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Women's Employment in Artillery
Ammunition Plants, 1942

By

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Women's Employment in Artillery Ammunition Plants, 1942

INTRODUCTION

Earlier survey.

In the spring of 1941 agents of the Women's Bureau visited two Government arsenals to study the occupations involved in the making of artillery ammunition. Processes used in the manufacture of metal components, projectiles, and cartridge cases were studied, as well as those that are necessary in the assembling and loading of parts and complete rounds of artillery ammunition. Powder-bag making and loading and the manufacture of certain types of powder pellets were included in the survey.

Following these visits, descriptions of the occupations in which women were engaged, and suggestions concerning operations being performed by men on which women could be used, were published in a bulletin entitled "Employment of Women in the Manufacture of Artillery Ammunition." While women were found to predominate in departments where small parts were being assembled and inspected, it was evident that they could be used more extensively on various machine operations requiring relatively short periods of training and on certain additional kinds of jobs. On operations requiring the handling of projectiles or cases, it appeared that the possibilities of employing women more extensively were somewhat limited because of the size and weight of many of these objects. Therefore, it was felt that women's work could be expanded mainly on the smaller shells and cases, such as those of the 37-mm. or 75-mm. sizes.

Scope of recent survey.

With the development of the defense program, and the rapid progress under a condition of actual war, many artillery ammunition plants have been built and others are still in the process of construction. Consequently, in the period from November 1941 to April 1942 a much wider survey was made, covering a very large proportion of these new plants, to determine the occupations in which women actually were being employed. In contrast to the two arsenals first visited, however, none of these plants is engaged to any appreciable extent, or will be so engaged, in the manufacture of metal components or other metal parts. Therefore, the occupations considered in this recent survey were confined to those involved in the making and loading of powder bags, or in the assembling and loading of shells and cartridge cases, and of small parts such as fuzes, boosters, primers, and detonators. One or two of the plants included in the survey

were making a somewhat wider variety of products, but occupations not directly related to artillery ammunition have been omitted from this report.

A representative group of plants, including several bag-loading establishments, were visited. Practically all these are new plants situated in the eastern, southern, and middle-western parts of the United States. Most of them are owned by the Government but operated privately, while a few are new or recently expanded Government arsenals or depots. The majority had begun to operate, though in a number of cases only partially, at the time of visit. The others were expecting to begin production soon.

Number of women.

Estimates as to the number of women these plants expected to employ at peak production were obtained from plant and Government officials, but such estimates were subject to revision with changes in circumstances, in production methods, or in other factors. Though the estimates given at the time of visit may prove to be too high in some instances, in others it is possible that they may be revised upward, especially as three plants were visited prior to December 7 or very shortly thereafter. Officials of a number of companies indicated that their original estimates concerning the proportion of workers who would be women have been raised from time to time, particularly since the outbreak of war. For instance, in three plants that had planned to use 35 to 40 percent women, the female labor requirements have been raised to 60 or 70 percent of the total.

However, on the basis of the best data available it seems evident that the proportion of women to be hired out of the total labor force in these plants depends largely on the size and type of the ammunition to be loaded. All the bag-loading plants, for example, expect to use a high proportion of women, ranging from 54 to 70 percent. Officials of two plants designed primarily to assemble and load fuzes, primers, and other small parts expect that 80 to 90 percent of the employees will be women. In the shell-loading plants, the number of women who can be used will depend mainly on the size and weight of the shells and bombs being loaded. Of all the plants visited, two Government depots probably will employ less than 20 percent women in their peak labor forces. However, neither of these plants is designed to confine its operations exclusively to the loading and assembling of artillery ammunition. In five plants it was estimated that probably 30 to 40 percent of the employees will be women. In all the others the officials interviewed said that more than half of the employees will be women, and in 10 of these plants it was stated that women will constitute about two-thirds or more of the labor force.

The plants already operating had more than 25,000 women employed at the time of survey. The estimates of these plants concerning anticipated employment indicate that approximately 80,000 women will be at work when the plants reach peak production, and most of them expect this peak by late summer or early fall of 1942. In the plants not yet in production it was estimated that 20,000 women eventually will be employed. Therefore, the total anticipated by all the plants at maximum production is 100,000 women.

All these figures concerning women employees include office workers and a few other groups of women, negligible in numbers, such as nurses, cafeteria workers, and matrons, not employed in the operating and producing parts of the plants. However, the great majority of the women are employed, and will continue to be, in shop operations, that is, in the actual assembling, loading, inspecting, or packing of ammunition. At the time of visit there was a wide range in the proportion of women office workers to the total women employees of each plant, but from the estimates of anticipated employment it would seem that in most plants this group will comprise not more than 10 percent of the woman labor force.

Other matters of inquiry.

It was apparent at the time the visits were made that there was variation from plant to plant in the types of work on which women were being employed; in several instances women were seen performing an operation in one plant that in another plant was being done solely by men. As this indicates that the employment of women can without doubt be extended to additional jobs in a good many plants, an effort has been made to describe all the chief types of shop or "factory" operations on which women were seen engaged, or about which definite information was obtained. While it was not possible to compile a complete catalog of all the dozens of small steps in operations on which women were employed, and normally would be employed, and while some operations may have been omitted, it is believed that the principal types and varieties of jobs, and those most typical, have been included.

Since this report is designed as a supplement to the earlier bulletin of the Women's Bureau on the employment of women in artillery ammunition, no attempt is made to describe here, except in very general terms, the products customarily included in artillery ammunition. The emphasis is placed on the work actually being done by women.

It is recognized, of course, that there are hazards involved in working with explosives, and that these are serious in connection with many jobs in artillery ammunition plants. In addition to the danger from explosions, workers are subject to dangers from poisoning or infection in working with various toxic substances, such as trinitrotoluene (TNT), tetryl, and lead azide. Some individuals have been found also to develop skin infections from working with cleaning fluids, or even from handling metal parts. Attention was given, therefore, to general working conditions and to provisions for safety in the plants visited, but no attempt was made to analyze thoroughly the health hazards involved in working with different kinds of powder and chemicals, a highly technical subject that for a long time has been a matter of study by Government experts.

In addition to information concerning occupations, and general working conditions, statements were obtained from plant officials concerning the numbers of women employed, the requirements for hiring, wage systems, scheduled hours and shifts, training, and other personnel policies.

OCCUPATIONS

The occupations in which women were engaged in the loading and assembling of components have been discussed separately from those in which they were working on lines where shells, depending on their sizes and types, were being loaded and assembled with cartridge cases, windshields, fuzes, fins, or other components and increments. The smaller varieties of shells usually were being assembled with all other necessary parts to make complete rounds of ammunition ready for firing. There was a noticeable difference in the proportion of women being employed on fuze lines, or lines handling other components, and shell-loading lines. Some plants were handling both types of product, but in others only components were being loaded and assembled, these to be shipped later to other plants to be combined with projectiles. Further, there seemed to be some tendency in the industry to differentiate between the two kinds of products, and the United States Army *Ordnance Safety Manual* states that "fuzes, primers, boosters, primer-detonators, and similar loaded components form a distinct class of ammunition when they are not assembled to or packed with projectiles."¹

Powder bags are essential increments of rounds of semifixed and unfixed (separate loading) ammunition. Since the operating plants making and loading these bags were found to be highly specialized and devoted entirely to this kind of work, the occupations in which women were employed in these plants also have been considered separately.

Components.

Because of their finger dexterity and patience in working with very small parts, women are rather generally considered particularly adept at the operations required in the loading, assembling, inspecting, and packing of different types of components, such as percussion elements, primers, boosters, booster cups, detonators, fuzes, and the many varieties and sizes of these. In fact, as might have been predicted from the first Women's Bureau survey of the industry, a high proportion of the employees found in this general type of work were women. A number of lines engaged in such operations were visited, and in some instances two-thirds or more of the employees were women.

However, it was not possible to visit all such lines in all plants, and in any case it would be impossible to describe all the operations in complete detail. Probably hundreds of different kinds of small operations are necessary to complete all the many types and varieties of components. Furthermore, exact processes, or steps in processes, vary somewhat from plant to plant, though many operations are actually quite similar, differing from one another only slightly. It is possible, therefore, to describe the principal types of operations in general terms. Also, a number of examples, illustrative of the different kinds of work being done by women in the plants visited, have been included to indicate the nature of the operations performed.

¹ U. S. Army, Office of Chief of Ordnance. *Ordnance Safety Manual*. U. S. Government Printing Office, Dec. 1, 1941, p. 112, sec. xvi, par. 133a.

Loading.

In a broad sense the term "loading" can perhaps be considered as including all the operations essential to the assembling of components in their final form to make a complete round of ammunition. However, loading is here considered in a narrower sense as consisting primarily of the operations quite directly related to the filling with explosives of various small parts, such as percussion elements, relay elements, booster cups, and detonators.

Generally the plants included in this survey were confining their operations to the loading and assembling of ammunition and were not manufacturing powder. However, in some instances several chemical substances were being mixed to make certain types of powder. Even in instances where men were making or mixing powder, no women were doing this type of work. In a number of plants, though, powder pellets, used most frequently in the loading of components, were being made. Usually these were made of black powder or tetryl, and here again most of the operatives were men. In one plant, however, women were operating the press machines to make black powder pellets, while men were doing the heavy work of handling the bulk powder. Each press was in a separate room, with a door equipped with a safety device so that it could not be opened while the machine was operating. After setting a press the woman operator left the room and turned a switch on the outside of the wall. Operations could be watched by looking at a mirror, placed so as to reflect the action of the machine, through a peephole in a thick wall. Each woman was responsible for the operation of two presses.

More women, however, were engaged in putting pellets, already made, or powder, already mixed, into various small parts. In this work quite a number of men also were employed. Lead azide, fulminate of mercury, tetryl pellets, and primer mix, which is a combination of several chemical substances, were the types of powder being used most commonly by women in these loading operations. Some women were inserting tetryl or black powder pellets in containers. This in itself is not difficult, though it is necessarily hazardous and, in the case of tetryl particularly, there is danger of infection or poisoning against which certain precautions are necessary.

Women were engaged also in loading percussion elements for primers. In one type of operation women were placing empty percussion cups in plates for filling and were then rubbing black powder over a brass plate perforated with holes through which powder was sifted into cups. A few women were being employed in tending foiling machines, which stamped out disks of shellacked red paper and pressed them over the powder cups. In another plant women were doing practically all the work in a section where percussion elements were being loaded with primer mix. With the use of tweezers one woman was picking up very small paper disks and weighing them on a fine scale to be sure that only one disk at a time was being used. The next woman in line was putting a drop of shellac in each primer "housing" or cup and inserting a disk. After one or two other small operations women were putting the wet primer mix in the cups. Then, after the covers had been placed over the cups, each one was inserted

under a press. Women were operating the presses. The excess primer mix was then wiped off and the completed elements were placed in trays to dry.

Several lines were visited in which women were engaged in various operations which are necessary in the loading of detonators. They were weighing powder, generally lead azide or fulminate of mercury, and using tiny ladles to load it into cups. Sometimes more than one kind of powder was used in detonator loading and then the charge was consolidated by means of a press. The powder used in detonators is highly explosive and can be set off suddenly, so each operator doing the loading was working behind a barricade containing a glass panel. However, in order to do the loading the operator ordinarily must insert one hand and arm behind the barricade. Throughout the detonator lines, in fact, barricades were being used, where possible, around presses used for crimping and between the different compartments where employees were working. Usually a number of men also were employed on these lines, sometimes on the most hazardous operations and sometimes to manipulate the presses requiring a fair amount of physical strength.

In the first survey made by the Women's Bureau's agents at two Government arsenals, it was found that men usually were employed to do the work of crimping the loaded detonators in presses and of ejecting them from sleeves or jigs used. However, in the plants visited more recently this was not uniformly true. Some women as well as men were operating presses on detonator lines. In one line visited, for example, women were operating all the kinds of presses being used and a woman was operating the final or "knock-out" machine that ejected the completed detonators.

Assembling and inspecting.

In connection with all loading operations, a number of women were employed in performing small assembly-line jobs, such as inserting disks in cups prior to loading or placing covers on loaded parts. Such jobs did not require the direct handling of explosives, but were being done in close proximity to loading operations. Some inspection also was being done along these lines.

In many instances women were working in rooms where various small parts, already loaded, were being combined and assembled into complete components. Some of these small loaded parts, such as percussion elements or detonators, came from other parts of the same plants, while others were received from outside. Women were being employed for virtually all the different kinds of operations on these lines. This is natural, because of the type of work required. For example, women were engaged in such jobs as the sorting of small pieces, the inserting of disks, washers, springs, or wires into metal cups or containers, the screwing together of different small parts, and the placing of tiny pieces in holes or depressions in parts of somewhat larger size. Also, women were employed in cleaning off excess paint in empty primer bodies. Some assembly work required the handling of inert materials only, that is, materials containing no explosives, but other work was being done with parts already loaded. Near the end of the assembling processes women were engaged in such operations as applying lacquer to stake marks, or glue or shellac to various parts of completed units, usually to make them waterproof.

Many of the women employed in assembly work were performing all the necessary operations with their hands, though a few were using hand tools, such as tweezers, wrenches, or files. However, a good many women were operating various kinds of presses, particularly for crimping or staking operations. Some of these were manipulated by hand levers, while others were operated by air pressure applied by foot pedals. Barricades often were found around these presses. Some pneumatic screw drivers and power drills also were handled by women.

At many stages during the assembling, as well as the loading, of fuzes, primers, or other components, inspections are made. The many small parts necessary for a complete fuze, for example, must be assembled in exactly the right way so that the fuze will be sure to function properly and at the right time. Parts received from other plants are inspected at the beginning of operations. Sometimes completely assembled fuzes, except that they are unloaded, are received from other plants, and these must be disassembled as well as inspected.

Women were doing practically all preliminary inspection and a great deal of other visual inspection in looking for surface defects. In a few instances magnifying glasses were being used. Women were using micrometers and various types of gages to check the dimensions, as well as scales to check the weight, of parts and completed assemblies. In two plants women were seen testing primer bodies for holes by sitting in a completely darkened room and holding the bodies over a small electric light bulb. In many cases arming machines also were being operated by women. By the use of such a machine it is possible, for example, to test a fuze to see whether it will operate when it revolves at a certain number of revolutions per minute.

Naturally there is considerable variation in the exact sequence of operations in assembling and inspecting all the many different types of fuzes, primers, and other components, but a few examples of operations seen may be mentioned. In one plant where a delay-action type of point detonating fuze was being assembled, women were engaged in putting into the plunger body a relay (a small aluminum cylinder filled with lead azide), a delay (a pellet of compressed black powder), a delay washer, a primer, and a primer cover. On this particular line each woman inserted all these parts in the plungers that she assembled. In the next operation centrifugal pins and springs were inserted. Then women assembled the firing pin, containing a plunger support and a plunger retaining spring. In a later operation the lock pin was inserted and crimped into place by use of a press.

On this same line another series of operations was being performed by women assembling the fuze heads. The metal heads were inspected for defects and gaged to be sure that they would fit properly with the firing pin. Detonators and detonator cushions were then inserted in the heads and a retaining screw was put on with a pneumatic screw driver and then staked by a press.

In still another operation slider tubes were being gaged to be sure that the threads had been made properly and then tensioned and staked into the body of the fuze. After the smaller parts were all assembled, the head and ogive of each fuze were tensioned and staked to the body, and then the completed fuze was gaged for over-all height and all stake marks were shellacked.

Similar types of operations were carried on by women on other lines where boosters were being assembled. Women were placing rotors in booster bodies by the use of tweezers. Onion-skin disks were being placed over the rotor covers by women. Some women were screwing the cups containing tetryl to the booster bodies by hand. Others were tightening these cups to the bodies with wrenches, and then the cups were staked to the bodies. The completed units were passed under an over-all gage and given a final inspection.

Packing.

At the end of all the assembly lines for components a number of women were engaged in packing operations. In some instances each completed fuze was first placed in an individual cardboard container. Smaller parts were being packed in boxes and women were employed in taping these boxes and dipping them in wax to make them water-proof. Women were employed also in stamping or stenciling information concerning the kind of fuze, primer, or booster contained in a package, the lot number, and any other essential data on the containers. Usually final packing of components is done in boxes of fairly large size, and men generally were doing all this work, since it is too heavy for women.

Shell loading and complete rounds.

A number of the plants visited were engaged in loading shells with explosives and in assembling them with components and other parts. Shells of the 75-mm. or 3-inch sizes, as well as smaller ones, usually were being made into complete rounds of fixed or semifixed ammunition ready for firing. The projectiles were being assembled with loaded cartridge cases, fuzes, and other necessary parts; for example, windshields in the case of armor-piercing shells. Projectiles to be used in trench mortars were among the types being assembled and on these fin assemblies were attached to the shells rather than cases containing propelling charges.

In unfixed (separate loading) ammunition, such as shells of the 155-mm. size, normally the propelling charge of powder bags and the fuzes would be packed separately from the shells and the final assembling would be done at the time of firing. Generally, work on shells of these sizes appeared to be considered too heavy for women, and for the same reason women were not employed to any appreciable extent on lines where bombs were being loaded. In fact, with a few exceptions women were employed generally on lines where shells of the 20-, 37-, and 60-mm. sizes were handled.

Partly because of the fact that different sizes of shells were being loaded in different plants, there was considerable variation from plant to plant in the type of work women were doing. But there was also variation in the occupations on which women were employed in plants loading some shells of very similar types.

In one plant, for example, women were engaged in scooping powdered TNT into cups, weighing it, check-weighing it, and pouring it into 60-mm. shells. The powder was then pressed tightly into shells by machines operated by men. In another plant, however, in which the same size of shell was being loaded on one line, men were performing all these operations. The weighing and pouring of powder, which women were doing in the one plant, requires no special physical

strength but is hazardous, and precautions against infection from TNT are necessary. Precautions should be observed also, of course, when men are employed.

Actually women were employed to only a minor extent in the loading of shells. In addition to pouring some powdered TNT, women were performing a few small operations in several plants on shells being loaded with a tracer charge. The women were dropping pellets into the shells, usually on top of the powder charge, to form tracer and igniter charges, and some were placing celluloid covers over the finished charges. Some women were operating presses to press down the powder in the shells, but men also were performing this part of the operation in some plants.

On the other hand women were being employed generally to load cartridge cases with propelling charges. Smokeless powder for fixed ammunition was being weighed and check-weighed on shadowgraph scales. Women were doing this work and also pouring the powder into cartridge cases. In one plant it was noted that women were performing this series of operations in groups of three.

In semifixed ammunition a number of plants were employing women to tie powder bags into cartridge cases. The first bag in a group was fastened over a hook in the base of the cartridge case, and the other bags in the charge were then placed in the case on top of this bag.

Women were performing a number of operations involved in the inserting of primers into the bases of cartridge cases. Arbor presses were used to press the primers securely into the cases, and women in some instances were operating these presses on cases of the 20-mm. and 37-mm. sizes. In one plant it was reported that women placed the primers in the cases but the presses were operated by men. However, at the time of the previous survey it was found that men were doing all the assembling of the primers into cartridge cases,² so apparently the employment of women has been extended to this type of work rather recently.

Women were employed in several other miscellaneous occupations common in the assembling of shells. Though practices varied from plant to plant, women were employed in at least one plant, and sometimes in several, on each of the following operations:

Removing grease and dirt from empty shells.—Women were seen using an air-pressure tube to clean shells as they passed on a conveyor belt. In a plant where men were doing this sort of work, officials said that women could perform the operation if they did not have to lift the larger shells.

Putting metal bands or tape on the threads of shells.—This was done to protect the threads while the shells were passing through a paint-spraying machine. Women were doing this work on shells of 20- and 60-mm. sizes. Some women were also taking off bands and tape and inspecting shells after paint-spraying.

Inserting fuzes in loaded shells.—A few women were being employed to do this as the shells moved along an assembly line. Women did not need to lift the shells and in at least one plant a few women were being used at times on a line where shells of the 75-mm. size were being assembled.

² U. S. Department of Labor. Women's Bureau. Bul. 189-3. Employment of Women in the Manufacture of Artillery Ammunition (1941), p. 15.

Assembling cartridge cases to shells.—In one plant women were crimping together the loaded cartridge case and shell of the 20-mm. size.

Shellacking the seams where projectiles and cases join.—Women were doing this on some of the smaller sizes of projectiles.

Staking fins and fuzes to shells.—Women were cleaning fins and operating pressing machines to stake the fins and fuzes to shells. In some instances men also were doing the latter operation.

Inserting propellant increments in fins.—Women were fastening sheets of smokeless powder into fins.

In addition to these operations women were doing some inspection of shells moving along assembly lines, and occasionally were retouching with a paint brush shells that had not been properly covered by paint-spraying machines.

Women were stenciling data concerning size, type, lot number, and other necessary information on the sides of shells and packing containers. In some cases smaller shells were being packed into individual cardboard containers by women, but the packing of shells together into larger containers, and most other work in the packing departments, was done by men. Without doubt much of this work would be too heavy for women.

Bag loading.

Three of the bag-loading plants visited were already in operation and women were being used very extensively for work in both bag-making and bag-loading departments. In only one plant, however, were they employed on the first important operation, which consists of cutting the pieces for the bags. This work is very similar to the work of a cutter in a clothing factory, and involves the use of an electric power machine to cut through many thicknesses of cloth at a time. In the company where women were employed on this work they had been trained within the plant.

Women almost exclusively were being employed for the other jobs in the bag-making departments. Much the largest number, of course, were sewing pieces of bags together on power sewing machines. The small pieces must be sewed together carefully and securely, with seams of the proper kind, and a small opening must be left in each bag so that it can be filled with powder. Some women in these departments were operating the printing presses used to stamp lot numbers and other necessary data on pieces of the bags before they are sewed together. A good many women were trimming and counting the bags after the sewing had been done, and still others were inspecting the completed bags very carefully. Some inspectors were using rulers to measure seams. Work in the bag-making department is not hazardous, since customarily this part of a plant is considerably removed from areas where explosive materials are used.

In the bag-loading departments the work is, of course, more hazardous, since powder, and bags loaded with powder, must be handled. One plant was not using women in these departments, but the other two were using women extensively and a plant not yet operating was planning to do so. Women were working in small groups, weighing powder, check-weighing it on shadowgraph scales, and pouring the powder through a funnel into the small openings left in the powder

bags. Then these openings in the bags were closed by women operating sewing machines with bronze needles. Women in another department then inspected and trimmed the loaded bags, and other women assembled and laced them together according to specifications. While more women were working on lines where smokeless powder was being loaded into bags, some were working on lines where bags were filled with black powder, a more hazardous type of work.

In all bag plants men were doing the heavy work of bringing powder from storage houses to the loading buildings and of pouring the powder into hoppers. Also they were doing the heavy packing at the end of each assembly line.

Miscellaneous occupations.

A few women were foreladies, assistant foreladies, supervisors, and instructors in the bag-loading plants visited, and in a few other plants there were some women supervisors. One plant had a group of 20 who had been specially trained so that they could instruct other women as they were hired, but such an arrangement was rare. In the great majority of plants not only the top production officials but also the line foremen and assistant foremen were predominantly men, even in departments where most of the workers were women. Of course, most of the women had been employed only a few months in most of the plants, in some instances only a few weeks. Further, due to the nature of the industry very few women had had any experience in ammunition prior to the construction of the new plants, but it appeared that many more men than women had been given an opportunity to take the necessary preliminary training to fit them for supervisory positions.

There was a wide range in the number and ratio of women office workers. In about half the plants, more than 100 women were employed in office work. No particular investigation was made concerning the kinds of work these women were doing, but most of them appeared to be engaged in the usual clerical occupations, such as secretaries, stenographers, typists, general clerks, and office-machine operators. Some women were working in employment offices as receptionists, and in some cases as interviewers. In one plant it was stated that several women interviewers had had a considerable amount of training and did a specialized type of interviewing. In spite of the fact that large numbers of women were employed, or eventually would be, in many of the plants, comparatively few women had been taken on to do personnel work with women employees, but in a few instances there was a woman assistant to the personnel director or to the plant official in charge of recreation and welfare. In one plant it was noted that a trained social worker had been engaged as welfare director to give service to all employees.

Since first-aid and hospital facilities are necessary in ammunition manufacturing, professional nurses were found in all the plants. The total number of these was, of course, small. In each plant, also, some women were employed as cafeteria workers, laundry workers, janitresses, and custodians of women's washrooms and change houses, where the women put on plant uniforms. Because of the nature of the industry some women have specialized duties in enforcing safety regulations concerning the type of clothing that must be worn in the

plants and the change-house routine that must be followed. In one plant, for example, the change-house hostess and her assistants inspected the women workers each day to be sure that matches, jewelry, and other forbidden articles were not taken into the explosives areas of the grounds. In some other plants such inspections were made at irregular and unexpected intervals.

Future possibilities for women's employment.

As indicated earlier, the plants included in this survey expect to employ eventually about four times as many women as were employed at the time of visit. A good deal of this expansion was expected to come, of course, through the hiring of more women to operate additional lines as they were ready to begin production, and through the placing of operations on a full three-shift, 7-days-a-week basis. Therefore many women will be hired to do the same kinds of work on which others already are employed.

Further expansion of women's employment in the industry will come also as a result of the beginning of production in new plants. Many of these will handle products similar to those now being made and hence the jobs for women will be much the same. Nevertheless, products will vary somewhat and there will be some differences in jobs. In one plant, which was expecting to load a type of tube not being produced in any of the plants visited, women were to be hired to place onion-skin disks over the ends of the tubes, to stencil data on the outsides of the tubes, and to clean, inspect, and pack them. This work will be quite similar to other kinds already done by some women.

If the present trend continues, it appears probable that women will be used more generally in the future in some occupations on which employed in only scattered instances at time of survey. Many plant officials foresaw an eventual scarcity of male labor. Also, housing shortage and lack of transportation facilities were reported to be serious problems in many areas. For these and other reasons considerable interest was expressed in the possibility of extending the employment of women to other types of work, with a view to taking on more women who reside near the plants, including many from the families of individuals already employed.

In departments where components were being loaded and assembled, it would appear that women could be used for practically all operations except those requiring the handling of heavy boxes in packing departments, and it is probable that expansion of women's employment will occur in such departments. Particular consideration could be given to the possibility of using women more extensively to operate pellet-making machines or loading devices, especially when the machines are manipulated by turning switches and by watching operations from beyond walls or barricades.

However, on most lines producing components a high proportion of the workers already were women, therefore it is on shell-loading lines, and in the assembling of complete rounds of ammunition, that a relatively greater expansion of women's jobs may be feasible. For example, women probably could be used more generally to pour powdered TNT into shells of the smaller sizes. One official stated that he believed women could be used to operate the machines to press this powder into the shells, though his plant was not as yet

using women for this work. Also, since women were operating the presses to fasten primers into the bases of cartridge cases in several plants, presumably they could be used more extensively on this type of work. Even on shells of 75-mm., 105-mm., or larger, some plant officials thought that at least a few women could be used in the future. Such expansion would be dependent partly on the availability of men to do heavy lifting or the use of conveyors or other mechanical equipment that would make heavy work unnecessary.

A few Army officers and other plant officials discussed the possibility of using women eventually on other kinds of jobs on which women were not employed at the time of this survey. For example, the possibility was mentioned of using women in some operations on lines where TNT is melted and poured into shell cavities. Generally such work has not been considered suitable for women, as it involves considerable hazard, but, as has also been said, there is no reason to believe that women are less careful than men.

The opinion frequently has been expressed by persons in the industry that women usually prove more susceptible than men to skin infections and poisoning from TNT, tetryl, and certain other powders. Individual women vary in their susceptibility to such infection and some women might be affected only slightly or not at all. If in cases of emergency or serious shortages of manpower women are tried experimentally on operations of this type, care should be taken to provide suitable uniforms, bathing facilities, milk for drinking, and other precautionary measures known to counteract the effects of exposure to various types of explosives.

It was reported in several plants that consideration was being given to the employment of a woman in the personnel department to take care of the problems of women workers. A report was received from one plant that a woman assistant to the line superintendent would be employed to look after the workers.

While this survey was concerned primarily with the work women actually were doing in connection with plant operations, and to some extent with the possibilities for their future employment in additional kinds of work, it was noted incidentally during plant visits that a considerable number of men were employed in office work. The possibilities of employing women in more of the office jobs were not discussed with plant officials but a few volunteered the opinion that a higher proportion of women would be employed in the future. In a number of plants, for example, young men were employed as reception clerks and interoffice messengers, but in one of the last offices visited it was noted that women were doing this type of work.

TRAINING AND GENERAL PERSONNEL POLICIES

Training.

Because of the nature of the artillery ammunition industry very few experienced women could have been available to work in the plants included in this survey. Moreover, officials of practically all the plants stated that no experience was necessary, and even the bag-loading plants, employing large numbers of power-sewing-machine operators, were hiring chiefly inexperienced workers. Some sewing-machine operators, however, had received preliminary train-

ing through the WPA or NYA, and other workers may have had some general shop or factory training in NYA or vocational-school classes prior to employment.

In most of the plants officials indicated that the jobs women were performing required no great amount of instruction, and the female workers were being trained within the plants after employment. Frequently Army officers and other Government employees had assisted in the setting up of training programs. In one plant it was noted that representatives of a State department of education were studying training needs, with a view to establishing a training program, probably a supplementary course, in a plant that was shortly to begin operating.

In one city a course designed to give training particularly suitable for women desiring employment in a nearby ammunition plant had been established by a public vocational school. All women employed at the plant were taking this course, approximately four weeks in duration. The work covered shop mathematics, sewing-machine operation, machine-shop work, and training in the rapid assembly of a variety of washers, rivets, and wires. The most apt students were given additional training in micrometer reading and other special kinds of work. In another city a course to give preliminary training in fuze assembly and loading with inert materials was being planned by a vocational school.

It has been the general policy of these plants to send a small number of key people to one of the Government arsenals to be trained as foremen, supervisors, and instructors. These people have then trained the rank and file of the other workers. Usually classes have been set up several months before production has started on any large scale, and classes normally would continue as long as large numbers of workers were being hired.

A few plants reported that women had been included among those sent to Government arsenals for training. One bag-loading plant, for example, had sent 6 women, and one shell-loading plant had sent 20. In more instances, though, it was stated that only men had been sent to Government arsenals and that all women had been trained in the plants themselves.

An official of one bag-making plant stated that inexperienced operators work first on small bits of straight sewing in order to become familiar with power sewing machines. Later they sew the more simple parts of bags and they progress gradually to types of work requiring more skill.

Frequently it was reported that workers being trained to handle explosives are given preliminary training in their duties on inert materials. For example, powder bags might first be loaded with corn or beans. A worker might obtain practice in weighing small charges of powder on very finely balanced scales and in pouring the powder into metal parts of ammunition, by going through all the operations using sand instead of powder. Those working with inert materials are trained to follow the procedures and routines necessary in handling explosives. One plant had constructed a model line solely for practice purposes.

Safety education is, of course, one of the most important types of training given to workers in such an industry. In addition to the

preliminary work with inert materials, plants constantly instruct workers concerning safety measures, as well as various types of operations to be performed, by means of lectures and motion pictures. Special manuals and instruction books also are issued to employees.

No generalization can be made from the information obtained concerning the time required for training. This is due partly to differences in the degree of skill required for different jobs and to the amount of hazard involved. In some jobs the training period was said to be only two or three days. In more instances, though, 10 days, or two or three weeks, appeared to be considered necessary. The opinion was expressed in one plant that workers seemed to lose interest in their jobs if the training period with inert materials was longer than two or three weeks. Sometimes new workers are placed beside experienced workers to watch them for a few days before attempting to do much actual work with explosives themselves.

Rates of pay.

In the plants already in operation, minimum rates of pay for women operatives ranged from 40 cents to 65 cents an hour. In one-fourth of them the minimum was 40 cents, but in almost half the beginning rate was 50 cents or more. No definite statistics were available concerning the prevailing rates for women operatives in these plants. Since some plants had been operating only a short time, some officials thought most of their women employees were still on the beginning rates. Others said that a good many women had been advanced to higher rates. Time and one-half the hourly rates was being paid for hours worked in excess of 40 a week.

In a few plants there was a system of automatic advancement for plant operatives at the end of a stated time, usually one to three months. In a good many instances, though, personnel managers stated that advancement was on an individual basis as ability was shown. In one plant an entire group on a production line normally would be advanced together, and could advance several times at the rate of 3 cents an hour. However, in this plant, as is fairly common, a maximum rate for each type of work had been set. A number of plants have worked out detailed systems of job classification and each job calls for a certain rate of pay. Therefore if a worker becomes skilled enough to be advanced to a more responsible job, she automatically receives the rate of pay for that job.

Generally, where each job has a specific rate hazardous jobs carry a higher rate of pay than nonhazardous ones. Several plants reported a minimum rate for those working in hazardous occupations that was 3 to 5 cents an hour higher than the rates for workers in the inert-materials departments. Differentials for work on second and third shifts were not very common. One plant reported that 5 cents an hour more was paid for those shifts, and in another plant workers on the night shift were paid for 8 hours though they worked 7½ hours. In a good many plants shifts were rotated, which was one reason for paying no differential.

Reports were obtained in almost half the plants concerning the minimum rate for men operatives. In only 2 of these were women

and men started at the same base rate of pay, 56 cents in one plant, 60 cents in the other. In 8 plants the differential ranged from 5 cents to 20 cents an hour, and in half of them it amounted to 10 cents or more. It was explained by some officials that men and women were not employed to any extent on the same kinds of jobs, and also that sometimes a man had to be hired to do the heavy lifting for women workers. However, the opinion was expressed by at least one official that probably there was no real justification for wage differentials between men and women in certain productive operations. Expression was given also to the principle that if women were employed on the same jobs as men they should be given the same pay. It should be noted that some work being done by women, such as power-sewing-machine operating and the assembly of small parts, generally is considered unsuitable for men, yet these operations are as intrinsically important to the production of ammunition as the lifting and packing of heavy objects, done traditionally and necessarily by men.

Scheduled hours of work.

In the majority of plants the scheduled hours for women plant operatives were $7\frac{1}{2}$ hours of actual working time a day. The overall time for each shift generally was 8 hours, with a lunch period of one-half hour. In some instances women were paid for this lunch period. Other plants had a scheduled workday of 8 full hours.

Two of the operating plants had 45-minute lunch periods; all the others but 2 had 30 minutes. The 2 exceptions had scheduled lunch periods of only 20 minutes but had short rest periods morning and afternoon. In a number of other plants rest periods of 10 minutes, and in one case of 15 minutes, were given twice a day.

The usual schedule for women was 6 days a week, making the normal weekly hours generally 45 or 48. However, because many of the plants were new, and most of them still were recruiting workers, certain irregularities in hours were reported. Though some women were working only 5 days a week, in 2 plants women had been working 7 days for some weeks. It was stated of the latter, however, that the practice was being followed because of an emergency and was not to be continued indefinitely.

Several of the operating plants were using some women on each of the three shifts, and the same number of others were employing them on two shifts. The remainder had women on only one shift. It was expected that many more women would be employed on second and third shifts as the plants approached peak production. Rotation of shifts was common and the most usual period of work on one shift before changing to another was two weeks, though two plants reported that shifts were being rotated weekly.

State laws concerning the working hours of women in manufacturing vary considerably in the States in which the plants surveyed are located. Three have no laws governing the weekly or daily hours of women workers. One State has a limitation of 45 hours a week and 3 others have laws providing for 48 hours. The laws of the other States permit a greater number of hours weekly. Three of the States have provisions limiting the hours of work to 8 a day, and in 4 the hours are limited to 9 a day. Only 3 of the

States have laws prohibiting or limiting the night work of women. Moreover, during the war emergency State authorities generally are issuing special permits or are making adjustments with respect to women's hours of work in specific plants engaged on war production where such arrangements are shown to be necessary.

Requirements for hiring.

In most plants the minimum age limit for women was 18 years; 3 were hiring no women under 21. In the beginning there apparently was a tendency to hire the younger workers, but over half of the operating plants reported no maximum-age restrictions for women. A number of women obviously over 40 were seen at work in some plants, but the majority probably were under 35. Most of the operating plants require physical examination prior to employment, which frequently includes tests of the heart, lungs, eyes, ears, and blood pressure; another plant was planning to give such examinations. The physical examination requirements probably tend to favor the younger group of workers.

There were no restrictions against married women as employees. No specific information had been compiled in the various plants, but a number of personnel managers estimated that probably at least half of their women employees were married. In some areas there was definite interest in recruiting more housewives from the nearby towns to work in the plants. This was especially feasible because of the absence of any necessity of previous experience.

Because of the character of the industry all workers in these ammunition plants must be citizens of the United States. Investigation of an applicant's previous employment record and general background and character is made in all cases by plant officials and members of the Federal Bureau of Investigation. Some application blanks call for many references, and fingerprints are taken of all prospective employees.

Food service.

Because of the large areas covered by these ammunition plants and the scattering of the buildings at considerable distances, the problem of providing hot food for the workers is difficult. A cafeteria near the administrative buildings is too far away from the production lines to serve the workers at lunch time except in a few of the operating plants visited. Eight plants had made some provision to get food to the production departments. In a few of these the central cafeteria was near enough to production lines to be used by all workers; where it was not, the plants had solved the problem by the erection of canteens in the shelter houses or in other buildings adjacent to the lines, or by transporting lunches to the workers by means of carts. Usually the lunch consisted of sandwiches and other cold dishes, but always hot coffee and in some cases such foods as soup were served. In the other plants it was stated that most workers were bringing their own lunches. Officials of several of these said that some consideration was being given by the companies to the possibility of erecting food facilities and of transporting food to the lines. Two plants apparently had given no particular consideration to making provision for serving any type of hot food to the plant operatives.

Uniforms.

Three-fourths of the plants already operating reported that some women employees were required to wear uniforms, and at least two others expected to have uniforms later. In a number of plants only those women on hazardous occupations, or in certain types of hazardous work, were required to wear uniforms. At the time of visit, women in bag-making departments generally were not wearing a uniform but some of them expected to begin this practice later. Two types of uniform were being used, some kind of washable slack suit and a cotton one-piece dress. For purposes of safety, slit pockets and rubber buttons were commonly used on these uniforms.

Some plants stated that employees' uniforms were provided by the company, but even in instances where the employees were supposed to provide their own, all laundering was done by the plants. This is really essential from the point of view of safety. Persons working in explosives departments are supposed to wear safety shoes; also, there are other safety regulations generally followed, such as stipulations against the wearing of metal hairpins and jewelry, or any other kinds of metal, in areas where such articles might cause an explosion.

General working conditions.

Special attention was paid during the construction of the new plants to the provision of certain facilities as aids to safe operation. All but 2 of the operating plants visited had new buildings, and 1 of the others was constructing a new plant while operations were continuing in its old buildings. The new buildings generally were clean, well ventilated, and well lighted. Fluorescent lighting systems were noted frequently. Obviously all buildings in explosives areas must be well built of noninflammable materials. These buildings are situated at considerable distances from each other for purposes of safety, and "shelter houses" or "bomb proofs" to which the workers can go in case of an electrical storm or other emergency are near the production lines.

The new buildings generally are provided with many exits. For example, in one rather typical building visited it was noted that there were doors near each end of every work table. The buildings usually were only one floor in height; but in instances where buildings had more than one floor, chutes had been provided down which workers could slide from the second floor in case of an emergency.

Other safety measures, not all of which can be mentioned in a brief report, are common. Much of the most hazardous work is done in very small compartments enclosed by thick walls or barricades so that an explosion is not likely to affect a large number of people. Placards announcing the number of persons and the maximum amount of explosives allowed in each particular room or compartment generally are posted in the buildings.

Because of the distances to be covered, transportation within and between the buildings is essential. Usually this appeared to be supplied by special buses operated by the plants themselves.

Hospitals, first-aid facilities, fire and police protection are essential in ammunition plants. All plants reporting had hospital facilities or

were constructing them. Nurses, doctors, and persons trained in first aid were available. Also, all plants but one stated that entrance medical examinations were required for workers; the other planned to require such examinations when its hospital facilities were completed. Some plant officials stated that periodic medical examinations were to be given, but complete information on this subject was not obtained.

