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Accounting for Cost of Naval Vessels under Cost-Plus-Profit Contracts*

BY FRANCIS P. FARQUHAR

Early in 1917, when it became apparent that the United States would enter the world war, the navy department foresaw that a rapid expansion and increase in speed would be required in its construction programme. There were at that time numbers of contracts for destroyers, battleships and battle cruisers let on the usual fixed price basis, but upon which work had not been begun. The problem before the navy department and the shipbuilders was how to carry out these contracts under conditions that would inevitably result in greatly increased cost. Moreover, the new conditions called for a large addition to the construction programme which meant filling up all the available shipyards with work to capacity. This precluded any possibility of using the customary method of submitting plans for competitive bids.

Conferences between the navy department and the shipbuilders resulted in the adoption of the cost-plus-profit plan of payment. There were no precedents for contracts of this character on anything like the magnitude of the scale required. The nearest analogies that existed were certain manufacturing contracts based on actual cost plus a percentage for profit. Time was limited and necessity was urgent, so this form was adopted as the best available.

The definition of cost was only briefly considered in the contracts. It was fairly obvious as far as direct labor and materials were concerned, but the accounting for overhead, as usual, presented difficulties. Some of the shipbuilders proposed a fixed percentage of the labor and materials costs as the basis for overhead; others a fixed percentage of the direct labor cost; while others suggested actual overhead as shown by the books.

The first two plans were abandoned as being too indefinite and also because the normal percentages of overhead varied widely in the different shipyards. The contracts were finally drawn up on the basis of actual cost of labor, material and overhead. The

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percentage for profit was agreed upon in every case as 10% of the total cost, excluding from this cost any sums that might be paid by the navy department for increased plant facilities. A number of these cost-plus-10% contracts were signed by the navy department and the various shipbuilders during the spring and early summer of 1917.

As work proceeded, it became increasingly apparent that the cost-plus-percentage basis had certain defects which rendered these contracts not the most desirable type. It was impracticable to change the existing contracts, but when it became necessary later in the summer to place a large number of additional orders for destroyers, a new type of contract was evolved, which, while adhering to the principle of actual cost, did away with the percentage basis for profit by substituting a fixed profit with a bonus for saving in cost below an estimated figure.

Almost all the naval construction undertaken during the period of the war was on the basis of these two types of contracts. There were a few exceptions in special cases, but these were relatively unimportant. It should be borne in mind that these contracts were prepared under most difficult conditions and were the result rather of urgent necessity than of desirable policy. In looking back in the light of subsequent knowledge, it is very easy to find ways in which they could have been improved. It is not the purpose of this article, however, to criticize these contracts or to point out their defects, but rather, accepting them as they stand, to describe some of the problems involved in administering the accounting and inspection required for the determination of actual cost and the approval of bills.

CONDITIONS OF COST INSPECTION

Approximately the same problems of determining actual cost were involved in each type, the differences being in the basis of profit and in the manner of providing for additional plant facilities. In most cases work on these two types of contracts was carried on simultaneously in the same yard under practically identical conditions. Of course, in the early part of the period the work was largely on the cost-plus-10% basis, while latterly it became greater on the cost-plus-fixed-profit basis. This involved certain special problems in the control of the costs, but did not affect the principles of determining them.

To describe fully the conditions under which these contracts were operated or even to enumerate all the problems arising from them would be far beyond the scope of a brief article, but in order that some idea of their nature and extent may be perceived a brief summary of typical conditions is presented.

When the war began in the spring of 1917 there were under construction in certain of the shipyards specializing in navy work several vessels for private owners as well as several naval vessels on the original fixed price contracts. In some plants a certain portion of the facilities was also devoted to ship repair work. To this was now added the work under cost-plus-percentage contracts, which increased rapidly in proportionate volume as time went on.

The first problem that arose was to see that work performed on the fixed price contracts was not charged to the navy cost-plus contracts. The solution of this problem soon became contingent upon the solution of many other problems of detail.

The question of what should be classed as direct labor and what as indirect arose almost immediately. It would obviously be unfair to charge foremen's time on fixed-price contracts to indirect expense while charging it on cost-plus contracts directly to the contracts. It should either be charged in both cases to indirect or in both cases to direct expense. The latter would, of course, be satisfactory only in case the correct charge were ascertainable. It was soon apparent, however, that in many cases such expenses could not be properly allocated directly to specific jobs, and it became necessary to consider all the doubtful cases as indirect expense and to draw up rigid directions for excluding such expenses from direct costs.

Another problem occurred in the charging of material. This was a question of organization rather than of principle. With a rapidly increasing volume of work, it was very difficult to be sure that material purchased and charged to a particular vessel was actually used on such a vessel. The stores and material accounting facilities for most shipbuilders prior to this time were adequate perhaps for their own purposes, but with enormous increase in volume of material handled a state of confusion not unnaturally resulted, from which it took many months of painstaking effort to restore order and accurate accounting.

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As time went on the fixed price contracts became completed and most of the work in the yards was on the navy cost-plus contracts, with a small amount of repair work and in some instances a few contracts for the Emergency Fleet Corporation. The last were also usually on cost-plus contracts differing slightly in form from those of the navy. This condition made it still more important to provide for a correct segregation of costs between the various contracts. It was obviously to the interests of the shipbuilder that the cost-plus-percentage contracts should bear their full costs without any diminution, and, as a matter of fact, a dishonest shipbuilder might have been tempted to throw costs properly belonging to other contracts on these cost-plus-percentage contracts. While it is not desired to express the slightest intimation that any shipbuilder wilfully diverted his costs in such a way, it must, nevertheless, be apparent that there was a wide opportunity for errors to creep in at the expense of the government. The proper segregation of charges between the contracts became, therefore, one of the fundamental points in which the government was interested.

As an illustration of the difficulty of carrying out this segregation, even with the best intentions on the part of all concerned, one need only to examine the processes entering into the building of a vessel. One not familiar with a shipyard might suppose that a vessel was a unit large enough to be kept entirely segregated from any other work. A great deal of the work on a vessel, however, is done before the material actually reaches the building slips. All the enormous fabricating and subsidiary shops, such as the machine shop, the boiler shop, the sheet metal shop, the pattern shop, the foundry, the galvanizing plant and others, contribute to the shipbuilding process; and, with these shops crowded to the utmost limits of their capacity, it is often no easy matter to keep track of the material destined for individual vessels. Add to this the fact that drillers and rivet gangs are repeatedly taken from one hull and sent to another perhaps only a few yards away, and it will be seen that constant watchfulness is required on the part of the time-keepers, shop clerks and inspectors to see that the proper charges are made on the cost records.

Another condition that tended to create uncertainties in the costs was the constantly increasing dilution of the shipbuilder's

force with inexperienced men. At times an enormous number of labor job tickets would come through with erroneous charges, which investigation proved were due simply to the ignorance of the men or their unfamiliarity with conditions. It sometimes happened that the job numbers written on the time cards would prove to be those used by the workman at another shipyard where he had recently been working. In other cases purely fictitious numbers would appear, and no amount of training and exhortation seemed to produce satisfactory results during the period of rapid expansion.

This condition could have been corrected much more rapidly if the shipbuilder's time-keeping and accounting forces had been able to expand with the requisite efficiency. But here the serious difficulty was encountered of getting competent help at a time when large numbers were responding to the call of the army and navy. Nor was it easy to obtain new men at anything less than prohibitive rates. It would often occur that a man engaged as a time-keeper would, in two or three weeks after becoming familiar with the work in the plant, discover that he could make double his wages by becoming a rivet holder. This meant another man added to the ranks of productive labor, but at the same time more trouble for the accounting department. The result of these circumstances was that for a considerable period large percentages of erroneous charges came through to the cost books and were rectified there only by the most strenuous efforts on the part of the veterans of the accounting system, aided by the close coöperation of the government inspectors.

These are only a few of the conditions that existed throughout a considerable period of war-time work on cost-plus contracts. The work of the shipbuilder's accounting forces and of the navy department's cost inspection force cannot properly be judged without making allowance for such extraordinary difficulties.

METHODS OF COST INSPECTION

The methods of cost inspection could not be determined fully in advance, but developed with the increasing volume of the work and the recognition of the complexity of the problems involved. Even a brief summary of the rules and procedure laid down for the navy cost inspection boards would require considerably more space than is here available. Varying conditions

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had to be met and ever changing problems encountered. The work of determining costs naturally fell, however, into the main divisions of (a) materials, (b) labor, (c) indirect expenses, (d) additional plant facilities. In determining these costs, the work of the technical inspectors of the navy, namely, the superintending constructor, the inspector of machinery and the civil engineer, formed an important part, but one which was not primarily concerned with accounting. The description here may, therefore, be limited to the work of the cost inspector's office, which was primarily the accounting office for the government.

ACCOUNTING FOR MATERIALS

The cost inspection of materials begins with the approval of the purchase order. Every purchase order issued by the ship-builder requires the approval of the navy technical inspector who is concerned with that particular material. This approval takes into consideration the price, the terms of delivery, the quality and the necessity for the article. The technical inspector naturally looks to the cost inspector for recommendation as to the reasonableness of prices. Accordingly, on every purchase order the cost inspector checks the prices by such data as he may have at hand or be able to obtain from outside sources. It is, therefore, necessary for him to keep a complete record of prices obtained from previous invoices, from navy yard records, published price lists and trade journals.

The next step after approval of the purchase order is for the cost inspector to file the order in such a way that when the invoice is presented it can be quickly checked against the order, for the purpose of determining that the invoice price is correct and that the total quantities invoiced do not exceed the quantities authorized on the purchase order. No invoices are passed by the cost inspector for payment unless they are checked against a properly authorized purchase order.

The procedure outlined refers to the purchase of materials ordered directly for use in constructing the vessels. It is often impossible, however, to determine the ultimate destination of material that is required for the various fabricating processes in the plant, although it may be known that all of this material will be required for the navy contracts. In such cases, the same

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procedure is followed, but in addition an inventory is required showing the disposition of material as it is expended and the quantity remaining on hand.

A great deal of material is also required for purposes connected with indirect expense. This is purchased by the shipbuilder for his own account and is drawn from his stores by requisition. As the values involved are often considerable it is incumbent upon the cost inspector to check the prices of this material and see that they are issued against the shop expense orders at actual cost prices, which, in this case, are taken as the average prices paid for the respective classes of material. A constant test is, therefore, required of the store-keeper's price records, which involves repeated checking of the general stores inventory.

Inasmuch as the shipbuilder is accountable for all of the material purchased, it is necessary for the cost inspector to keep bills of material continually posted up to date in order to ascertain that no excess amounts of material are ordered. If it were not for these bills of material, it would be possible for serious errors to occur that could not easily be detected. Materials ordered for certain specific jobs might be diverted in part by the shop foreman to fill up emergency orders upon which material was short. If, through some error, the credit did not reach the navy account it would result that the navy would be charged with material not received. When the time came for using such material on the navy vessels it would be missing and a new order would be made by the shipbuilder which would result in a duplicate charge to the navy account. By keeping track of every order issued on a bill of material, however, the new order would show as an excess quantity and an explanation would be required. It should not be inferred from this that any deliberate attempt at duplicating orders or diversion of materials is the practice of the shipbuilders, but, when the enormous volume of work in some of the large shipyards is considered, it will be seen that errors of this sort might very easily occur in spite of the best of intentions.

ACCOUNTING FOR LABOR CHARGES

Perhaps the most difficult part of cost inspection is the checking of the labor charges. This, at first, might seem to be the easiest, and under normal conditions it might well be easy. But under the abnormal conditions prevalent during the war period,

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only the most thoroughly organized and painstaking efforts on the part of the cost inspectors have sufficed to reduce to a minimum the errors in this branch of the accounting. Some of the difficulties have already been recounted, but perhaps the most perplexing condition of all is in the piece-work counting. During the early part of the period few shipyards had an established piece-work schedule, and in almost all the yards such schedules as did exist were subject to continual changes. This made it difficult for the inspectors to find anything definite with which to check. Until the inspectors themselves became thoroughly familiar with the conditions of work it was often impossible for them to determine whether the rates placed by the foremen on the piece-work slips were reasonable or not. With the tremendous expansion of work it was only natural that the piece-work rate-setters should make mistakes and not infrequently these mistakes produced large discrepancies, not always to the disadvantage of the government. It should be mentioned that as time went on this condition showed considerable improvement.

Without casting any reflections upon the integrity of the large body of workmen and the piece-work counters in general, it must be admitted that a considerable amount of wrong counting took place in almost every yard. Piece-work counting at best requires the utmost vigilance and care even when all parties are disposed to be rigidly honest. The least carelessness will often result in a large error in the count. In rivet counting, for instance, it is very easy to miss a number of rivets in the count. The riveter knows this and it is only human nature that he should try to offset it by counting in all the rivets he can claim as his own. With inexperienced counters this not infrequently results in duplicate counts. Proper organization and training of the counters can overcome this to a great extent, but proper organization and training were not to be had during certain stages of the work. A green counter is also likely to make this mistake: he will turn in a count as for $\frac{7}{8}$ inch rivets, when as a matter of fact the size actually driven was $\frac{5}{8}$ in. With rates at \$5.50 per hundred for $\frac{7}{8}$ inch, and \$4.50 per hundred for $\frac{5}{8}$ inch, it will be readily seen that an error of this sort makes considerable difference.

Illustrations of errors due solely to inexperience or carelessness that can creep into the accounts through the labor records

could be multiplied without end. Not all the sources of these errors were discoverable from the start, but it can be said that through the constant watchfulness and alert minds of some inspectors who came in direct contact with the work a large percentage was detected and the causes were removed.

Another source of error in the labor accounts, which gave considerable trouble in some yards during the early stages, was the success of some of the men in circumventing the methods of checking in and out of the gate. It might be supposed that gate checkings methods were sufficiently well known to prevent any errors of this sort, but here again reference must be made to the rapidity of expansion and inexperience of the shipbuilders' gate forces. To inadequate physical facilities was added the complication of numerous shifts and the practice of overtime work. In the face of these conditions the gate check not infrequently broken down to a considerable extent, often making it possible for men to claim credit for work when they were not actually present in the yard at all. This condition also showed much improvement as time went on.

The following is an illustration of this sort—a method which was fortunately discovered in time to prevent much abuse. It was found at one plant that a man rated at six dollars a day could hire a boy rated at three dollars a day to call out the higher priced man's number on entering the gate in the morning and leaving at night. The result was that the six dollar a day man was marked present on the muster rolls, although he turned in no ticket for his work. At pay day, when he received no pay for that day, he could claim that his job ticket must have been lost, as he was present on that day. An investigation of the muster rolls would apparently prove him in the right and upon his statement that he worked on such and such a job, there could be no other course than to grant him his pay. He could then split up with the boy whom he had engaged. Of course, this was a simple condition, but, like many others, it was actually worked until it was discovered or until the shipbuilder's gate force became adequate to handle the expansion of work. As an illustration of the expansion of work it may be stated that at some of the large shipyards the force increased over 400% within a year, a large part of this increase coming within the period of a few months.

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INTERPRETATION OF CONTRACTS

In addition to what may be termed the external features of cost inspection there arose a multitude of questions involving the interpretation of the contract terms. The final authority in such cases rests with the secretary of the navy who acts through a board appointed by him and known as the compensation board. In referring matters to the compensation board at Washington it is incumbent upon the local cost inspection boards at the shipyards to present arguments and data for guidance. This requires frequent conferences between the different inspectors and between the navy officers and the representatives of the shipbuilder. These conferences and the necessary investigations comprise a considerable part of the work of cost inspection and require constant alertness and continual reference to the principles of accounting as well as to those of law and engineering.

AUDITING AND REPORTS

The results of all the external inspections and the decisions of the boards are ultimately reflected in the accounting records of the shipbuilder. The navy cost inspector is responsible for auditing the records and ascertaining the correctness of the bills rendered by the shipbuilder. This amounts to a continuous audit comprising nearly all the phases customary in public accounting practice. The clerical accuracy of the bookkeeping must be thoroughly tested; satisfactory vouchers must be seen in a sufficient number of instances to establish the authenticity of the entries; authority for journal entries and all unusual items must be made evident; the building up of summaries must be critically examined; and, above all, the indirect expenses must be submitted to the closest scrutiny as to both the nature of items and the method of distribution.

As an aid in conducting this audit and for the purpose of providing the navy department with data in support of the bills rendered, it is necessary for the cost inspector to keep records and summary books agreeing with the shipbuilder's accounts. These are not intended to duplicate the shipbuilder's work, but are rather a supplementary record. From these records reports are rendered monthly to the navy department. It is in reliance upon these records as a summary of his audit that the cost inspector attaches his signature of approval to the bills.