LECTURE

ORDNANCE DEPARTMENT WAR PLANS

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by

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## I. OUTLINE.

1. In this paper it is proposed to discuss war planning of the Ordnance Department under five general headings.

(1) The mission of the Ordnance Department.
(2) The general problem of the Ordnance Department in carrying out its mission.
(3) A brief description of the organization of the Ordnance Department to meet the problem.
(4) Description of the steps involved in the procurement of a specific item as an illustration.
(5) Discussion of some of the difficulties which are special to the Ordnance Department in carrying out the plan.

## II. MISSION.

2. General. The mission of the Ordnance Department is to supply Ordnance to our Armies at least equal in quality and quantity to that of the enemy. This includes design, procurement, storage, issue and maintenance.

3. Peace Time Activities. In peace time activities are limited by funds available. Procurement, supply and maintenance is limited to the relatively small number of active units of the army. Procurement is consequently very limited. Work is concentrated on projects for development of improved armament. Design and test are emphasized. This is a logical situation because new and improved types should be made standard in peace time, whether any quantity is procured or not. Time, after the emergency arises, is a vital element. Time spent after M Day in development, test and standardization of any article delays the procurement of that particular item by at least that amount, and probably more since it confuses the whole procurement program.

4. War Activities. In an emergency the situation is somewhat reversed. Procurement, supply and maintenance are the paramount things, and of these procurement is by far the most difficult to accomplish. This becomes obvious when it is considered that for just one item in a major emergency such as 75 mm shell, the monthly requirement may run as high as 4,000,000. With some 200 major items of Ordnance to be procured, nearly all of equal importance, the size of the procurement problem is seen to be enormous.

III. PROBLEM.

5. Non-Commercial. The very great majority of Ordnance items have no counterpart in commercial production. Special manufacture is required. Facilities capable of conversion to the manufacture of Ordnance exist in a number of cases, but even these must have a new set up before any guns or ammunition can be produced. For example, the General Fire Proofing Company makers of steel furniture is asked to make shrapnel, the Burroughs Adding Machine Company, pistols, and the Reo Motor Company, Tanks, Colt, Winchester and Remington make small arms for the sporting trade. Their manufacture is probably the nearest approach to finished items of Ordnance that exist in commercial production. Even these plants require months before they can reach quantity production of our standard small arms. There are some powder making companies operating in peace time. Their capacity without expansion of existing facilities is about 1,000,000 pounds per month, while the war requirements may run as high as 40,000,000 pounds per month.

6. Disproportionate Requirements. The problem which the Ordnance Department has for the determination of requirements is not at all parallel to that for other supply services. Take for example, ammunition, in peace time our total consumption of ammunition is only that used in target practice, which is a very small quantity, yet in case of war we must supply certain number of rounds per gun, per day, for every gun in the Theater of Operations and another rate for each gun in training. Equipment and supplies for each individual soldier, which are common to all, remain the same whether that man be Infantry, Cavalry or Artillery. He eats the same amount of food in peace as he does in war. These requirements then can therefore be based on units of 1,000 or 10,000 men and the total easily determined. On the other hand most of Ordnance is organizational equipment. A 75 mm Gun Regiment takes 24 guns whether it be peace or war strength. A Division takes 48 of these guns regardless of its strength. When the divisions are organized in the Corps, the ratio of guns to the number of men varies again because the number of men is increased, but there are no additional 75 mm guns in the corps artillery. By comparing the curves of total personnel mobilized, and 75 mm gun requirements, ratios can be determined showing the number of guns required for units of 10,000 men. However, these ratios vary very materially in different months of mobilization of any one plan. Further these ratios vary for different plans. In the 1924 General Mobilization Plan this ratio varies ffom 44 in the first month to 16 in the 9th month, while in the 1928 General Mobilization Plan they vary from 10 in the first month to 13 in the 10th month. Another phase occurs in connection with the mobilization of units because the forces are not balanced in any one period. The 1928 General Mobilization Plan mobilizes prac-

tically all Antiaircraft Regiments in the early stages but has scarcely any thereafter. Units such as Laundry Companies armed with pistols are mobilized at a later date increasing the number of pistols per 10,000 men very materially. It has been suggested that requirements be determined by means of equipment related to main items. For example, the 75 mm gun always has with it sights, caissons, fire control equipment, etc. In some of these items a ratio can be obtained for initial equipment between the main item and the related item. However, a number of these related items also accompany other main items such as the 155 mm Howitzer and 155 mm gun, etc. Again the wastage ratio for the related equipment is not the same as that for the main item, which further confuses the calculations. In the case of the 75 mm gun the related equipment varies for the different types of regiments. The horse-drawn varies from the tractor-drawn and varies again from the portee. A later suggestion which appears to have merit, although it has not been tried on a complete plan, is based on the general similarity in rates of requirements over certain periods in general mobilization plans. Graphs were plotted for several items of different classes for both the 1924 and the 1928 General Mobilization Plans, and it was found that requirements from M Day to the month of stabilization in practically all cases have rather definite points of similarity. The month of stabilization is taken as the month when all units are in the Theater of Operations. In every case practically 80% of the total cumulative requirements, up to the month of stabilization, were required by the time all initial equipment was issued. After that the monthly rate is practically uniform up to the month of stabilization. In this method requirements are calculated for M Day and for the month of stabilization. 80% of the latter are required by the month when all units are initially equipped. The remainder of the work is then interpolation at an even rate. This method materially reduces the time and labor required.

7. Wastage Factors. Wastage factors for Ordnance vary tremendously between peace and war. We might assume that a passenger car would have approximately the same wear and tear in peace use as it would have in war use. The 75 mm gun on the other hand in peace time will last a great number of years if properly cared for. In the Theater of Operations the monthly wastage for the 75mm guns is 8%, which would correspond to 100% replacement over 12 months. Similar factors must be determined for all items of Ordnance equipment. The consumption factors vary in the same fashion for example, the ammunition used in peace time is very small, yet for the 75 mm guns in the Theater of Operations the rate of consumption is figured at the rate of 40 rounds per gun, per day. For such things as commercial hardware and accessories,

it has been assumed for wastage calculations that -

7 days intensive firing is equivalent to -

1 month in the Theater of Operations,
3 months in the Zone of the Interior, or
6 months Peace Time Operation.

The peace wastage of this class of items then can be used to determine the war requirements. Exhibit - 1

IV. ORGANIZATION.

8. General. In order to explain the war planning organization it is believed best to first discuss briefly the organization of the Ordnance Department. Exhibit - 2

The Office of the Chief of Ordnance has 4 major groups, their names indicate somewhat the general duties of each. They are -

General Office
Manufacturing Service
Field Service, and
Technical Staff.

9. The General Office. This office includes the personal office of the Chief of Ordnance and has in addition 7 divisions which under the direction of the Executive Officer, performs the executive and administrative duties common to various activities of the Ordnance Department. The divisions are -

Executive
Administrative
Advisory
Military Personnel and Training
Civilian Personnel
Fiscal, and
War Plans.

10. Manufacturing Service. The Manufacturing Service is charged with the design, development, production, procurement, inspection and acceptance of Ordnance materiel. It has 5 main divisions -

Executive
Ammunition
Artillery
Small Arms, and
Gage.

The Manufacturing Service operates 6 manufacturing arsenals -

| | |
|---|---|
| Frankford: | Fire Control Instruments,<br>Small Arms Ammunition,<br>Fuzes. |
| Rock Island: | Mobile Artillery Carriages. |
| Picatinny: | Artillery ammunition,<br>Explosives,<br>Fuzes. |
| Springfield: | Small Arms. |
| Watertown: | Heavy artillery carriages. |
| Watervliet: | Cannon. |

The 14 procurement districts are under its control. In war time it would also operate the government loading plants and acceptance proving grounds. The procurement districts are considered to be the backbone of our procurement organization. When it is realized that the arsenals can produce only about 5% of the total requirements for the major emergency, the relative importance of the districts is seen to be very great. The districts are headed in each case by civilians prominent in the business world and well known in his district. In his office he has an executive officer, who is a regular officer of the Ordnance Department, and one clerk. Exhibit - 3

It is interesting to note here what caliber of men occupy the positions of district chiefs at the present time. They are -

| District | District Chief | Business Affiliations |
|---|---|---|
| Boston | Col. Charles H. Tenney | Pres., Charles H. Tenney & Co., (Public Utilities) Springfield, Mass. |
| Bridgeport | Col. B. A. Franklin | Vice-Pres., Strathmore Paper Co., Mittineugue, Mass. |
| New York | Col. James L. Walsh | Vice-Pres., Guardian Detroit Bank, Detroit, Mich. Formerly Ass't. Vice-Pres., Bankers Trust Co., New York. |
| Buffalo | Col. Ledyard Cogswell | Financier, Albany, New York. |
| Philadelphia | Mr. John Clifford Jones | Vice-Pres. and Gen. Manager, H.S.B.W. Cochrane Corp., Philadelphia, Penna. |
| Pittsburgh | Mr. Frank B. Bell | Pres., Edgewater Steel Co., Pittsburgh, Pa. |
| Baltimore | Mr. Howard Bruce | Pres., Bartlett-Hayward Co., Baltimore, Md. |
| Cleveland | Mr. Henry C. Osborn | Pres., The American Multigraph Co., Cleveland, O. |
| Cincinnati | Col. Chas. L. Harrison | Pres., Cincinnati Terminal Warehouse Co., Cincinnati, Ohio. |
| Birmingham | Col. John Stephen Sewell | Pres., Alabama Marble Co., Birmingham, Ala., Graduate West Point 1891. Built the War College, Fine Overseas record in Engineer Corps. |
| Detroit | | |
| Chicago | Mr. E. A. Russell | Retired, Formerly Vice-Pres., Otis Elevator Co., Chicago, Ill. |
| St. Louis | Col. M. E. Singleton | Financier, St. Louis, Mo. |
| San Francisco | Col. Bruce Cornwall | Member of firm: Caldwell, Cornwall and Banker, Real Estate, San Francisco, Cal. |

In peace the districts are expected to plan their organization, tentatively place orders for quantity production of the items assigned to the district, and see that factory plans are made. The small force available for district offices, due to the limited funds available, causes work to be slow. It would be desirable to have one or more production engineers to work on plant surveys and assist in factory plans. In a major emergency the district places orders, inspects and accepts the product, unless a proving ground test is necessary.

11. Field Service. Field Service is charged with the storage, issue, inspection and maintenance of Ordnance materiel. It has 4 main divisions, as follows:

Executive,
Ammunition Supply,
General Supply, and
Maintenance.

Field Service in peace time operates 10 storage and issue depots. They are -

| | | |
|---|---|---|
| General Supplies | - | Augusta Arsenal,<br>Benicia Arsenal,<br>Erie,<br>Raritan, and<br>San Antonio. |
| Ammunition | - | Charleston Ord. Depot<br>Curtis Bay " "<br>Delaware " "<br>Nansemond " "<br>Savanna " " |

and two Ammunition Storage Depots - Ogden, and Wingate.

12. Technical Staff. Renders technical advice, conducts tests of experimental materiel, keeps records concerning standards for supply and procurement, maintains technical liaison and distributes technical information. It has 4 main divisions -

Executive,
Ammunition,
Artillery, and
Small Arms.

In the Technical Staff there is also the Ordnance Committee, which is composed of members of the Ordnance Department and officers of other interested arms and services. It recommends action effecting experimental materiel. The Technical Staff operates the

Aberdeen Proving Ground where tests of experimental materiel are carried on. It is also charged with the preparation of plans for typical proving grounds which would be necessary in a major emergency for acceptance tests of Ordnance materiel.

13. Peace and War Organization.

a. Decentralization. The organization which has just been outlined is intended to be the same in peace and in war only expansion of the various divisions or sections as required. The organization for war planning is decentralized as far as practicable, each group having its own war planning section. This organization is based on the principle that it is better to have the division which is charged with the execution of any part of a plan, prepare that part of the plan. This method while more difficult to carry on in peace than a centralized organization, brings to the attention of all personnel the possible requirements in an emergency and keeps alive the information in the hands of those who will have the detailed work to carry out.

b. Planning divisions and changes. The War Plans Division of the General Office is charged with the general supervision of all war planning for the Ordnance Department. This division determines the requirements according to the troop basis issued by the War Department. This total requirement is then compared with the existing stocks and the difference is the procurement requirement which is furnished to the Manufacturing Service for action. The total requirement and the procurement requirement are furnished the Field Service for use in their plan for distribution. In war the War Plans Division would become merely a requirements division with a statistical section. The War Plans Section of the Manufacturing Service would become the Progress Section. The small war plans sections in divisions would rapidly be absorbed in current work. In this expansion the Automotive Section of the Artillery Division would undoubtedly become a separate division and the Aircraft Armament Section of the Small Arms Division would become a separate division.

V. ILLUSTRATION.

14. In order to present a definite picture of the steps taken regarding any one item for its standardization and procurement, let us take an hypothetical example,

Assume that the Field Artillery desire a new type carriage for a 75 mm gun: Exhibit 4

(1) The Chief of Field Artillery initiates a request to the War Department for the development of the carriage stating the reasons, and the desired military characteristics such as traverse, weight, rate of fire, how transported, etc.

(2) The Secretary of War approves the military characteristics and authorizes the Chief of Ordnance to proceed with the development.

(3) The Technical Staff, Office Chief of Ordnance, sets up a development project for the carriage going into such detail as may be necessary.

(4) The Artillery Division of the Manufacturing Service makes a preliminary design.

(5) In consultation with the Technical Staff the design is approved. Representatives of the Chief of Field Artillery are consulted, and approve the design thru the Ordnance Committee.

(6) The Fiscal Division in the meantime has set up funds to cover the project, if they are available, and has made necessary allotment to the Artillery Division.

(7) The Rock Island Arsenal then manufactures the pilot carriage according to the design and instructions given by the Artillery Division.

(8) The Aberdeen Proving Ground tests the carriage according to a program given by the Technical Staff.

(9) If successful in these tests the carriage goes then to the Field Artillery Board for test.

(10) The Technical Staff recommends adoption as standard and whether the item is essential or not. By essential is meant whether the item is necessary to the combat efficiency of troops and is unobtainable from civil stocks or production in the time and quantity required.

(11) The Assistant Secretary of War considers the design and the materials entering into it, and approves it for procurement.

(12) The Secretary of War approves it as standard and specifies whether it will be considered as an essential item or not.

(13) The Technical Staff now enters the item in the Book of Standards.

Exhibit - 5

(14) The Artillery Division of the Manufacturing Service completes the drawings, specifications and list of parts for manufacture. Exhibit - 6

(15) The Gage Division designs inspection gages, checks tolerances, gaging points, etc. for the manufacture of the item. As an indication of the number of gages required for inspection it may be noted that 295 gages are required for a complete round of 75 mm shrapnel. For the receiver only of the 1903 rifle 246 gages are required. Exhibit - 7

(16) The Rock Island Arsenal prepares a description of manufacture for the carriage. This may be a complete description stating exactly the machines by model, size, etc. with the exact description of each operation to be performed in sequence, the time required for each operation, the routing of each piece thru the shop and the bill of material. Or it may be an abstract showing the machines required, number of operations for each machine, time required by each machine, and material required. This will be used in making factory plans for production by commercial firms. Exhibit - 8

(17) The Chief of Field Artillery then indicates the basis of issue desired.

(18) a. The War Plans Division, General Office incorporates the allowances in the War Planning Equipment Chart. Exhibit - 9

b. The same division in cooperation with the Maintenance Division, Field Service determines the wastage factors for this carriage in the Theater of Operations and in the Zone of the Interior and recommends them to the General Staff for approval. Exhibit - 10

(19) The War Department, General Staff approves the wastage factors.

(20) Field Service determines the essential accessories and spare parts required to maintain the main item for 6 months.

(21) The War Department, General Staff issues the troop basis which includes troops armed with this weapon, gives the rate of mobilization and rate of entry into the Theater of Operations. Exhibit - 11

(22) a. The War Plans Division, General Office computes the total military requirements by months. These requirements include initial equipment, overhead for distribution and wastage. The total requirements for the carriage must provide also for sufficient accessories, and extra component parts to maintain the

carriage for its expected life in action. The determined wastage factor takes into account the expected life of the carriage. For similar carriages the wastage factor used is 4% per month in the Theater of Operations. At this rate 50% of the carriages in the Theater of Operations would be replaced in 12 months. Requirements of essential accessories and spare parts are then listed in sets per 100 carriages for life. These form the basis of procurement requirements for spare parts and accessories. Exhibits 12 & 13

b. After consideration of stocks on hand the War Plans Division, General Office determines the procurement requirement. These are furnished to the Manufacturing Service for procurement. Exhibit - 14.

(23) Assume this carriage is to be procured in the Cleveland and Chicago Districts. The Artillery Division tentatively apportions the requirements to these districts, furnishing the required data in drawings, specifications, list of parts and descriptions of manufacture. Exhibit - 15

(24) The districts then in consultation with plants available estimate the possible production and make a report to the Artillery Division. Exhibit - 16

(25) a. The Artillery Division considers these estimates, and the suitability of the plants recommended, and issues apportionments to the districts who will place accepted schedules of production with the companies selected.

b. The Manufacturing Service then reports to the War Plans Division, General Office the total estimated production. This information is used by the War Plans Division and by Field Service in comparison with the total requirements and existing stock to determine what shortage, if any, will occur for supply. Exhibit 18

(26) The Districts, or the plants having the tentative orders, prepare Factory Plans based upon the factory equipment available compared with the description of manufacture. Factory Plans are made in more or less detail depending on the amount of deficiency of production to meet requirements. Exhibit - 19

(27) The Artillery Division upon receipt of the Factory Plans prepares a specific procurement plan. Exhibit - 20

(28) The Assistant Secretary of War approves the specific procurement plan.

This example has assumed ideal conditions. No account has been taken of any troubles that might arise in carrying it out. Practically much of the work is done out of the order stated.

Undoubtedly the whold procedure would rarely move smoothly thru all these steps. For example the service test will probably indicate desired changes in any pilot. In such a case the pilot is returned to the Ordnance Department for modification and steps 4 to 9 inclusive, from design, manufacture, etc. to test are repeated. This may happen more than once for the same pilot. Please do not mistake me by assuming that all these steps have been taken for all items of Ordnance. Much work remains to be done.

## VI. DIFFICULTIES INHERENT TO THE PROBLEM.

There are a great many difficulties encountered in meeting the problem besides lack of funds and personnel.

15. Rearmament. One complication is rearmament. Undoubtedly our armies should be armed with the very best and latest types obtainable. In the case of the 75 mm guns, our stocks consist of the M1897 (French), the M1916 (U.S.) and the M1917 (British). The standard is the M1, of which very few exist. There is no production for this standard, nor are there any facilities tooled up or equipped to jump right into production. It would then be necessary to use the existing models to arm troops in the first months of a war. Further it would be necessary to manufacture sufficient spares of the best old model (1897) to maintain or replace those in existence. Reasonably early production is feasible here because the M1897 was manufactured; tools, jigs, fixtures and gages were retained for this model. Early production at arsenals can be established to handle the requirements for this model. On the other hand it will take many months to get a set up to produce the M1 gun. It is planned to produce this gun in the Chicago and Cleveland districts, and it is estimated that production can reach a sufficient quantity to start rearmament in the 12th month with the M1 gun. Even the ammunition for this gun is different from that for the other models, and production must be built up for this ammunition at the same time that ammunition for the other gun is being produced. When rearmament starts the production of the older model of gun and ammunition must be cut down, and possibly this production may be converted to the manufacture of the new M1 type guns and ammunition.

16. Ammunition Components. The termination of the World War left plants with contracts for the production of great quantities of Ordnance. These were actually in production. The cancellation of these contracts and stopping of production in various stages of manufacture left large stocks of components, most of which were unbalanced. This was particularly true in the case of artillery ammunition. Early production of ammunition depends to a great extent on the use of these components. Studies have therefore

been made with a view to determining the amounts, location and condition of such components, and to develop a plan for their utilization. Requirements of components to balance existing stocks were determined and facilities located which were capable of producing them at the required rate. Commercial facilities are used as far as practicable, and are chosen so as not to interfere with production of complete rounds.

17. Loading Plants. The use of these components leads up to the question of loading. Since maximum use must be made of these components in early production, and in many cases the components exist in an unloaded condition, it is essential that provision be made for the loading of such components as rapidly as possible. The only existing facilities for loading are Picatinny Arsenal and six renovation plants at ammunition depots. The capacity of Picatinny is more comparable to that of a laboratory than to the total capacity for major emergency production. The renovation plants are now reworking artillery ammunition on hand to make it serviceable. It has been decided to build government plants to load components and assemble them into complete rounds. It is planned to have 16 of these plants, of which 4 will be expansion of present renovation plants. It is estimated they will cost $100,000,000 and require 55,000 men to operate them. It is contemplated that a few of these plants will be created by commercial facilities. Exhibit - 21

18. Manufacturing Proving Grounds. The Aberdeen Proving Ground has not sufficient capacity to handle all acceptance tests which would be required. All artillery ammunition, guns, carriages, bombs and pyrotechnics require such tests for acceptance. It will, therefore, be necessary to establish additional proving grounds to conduct acceptance tests. Present plans call for four new proving grounds, located as conveniently to production centers as is practicable for the tests of new material and ammunition. The Aberdeen Proving Ground has prepared typical data which may be used for new proving grounds.

19. Spare Parts and Accessories. Requirements are not complete when they have been determined for the main item only. The number of spare parts and accessories required for the major items run into the thousands. The computation of the requirements for these parts calls for a great deal of time and labor. Obviously it is easier to procure extra parts at the same time the major item is being manufactured. Their requirements must accompany the requirement for the major item. Studies are, therefore, made for each major item based upon experience with that and similar items to determine the rate of replacement of parts. The parts required are then listed in sets per 100 or 1000 of the major item for life to be procured at the same time as the major item. For major items of which there is a considerable stock on hand, requirements of spare parts are determined in a similar manner. That is the set of spare parts per 100 or 1000 of the major item for life are used

to determine the quantity of spare parts required for life of the total number of the major items on hand. This requirement when compared to the stock of spare parts on hand, shows the procurement needed to balance the existing stock of spare parts. These requirements are in addition to those parts to maintain the major items under manufacture. Exhibit - 22

20. Optical Instruments. Optical instruments are made up of metal components and optical glass. The capacity of existing plants which specialize in complete optical instruments is not sufficient to meet our requirements. The production of metal components is not at all similar to the production of optical glass. It will therefore be necessary in using additional facilities not now making optical instruments to procure the metal components from one class of plant and optical glass from other sources, and arrange for assembly at plants now familiar with instruments. The procurement of the metal parts present no difficult problem since they are relatively easy to manufacture. The few plants now making optical glass produce an excellent quality of glass, but their capacity is limited. It has been estimated that if the capacity of commercial plants and the bureau of standards be expanded and further augmented by one additional plant to be built, that the total capacity will be sufficient to meet our requirements after one year. There would be a shortage from production up to that time. Exhibit - 23

21. Hydro-Pneumatic Recoil Mechanisms. These mechanisms are very difficult to manufacture. They must retain gas and liquid both of which are in contact with moving parts. The tolerances permitted are very small, and a mirror like finish is required in the cylinders. These mechanisms were manufactured during the World War in plants specially constructed for the purpose, but only after much delay. In peace time all such work has been concentrated at Rock Island Arsenal in order to keep the art alive. This arsenal has not sufficient capacity for war requirements however and certainly private plants will have to be used. By making Rock Island Arsenal the center for such information and making it responsible for their procurement, it is believed that enough plants can be allocated to produce the mechanisms required.

22. Strategic Materials. In the design of Ordnance care must be exercised to avoid if possible the use of material which cannot be obtained in quantity under war conditions. In the design of a gun carriage it may be possible by the use of certain alloys of steel to reduce the weight considerably, but if this alloy is such that quantity production is not possible, a redesign would be necessary. There are some 26 raw materials which are regarded as strategical. Strategic materials are those essential

to national defense, which come in whole or in part from sources outside the Continental United States and for which there are no satisfactory substitutes available in the United States. Studies are being made constantly to either develop resources within the United States for the supply of these materials, or to adopt suitable substitutes for them. Nitrate has been a strategic material since our main source of supply was Chile. Manufacturing methods have developed so far however, that there is believed to be a sufficient capacity in the United States to meet requirements. The Allied Chemical Company has a plant in Virginia which if kept in operation could produce a great portion of the requirement. Experiments are being made to substitute cotton for silk in powder bags. It has been found that rayon can be used for parts of the bags, and the requirement for silk can be reduced accordingly. Some of the strategic materials that the Ordnance Department is particularly interested in are -

Antimony
Chromium
Manganese
Nickel
Nitrates
Platinum
Quicksilver
Silk
Tin, and
Tungsten

Exhibit - 24

23. Gages. You have seen something of the size of the gage problem. These gages are difficult to make, and a great deal of time is required if they are to be made available. Yet they are the essential things that in commercial production make it possible for you to buy a spare part for your car, that can replace a broken or worn out part and insure the car working as well as before. It has been the policy of the department to preserve all gages, jigs, fixtures that were used in the manufacture of standard items. There are on hand a very considerable quantity which pertain to existing types of material in service. However, we are confronted with the necessity for the design and manufacture of these for new standards and changes in old standards in a great many cases. The gages designed by us are for the government inspection, and do not provide any for manufacture. The two sets are different, for certainly if inspection gages call for a tolerance of .005, the manufacturer cannot expect every piece to meet this exact figure. He takes a smaller tolerance, say 10% less that the inspection gage, and expects by that means to have less rejections. The annual appropriation for gages for the past few years has been $75,000. That covers design, storage, maintenance and new manufacture (except

where they are manufactured as part of the cost of the main item.) Right now the inspection gages on hand are valued at around $18,000,000. The annual appropriation does not go very far.

New Processes of Manufacture. Constant improvement is being made in manufacturing processes.

24. Welding. A few years ago all artillery carriages were made up largely of steel castings, but lately satisfactory types have been built where practically all castings replaced by built up welded construction. Both the time required and cost are reduced by this method.

25. Cold Working Process. For many years guns were built up by making the tube and shrinking jackets and hoops on it to reach the required strength. Processes have now been developed for guns up to a caliber of 6-inch, where a single forged tube can be used, and by applying interior pressure under certain circumstances the strength of the tube is made even stronger than that of the built up gun. This process will save about one third the time and cost of manufacture.

26. Centrifugal Casting for Guns. Experiments are being made also for the manufacture of cannon of calibers smaller than 6-inch by centrifugal casting. The molten metal is poured in a rapidly turning mold, and the metal is cast against the side of the mold in the desired shape. This method gives promise of being quite successful for smaller cannon.

27. Seamless Tubing. Improved methods have developed for the manufacture of seamless steel tubing where tubes can be made up to about 12 inches with practically any thickness of wall. Probably such tubing can eventually be used to replace the forgings now used for shell.

28. Machine Tools. The design of machine tools has gone forward by leaps and bounds within the last ten years. Equipment of this kind, which in 1917 and 1918 was very modern, is now in many cases obsolete.

29. Educational Orders. Quantity production of munitions is greatly hindered and delayed by lack of knowledge of their manufacture in commercial plants. It has been pointed out by manufacturers that much earlier production could be reached if plants in time of peace had the opportunity to make munitions in small quantities so that at least a nucleus of their personnel would be familiar with the production. This nucleus would be available for instruction of the much larger force required for quantity production. Existing laws require that for non-commercial products that the arsenals be used if they can produce the product econimically.

If purchases are made from private plants, it must be by bid, and the contract goes to the lowest bidder. If it were possible to place small orders with the plants now allocated for the production of certain products the interest of the manufacturer would be kept up, and the plant would at least have some experience in the production of munitions similar to those which they would be called upon to make in a major emergency. Bills have been introduced in Congress for this purpose, but so far none have passed.

30. Factory Plans. The factory plan for a major item of equipment if it is complete will cost from $10,000 to $15,000. Manufacturing companies, though willing to cooperate in planning, and are willing that their personnel consider the manufacture of items are not willing to spend that much money on exact plans, where every step is taken up and a solution planned for each forseen difficulty from the purchase of raw material to the routing thru the plant, etc. to the finished product. When an arsenal prepares a description of manufacture, it is based on equipment available there and with which the personnel is familiar. There are no two factories equipped exactly alike, so that while the arsenal may specify machines of certain kind, type and capacity, it is most certain that the plant having the order will not have exactly the same equipment. The plant is of course interested in seeing a successful plan for manufacture. However, considerable adjustment is required even if the plant would manufacture according to the description of manufacture. Abbreviated descriptions of manufacture showing only the type of machines and capacity, the operations to be performed, the time required and the bill of material have been prepared in many cases where complete plans take too long to assemble. This then when compared with the equipment in any plant shows very rapidly the capacity of the plant to manufacture a certain article, and indicates what equipment is short. The estimate made by this method is certainly accurate enough for planning, and at the same time does not attempt to build up the detail required finally for the manufacture. That detail is so liable to change, thru shifts of equipment, personnel, and improved methods, that generally speaking it is not desirable to build up any mass of such data.

31. War Reserve. This subject is a very vital one for arming forces mobilized. There is no doubt but that men can be mobilized and sent into the Theater of Operations ahead of the time that the necessary munitions could be produced to properly equip them. In the matter of Ordnance, where special manufacture is required for most articles, this shortage of equipment and ammunition would be disastrous. It is absolutely necessary that suitable reserves be kept on hand to tide over the period when production is getting under way. Plans for reserves to be

maintained include only essential items. These are items necessary to the combat efficiency of troops and unobtainable from civil stocks or production in the time and quantity required. They are determined by calculating the equipment required for a troop basis furnished by the General Staff for this purpose only. These cumulative requirements are compared with the cumulative estimated production. The maximum deficit then is taken as the war reserve to be maintained. The large quantities of finished material and components left from the last war have made it possible to at least have a war reserve somewhat like we should have. These stocks are not balanced however, for equipping troops, and also for some items stocks of components even are not balanced. Various studies have been made with a view of establishing what should be in the War Reserve. Congress has in the last few years stated in the appropriation act that stocks will not be depleted below those necessary to supply two armies or 1,000,000 men. The War Department has issued two troop bases for determining the war reserve. The 1927 War Reserve now in force is based on the first two armies of the 1924 General Mobilization Plan. Another known as the 1929 War Reserve based on the first Two Armies of the 1928 General Mobilization Plan has been calculated and goes into effect July 1, 1932. The greatest deficit in both is in antiaircraft artillery and fire control and all kinds of ammunition. The ammunition stocks have constantly been depleted by target practice allowances, and deterioration. Estimates are made each year of funds required to complete the reserve. However, only a very small portion usually about $25,000 annually has been appropriated to augment the War Reserve. Most of this is used to procure ammunition. Effort is constantly being made to build up the items where the greatest shortage exists, with due regard of course to its importance in early stages of any mobilization. Some figures as to the value and status of the war reserve are given below. The 1929 War Reserve is much larger than the 1927, because the rate of mobilization is so much faster. These figures are made up as of November 1, 1930 and include the Two Army Reserve, the Overseas Defense Projects, and the Seacoast Defenses of the Continental United States.

| | 1927 War Reserve | 1929 War Reserve |
|---|---|---|
| **Ammunition** | | |
| Value of Applicable Stocks on Hand | 480,000,000 | 480,000,000 |
| Cost to renovate unserviceable Stocks | 6,000,000 | 6,000,000 |
| Net Value | 474,000,000 | 474,000,000 |
| Replacement Value of Authorized W.R. | 830,000,000 | 1,024,000,000 |
| Cost to make W.R. complete and serviceable | 356,000,000 | 550,000,000 |
| **Equipment** | | |
| Value of Applicable Stocks on Hand | 266,000,000 | 316,000,000 |
| Cost to Renovate unserviceable Stocks | 3,000,000 | 3,000,000 |
| Net Value | 263,000,000 | 313,000,000 |
| Replacement Value of Authorized W.R. | 335,000,000 | 521,000,000 |
| Cost to make W.R. complete and serviceable | 72,000,000 | 208,000,000 |
| **Total** | | |
| Value of applicable Stocks on Hand | 746,000,000 | 796,000,000 |
| Cost to renovate or overhaul unserviceable stocks | 9,000,000 | 9,000,000 |
| Net Value | 737,000,000 | 787,000,000 |
| Replacement Value of Authorized W.R. | 1,165,000,000 | 1,545,000,000 |
| Cost to make W.R. complete and serviceable | 428,000,000 | 758,000,000 |