentrated to establish time saving procedures in the melting, casting and cooling operations. In March, experiments were conducted to determine the feasibility of using break-off plates or rings for the risers of the Outer Component. If the risers could be removed at the melt building immediately after stripping, a troublesome remote control saw riser operation could be eliminated. Preliminary work was concentrated on the use of brass break-off plates, inserted in the riser after casting, and the elimination of the probing operation which prevented the risers from freezing during the initial cooling period. It was established that riser probing was essential, so a rubber ring was designed to be inserted in the riser before casting. The ring had a 2-inch diameter hole in the center, making probing possible. These rings proved so satisfactory that rings were designed for the Inner molds and these rings were used in production by September 1950.

During February 1950, new x-raying procedures were devised whereby a single film per exposure was used instead of a double film as used previously for the Baratol. The number of exposures per Outer casting was also reduced. These procedures resulted in substantial yearly savings on x-ray film.

Throughout 1950 periodic ballistic fluctuations prompted various studies, surveys and experiments pertaining to the Baratol raw materials and operations. Firing data indicated that the detonation wave was traveling too fast through the center of the Baratol with respect to the wave at the outer edges. Barium nitrate composition was again increased to correct for ballistic inequalities. By the end of the year the percentage was 76.8. As the barium nitrate composition was increased, the viscosity also increased which made the melts more difficult to cast. With this in mind, experiments were conducted with bimodal grinds and conclusions were verified that this type of grind could be used to lower the viscosity if needed. Acceptance varied very little due to the ballistic fluctuations even though the average range was higher.

Cracks began to appear around the booster hole in the Outer during October 1950, and permission was received to increase the ortho and para nitrotoluene addition which corrected the situation.

During January 1951, the supply of wartime Grades IA and IAA, Composition B, were exhausted and Holston reworked Composition B was introduced to be used that February. Therefore, preliminary tests were conducted on the Inner components. Densities were found to be lower with this material than with the old Grade IA Composition B and very little settling was experienced. This reworked material also affected the firing of the Outer Components by increasing the range. This range increase, plus the range due to limited contour variation on the Baratol, caused several batches to be classified either Grade II or rejects. Since the contour could not be modified, the barium nitrate composition in the Baratol was again increased by 0.2 per cent to 77 per cent which corrected the difficulty. Previous to this, the general consensus had been that various grades of Composition B would not appreciably affect the ballistic results.

During the summer of 1950 it was decided to double the

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capacity of the plant. Construction plans for revision and expansion of Line I facilities had been initiated during the summer and fall of 1950, and by January 1951, production schedules were increased in order to complete the MK 4 Program as soon as possible so that new construction could begin by the summer of 1951. Production increased to three times the original designed capacity rate during the spring and summer months of that year.

By April the Inner production was complete although Baratol and Outer production continued until October, at which time all buildings were opened to construction. Yields dropped somewhat during August and September because of limited and erratic production needed to complete the required quota.

SAFETY PROGRAM

In even the most cursory reading of the preceding sections, it must have become apparent that a crash construction program which eventually blended into production operations must have required extraordinary safety precautions. It might also have been suspected that under such conditions, many of the conventional safety rules and regulations would have been waived or by-passed entirely. This was not the case. At no time were extant safety procedures violated or by-passed.

Silas Mason Company management was determined that the IOP operation be, above all else, a safe one. Accordingly from the very beginning of field operations, a job safety training program was initiated with periodic safety lectures to the individual crafts. A campaign of safety-consciousness was maintained continuously by means of posters, movies and awards for accepted safety suggestions. The net result of this intensified safety program has been one of the most gratifying and successful highlights of Silas Mason Companys entire operation at the IOP.

In referring to Table I, page 58, it need only be pointed out that after a total of 10,967,820 man-hours of productive work to May 1954, the accident frequency based on injuries per 1[illegible]000 man-hours is 1.6. This compares most favorably to the average figure of 7.44 for industry as a whole during 1953, as cited by the National Safety Council in "Accident Facts" 1954 edition. Silas Mason accident frequency also compares favorably to the average frequency of 2.43 for the Ordnance Ammunition Command installations for the 1949 - 1952 period, and the figure of 1.9 for 1953. The comparative construction figures are 4.4 for Silas Mason Company and 15.68 for the construction industry as a whole.

TABLE I

LOST TIME INJURIES FOR SILAS MASON COMPANY DIVISION B OPERATIONS AT IOWA ORDNANCE PLANT FROM 1948 TO PRESENT

Year	Man-Hours		Lost Time Injuries		Frequency Injury per 1,000,000 Man-Hours		Severity	
	Year	Total	Year	Total	Year	To Date	Year	To Date
1948	284,884	284,884	0	0	0.00	0.00	0.00	0.00
1949	1,855,214	2,140,098	9	9	4.80	4.20	0.14	0.12
1950	1,820,688	3,960,786	0	9	0.00	2.30	0.00	0.06
1951	1,759,789	5,720,575	1	10	0.57	1.70	0.03	0.06
1952	2,718,783	8,439,358	5	15	1.80	1.80	0.14	0.34
1953	2,038,301	10,477,659	3	18	1.50	1.70	0.12	0.11
May 1954	499,661	10,967,820	0	18	0.00	1.60	0.00	0.11

IV. PROJECT EXPANSION

During the spring and summer of 1950, discussions were held between GMX Division at Los Alamos Scientific Laboratory and personnel from Silas Mason Company relative to the manufacture of high explosive components of MK 5 and MK 7 nuclear weapons. These models were to be made using new methods not used previously in manufacturing plants. The most important innovations involved in these new techniques were to cast blanks of unclassified shape and machine them to final shape and then to glue the machined castings into place in the assembly. Very close dimensional machining tolerances were required by this technique. At the same time, the production quantities required called for a substantial increase in plant capacity.

On September 18, 1950, a proposal by Silas Mason Company was submitted for the addition of four new processing buildings to the existing facilities, with interconnecting ramps and the modification of other existing facilities in order to provide the required capacity. The design of these facilities involved a concept long advocated by Silas Mason Company. The new buildings were to be built with their roofs at ground level.

At a meeting on October 6, 1950, in Washington, D.C., it was agreed to start purchase of items on which long delivery was expected. Additional information was received and a new proposal was submitted October 20, 1950. This was again modified November 4, 1950, when the requirement for a second x-ray machine became known.

By January 1, 1951, approximately $500,000 had been committed for construction material and production equipment. Delivery had started on some items.

DESIGN AND CONSTRUCTION

The designs for the construction of new buildings and modification of old buildings were based on information received concerning the quantities and preliminary specification of the models to be produced. These specifications were not firm during the design period and were changed several times necessitating corresponding changes in design. Engineering was started in September 1950, though final specifications for the MK 7 explosive components were not received until September 1951. Because of the long delivery on many items, as much material as possible was purchased from preliminary drawings.

Projected schedules indicated that the raw materials preparation area had sufficient capacity to receive, screen, weigh and store required materials; the mikropulverizer feed drives being the only change required. It was agreed that the existing conveyor systems could serve both melt builcings without modification. However, the melt and cast buildings required extensive modification in order to produce the proposed quantities. The existing melt kettles were too few in number and too small in size. Moreover, some difficulty was being experienced in maintaining the hydraulic system used for the agitator drives. Because of this, eight new 110-gallon vacuum melt kettles, designed and fabricated by Groen Manufacturing Company around Silas Mason Company specifications, were installed. The agitators of these new kettles were driven by air motors mounted on the lids. The control systems remained essentially the same, except for the addition of air motor speed controls. Holding reservoirs and pouring machines were installed for use in connection with the melt kettles.

The sizes of the components of the new models required the design and procurement of new molds. The final dimensions of the various components had not been set firmly at the time of the mold design, therefore, at the direction of Los Alamos Scientific Laboratory, in order to provide a product of the highest quality, it was decided to cast the pieces as blanks in the form of truncated cones from which a goodly percentage of material would be machined to final finished dimensions. For ease of handling, the molds were designed in gangs of three, or six; a concept new to this industry that has been since used on molds for all subsequent marks of the same type. The molds were mounted on wheels for mobility. This allowed movement from the pouring machine to the service post in the cooling bays where the castings went through a controlled cooling cycle.

In order for the service posts to handle both the new type and increased number of molds, a complete redesign of them and of the circulating cooling water system was necessary. Supply pumps of 250 gallon per minute capacity were replaced with 700 gallon per minute pumps on all systems. The piping for these systems was enlarged from four inch to six inch. In the interest of reducing costs, the mixing valves were replaced with larger ones of a different style but existing positioners were utilized.

For handling the castings after stripping from the molds, a standard type tote box was designed. Various inserts were used in the box to accommodate the different components. The tote boxes could be handled on the forks of a fork truck or on mercury trailers towed behind the trucks.

After casting the explosive components a radiographic inspection to determine their soundness is necessary. The new specifications required two 1,000 kilovolt peak x-ray units instead of the 250 kilovolt peak unit which had previously been used. To house this equipment, Building 1-100 was constructed in the line between the casting building and the machining buildings. To prepare the casting for x-ray, the riser was first removed. Four sawing bays were located in the x-ray building in order to facilitate riser removal.

After x-ray the castings rest in a temperature conditioned space to bring them to a specified temperature before machining and to reduce the thermal shock from contact with water and air. Thus each component is machined at the same temperature at which it is gaged and assembled.

It was required that the components be machined to various curvatures, contours and flat surfaces. For the curvatures, it was planned to use drills and lathes and for the flats, mills. Later the mills and milling fixtures which did not prove entirely satisfactory were abandoned and in their place special machines called "Jewels", designed by LASL, were substituted. For each machining operation, holding fixtures and cutter heads were designed.

The holding fixtures made use of vacuum to position and accurately maintain the components in place. Because of the explosive nature of the material being machined, special efforts were made in the design to reduce the likelihood of creating explosion hazards. The designs of both fixtures and cutterheads were made for interchangeable use between the MK 5 and 7 Program wherever practicable. Two sets of tooling, including spares (molds, fixtures, cutterheads, etc.) were procured. The extra set was for use at another production plant.

The existing plant did not provide a sufficient number of temperature conditioning bays, machining bays and assembly bays. Since it was necessary to produce two different models at the same time, it was planned to make additions so that two production lines might be operated within the existing manufacturing area. This called for the addition of a rest house of eight bays (Building 1-07), a machining building of twenty-two bays (Building 1-40), and an assembly building of twelve operating bays (Building 1-61). In addition to these, six bays in the existing Buildings 1-10 and 1-12 were converted to machining bays. The process flow for the two models divided at the new x-ray building, the components for one Mark going down the old line to Buildings 1-10, 1-12 and 1-13 by way of a new ramp, and components for the other going through the new buildings. See Figure 7, Appendix A, for Line I plot plan with shaded areas representing facilities constructed or revised in 1950-51.

Because of the increased number of components to be handled and the closer tolerances to be held, an improved method of gaging was necessary. This was provided by purchasing air gaging equipment from Sheffield Corporation. Silas Mason Company was the first to use air gages for the mass production gaging of these items and the system has been adopted on all subsequent Programs.

Sub-assembly was accomplished in the machining buildings. For this purpose fixtures were required to hold the components ridgidly and accurately in place during the set-up of the glue being used. Final assembly, because of its more classified nature, required a more secured area. This area was fenced and a guard post set up to control the access of persons to this area.

A certain percentage of components were required to be test fired for quality control purposes. This had been done previously for one size component only. Under the new program, several sizes would be fired. This required a more universal firing arrangement. Also, new firing circuits were required and extensive repairs were needed on the firing sites. Using previous experience as a guide, the sites were redesigned and rebuilt.

Because of the type of casting and machining operations specified, a much greater quantity of explosive scrap than previously had been experienced was expected. A burning ground with six burning pads, a personnel shelter, necessary roads, firing circuits and igloos in which to accumulate the scrap was designed.

For the new program, a greatly increased number of personnel became necessary. Since employment was at a high level in this area, with production operators scarce, and since, the components being handled were small, it was planned to use women as well as men. The cafeteria and change house facilities that existed did not provide services for the number of people expected. To solve this problem three change [redacted] efficient by reducing the transportation distance between operations in the process, as well as to increase the safety of the operation, it was decided to seperate these buildings the minimum barricaded quantity distance allowed by the Ordnance Safety Manual. It was determined that the additional cost of underground buildings over aboveground type facility would be more than offset by the savings in heating and air conditioning operating costs in two years time. Therefore, it was decided to place these buildings underground with their roofs at ground level. The assembly building required railway access and for this reason a floor at dock level was provided for use as a shipping point. These new processing buildings were all connected by underground ramps.

The existing classification Yard A fell within the quantity distance of the new buildings. Because of this, and after much discussion it was decided to move the yard a sufficient distance away to satisfy the requirements of the Ordnance Safety Manual.

Railway service was provided to Building 1-61 for shipping and receiving. Roads were built to this and other buildings where road service was necessary.

The aboveground portions of Buildings 1-61 and 1-100 were barricaded by earthen embankments. In the case of Building 1-100, this required enlarging the barricade to the north of 1-10 and placing a new one to the north of 1-100.

Building 1-61 was barricaded to the north and west.

Building 1-07. Building 1-07 was designed as a rest house used for temperature conditioning of high explosive components. It has an area of 5,256 square feet and consists of eight bays separately air conditioned to a temperature of 75°F. and relative humidity of 45 per cent. The walls and floor are of reinforced concrete construction with masterplate applied to the floor as a finish. Since the building is underground, the outside surface was coated with a waterproofing material. See construction photographs, Appendix A.

Attached to Building 1-07 is an equipment room, 672 square feet in area, in which is housed air conditioning equipment consisting of filters, preheat coils, cooling coils, humidifier, fan, eight zone reheat coils and necessary controls. Heat and humidification is supplied by steam from the distribution system. Cooling and dehumidification is accomplished using chilled water pumped from the refrigeration system in Building 1-40E. Condensate is returned to the condensate return system. Drainage water from around the building is piped to a sump from whence it is pumped to open ditches. Fire protection is afforded by a rate of rise of temperature alarm connected to the plant fire alarm system.

Building 1-40. Building 1-40 was designed with a new concept in explosive processing. It is compact for efficient operations and still provides necessary bay-to-bay safety. It was designed and built as a machining building which consists of 22 operating bays along a central corridor, "U"-shaped around an equipment room, Building 1-40E. The total area of the building, including the equipment room, is 44,100 square feet.

Services available to the machining bays include vacuum, air, conditioned water, raw water, electric power and air conditioning. These services are supplied through a service corridor located over the central corridor. The temperature of each bay is individually controlled at 75°F. and recorded continuously. The humidity is controlled at 45 per cent relative humidity.

Ventilation air for this conditioning is supplied by two fans located in the equipment room. Also located in the equipment room are preheat coils, cooling coils, three 60 cubic feet per minute vacuum pumps, two 300 cubic feet per minute air compressors, an indoor sub-station, duplex sewage pumps and duplex drain water pumps. Condensate return pumps receive condensate from the heating systems, hot water heaters and Building 1-07 and return it to the boiler house. Water chilled by 900 tons of absorption refrigeration is pumped to cooling coils in Buildings 1-07, 1-40 and 1-61. A cooling tower located northwest of the building is part of this refrigeration system.

Contaminated water from the explosive machining flows through aluminum gutters in the floors of the bays into a large sump from whence it is pumped to a vacuum filter for removal of the solids. The filtrate which now contains only a small amount of dissolved explosives, is pumped to open ditches.

Air, exhausted under six escape stairways, serves to keep the snow removed from the steps during the winter months.

Building 1-61. Building 1-61 was designed as an assembly and shipping building. It has an area of 26,710 square feet divided among two floors and the equipment room. The lower floor is underground and is made up of ten bays used for the assembly of explosive components, an electrical test bay and large storage bay for metal parts used in assembly. The upper floor is at dock level and is divided into two large bays and three small offices. These bays are equipped with overhead traveling cranes used in the final assembly of the product. Sliding doors allow for loading directly into railway cars.

The building is air conditioned in three zones. Each zone is controlled separately and is held at 75°F. and 45 per cent relative humidity.

The upper floor and the ten explosive assembly bays have sprinkler systems for fire protection. In addition one small glue storage bay has a carbon dioxide extinguisher system operated by rate of rise of temperature.

Steam and air for use in heating and controls are supplied from the plant distribution system. Sewage is pumped to the sanitary sewer and ground water drainage is pumped to open ditches by duplex sump pumps. Condensate from the heating facilities is returned to the boiler house.

Building 1-100. Because of the quantity distances from Buildings 1-05-1 and 1-10 and the locations of Ramps 1-82-8, 1-82-9 and 1-82-64, Building 1-100 was limited in size. Its primary purpose was to house two, one million volt x-ray machines. Its secondary purpose was to provide four machining bays to complete machining operations required prior to x-ray. The x-ray exposure bays were built to allow continuous x-raying of explosives on a conveyor utilizing 270° of the reflected x-ray beam instead of a turntable utilizing only 180° of the reflected beam. Provisions were also made so as to use the transmittal beam in the basement should this type of exposure become necessary. These bays were constructed of reinforced concrete of such a thickness that personnel working in adjacent bays were safely shielded from exposure to radiation. Since half the flow of material from the building was to the underground plant, an elevator sized to hold a fork truck and trailer was installed.

Steam, air and water were piped from the plant distribution

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system. Vacuum pumps were installed in building to provide this service. Power and lights were furnished from unit indoor type substations in the basement. The building was air conditioned to hold a set temperature between 75° and 95°F. and 45 per cent relative humidity as required.

Contaminated water from the machining operation flows through aluminum lined gutters to the filter Building 1-70 where the solids were removed as described earlier.

Ramps. Buildings 1-07 and 1-100 are connected by the underground Ramp 1-82-67. It can be reached from Building 1-100 either by means of an elevator or stairs. Of reinforced concrete construction, it has an area of 3,224 square feet. The ramp passes under the plant water main at approximately the mid-point of the ramp. At this low point, there is a sump with duplex drainage water pumps. Heating is by bare steam pipes thermostatically controlled.

Ramp 1-82-68 connects Buildings 1-07 and 1-40. Its area is 3,333 square feet. This ramp is of reinforced concrete totally underground with approximately four feet of ground cover except for a blow section bisecting the ramp. Heating is accomplished by a bare pipe running the entire length of the installation which is thermostatically controlled to maintain a minimum temperature of 75°F. Chilled water lines to service Building 1-07 and a condensate return line are supported from the roof. An escape stairway leads up from the blow section. Exhaust air from the ramp flows under these stairs to provide for snow removal.

Buildings 1-40 and 1-61 are connected by Ramp 1-82-69. It has an area of 3,812 square feet, including the blow section where a guard post is located. This guard post is used to control the access of personnel to the assembly building. Heating and ventilation is similar to the other underground ramps. Chilled water piping from 1-40E for the air conditioning in Building 1-61 is supported on racks on one side of the ramp.

Ramps were built from each change house to connect with parts of the operating line in order to protect personnel from inclement weather after they had changed to protective clothing. These ramps were numbered as follows: from Building 1-137-2, Ramp 1-82-61 was to intersect with Ramp 1-82-55; Ramp 1-82-61 was extended to 1-137-4; from 1-137-5 to Building 1-01 Ramps 1-82-71 and 1-82-72 were built. The construction was concrete slab floors, wood framing with Cemesto siding and industrial windows. Heating was provided by finned pipe or radiators thermostatically controlled.

Ramp 1-82-51A was extended to intersect with Ramp 1-82-2 in order to permit movement of material to Building 1-13 by means of fork trucks. The construction of this ramp was similar to the other ramps in that area.

<u>Buildings 1-10 and 1-12</u>. Buildings 1-10 and 1-12 were

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existing machining buildings. However, most of the bays were originally designed for storage and temperature conditioning of various components. The proposed expansion required that additional machining bays be constructed in these buildings, so two were constructed in Building 1-10 and four in Building 1-12 making a total of sixteen machining bays in these two buildings. Necessary services including air, conditioned water and raw water were supplied to the bays from the building equipment rooms. Vacuum was supplied from the existing vacuum rooms.

CONSTRUCTION WITH OPERATION IN PROGRESS

In the initial planning and scheduling of the construction program, one melt Building 1-05-2 and two machining Buildings 1-10 and 1-12, were given priority so that these buildings could be released to production during January, 1952. Production was urgently needed to meet the monthly quotas of assembled units, and before acceptable production could be realized, extensive experimental work was necessary to establish operating instructions for the new MK 5 and 7 Programs.

Sections of Buildings 1-10 and 1-05-2 were released to production in January with construction forces continuing with the revision of the south bays in Building 1-10 and 1-12. The installation of melt kettles, holding kettles and pouring equipment continued in Building 1-05-1 and 1-05-2. Most of the concrete work had been completed for the new Buildings 1-07, 1-40, 1-61 and 1-100. Building services and equipment were not complete however. As construction personnel completed each of these buildings, production operations were moved in as soon as possible. This type of operation continued until June, 1952 when all buildings were released to production. The remaining equipment installation and cleanup was performed by maintenance forces.

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V. EXPANDED PRODUCTION OPERATIONS

In preparation for the new MK 5 and MK 7 programs, fifteen

[redacted]

To accomplish this a Remington-Rand tabulating system was installed. These machines were also utilized by Payroll, Cost Accounting and Timekeeping Departments for necessary tabulation and records.

PRODUCTION OF MK 5, MK 6, MK 7, MK 12 AND COBRA

By the middle of January, one melting, casting and cooling building was secured from construction. Only two melt kettles were complete and available. However, these were sufficient for the urgent experimental work on melting, casting and cooling operations. The melt kettles had been installed during construction and these were a new design by Groen for Silas Mason Company. Limited information was available from LASL on the melting and cooling techniques. Differences of air temperature, kettle pressure, bay humidity, cooling water temperature and casting techniques meant that additional experimental work was necessary before actual production could be started. Composition B and Baratol melts were made during the MK 4 Program, but with completely different casting procedures and slightly different melting procedures.

Experimental work had been started on the MK 5 Baratol as early as August 1951. Construction and installation of equipment had hindered the work. The first experimental batches, after construction, were melted and cast on January 17, 1952. The melting techniques were quickly established for Composition

B and Baratol, so that the main problems were those of developing casting and cooling cycles for the various components. At the same time, improvements in the casting operations were being made. Also, during the latter part of the month, Mk 6 Inner (Pent Tic) Components were being produced for off-area shipments. The casting and machining of these components caused considerable interruption in the experimental work for the MK 5 and 7, particularly in the latter case, where machines and space were limited at this time.

Since all finished surfaces were machined instead of cast, as for the MK 4, the machining of MK 5 and 7 components was a completely new operation. See photographs of "as-cast" and "finished" components, Appendix A. During January only one machining building was available for use, so the number of MK 5 and 7 Baratol components that were being machined was small. The initial problem was to establish an acceptable slow component (Baratol) contour, as indicated by firing characteristics. A template for contour machining was available from Los Alamos. However, variations from this were necessary before a workable contour was perfected for the IOP type of casting. Along with the contour machining which was accomplished on a tracer lathe, drills were set-up for formation of the top and bottom curvatures and the detonator recess on the MK 5 Outer Components. The tooling was not available for these operations, so temporary cutter-heads and fixtures were fabricated in order that test firing data could be obtained.

By February 1, the casting and cooling instructions for the MK 5 Baratol were issued to production, since this component was now being produced for acceptance. Eleven MK 5 Baratol six gang molds (66 cavities) were available for February production. Experimental casting and cooling was continued on the other components.

As the experimental contour machining continued for the MK 5 Baratol, difficulty was encountered, and approximately eight variations were machined and test fired before an acceptable contour was established by the middle of March.

By February 15, another machining building, 1-12, was available. Therefore, machines and tooling for the Outer Components were immediately set-up in this building. This location was permanent for the MK 5, but the MK 7 was to be transferred later to a new building.

During March, the shortage of molds was the major problem in the casting operations. The cooling cycles and casting instructions were established for all Mk 5 components, even though only two Outer molds and one Inner mold were available. The MK 5 Baratol contour was established and acceptable Outer production started. Limited production also began on the Inner Component.

During this same month another important problem was pressing; the lack of proper gaging equipment for the machined components. Shipment of air gages had not been made except for one

MK 5 Baratol contour gage.

With the installation of a "Jewel" for milling the side flat, the MK 5 Inner experimental machining began. Considerable difficulty was encountered with this operation due to insufficient temporary tooling, lack of gaging facilities and necessary redesigning of various parts of the "Jewel". All of these problems had to be solved before a workable operation was evident.

During the latter part of March and first part of April, the MK 7 Baratol contour was established and acceptable Outer production was underway. The cooling cycles and casting instructions were issued to production completing preliminary experimental work at the melting building. Three melt kettles were then available, and casting operations were proceeding as rapidly as possible with all available molds. Twenty-two individual Mk 7 Inner molds were secured from LASL and additional MK 5 Inner Components were being produced in regular MK 4 Inner molds.

Attention was now being concentrated on the MK 5 machining to obtain sufficient Outer Component clusters for a complete unit. With increased production schedules, Division "B" was now operating on first a six, and by the middle of April, a seven-day schedule. Supervisory personnel were now working from t en to sixteen hours daily in an effort to increase quality and quantity. Due to labor shortages, female production employees were hired.

A temporary machining operation for the MK 7 Outer Component had been set up earlier, and by April "Jewels" were available for the Outer and Inner side flat operation.

During these early months of the new programs, experimental data and information obtained primarily by the process engineers, assisted by production and inspection supervision and employees, was of the utmost importance. As additional equipment, tooling and process procedures were made available, production increased and the problem of training new employees became evident. The operation of machines and the handling of high explosive components are of extreme importance since the specifications require very close tolerances of the machined surfaces.

By the first of May, sufficient MK 5 components were completed for a preliminary lay-up of a sphere, and the first assembly was accepted May 22. The components for the initial assembly were machined without an Outer or Inner side flat gage. At this time the MK 5 machining was progressing with established schedules, even though many problems had not as yet been solved. Considerable revision was to be made later and the Inner machining on the "Jewels" was still a problem. Precise air gages were now being received, so that adjustments and alterations were easier and faster..

By the middle of May, another melting and casting building was available, 1-05-1,and during the month the batch size of the MK 5 and 7 Baratol and Overcasts was increased to seventy-two

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and seventy-eight respectively, with the addition of new molds. Rearrangements of components in the two melt buildings was necessary for the increased production.

During the latter part of May, construction was completed on the new MK 7 machining building, 1-40, so that these operations were immediately transferred from Buildings 1-10 and 1-12 where they had been temporarily located. With the addition of this building, process flows were established and definite machining bays assigned to specific operations. The same problem of adjusting the "Jewels" for the MK 7 Inner and Outer side flat operation was encountered as on the MK 5 components; however, increased knowledge and experience with the machines made the solutions to the various problems much easier. All buildings were now released from construction and production was proceeding at a faster pace.

Production was being pushed on the MK 7 components in particular at this time, because assemblies were urgently needed to meet the demands of the Atomic Energy Commission. This rush initiated the 7 N or "Crash" program, whereby a certain number of units were to be shipped by the end of July 1952. Maximum effort was being applied to machine and assemble the required number of units in June and July under this program. The first 7 N units were accepted on June 28 and the final one on July 30. By August 1, Grade I MK 7 assemblies were being accepted.

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The new x-raying bays and radiographic equipment in Building 1-100 were available for operation and preliminary experimental work was being conducted by the radiographic department to establish exposure time and x-raying procedures for all components.

Five MK 5 acceptable assemblies had been made by the middle of June, and from that point on sufficient high explosive components were in process throughout the line to proceed with all MK 5 operations as rapidly as possible. Most of the permanent tooling had been put into operation and the gaging equipment for the MK 5 Program was available.

During the first six months of production (January 1 to June 30, 1952), despite the lack of proper tooling and gaging equipment and that the initial production of components was based on completely new concepts, the yield for the MK 5 and MK 7 averaged slightly better than 80 and 75 per cent respectively. These percentages represent only the castings lost due to radiography and physical inspection. Laboratory samples and test fires are not included.

By July 1952, the quantity of high explosive being produced was approaching full production throughout the process buildings resulting in an infinite number of smaller problems being encountered which were not apparent during the earlier months of pilot plant or semi-production operations. To cope with these problems, process and line engineers were assigned to the machin-

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ing and melt buildings on a three shift basis. These engineers were concerned primarily with observing operations and clarifying instructions to production supervision and correlating with tooling engineering sections necessary design or redesign of efficient tooling.

Besides the necessary tool design and handling equipment, the engineering design sections were concentrating on new casting equipment which included a jacketed reservoir, with six outlets, located on the same floor as the melt kettle. These outlets can be adapted to casting from one to six castings simultaneously.

The casting operation for the MK 7 Inner continued to be troublesome due to air trapped in the component at casting. Changes in casting procedures, cooling cycles and even more important, casting techniques were primary solutions to the problem. The side flat machining for the MK 5 Inner Components was being made in two operations. The first operation was a rough cut to within 1/4 inch of the finished piece, and then the finish cut was made on a second machine. It was found that the necessary tolerances were very difficult to hold using the original fixtures and could not be conducted on a production scale without this two step operation. This was particularly true for the MK 5 Inners being cast in the large MK 4 molds. After the machining change, very few Inner Components were rejected due to incorrect central or dihedral angles.

The formation of the conical recess in the MK 7 Outer was also performed in two operations; the recess itself in one and the counterbores in the other. The tolerance specifications were too tight for the operation to be performed efficiently on a production scale, using a one cutter operation. After splitting the machining into two different operations the problem was solved.

During July, design on shaped inserts for the Mk 5 and 7 Inner molds was initiated. It was realized that a shaped insert would save approximately twenty pounds of material per casting.

Extensive studies were made during the latter months of 1952 to determine the cause of cracks in the Baratol component, which were constantly a problem. It was found that no single item was responsible. However, the study indicated that barium nitrate grind fluctuations, cooling cycles and annealing periods were all contributing factors. From the study, maximum rest times and the optimum micron size distribution for the barium nitrate grind were determined. The cooling cycle was checked frequently, but despite these precautions cracks in the Baratol would appear periodically.

As stated earlier, MK 7 Grade I units were being accepted and production of this item continued at an accelerating pace until this program was on schedule by March, 1953. The monthly quota for the MK 5 Program had already met schedules by September, 1952.

Extensive experimental work was conducted during 1952 to determine the factors, both in the Baratol and Overcast of the MK 7 components, which controlled or affected the range, slope and firing characteristics. It was found that the diameter of the counterbores, H.E. wafer dimensions, glue gaps, and metal barrier in the Outer were controlling factors, as well as the known Baratol characteristics of density, composition, barium nitrate size distribution and contour. By varying each of these factors individually and analyzing the firing results, definite limits were set for the operations controlling them. Additional inspection points and controlled gluing procedures were incorporated as operating instructions. With these limits and procedures in effect, an efficiently operated production was realized with much less variation in firing results as indicated by Figure 3, page 87.

The firing results for the MK 5 Baratol continued to be good. Throughout the entire program the "in batch" control of range remained below 0.10 microseconds. See Figure 4, page 88.

Dimensional rejects at machining continued to decrease with additional experience and know-how of the machine operators and tooling set-up personnel. Cracks in and around the

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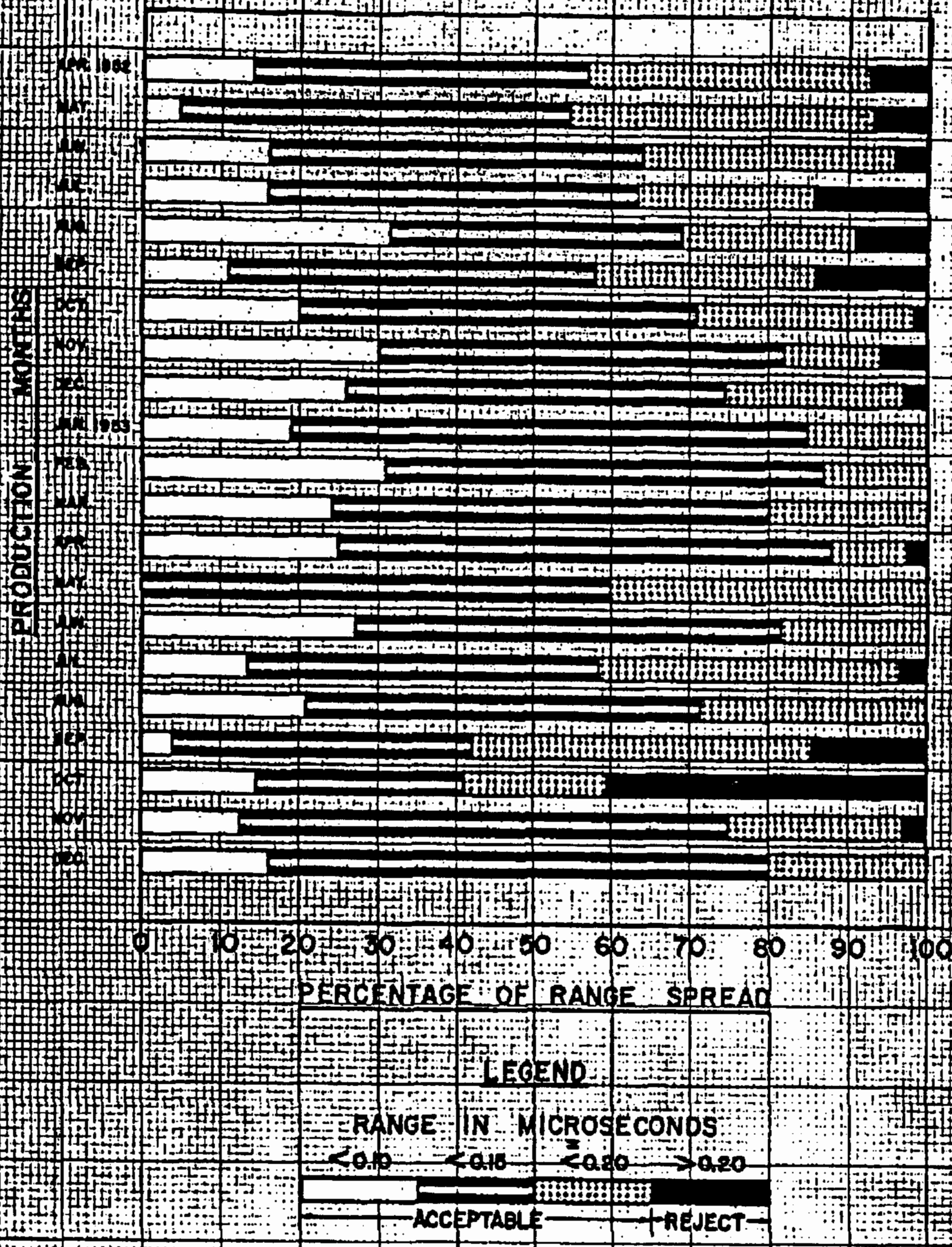

FIGURE 3 BARATOL RANGE SPREAD — BATCH PROOF FIRING MK 7 PROGRAM

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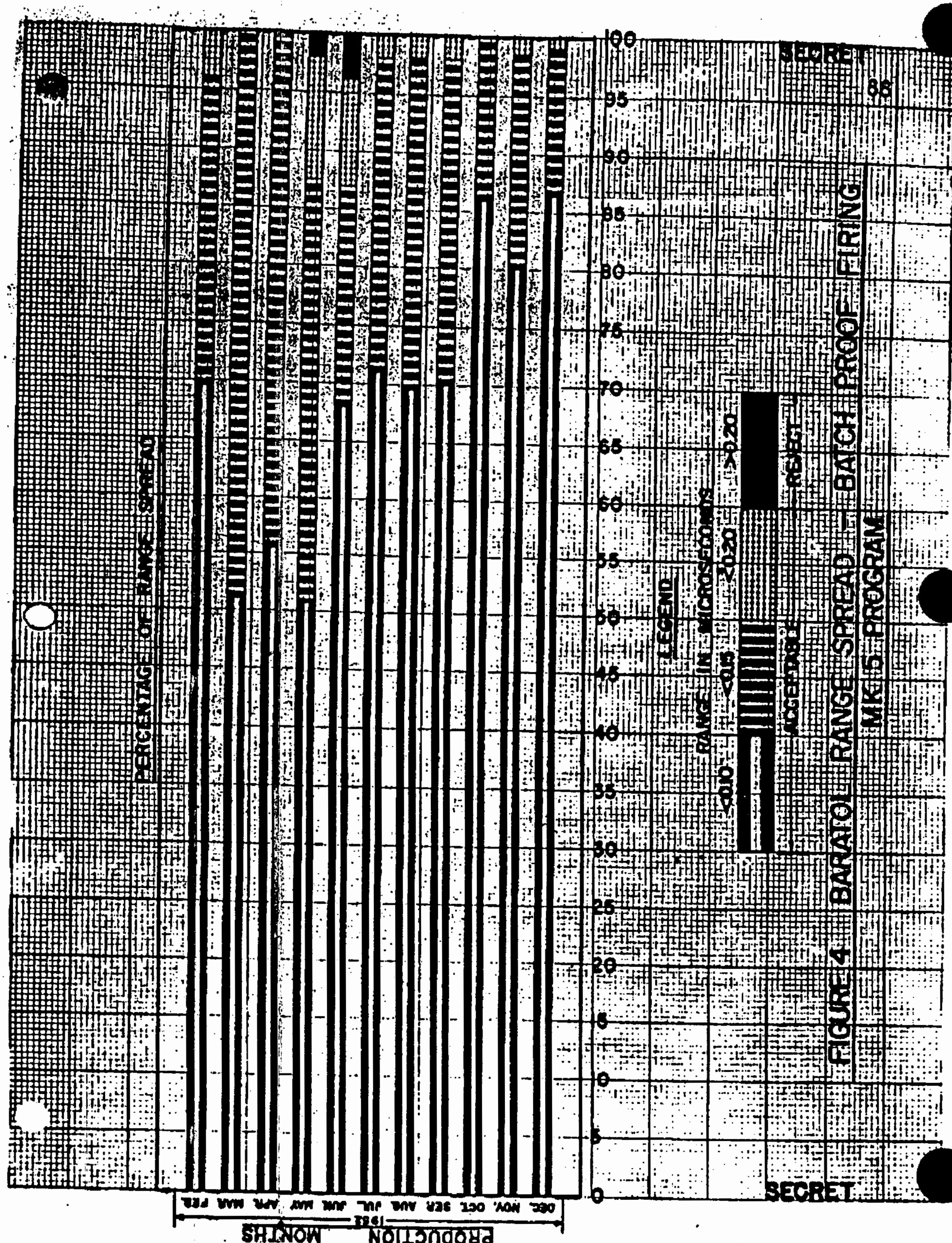

FIGURE 4 BARATOL RANGE SPREAD - BATCH PROOF FIRING
MK 5 PROGRAM

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detonator adapter recess of the MK 5 Overcast were corrected with the use of a small percentage of anthracene in the melts from which these items were made. Small channels or cavities which are normal to the Baratol contour began to appear in the Outer Components. These channels were partially corrected by dampening the surface of the machined Baratol before overcast with acetone. Later ortho-nitrotoluene was used instead of acetone and this completely eliminated the channels. Acceptance of the Outer Components gradually increased to 80 per cent for the MK 7 and 78 per cent for the MK 5 by the end of 1952. After the problem of density and radiographic rejects due to air bubbles in the MK 7 Inner was corrected during July, 1952, the Inner Component yield continued to rise and acceptance by January 1953, was 84 per cent for the MK 7 and 80 per cent for the MK 5. These percentages represent a ratio of the actual pieces accepted to the number cast, including the loss due to destructive sampling and test firing as shown on Figure 5, page 90.

The scheduled tooling and gaging equipment was being received throughout the latter months of 1952. Thus, all of the MK 5 and MK 7 Inner molds were not received until September, and the last gage in December.

During December, the first of six reservoirs together with new casting equipment was installed, tested and placed in production. Considerable production time was saved by the fact

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that six cavities could be cast simultaneously. Additional reservoirs were installed as melt kettle bays could be released without hindering production. Design was underway for an automatic pouring operation to replace the manually operated equipment.

In November 1952, the Silas Mason Company was notified that a finite number of units was needed to finish the MK 5 Program, and that the MK 6 would replace it in production. The necessary casting of the MK 5 components to complete the program was finished by the middle of January 1953. Assembly, which was prolonged due to the lack of metal parts, was not completed until May. This change in plans meant the removal and storage of all MK 5 tooling and equipment.

The tooling, molds, gages, etc. were already available for the MK 6 from the MK 4 Program since the component requirements for both programs were identical. Melting and casting operations for the MK 6 components were started during January 1953. A limited amount of experimental work was necessary because the casting procedures had been changed since the MK 4 Program. Most of the difficulties were solved rather quickly, and production was soon in progress. The cooling cycles were approximately the same as for the MK 4 components. It was evident from the start of the program that it was necessary to cast the Baratol by vacuum, because the very viscous Baratol slurry hindered the escape of air from the casting resulting in

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radiographic rejects. Design of a complete vacuum system, from holding reservoir to mold, was started immediately and in a matter of a few days an experimental system was in production.

As the MK 5 machining was being completed, MK 6 tooling was installed and machining was started by February 1. Revision and new design was necessary for much of the tooling, even though most of the MK 4 tooling was used to get the program started. In conjunction with tool design, necessary handling equipment was designed and installed in inspection and radiographic bays for use on the larger components.

It was found during the initial cooling cycle study and testing that a 77 per cent barium nitrate Baratol was necessary to achieve the proper firing characteristics in the MK 6. As stated above, this material is extremely viscous and difficult to handle in production. It was therefore decided to make a 76 per cent barium nitrate Baratol and machine the entire contour rather than cast a portion of it. Also, it was believed that more consistent firing results would be obtained. The MK 6 firing data for the entire program is shown on Figure 6, page 93. The experimental results were very encouraging, hence the procedure was approved by LASL, and 76 per cent barium nitrate Baratols were in production by June 1953. The Baratol acceptance continued to increase, except during August and September when TNT was changed from Volunteer to Kankakee. This change resulted in an increase in cracks.

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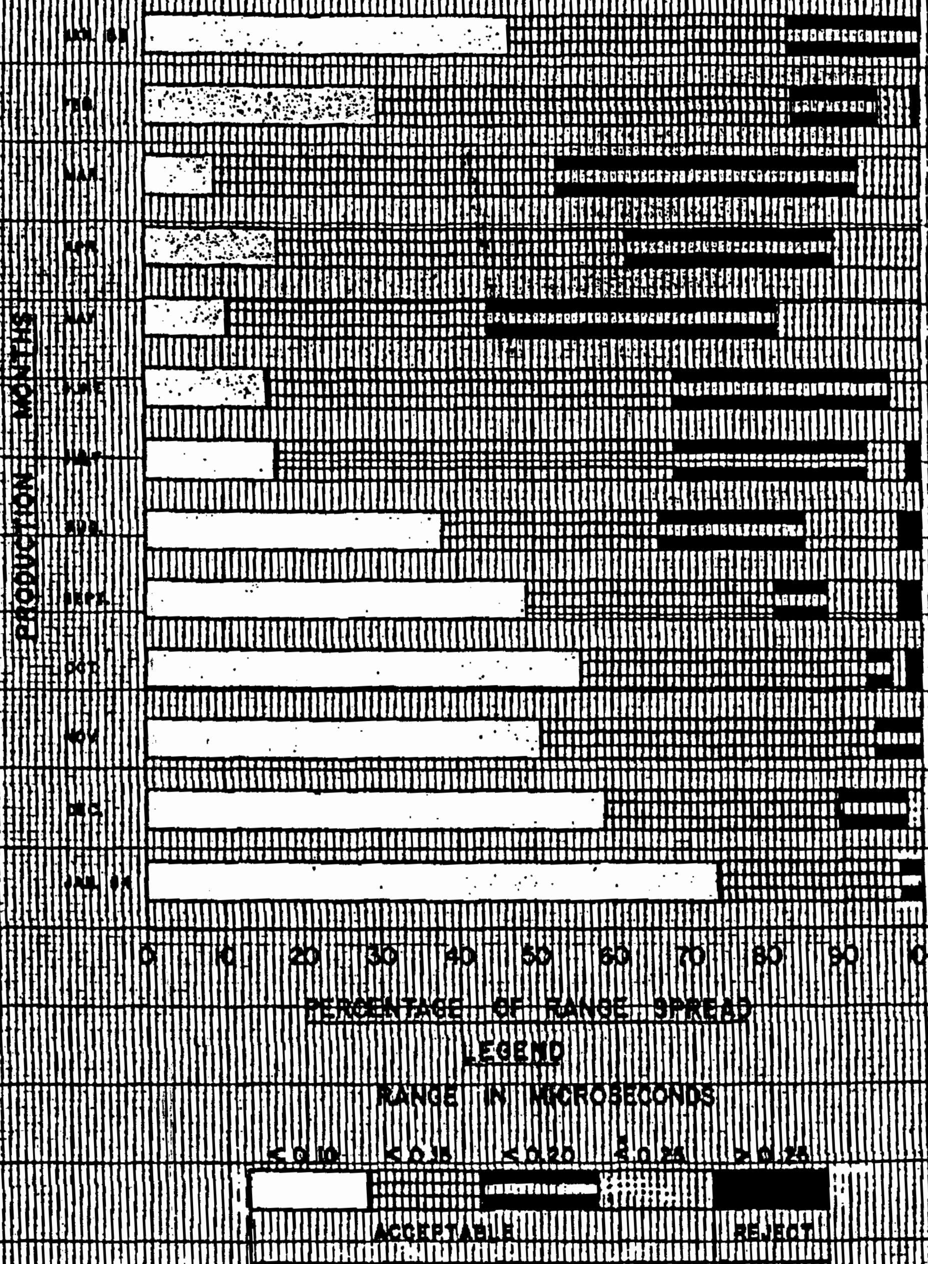

FIGURE 6 BARATOL RANGE SPREAD
BATCH PROOF FIRING MK 6 PROGRAM

By the middle of March, reduced production schedules made it possible to reduce one machining building and the assembly areas to one shift, the remaining machining buildings were cut back to two shifts.

As a result of high quality yields and operational consistency, Silas Mason personnel initiated a revised x-raying procedure whereby all components would be x-rayed on a sampling plan. The continuation of this plan would depend upon continued high yields. Previously, all components had been x-rayed one hundred per cent; however, in the interest of cost reduction, it was felt that the sampling plan was of great value. LASL concurred with this reasoning, so the plan was initiated for the MK 6 Inner Component in March 1953, and later for other components.

In June 1953, the first shaped inserts for the MK 7 Inner molds were received. Delivery was delayed (contract delivery-March) due to casting and machining difficulties encountered by the contracting company. Development of cooling cycles began immediately, and extensive work was necessary before an acceptable cycle was established. By September 1, sufficient inserts had been received to place them in production. This was not only a saving of twenty pourds of raw material per casting, but the saving of machine time was also important. See photographs of round and shaped castings in Appendix A.

In connection with material saving, design of new riser sections for the molds of all MK 7 components was started. After favorable developmental results, it was determined that these proposed "short risers" could be used in production. Fabrication was started immediately.

During July, the supply of TNT manufactured by Volunteer Ordnance Works was nearing exhaustion, so the purchase of TNT from Kankakee, Illinois was begun. The new Kankakee TNT contained less impurities, and experiments were conducted to determine the effect of this on the Baratol production. Very little change was noted in firing results, but cracks in the castings began to appear. Cooling cycle adjustments, varying of additive percentages and melting procedures were necessary before acceptable castings could be produced with this TNT. As stated earlier, the MK 6 Baratol yield dropped for two months but acceptance was up again by October.

During the summer months of 1953, cracks on the top curvature of MK 6 and 7 Inners and Overcasts began to appear and this was corrected by adding a small quantity of anthracene to each Composition "B" or Cyclotol melt. This procedure virtually eliminated the cracks in the Outer Components. Various changes in cooling cycle were made periodically to correct cracks or air bubbles in the Inners.

Prior to September, various vacuum systems had been used

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in casting the MK 6 Baratol. In September, the installation of a newly designed electronic pouring device was made available to production. A jacketed orifice, 6 inches long, was clamped to the existing H. E. valve. This orifice served a double purpose by reducing the material flow and by locating the vacuum head and electronic Teflon probe on the mold. The openings in the vacuum head, for the probe and orifice, had a double o-ring seal which allowed a vacuum to be maintained in the mold during the pour and also, permitted the vacuum head and probe to be raised, so that the molds could be moved under the pouring machine for filling or withdrawal. Solenoid valves operated the H. E. valve and a manual lever control valve operated the vacuum to the molds. The operator opens the solenoid valve and the material fills the mold to the tip of the Teflon probe, which electronically closes the solenoid valve upon contact with the liquid. This vacuum system proved very satisfactory for the MK 6 Baratol, and was used throughout the remainder of program. A device such as this could be adapted to any casting operation where vacuum pouring was necessary.

By the end of September, experimental and developmental work began on a new Slow Component using a boric acid-TNT slurry called a Boracitol. This component was to be used in a new Cobra assembly. Limited information from small scale and semi-production operations was available on the melting procedure, cooling cycle and firing characteristics of this item. Additional data was essential before production was possible. It soon was evident from the poor quality melts, and from literature containing phase diagrams of boric acid decomposition, that either the temperature or the vacuum currently being used for Baratol melts was too high for Boracitol. Maximum and minimum temperatures and pressures were established, and by November 1 acceptable Boracitols were produced. Work then was begun to establish a contour for this component. By the middle of December, an acceptable contour was established and production was started for all components. The Overcast and Inner Components are the same dimensionally as the MK 7, so machining was performed on the extant equipment set-up for the MK 7 Program. A small quantity of these units were due for delivery in January, 1954.

This was the first time product development had been performed in a high explosive production plant for the AEC, and the complete development of the Cobra unit was accomplished in a period of only three months. Production schedules were met on a bi-monthly peg point basis for the Cobra.

A special order was received in September 1953 from the Sandia Corporation to manufacture 1000 one-inch diameter spheres made from Composition B. Necessary tooling was designed, fabricated and installed. Very close tolerances were specified; nonetheless, the order was completed by November 1 with 99 per cent acceptance.

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The tooling, molds, and gaging equipment for the MK 12 Program began to arrive at this installation in August 1953, and continued throughout the year, although production was not to begin until April 1954, with the first assembly quotas set for June.

During December 1953, sufficient "short risers" for the MK 7 Baratol and Overcast molds had been fabricated to place these in production, and this type of work was continued on the manufacturing of new risers for the Inner molds. These became available in January. The raw material saving per casting was 55 per cent for the Baratol, 63 per cent for the Overcast, and 75 per cent for the Inner. See photographs comparing "short risers" to original castings, Appendix A. From November 1953 to April 1954, the high explosive cost per MK 7 sphere had been reduced by approximately 65 per cent by the use of these various material saving procedures; the more important ones being shaped inserts, short risers and higher acceptance.

Experimental work began during January 1954, to establish cooling cycles and casting procedures for the MK 12 components. The castings are smaller than the MK 7 components. In conjunction with the development of regular cycles, design and cooling cycles for "short risers" for the MK 12 components were also established.

During February, the casting operations for the MK 6 were completed. As soon as machining of the components was complete, two machining and one melt building were processed for temporary layaway. Procedures were also issued for storage of MK 5 and MK 6 equipment and tooling.

Machine and tooling set-up began for the MK 12 Program during March with limited production to begin in April. Machining Buildings 1-10 and 1-12 were processed for temporary layaway since all machining was to be performed in Building 1-40. Rearrangement of machining equipment, process flow, gages and tooling was necessary to facilitate an efficient machining operation. Practically all the tooling and gaging equipment was available for the MK 12, so installation and set up were the primary factors.

Melting and casting procedures for the MK 12 components already had been developed in January. Although revision of some tooling was necessary to suit IOP machines and process flows, April yields were 84 per cent for the Outer and Baratol components and 93 per cent for the Inner, as shown on Figure 5, page 90.

During May and June engineering design sections were concentrating on the development and use of mold inserts to cast shaped pieces for the Cobra Boracitol and Overcast. The inserts were available for July production, which resulted in a substantial decrease in raw material usage. Table II, page 100,

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TABLE II

COMPARATIVE WEIGHTS OF MK 7, MK 12 AND COBRA COMPONENTS BETWEEN ORIGINAL AND PRESENT MOLD DESIGN

Component		Individual Components Weight (Lbs.)				
		Original Design As Cast	Short Riser As Cast	Shaped And Short Riser As Cast	Finished Piece Round	Finished Piece Shaped
MK 7	Baratol	* 17.0	7.7	4.5	2.97	2.51
	Outer (c)	12.0	4.5	2.8		1.17
	Inner	54.0	---	14.0		8.77
Cobra	Baratol		4.2	2.6 (a)	1.77	1.40
	Outer (c)		4.5	2.2 (a)		1.17
	Inner		---	14.0 (a)		8.77
MK 12	Baratol	6.1 (a)	2.9	2.4 (b)	1.72	1.20
	Outer (c)	3.8 (a)	1.5	1.3 (b)		0.60
	Inner	37.0 (a)	---	21.8 (b)		14.60

a - in production
b - awaiting approval from LASL
c - Composition B weight ONLY

indicates the material saving realized per casting by the use of "short" riser and shaped inserts. This resulted in reduced Cobra yields for July. However, it is anticipated that yields will be higher in future months as modifications in the cycles are made.

At present, design and experimentation is being conducted for use of shaped inserts and short risers for the MK 12 molds. As soon as approval is received from LASL the inserts will be fabricated.

During the first six months of 1954, the always continuing efforts to lower the operating costs at IOP by reducing material, labor and burden expenditures were intensified. Yields for all components continued to increase and, at the same time, operating costs were reduced.

RESEARCH AND DEVELOPMENT ACTIVITIES

From the beginning of production operations by Silas Mason Company at Iowa Ordnance Plant it has been proven imperative to continue at all times product development and pilot experimentation to insure continued high quality and process efficiency. The time lag in correcting a quality lapse increases with a decrease in continuing experimental work.

Prior to January 1954, product development was performed primarily by process engineers in conjunction with their regular production work. In January 1954 a research and development program was established with designated expenditures. Projects were then assigned to engineering personnel along with other duties. However, in May 1954, a Research and Development Department was established so that assigned personnel could devote their time exclusively to these projects. Even though continual product quality development had been performed during all production phases, it was felt by management that time and material savings as well as equipment modifications to reduce operating costs and increase process efficiency were equally important.

Probably the first of these projects, June 1950, was the instigation of riser break-off rings, made of neoprene, for use in the MK 4 Outer and Inner molds. The ring is inserted into the riser section of the mold before casting, and when the casting is stripped from the mold the riser section can be removed and the rings reused. With the risers removed from the Outer, the saw riser operation is eliminated and the Inner is more conveniently handled and transported.

During construction for plant expansion, 1950, 1951 and 1952, numerous devices were designed and installed to aid in greater capacity. One of the more important such items was the manual, and later the semi-automatic pouring machine. Along with this came the design for a high explosive (H.E.) valve. Previously, during the MK 4 Program, the raw material had been melted, first in small transport kettles and later in stationary kettles, and the material was either drawn from the kettles into the molds by vacuum or buckets were used to transport material to the molds; therefore, H.E. valves were not used. Increased production made this method obsolete, so with the design by Groen of new 110 gallon vacuum melt kettles it was necessary to design appropriate pouring equipment.

The operation of this pouring equipment is essentially as follows: after the material is melted, it is poured from the melt kettle and flows by gravity into a holding reservoir located on the same floor. From the reservoir the material drops through the outlets, (from one to six may be used depending upon the type of mold used for casting), via a series of downcomers to the H.E. valve, located just above the mold in the casting bay. Attached to the H.E. valve is an orifice to reduce the material flow into the mold. All this equipment is suspended from the reservoir by quick-opening clamps. The H.E. valve is a jacketed shell with a rubber tube in the center so that air can be applied around the tube forcing it together to stop the flow. When the air is released, the tube opens again allowing the material to flow. Vacuum may be applied, if necessary, to open the valve. Manually operated air valves located on a panel controls the air and vacuum to and from the H.E. valves. This apparatus proved successful and design was continued to perfect a system to automatically close the H.E. valve when the mold was filled. An experimental model was installed during the [illegible] of 1953, using the gravimetric principle. However, reduced schedules made it impractical to continue fabrication. [redacted] extensive research has been conducted to establish a procedure to remove the TNT from the streams. It was found that fly-ash from the reservation power plants would decontaminate the water, if applied in portions of 100 pounds of fly-ash per 500 gallons of water. A temporary hopper was installed over the stream to dispense the fly-ash into the water. The fly-ash treatment reduced the TNT content from 22 to 14 ppm. This procedure has been in effect since May 1953, and periodic tests of the water below the fly-ash hopper indicated that the TNT content is below one ppm.

Projects pertaining to material savings have been underway since July 1952, and have been expanded to include shaped inserts and shorter risers for all components, as well as the reuse of kettle "heel" for subsequent melts. At present, short risers and shaped inserts are used for all components of the Cobra. This improvement reduces the "as cast" weight from 17.0 to 4.5 pounds for the Baratol, 12.0 to 2.8 pounds for the Outer, and 54.0 to 14.0 pounds for the Inner. Further design of shaped inserts for the MK 12 molds is now in progress. Cooling cycles and machine times are also reduced. Photographs of the castings, Appendix A, compare the original to the present "as cast" components.

Ring lens studies in the past were conducted at various times during production periods only when difficulties were encountered. This project was formalized and expanded to evaluate and determine to what degree external and internal production plant variables affect the speed and simultaneity of the explosive wave as it passes through the ring lenses. As a result of these studies, statistical control of production operations has been set up.

Oven cooling of molds has long been a topic for discussion by Silas Mason personnel. However, no research was done until the Research and Development Department was established in May 1954. Preliminary studies have been conducted with favorable results and this work will continue to determine the feasibility of this type cooling.

The Research and Development Program is expanding and additional funds have been requested for the Fiscal Year 1955. If approved, Silas Mason Company will conduct a larger program in an effort to reduce operating cost through increased efficiency.

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VI. ORDNANCE ADMINISTRATION

This section of the historical summary of activities related to Contract W-49-010-ORD-68, deals with Government administration of the work, particularly by the Ordnance Corps. However, mention is made of the Corps of Engineers and the Atomic Energy Commission, two other Government agencies having a definite role in any history of the project. Only a brief resume of the Ordnance administrative aspects, including a succession of Commanding Officers and Contracting Officer's Representatives, is set forth here.

During the summer of 1947 a portion of the Iowa Ordnance Plant, specifically the Line I area, was selected by the Atomic Energy Commission and the Ordnance Corps as a site for production of certain items for the AEC. Selection of the facility was made following a survey accomplished by Black & Veatch, Architect-Engineer contractor to the AEC.

Col. W. L. Bell, Jr., Col. Merle H. Davis, and Col. Otto M. Jank of the Office, Chief of Ordnance, and Col. R. G. Butler of DMA, were active during the original negotiations between the Ordnance Corps and the Division of Military Application, AEC. These officers continued to participate in directing activities, including the selection of a contractor, thru the initial phases of construction and operations.

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Silas Mason Company was selected as the contractor to undertake the task and, on 5 August 1947 a letter order was executed between that company and the Ordnance Corps, giving orders to proceed with such action as necessary for the construction of new facilities, conversion of existing facilities, and operation of the plant for the production of explosives and components as directed by the Contracting Officer. A definitive contract was negotiated and executed 21 October 1947, providing a formal instrument between the Government and the contractor. This contract was designated as Contract No. W-49-010-ORD-68.

Division B, a segment of the operational activities of the Iowa Ordnance Plant, was established in August 1947 for the purpose of administering Contract W-49-010-ORD-68. Originally, all work in connection with the contract was under strict security cover, which prohibited divulgence of AEC interest in the project. For security purposes, the titles "Division B" and "Project Sugar" were used to designate the project during the period of construction and operation under the security cover. With continued usage the "Division B" identification has come to be the recognized official designation of the organizational unit.

In addition to the military personnel previously mentioned, other individuals who participated in important roles in the early phases of the work included Lt. Col. J. S. Jefferds, Commanding Officer, Lt. Col. William E. Ryan, Contracting Officer's Representative, Col. Louis W. Prentiss and Mr.

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Earl W. Fiala. The latter two individuals were Contracting Officer's Representatives for the Corps of Engineers. Lt. Col. Ryan, during his tenure as Contracting Officer's Representative, also acted in the capacity of Field Manager for the Atomic Energy Commission. In this capacity he directed liaison activities between the Santa Fe Operations Office of AEC; Black & Veatch, the AEC Architect-Engineer; Corps of Engineers; and the Silas Mason Company.

The Corps of Engineers, Omaha District, with Col. Louis W. Prentiss as District Engineer, was charged with the responsibility of administering the work under Title I of the contract during the initial construction phases. Mr. Earl W. Fiala, Contracting Officer's Representative for the Corps of Engineers, established a local office and with his staff functioned from the inception of the contract until 31 December 1948, at which time the Ordnance Corps assumed overall responsibility of the contract, including completion of construction work.

Col. Merle H. Davis, Ord Corps, and Col. Homer B. Petit, C of E, were the original Contracting Officers appointed respectively by the Chief of Ordnance and the Chief of Engineers. Col. Davis participated extensively in the direction of the work on behalf of the Office, Chief of Ordnance. During this period he was promoted to the rank of Brigadier General.

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Upon Gen. Davis' retirement from active duty in June 1953, the administration of the contract was transferred to the Ordnance

Ammunition Command with Brig. Gen. W. E. Laidlaw as Contracting Officer.

Security requirements, as prescribed by the AEC, were relaxed on 21 May 1951, to the extent that security cover was lifted, and the relation of the work to the AEC program was publicly announced. The disclosure was made by Brig. Gen. Merle H. Davis in a speech over Burlington Radio Station KBUR. Also at that time, Gen. Davis made public a letter from Sumner T. Pike, Acting Chairman of the AEC. Excerpts from that letter are quoted below:

"I am very happy to be able to advise you that the Commission feels it is no longer necessary to maintain security restrictions on the association of the Atomic Energy Commission with Army Ordnance in the work at the Iowa Ordnance Plant at Burlington.

"It is with genuine pleasure and satisfaction that we can now permit Army Ordnance and your contractor, the Silas Mason Company, to acknowledge publicly that the Burlington project is an important part of the National Atomic Energy Program. With your activities merged with ours for mutual benefit, the Iowa Ordnance Plant has had a key assignment in the program managed by the Atomic Energy Commission office of Santa Fe Operations at Los Alamos, New Mexico.

"We want to express our appreciation of the

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manner in which Army Ordnance has administered this project, and particularly the manner in which the Silas Mason Company has carried out a difficult assignment, both in the process engineering and in carrying on the operation.

"The experience gained at Burlington has been of the utmost importance in the establishment of additional facilities under similar arrangements with Army Ordnance. I hope you will convey to the contractor and his employees our congratulations and thanks for the work they are doing.

"As you know, of course, all technical data and details of plant operation must continue to be withheld for reasons of national security. In this connection, we want to commend Col. Schwecke and his staff of the Iowa Ordnance Plant and the personnel of the Silas Mason Company for the high standards of loyalty and discipline which have characterized the security conditions at the plant."

Mr. E. W. Giles, civilian employee of the Ordnance Corps, was appointed as Alternate Contracting Officer's Representative by Col. Ryan 10 November 1947. Upon Col. Ryan's transfer to Holston Ordnance Works 25 August 1950, Mr. Giles was appointed by AEC to serve as Field Manager concurrently with his responsibilities as COR.

D-5 In the meantime, 3 September 1948, Lt. Col. H. R.

Schwecke had succeeded Lt. Col. J. S. Jefferds as Commanding Officer of the Iowa Ordnance Plant. Col. Schwecke was also named to succeed Col. Ryan as COR by Brig. Gen. Davis at the time of Ryan's transfer to Holston Ordnance Works.

It became increasingly evident as time progressed, that a definite separation of responsibilities, as between the AEC and Ordnance Corps, was desirable in the administration of the contract activities. Accordingly, Col. E. R. Gillespie, who had replaced Col. Schwecke as Commanding Officer and Contracting Officer's Representative 20 June 1952, requested Office, Chief of Ordnance, to consider transferring to AEC, Ordnance administrative personnel who were performing activities determined to be responsibilities of the Commission. This request was approved and effective 23 March 1953, an orderly transition of responsibilities was commenced with the appointment of Mr. Keith C. Harrison as Alternate Contracting Officer's Representative to succeed Mr. E. W. Giles. Mr. Giles was transferred to the AEC and, with a staff of AEC employees, functions as local Field Manager for the Commission.

Lt. Col. Wm. F. Bobzien, Jr. succeeded Col. Gillespie as Commanding Officer and Contracting Officer's Representative 17 April 1953.

On 26 February 1954 a formal agreement was entered into between the Ordnance Corps and the Atomic Energy Commission, which provided a sound foundation for administrative and operational activities and relationships in connection with the work under the prime contract. This agreement was further augmented by execution 23 April 1954, of a Memorandum of Understanding between Ordnance Ammunition Command and AEC, Santa Fe Operations Office.

Since the initial definitive contract designated as Supplement No. 1 was executed, there have been ten (10) other Supplements and Change Orders to the contract. These supplements, together with a brief description of primary provisions, are tabulated herewith:

Change Order No. 2	-	3 May 1948 Provided for performance of dismantling or other related activities at such places as might be designated by the Contracting Officer.
Supplement No. 3	-	31 December 1948 Provided that work previously started by the Corps of Engineers under Title I, would be completed under the supervision of the Ordnance Corps.
Supplement No. 4	-	21 April 1949 Provided for division of project and designation of Plants A and B; and for expansion of facilities including Plant B. Further provided for continued operation through 30 June 1950.
Supplement No. 5	-	13 June 1950 Provided for continued operation through 30 June 1951.
Supplement No. 6	-	6 October 1950 Provided for further expansion of facilities referred to as Plant C.

Supplement No. 7 - 29 January 1951
Provided for mutual assistance in prosecution of an AEC contract held by Silas Mason Company, for architect-engineer work at Pantex Ordnance Plant.

Supplement No. 8 - [illegible]
Provided for continued operation, including Plant C, through 30 June 1952.

Supplement No. 9 - 26 June 1952
Provided for continued operation through 30 June 1953.

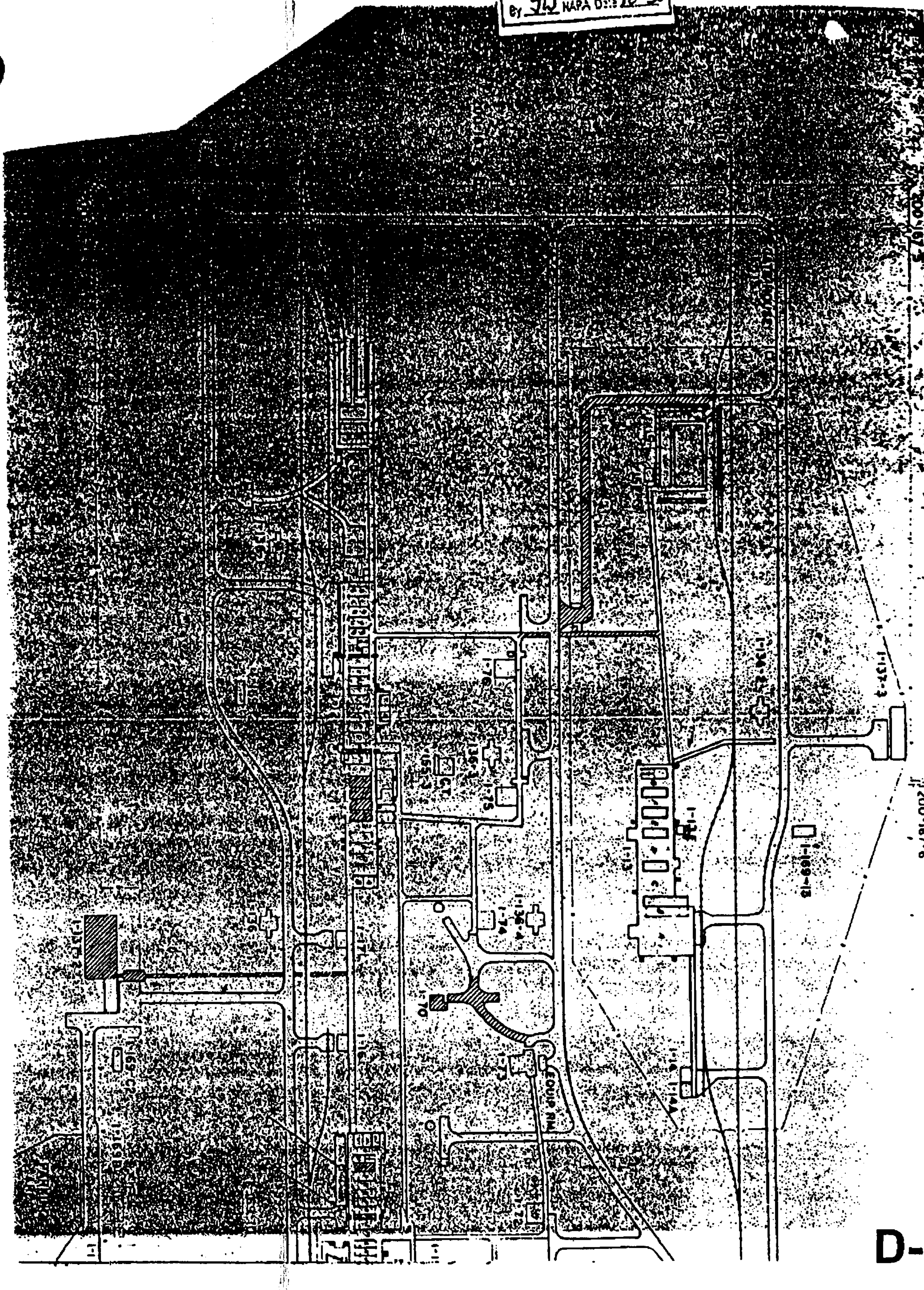
Supplement No. 10 - 16 June 1953
Provided for continued operation through 30 September 1953.

Supplement No. 11 - 1 October 1953
Provided for continued operation through 30 September 1954.

At the time Division B was established, five Ordnance personnel were assigned to the work. As activities increased, personnel strength rose to a high of twenty-seven in 1951. At times such personnel included firemen and inspectors. At 30 June 1954 personnel strength of the Ordnance administrative staff for Division B stood at thirteen.

VII. APPENDIX

The plot plan of Line I, TOP Area map, photographs of H. E. Components and photographs of construction during 1950, 1951 and 1952 are included on the following pages.



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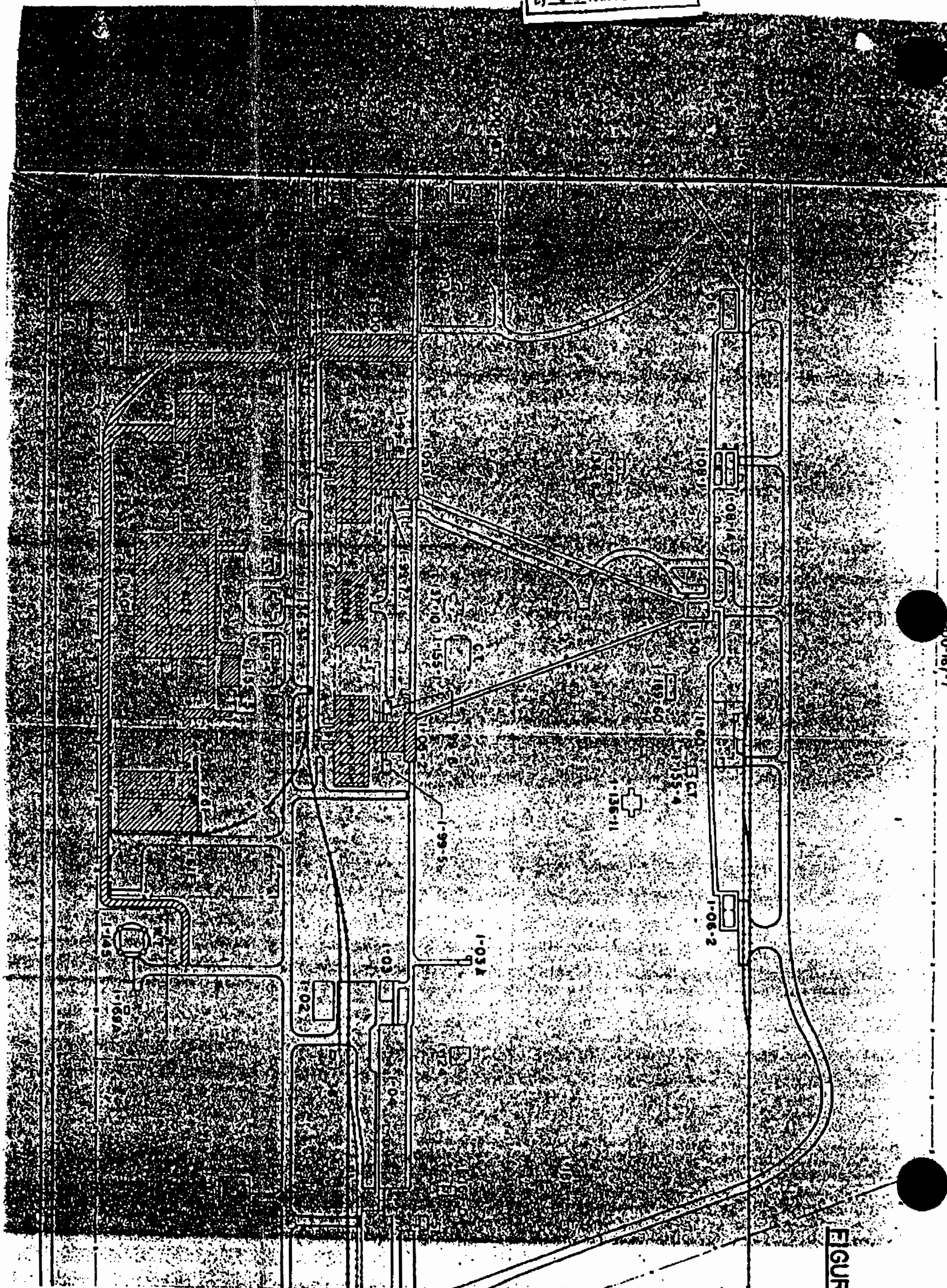

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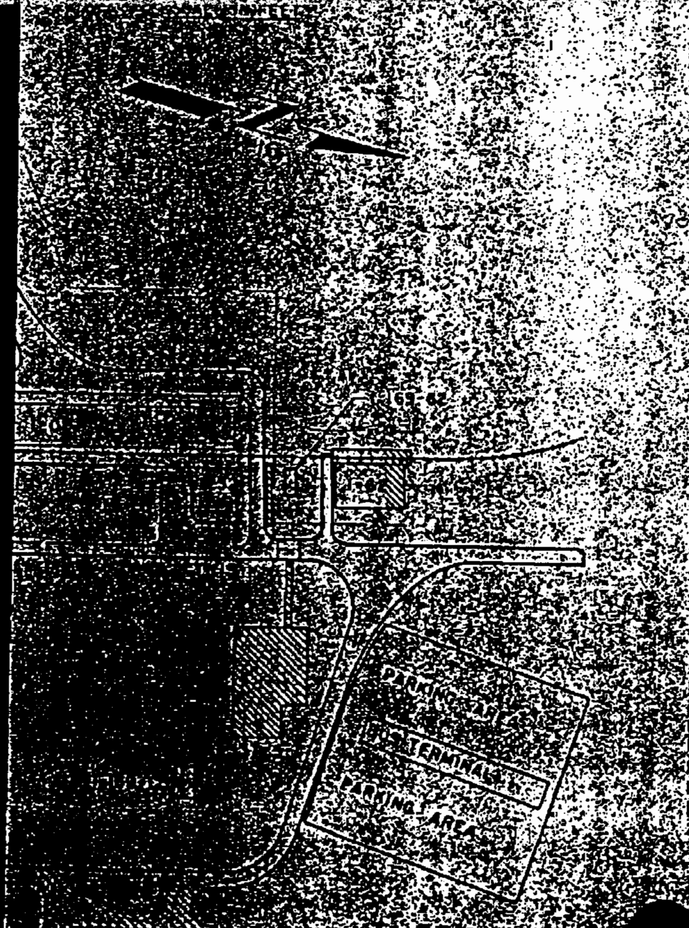
E 7 - PLOT PLAN LINE I
IOWA ORDNANCE PLANT

NOTE: SHADED AREAS REPRESENT FACILITIES CONSTRUCTED OR REVISED 1950 – 1951



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BUILDING SCHEDULE

SECTION NO. LINE I LAYOUT	
1-01	MAINT. SHOPS
1-02	BOILER PLANT
1-03	SAMPLE PROCESSING
1-03A	H.E. REST FOR LAB.
1-04	OFFICES, SHOPS & LAB.
1-05-1	MELT (EQUIPMENT ROOM UNDERGROUND)
1-05-2	MELT (EQUIPMENT ROOM UNDERGROUND)
1-06-1	MAGAZINE FOR COMP. B & TNT
1-06-2	STORAGE FOR NC & ACETONE
1-07	REST (UNDERGROUND)
1-07E	EQUIPMENT BLDG. (UNDERGROUND)
[illegible]	COMP. B & CYCLOTOL RAW MAT'L INSP.
1-08-1A	REST
1-10	MACHINING BLDG. (EQUIPMENT ROOM UNDERGROUND)
1-12	MACHINING BLDG. (EQUIPMENT ROOM UNDERGROUND)
1-13	ASSEMBLY
1-13E	EQUIPMENT BLDG.
1-14	INERT STORAGE
1-14A	BATTERY CHARGING STATION
1-15	REST
1-16	BATTERY CHARGING STATION
1-17	BATTERY CHARGING STATION
1-40	MACHINING BLDG. (UNDERGROUND)
1-40E	EQUIPMENT BLDG. (UNDERGROUND)
1-50	TRANSFER STATION
1-51	FILTER CLEANING BLDG.
1-52	GUARD HEADQUARTERS
1-53	SHIPPING
1-60	BN PROCESSING
1-61	ASSEMBLY
1-61E	EQUIPMENT BLDG.
1-62	BOILER PLANT
1-70	FILTER BLDG.
1-71	REST
1-72	REST
1-73	GAMMA
1-74	REST
1-75	REST
1-76	REST
1-99	VACUUM SERVICE BLDGS. (1-99-5,6,7 & 8 UNDERGROUND)
1-100	X-RAY & SECTIONING BLDG.
1-110	GUARD GATE (3 GATES)
1-119	PAINT SHOP & STORAGE
1-124	WELDING SHOP
1-129	GARAGE
1-130	BOMB SHELTER (11 SHELTERS)
1-137	INERT STORAGE
1-138	CHANGE HOUSE & CAFETERIA
1-145	WATER TOWER (1 TOWER)
1-159	COOLING TOWER (5 TOWERS)
1-165	TRANSFORMER STATION (13 STATIONS)
1-198	NC STORAGE
1-200	GUARD TOWER (5 TOWERS)

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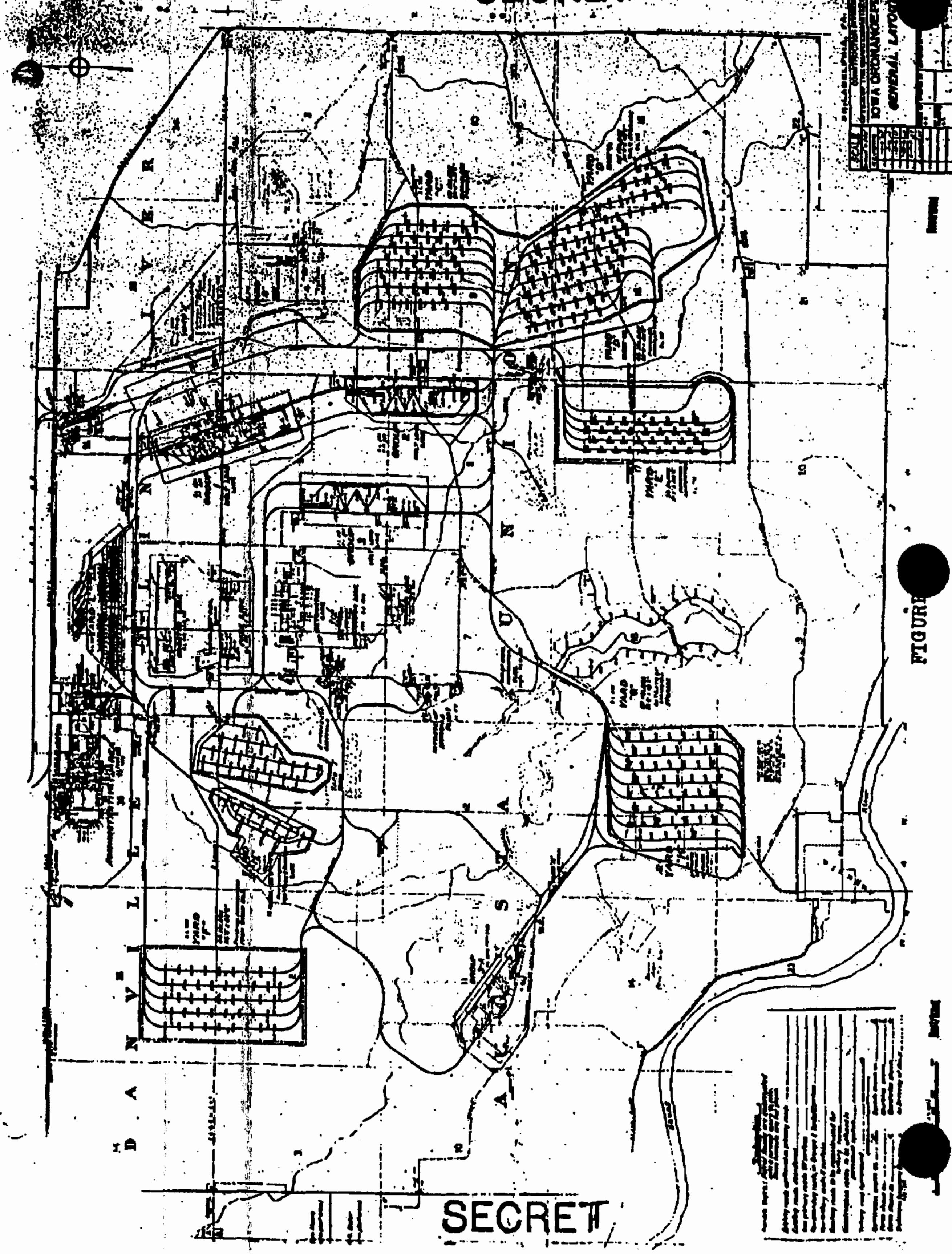

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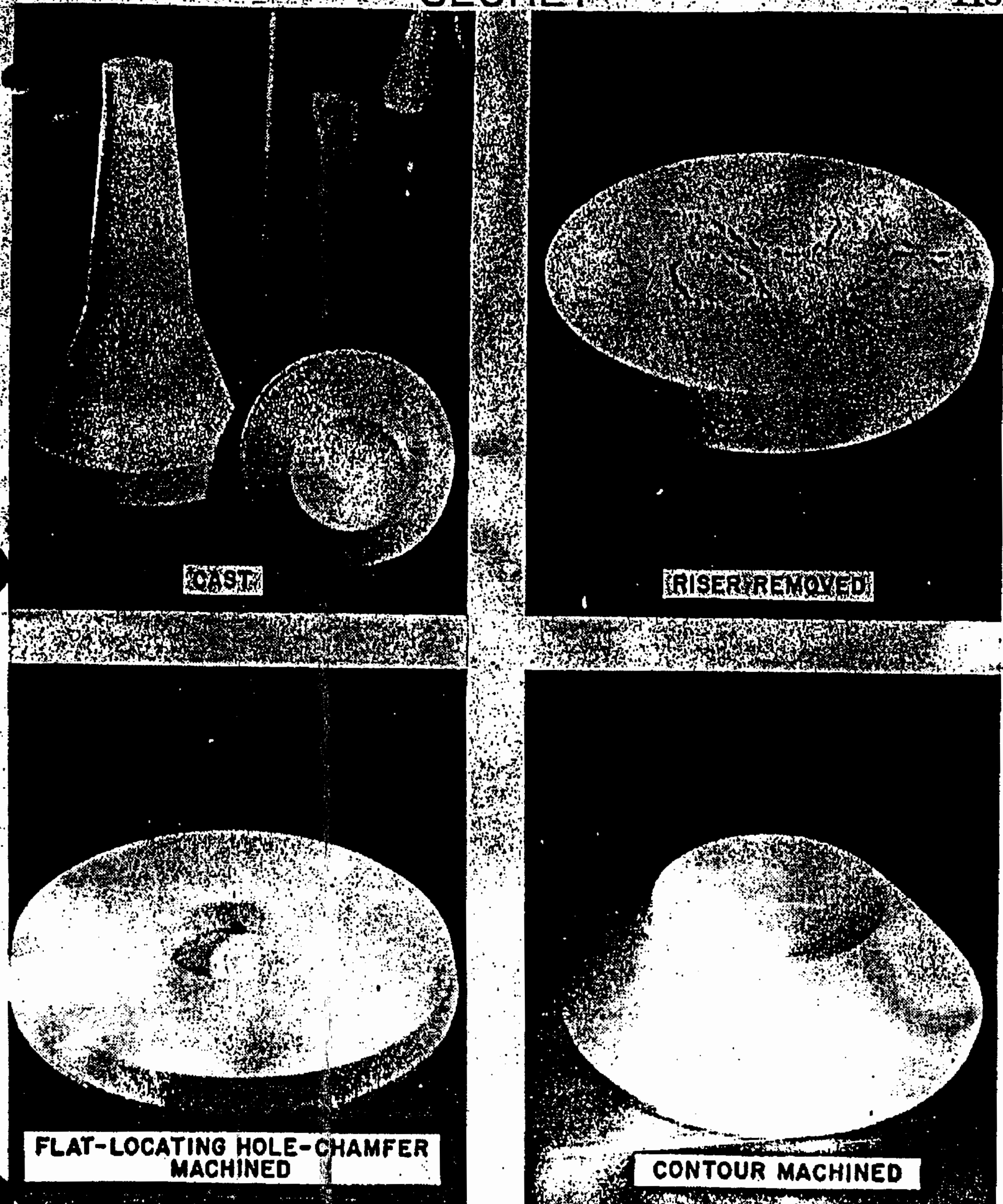

Figure 9 MK 7 BARATOL OPERATIONAL FLOW

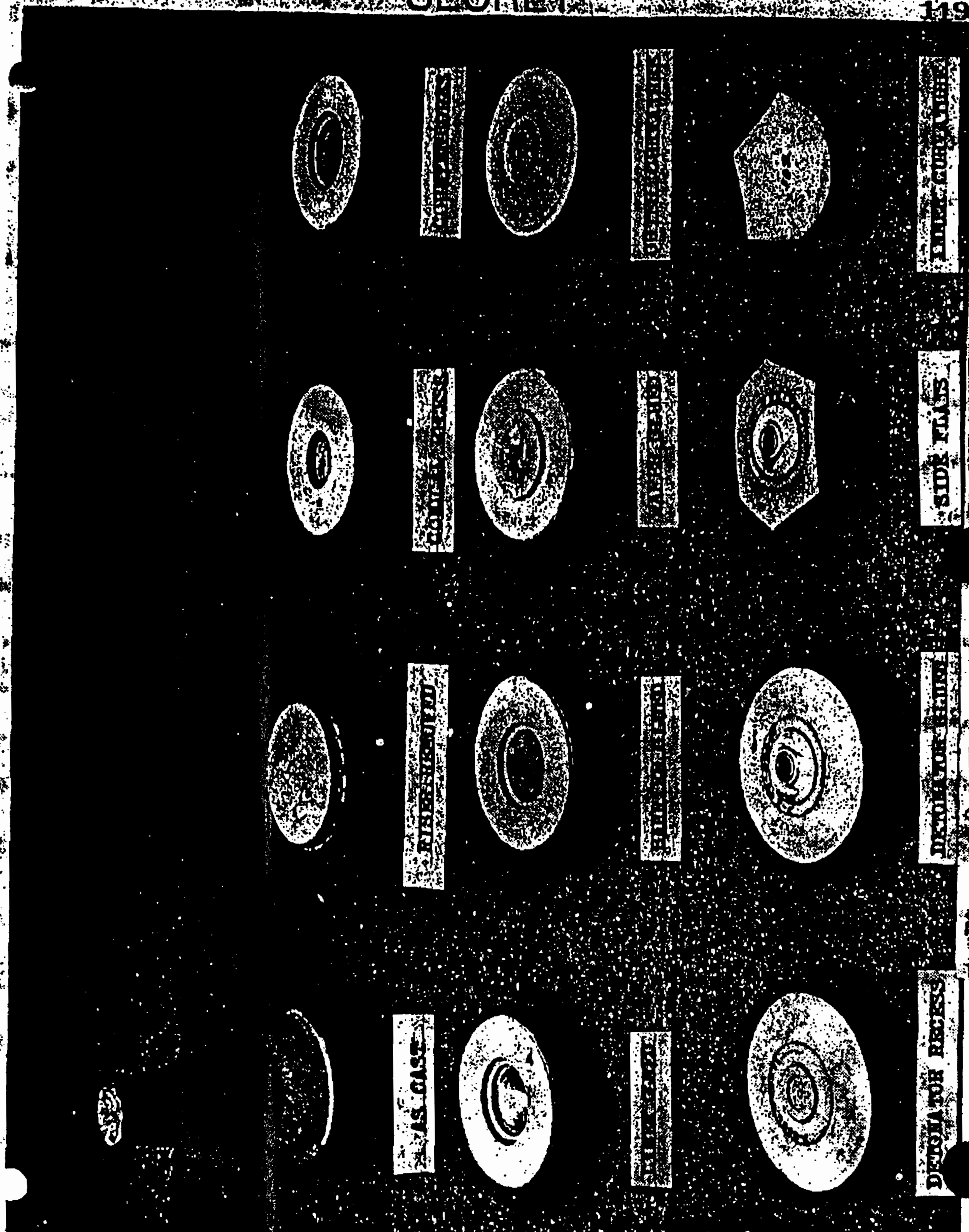

Figure 10. MK 7 OUTER COMP... OPERATIONAL FLOW

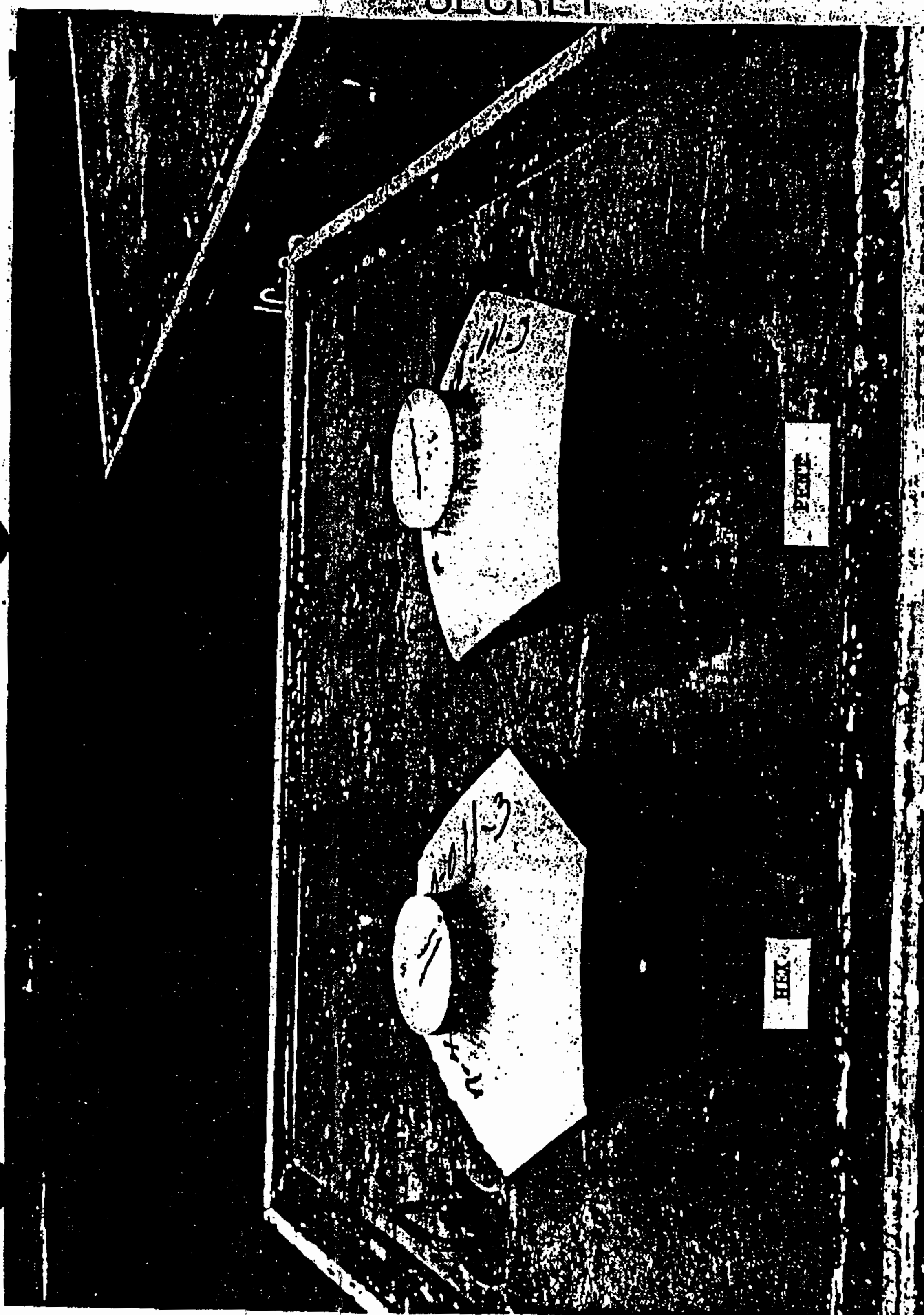

Figure 13 MK 7 LINER COMPONENT AS CAST (SHAPED, SHORT RISER)

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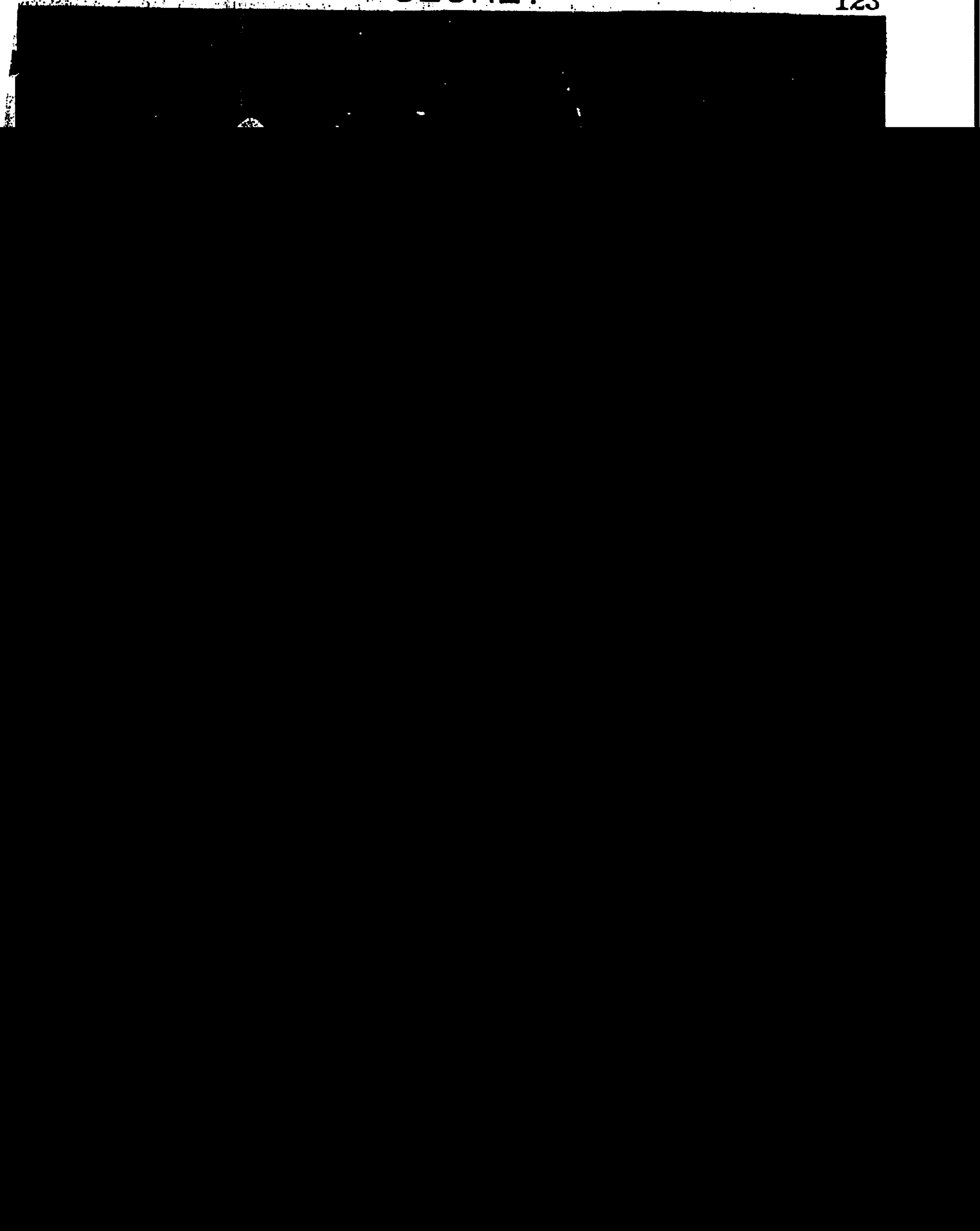

Figure 15 M 6 BARATOL OPERATIONAL FLOW

Silas Mason Company

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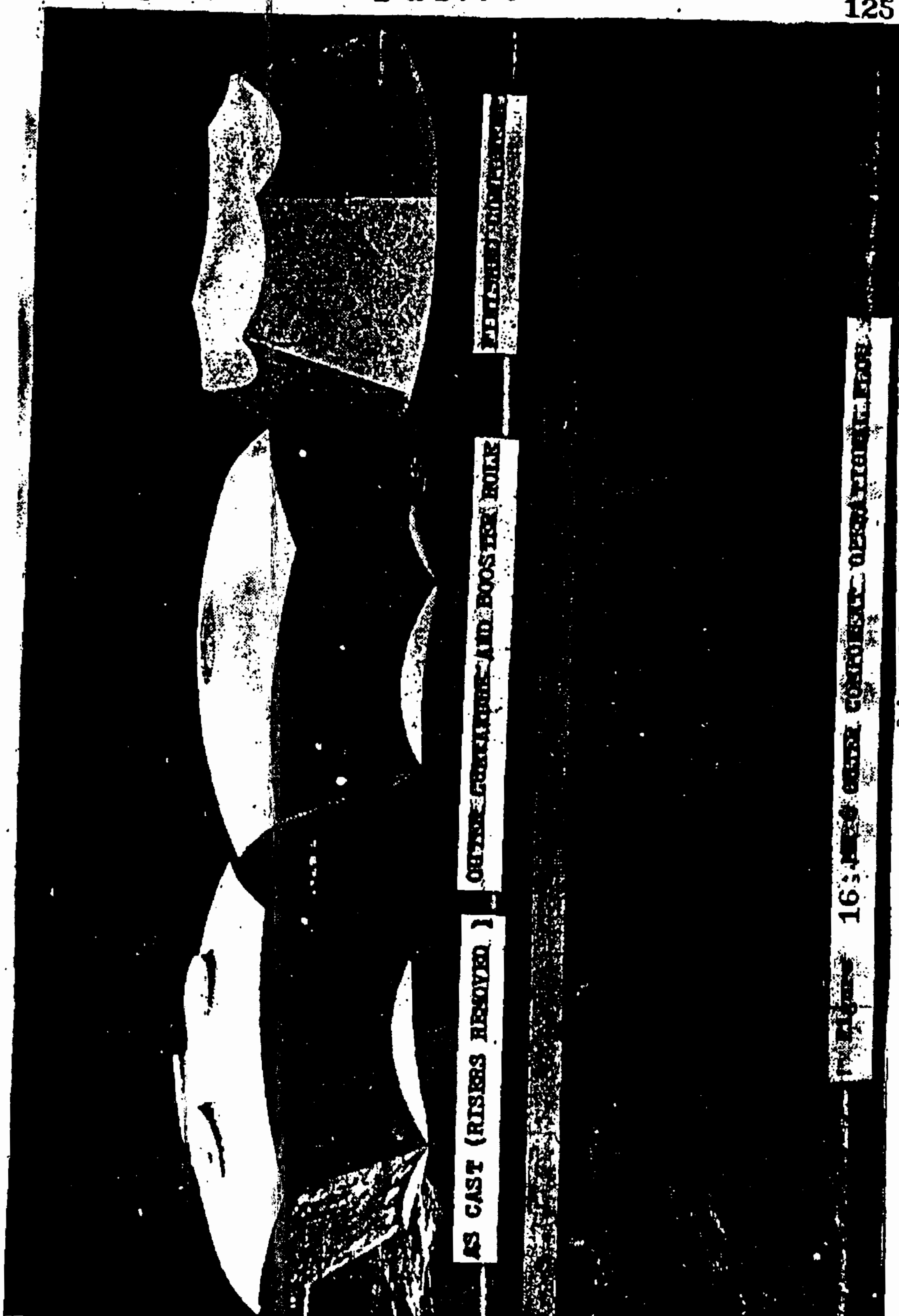

Silas Mason Company

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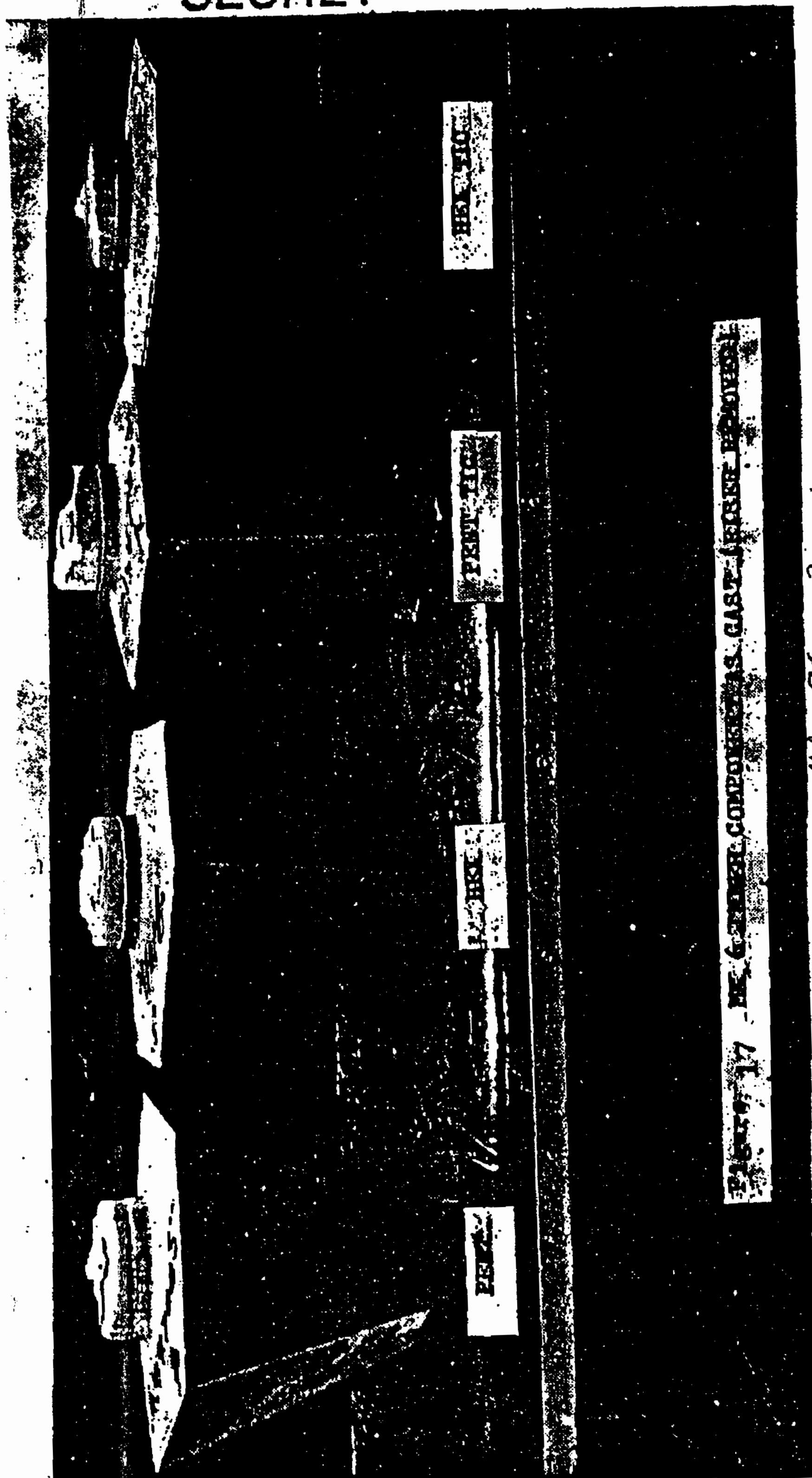

Silas Mason Company

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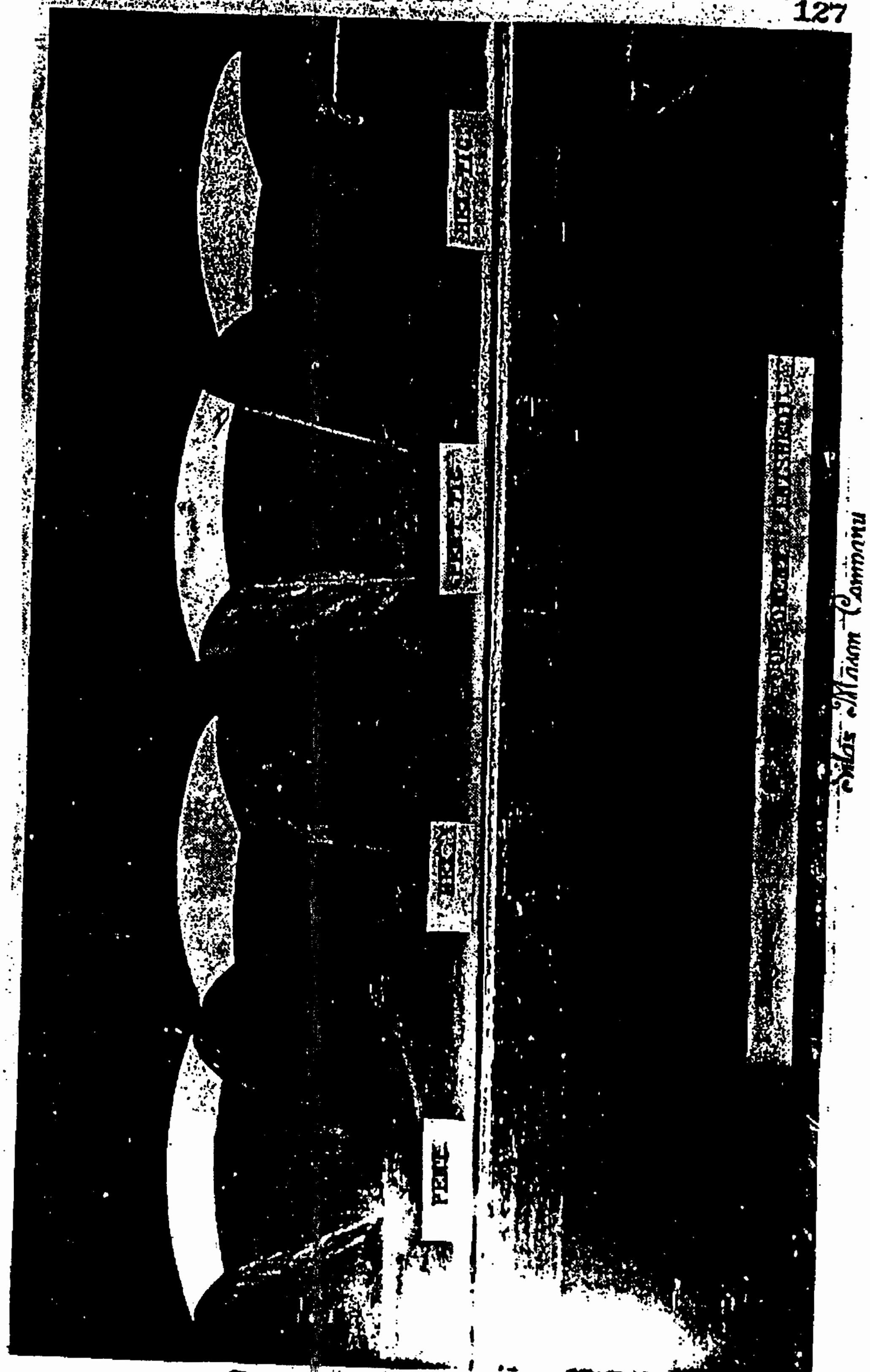

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