REPORT TO THE CONGRESS

Adverse Effects Of Large-Scale Production Of Major Weapons Before Completion Of Development And Testing B-163058

Department of the Navy

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This is our report on adverse effects of the Navy's large-scale production of major weapons before completion of development and testing. Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Director, Office of Management and Budget; the Secretary of Defense; and the Secretary of the Navy.

Elmer B. Staats

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

ADVERSE EFFECTS OF LARGE-SCALE PRODUCTION OF MAJOR WEAPONS BEFORE COMPLETION OF DEVELOPMENT AND TESTING
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D I G E S T

WHY THE REVIEW WAS MADE

Large-scale production of major weapon systems prior to completion of development and testing--concurrent development and production, or concurrency--is a primary cause of cost growth because of problems in attempting to produce items on the basis of unproven designs. (See p. 4.)

Aware of these problems, the General Accounting Office (GAO) wanted to know the extent of concurrency in the Navy, how it was managed, how the Navy decided that it was necessary and likely to be successful, and its results. GAO examined five systems--developed and produced concurrently--costing $2 billion and reviewed a Navy study of 13 weapons, nine of which also were produced concurrently.

FINDINGS AND CONCLUSIONS

Most of the Navy's major weapon systems are approved for large-scale production before development and testing is completed. The systems cost many millions of dollars. (See p. 6.)

Since concurrent development and production, and development followed by production, can never be performed on the same system, the adverse effects of concurrency cannot be clearly established. However, when concurrent development and production occurred, weapons frequently would not perform all the functions intended and the Government spent sizable amounts of time and money to correct deficiencies. Moreover, it appears that deployment of effective weapons may not have been accelerated and, in fact, may have been delayed. There may have been a corresponding impairment in the planned combat effectiveness of the fleet. (See p. 6.)

Since concurrency can seriously affect cost and readiness, it is wise to limit its use to those cases where the risk is necessary and there is a reasonably good chance of success. Present Navy procedures for concurrency have not been sufficiently effective. Decisionmakers have not been presented with all the information that should have been available to them in considering whether to proceed into production of an item before completing its development. (See p. 22.)

The Blue Ribbon Defense Panel recommended on July 1, 1970, that:

> "A new development policy for weapon systems and other hardware should be formulated and promulgated to cause the reduction of technical risks through demonstrated hardware before full-scale development, and to provide the needed flexibility in acquisition strategies."

The Panel's report stated the new policy should provide:

> "A general rule against concurrent development and production, with the production decision deferred until successful demonstration of developmental prototypes." (See p. 31.)

RECOMMENDATIONS OR SUGGESTIONS

The Secretary of Defense should have the Navy revise its instruction on concurrent development and production. The instruction should provide for submission of the following data to the Assistant Secretaries who make concurrency decisions.

1. A comparison of design performance requirements and actual performance based on testing. This will show how nearly the equipment meets required performance goals. (See p. 23.)

2. An assessment of how essential an unproven component is to the weapon system, and the feasibility of either delaying production or using a substitute for the component. (See p. 25.)

3. Documented views of Government activities and contractors involved in the project, as well as the project manager, as to the feasibility of proceeding on a concurrent basis. (See p. 27.)

4. An assessment of the contractor's ability to produce the weapon under regular production conditions. (See p. 28.)

Also, the Naval Audit Service should consider regularly scheduled audits into the practice of concurrent development and production. (See p. 35.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

Both the Director of Defense Research and Engineering and the Navy generally agreed with GAO's recommendations. They said that the following corrective actions had been taken or planned.

--The Navy will review and revise its directives governing concurrency to incorporate the substance and intent of the GAO recommendations. (See p. 32.)

--The Navy will charge "the appropriate organization" with responsibility for making periodic audits of Navy projects involving concurrent development and production. (See p. 35.)

The Director of Defense Research and Engineering said establishment of the Defense Systems Acquisition Review Council and use of the Development Concept Paper will strengthen and improve the management of major weapon system acquisitions. (See p. 34.)

GAO plans to continue to monitor the management of concurrent development and production of major systems by the Department of Defense.

MATTERS FOR CONSIDERATION BY THE CONGRESS

In November 1969, GAO suggested that the Congress might wish to require the Department of Defense to furnish additional information on weapons which it plans to develop using concurrent development and production. The above actions proposed by the Department of Defense are internal and do not contemplate furnishing additional information to the Congress. GAO believes that this report indicates further need for providing such information to the Congress. (See p. 33.)

Tear Sheet

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CHAPTER 1

INTRODUCTORY COMMENTS

In what the Department of the Navy considers the desirable or normal sequence of events for the acquisition of a new weapon, or a major component of such a weapon, large-scale production is preceded by development of working models of the weapon or the component and the testing of these models to see that they are satisfactory for operational use. Under certain circumstances, however, the Navy will permit deviation from this procedure and will authorize large-scale production prior to completion of development and testing. This is called concurrent development and production, or simply concurrency.

Essentially, concurrency is a means of attempting to shorten the time required to put an effective new weapon into operational use. Under this method, production of the item in quantities needed for operational use is started before the developmental model of the weapon has been tested sufficiently to determine its effectiveness.

The risks inherent in the use of concurrent development and production are great. If the development work produces a weapon that works well and does not require significant change after testing, time has been gained because production items will be almost immediately available. On the other hand, if the weapon does not perform satisfactorily and significant change is required, the problem of making the change has been greatly increased. The change then is not limited to a few developmental models but must also be applied to all items already manufactured in the runs of the item. This involves both time and money.

Making changes becomes even more costly and complicated after items have been installed in an aircraft or ship that has been put into operating use. To make the changes, either the weapon must be returned to the manufacturer, or contractor personnel required to make the changes must travel to the location where the aircraft or ship is stationed.

Also, installing unproved weapons on an operational ship or aircraft may affect the combat readiness of the organization to which such ship or aircraft is assigned. If the ship or aircraft is not fully effective because some weapon or component that is installed therein does not perform properly, the combat readiness of the organization having the ship or aircraft will be detrimentally affected.

We recognize that it may be necessary and desirable to authorize concurrency under special circumstances. Such decisions involve substantial cost and risk hazards, however, and therefore should be made by top management in limited instances on the basis of careful consideration of all pertinent factors.

The purpose of our review was to determine the extent of concurrency in the Navy, how concurrency was managed, how the Navy decided that it was necessary and likely to be successful, and its results. As a test, we selected five major systems that had been under concurrent development and production for a substantial period of time. The scope of our review is described on page 36.

A list of the principal officials of the Department of Defense and the Department of the Navy responsible for administration of activities discussed in this report is shown as appendix II.

CHAPTER 2

THE EXTENT OF USE AND THE RESULTS OF CONCURRENCY

Large-scale production has been undertaken for the majority of the Navy's major weapon systems before completion of development and testing. Significant amounts of funds have been involved. The Navy's use of concurrency resulted in

--the operating forces' receiving some weapons for operational use which would not perform the full range of functions for which they were intended,

--the Government's incurring sizable additional cost to retrofit equipment with new components or to otherwise correct deficiencies.

In addition, it appears that deployment of effective weapons at least for the systems examined by GAO and the Navy was not accelerated by the use of the concurrency technique and, in fact, deployment may have been delayed with a corresponding impairment in the planned combat effectiveness of the fleet.

NAVY USES CONCURRENT DEVELOPMENT AND PRODUCTION EXTENSIVELY

Although concurrent development and production is intended to be an exception to the normal practice (see p. 18 for the Navy's normal plan for material development), our review showed that, for the more expensive systems, it has become the norm. The Deputy Secretary of Defense stated in May 1969:

> "There is considerable evidence that many--in fact, I can almost include most complex weapons--are put into production before they are fully developed."

In this respect, we found that a majority of the Navy's development projects funded at over $25 million each during

fiscal years 1966 through 1968, were approved for production prior to completion of development and tests.

Further, portions of other major projects and smaller projects were produced prior to completion of development and tests. Development funding for all Navy development projects amounted to about $3.7 billion during this period. Development funding for the projects involving concurrent development and production accounted for about 54 percent of that total. In addition, large amounts of production funds were expended on these projects.

Equipment being developed and produced on a concurrent basis included a majority of the major Navy research and development project categories. Concurrent development and production effort occurred in categories of antisubmarine warfare weapon systems, undersea attack weapons, surface-antiair missiles, aircraft developments, aircraft fire control systems and air-to-ground guided missiles.

Because these systems involve many millions of dollars and are so essential to the defense of the country, we believe it is important to recognize how extensive the use of the concurrent development and production technique has become and to authorize use of this technique only after the most careful scrutiny. We also believe that every avenue of improving the likelihood of success should be explored.

RESULTS OF NAVY'S USE OF CONCURRENCY

Evaluation of the results of concurrent development and production in specific cases is a complex problem. The primary objective of concurrency is to put effective weapons in the hands of the operating forces sooner than if concurrency was not used. Therefore, to be successful the concurrency technique has to result in an effective weapon reaching the operating forces more rapidly than if the conventional (i.e., sequential) technique was followed. However, no weapon or weapon system component is ever developed and produced both ways. Thus, when concurrency is used, the time required using the concurrency technique is known, but the time that would have been required if development had been completed before production for deployment began--the sequential technique--can only be estimated.

The Navy made an evaluation of the results of development and production for 13 weapons or weapon system components. Nine of the weapons were developed and produced concurrently. The Navy's study was made by a body called the SECNAV Project Review Working Group established by direction of the Assistant Secretary of the Navy (Research and Development). The objective of the group was to review current policies and practices with a view toward identifying the factors that contribute to successful development. The Working Group's report was dated May 1966.

In judging success for the systems reviewed, the Working Group's major considerations were development costs, schedules, and performance. One of the conclusions reached by the study group was that an acceleration program, i.e., the use of the concurrency technique:

> "should be carefully considered before it is implemented since it usually requires a major increase in funds and personnel commitments, normally without realizing the benefits expected. No acceleration program of the projects studied materially decreased the development time."

The report also contains the following statements:

> "Acceleration programs of the cases studied did not result in accelerated developments. This fact can be attributed to the climate of extreme urgency that developed when the pressure of the acceleration program was placed on the project team. As previously discussed, under these conditions certain factors or procedures that should receive attention are allowed to 'fall between the cracks.' Factors which contribute to system effectiveness (reliability, maintainability, human engineering, documentation, etc.) cannot be disregarded if an effective system is to be developed. Test programs and the like cannot be cancelled and still develop an optimum system."

> "It is recommended that acceleration programs be kept to a minimum and be directed only after careful consideration of the possible undesirable consequences of such a program."

In making our own assessment of the results of concurrent development and production, we selected five systems for review. The systems selected were neither outstanding successes nor complete failures. Total incurred or programmed costs for these five systems amounted to about $2 billion through June 30, 1969. The cost of individual systems ranged from about $218 million to $723 million.

Each of the systems that we reviewed had been under concurrent development and production long enough to reach a point where the relationship of actual accomplishments and planned goals could be compared. Also, development of the systems was initiated at various times. This permitted us to consider decisions made over a number of years to undertake production while development was in process. Such decisions were made both before and after the issuance in 1965 of the regulations governing the use of concurrency that were in effect during our review. Because recurring decisions were made for some of the systems, our review included more than just five concurrency decisions.

In all five cases, estimated dates for having effective equipment in the hands of the operating forces were not met. Also, each of the systems experienced significant cost growth which in at least four of the cases could, in part, be directly attributed to concurrent development and production. The Deputy Chief of Naval Operations (Development) has advised us that each of the systems is now functioning in the operational environment in a satisfactory manner. We have found, however, that the systems are not operating in all respects as successfully as originally planned. In our opinion, the Navy is "making do" with what it gets, rather than what it originally stated that it needed.

A summary of the information regarding the results of concurrent development and production for the five systems we reviewed is presented below. We have not used the specific names of, or given complete information for, the systems involved, to avoid security classification of the report. We did furnish Navy officials with complete identification of the systems. The following designations for the five systems have been used.

1. Sensor A
2. Missile A
3. Missile B
4. Missile Control System A
5. Torpedo A

Delays in deployment

In all these cases, the time actually required to obtain a satisfactory weapon (based upon the Navy's definition of satisfactory) was greater than that planned by the Navy. Although two of the five systems experienced only moderate delays, the other three systems showed significant delays.

For example, Sensor A had a planned deployment date of 1963, however, it was not until August 1966 that a reasonably satisfactory model was deployed. Although the Navy states that it plans to use this model generally as it was deployed, this model does not perform as well as a subsequent model which was deployed in March 1969.

In the case of Missile B, Navy records indicate that the first shipfill[1] of missiles was not available until January 1969, although the planned deployment date was March 1968.

In the case of Missile Control System A, the delivery delays for this system had a related impact on a number of Navy aircraft. At the time it was deployed, this system was not performing as the Navy originally desired nor did we find any evidence that it was fully meeting requirements at the time of our fieldwork. The Navy, in commenting on our draft report, has advised us that, although the design reliability has not been wholly achieved, reliability has now reached 85 percent of the design goal and that this performance has proven acceptable in the field. The 85-percent reliability figure cited by the Navy relates to a lower reliability goal than originally planned.

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[1]The quantity needed to outfit one ship.

The effect of these delays is difficult to assess precisely. However, such delays contribute both to impaired readiness and to increased costs.

Readiness of Navy units affected

Sensor A is a detection system used aboard ship, which was developed and produced on a concurrency basis. It was intended to replace another sensor and was to provide improved detection capability. Subsequent to the development model of Sensor A, the Navy produced four different versions of the sensor--each new version was somewhat more capable in meeting stated performance requirements than its predecessor, although none satisfactorily met these requirements. The sensors delivered to the fleet were plagued with problems involving lack of reliability. Statistics obtained from eight ships deploying one version of the sensor showed that the sensors were out of action for repair and maintenance about 29 percent of the time.

The reliability problem was so acute at one time that the Commander in Chief, U.S. Atlantic Fleet, recommended cancellation of planned purchases of Sensor A because of its unsatisfactory performance, marginal improvement in performance over an earlier sensor, diversity of models, and highly skilled personnel requirements for its maintenance and use. He further recommended that the earlier and more reliable sensor be substituted for Sensor A in subsequent new ship construction. It was decided, however, to proceed with Sensor A and try to improve its performance capability and its reliability.

At a meeting with us in March 1969 to discuss our review, the Navy acknowledged that there had been a number of troublesome problems with the sensor but indicated that, at the time of the meeting, it was performing about 95 percent of the time. This Navy performance figure is supported by reports on Sensor A that indicated only that the sensors were operable 95 percent of the time but did not show whether sensors were performing all their functions or whether the sensors were performing specific detection functions up to desired levels of performance.

Missile B is an improved missile designated to replace certain existing Navy missiles. The Navy authorized production of Missile B before development and testing were completed. On the basis of its plans for producing this missile, the Navy canceled further production of the missiles which were to be replaced by the new one. Because problems developed in producing Missile B, deliveries scheduled to be completed in 1968 were delayed and stretched out to 1970. The result was that certain ships did not have the quantity of missiles they were supposed to have and their readiness was therefore impaired. The Navy advised us in March 1969 that the missile shortage no longer existed.

Additional costs incurred

Increased costs are an obvious result of concurrent development and production. These increased costs result from changes in design upon availability of developmental test information. These changes are reflected in the retrofit of items delivered from production--often when already in operational use--as well as in the production process itself.

If design changes resulting from testing have to be made to a large number of production items instead of a few developmental models, it is axiomatic that higher costs will result. For instance, as a result of significant deficiencies in models of the first two versions of Sensor A, an extensive retrofit program was undertaken to correct the deficiencies. On the basis of data furnished by the Navy, we estimated the cost for the retrofit program to be about $21 million--an amount greater than the original cost of the sensors that were retrofitted.

A large number of aircraft were delivered to the Navy without Missile Control System A because of the concurrent development and production. Consequently, about 120 of these aircraft have or will have the missile control system installed at an additional cost of about $900,000. This cost would not be incurred if the missile control system was available and installed during the aircraft construction.

Because of defects revealed by testing after production had begun for Torpedo A, retrofit costs of about $1.5 million were incurred. In fact, in practically every

weapon system we examined, changes were made to production items which could have been avoided if development had been completed before production began.

Design changes reflected in the production process itself, i.e., prior to the complete delivery of production items on contract, result in increased costs due to delays, the use of more specialized personnel, work which must be redone, the obsolescence of material components no longer to be used, and other factors such as changes required in purchasing and production lines. Such causes of numerous contractual change orders would occur to a much lesser extent if production were based upon a stabilized design resulting from completion of development and test.

As previously commented upon, without performing parallel sequential and concurrent development programs it is not possible to reach firm conclusions on the difference in results produced by concurrent development and production as compared with sequential development and production. However, both the results of our review and the results of the Navy's Working Group (see p. 8) have indicated that concurrency results in appreciably greater cost and, for a time, impaired readiness without achieving a significant reduction in the time required to put a sufficiently effective weapon into operating use. In fact, concurrency can and often does result in a stretch-out of deliveries before satisfactory equipment is obtained. Thus, the decision to use concurrency would seem to warrant the greatest consideration and care.

AGENCY COMMENTS AND OUR EVALUATION

In discussions with Navy representatives during our fieldwork, we were advised that there was no disagreement that there were problems in the use of concurrent development and production and on some of the specific projects we examined. The Navy representatives stated, however, that there were more successful applications of concurrency than we had cited in our review. The Navy advised us that a certain missile, the development of which had been proceeding in a normal fashion, was urgently needed for use in Vietnam. According to the Navy, acceleration of the development and production process resulted in obtaining a previously nonexistent capability on an expedited basis. When the enemy introduced countermeasures, concurrent development and production enabled the Navy to quickly overcome the countermeasures. In such cases the Navy felt that, although expensive in dollars, the concurrency technique was well worthwhile.

We did not review the specific projects mentioned by the Navy and therefore cannot express an opinion of them. The systems we examined were selected because information previously obtained on each system indicated that concurrent development and production was used and cost growth was experienced. Although the systems designated by the Navy may have been more successful than the ones we reviewed, there is no disagreement on the fact that concurrency is fraught with risk, problems, and expense.

The Director of Defense Research and Engineering commented on our draft report by letter dated March 31, 1970. (See app. I.) The Department of the Navy comments were included as an attachment to his letter. In his reply, the Director of Defense Research and Engineering advised us that, in general, our report was a fair appraisal of the risks of concurrency. He also stated:

> "*** when a conscious management decision is made to use this concept *** all of the factors involved should be carefully considered prior to such decision."

Likewise, the Navy indicated that our report was a perceptive treatment of a portion of the overall problem of major weapon system acquisition. The Navy also stated that concurrency, of itself, could have significant cost implications either positive or negative; could speed up or delay product delivery; could increase or decrease weapon efficiency; and despite the uncertainty of successful application, offered to the Department of Defense decisionmaker the hope that its application would permit the introduction of a necessary weapon system in time to meet a threat to the security of the country.

We agree with the Navy's description of the possible results of using concurrency. We pointed out in this report however that, in all five cases we reviewed, estimated dates for having effective equipment in the hands of the operating forces were not met and, in four of the five cases, additional costs resulted because of the concurrent development and production. Most important, the operating forces received some weapons for operational use which would not perform the full range of functions for which they were designed. This indicates that improvements are needed to limit the use of the concurrency technique to special circumstances.

The Navy, in commenting on our report, advised us of the following three reasons for using concurrency other than as a "preplanned" attempt to shorten the time from development to deployment.

1. Concurrency forced upon the developer due to circumstances unforeseen in the original plan.

2. Concurrency, not just to speed up, but also to attain at the operational date near-optimum matching of large numbers of technological capabilities involved in complex systems.

3. Concurrency used to avoid adverse time and cost economics implicit in shutting down the production process for complex systems after prototype and evaluation models have been produced.

We recognize that unforeseen circumstances as stated in the first reason listed above may require authorization of concurrency even though it may be costly. Because of the substantial cost and risk hazards, however, we believe top management should be aware of pertinent factors such as the actual status of development before the concurrency decision is reached.

As to the second reason, concerning the need to attain near-optimum matching of the capabilities involved in complex systems, we recognize that concurrency may be warranted in such instances. We believe, however, that there is a need for greater consideration of component availabilities in setting completion dates for weapon systems. (See p. 25.)

The third reason cited by the Navy for using concurrency was to avoid adverse time and cost of interrupting the production process for complex systems after prototype and evaluation models have been produced. We believe that this factor alone is not a valid reason for using concurrency. Although the initiation of large-scale production may be delayed to complete the development and testing, we believe that in the long run, a penny spent in the development cycle may save dollars in the production cycle.

Although the Navy generally agreed with our proposals contained in this report, the Navy took issue with certain facts pertaining to the degree of success attained for specific weapon systems and some which relate cost and concurrency without qualification. The Navy also stated that our report did not adequately recognize that concurrency is necessary in some instances. We have made several revisions to our report on the basis of the Navy's comments. Our proposals, Navy comments, and our position thereon are presented at the end of the chapter where applicable.

The Navy has also advised us that each of the five major weapon systems reviewed

--was designed to overcome a serious lack of capability in a major naval warfare area, and the concurrency decisions were made for the purpose of attempting to

achieve, at the time needed, the advanced capability represented by the proposed systems;

--was then operating effectively in the fleet and represented substantial improvements over previously existing capabilities; and

--was placed in concurrent development and production by responsible level decisionmakers after in-depth analysis of the risk and cost versus the enemy threat.

Our review was not designed to evaluate the need for or current effectiveness of the five systems, but rather to ascertain how the Navy was managing concurrency and the effects of using concurrent development and production. Although each of the five systems may be currently operating effectively, they are not operating in all respects as successfully as originally planned. In addition, our review of five systems and the Navy's study indicated that deployment of effective systems was not accelerated by the use of concurrency and, in fact, may have been delayed with a corresponding impairment in the planned combat effectiveness of the fleet. Further, although the Navy indicated that the concurrency decisions were made on the basis of an in-depth analysis of the risk and cost of concurrency, we found that the decisionmakers were not provided all the information needed to consider all the risks and costs involved. The additional types of information needed for careful consideration are discussed in chapter 4.

CHAPTER 3

PROCEDURES GOVERNING THE USE OF CONCURRENT DEVELOPMENT AND PRODUCTION

Because the risks of concurrent development and production are great, the Navy has prescribed regulations for limiting its use and has prescribed controls to be applied when it is used.

The normal plan for material development in the Navy provides for a sequential progression from development into production as follows:

1. Research and Exploratory Development.
2. Development of prototype.
3. Manufacture of test models.
4. Technical evaluation to determine whether the test model meets design specifications.
5. Operational evaluation to determine effectiveness of the test model in an operational environment.
6. Final approval--approval of new equipment for service use based on the results of tests and evaluations.
7. Large-scale production.

According to Navy instructions, a weapon system, support system, weapon, aircraft, or other material, to qualify as "approved for service use," must successfully undergo appropriate technical and/or operational evaluations during which it must achieve desired capabilities, perform reliably, be effectively operated and maintained by service personnel, and demonstrate that it can be supported logistically in a deployed status. Large-scale production of major material items normally will be accomplished only

after final approval for service use by the Chief of Naval Operations.

Although basic policy calls for an orderly progression from development into production, under actual situations, whenever a new weapon showed promise of improving the service's capabilities there were pressures to speed up the process and get the weapon into the hands of the services as soon as possible. Measures taken to expedite production of such weapons have brought a host of problems. In recognition of many of the problems inherent in expediting development, production, and deployment of complicated military equipment, the Department of Defense in 1956 issued policy guidelines with regard to the approval of new electronic equipment and systems for service use.

These guidelines directed the military services not to authorize quantity production of new electronic equipment or systems for service use until the equipment has been properly engineered for production and approved for service use by the appropriate military department. This directive further advised the military departments that the tremendous maintenance and logistics problems of electronic equipment and systems already confronting the military departments would not tolerate an additional load of any but the most reliable and readily maintainable equipment. This policy remained in effect until June 1964.

In September 1964 the Secretary of the Navy established Navy policy for approving production of new material for service use which was very similar to the policy that had existed in the Department of Defense. This instruction provided, in pertinent part, that:

> "New equipment or systems *** developed under the RDT&E [research, development, test, and evaluation] program, shall not be placed in production for service use until the equipment has been

properly engineered for production, evaluated, and approved for service use."[1]

This instruction also directed Navy organizations to determine the producibility of the new equipment or system by manufacturing a pilot production quantity using production methods and representative tooling. The instruction provided for deviations in those instances where urgency, important operational considerations, or program slippages indicated a need to deviate from normal procedures.

The risk involved in committing equipment to production before approval for service use has been explicitly brought out in another Navy instruction issued in July 1964 dealing with concurrency practices (deviations from the normal cycle) in research and development and which contains the following conclusion:

> "The indiscriminate practice of concurrency can result in the requirement for costly 'fixes' after equipment is installed and deployed, and in a period of reduced readiness rather than increased readiness in the Fleet. The decision to practice concurrency must be tempered by a very careful analysis of the costs and benefits, the particular management tools to be used in the course of the development, and a clear assurance that the costs and risks are in the national interest."

When such risks are involved, it is clear that careful controls must be instituted if unnecessary costs or impaired readiness of the fleet are to be avoided. The Navy has used essentially two procedural methods for controlling procurement of equipment prior to service approval.

1. Prior to 1965, the Chief of Naval Operations was authorized to approve the release of equipment for

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[1]Approval for service use signifies that the equipment has performed satisfactorily in operational tests and that development is completed.

production before service approval. However, so far as we could determine, there was no requirement to assess the feasibility of going into concurrent production in making this authorization.

2. The Chief of Naval Material issued an instruction on February 25, 1965, which established more stringent requirements concerning requests for production in advance of service approval. The instruction required that estimates of technical, logistic support, economic, and management feasibility be prepared. It also required that system effectiveness be assessed and that a test and evaluation plan be submitted. Under this instruction, approval to proceed for items exceeding a unit cost of $100,000 and a total cost of $1,000,000 must be obtained from the Assistant Secretary of the Navy (Installations and Logistics) and the Assistant Secretary of the Navy (Research and Development).

CONCLUSION

We found that these Navy procedures have not been sufficiently effective in ensuring that top management is provided with all the information needed to make a concurrency decision which should be based on careful consideration of all pertinent factors. The specific types of information that we believe should be accumulated for consideration are discussed in the next chapter of this report.

CHAPTER 4

DECISIONMAKERS NEED ADDITIONAL DATA TO MINIMIZE RISKS OF CONCURRENT DEVELOPMENT AND PRODUCTION

Since the consequences of concurrency can be significant both in cost and readiness, it is prudent to have procedures which will limit the use of this technique to those cases where the risk is necessary and there is a reasonably good chance that a favorable outcome will result. As shown in chapter 3, the Navy has such procedures. Nevertheless, concurrent development and production has been used extensively in the Navy at substantial cost.

On the basis of information gathered in our study of the five selected systems, we believe that the decisions to authorize concurrent development and production were made without sufficient knowledge of essential data. To enable the decisionmaker to have all the information that should be available to him in considering whether to proceed into large-scale production of an item before completing its development, we believe that the following specific types of information should be accumulated for his consideration:

--Actual capabilities of the equipment based upon testing, at least of prime subsystems. (See p. 23.)

--Component system availabilities in relation to completion dates for weapon systems. (See p. 25.)

--Views from other informed sources in addition to the project management group. (See p. 27.)

--Producibility of the equipment. (See p. 28.)

These categories of data are discussed in detail below.

NEED FOR GREATER CONSIDERATION OF ACTUAL CAPABILITIES OF EQUIPMENT

Before a project manager and his team can proceed with concurrent development and production, they must obtain approval from both the Assistant Secretary of the Navy (Research and Development) and the Assistant Secretary of the Navy (Installations and Logistics). Under the Navy's instruction, which established policy and procedures for obtaining approval for concurrent development and production, the project manager must present estimates of the feasibility of a successful result. These estimates of feasibility must cover five areas of concern--technical feasibility, practicability of logistics support, system effectiveness, economic feasibility, and management feasibility. In each case, except economic feasibility, the project manager is required to indicate problems being experienced with the system and what is planned to overcome these problems.

In our review we noted that submissions prepared for consideration by approval authorities were very optimistic and indicated that the problems could be readily overcome. We believe that the submissions gave the impression that problems were solved when in fact the solutions proposed were untried and the Navy's ability to correct the problems was really not known. For instance, documentation supporting the initial request for approval of entering developmental Missile A into production on a concurrency basis outlined a development history and stated as follows:

> "Although recent flight tests have not been successful in meeting overall test objectives, the flight failures were caused by random component failures rather [than] complete missile system failures. In the engineering judgement of BUWEPS [Bureau of Naval Weapons], NOL [Naval Ordnance Laboratory], and [the prime contractor], the present missile design is satisfactory."

On the second request to procure Missile A in advance of service approval, the Assistant Secretary of the Navy (Research and Development) was advised that no technical problems existed at that time and that all scheduled test objectives had been successfully met. The third request

indicated that a technical appraisal of the missile's flight test program had been made and the prospective capability of the equipment to meet operational requirements constituted an acceptable technical risk. All three requests were approved and resulted in production of Missile A.

These requests, however, apparently did not bring out, when the information was available, the serious problems and the significant number of changes in the production drawings. Also, we found no indication that the assurances cited above took into consideration the reliability of the missile at the time the decisions were made. For example, flight reliability at the time of the initial decision was only about 35 percent. The Navy had anticipated that missile flight reliability would reach 70 to 80 percent at that time.

In discussions with Navy personnel, we were advised that it was natural for project managers and their assistants to be optimistic, and that if they were not, they would not have the enthusiasm needed to overcome the trials and continual setbacks of developmental work.

We concur in the view that project management personnel should be optimistic, but a decision to go into concurrent development and production is of such significance that we believe a cold, hard look at the facts is needed, not unrestrained optimism. Project managers may be too intimately associated with their projects to review them objectively, therefore, their superiors should make special efforts to obtain a factual evaluation. In any case, we believe that greater consideration should be given to actual performance from testing and that plans for improving performance and overcoming problems should not be viewed as sure cures but rather as possible improvements which are unproven and may or may not be successful.

Judging by the cases we examined, complete information is ordinarily not provided for the consideration of those having to decide whether or not to proceed with concurrent development and production. Consequently it is difficult under existing practice to give appropriate consideration to actual performance data based on testing--or the lack of such data. Recognizing the inherent tendency toward

optimism of project managers, we believe it is essential that those having broader responsibilities should provide a counterbalancing skepticism. Accordingly, we believe that the Navy's instruction relating to this matter should be revised to provide that actual performance data including test results accompany requests for permission to undertake production concurrently with development.

NEED FOR GREATER CONSIDERATION OF COMPONENT AVAILABILITIES IN SETTING COMPLETION DATES FOR WEAPON SYSTEMS

Modern weapon systems, such as ships or aircraft, often consist of a variety of highly complex components. For example, a modern fighting ship may contain, as components, radar, sonar, and missile systems. A missile system often includes, as components, complex guidance systems and fire control systems. Generally, the weapon system itself is built by a prime contractor--a shipbuilder, aircraft manufacturer, or other major contractor--and the component systems are built by other contractors.

Our review indicated that the component systems often require more breakthroughs in the state of the art than the major system itself. For instance, construction of a ship may involve fewer departures from what is known and has been proven than the development and production of a new type of radar for shipboard use that is intended to provide data that has not previously been obtained in this way.

Although more technical breakthroughs may be needed on the component systems, the completion schedule is usually predicated upon the time it takes to produce the prime system, i.e., the ship, aircraft, or missile. In some cases, it appeared to us that a statement of urgent need for concurrent development and production of the component system was virtually ensured from the start because of the schedule requirements dictated by the plans for the prime system. The following examples illustrate the point.

Sensor A was included in the design of two classes of ships before a prototype had been made to test its capabilities. It was known at the outset that this would mean that production for deployment of Sensor A would have to begin

Some examples follow:

--The views of the Navy unit which performed operational testing of Missile B were not formally presented to the decisionmaker when it was decided to go into production. Correspondence from the commander of the testing unit indicated that in his opinion the missile needed further testing. A subsequently issued Navy document indicated that problems had been encountered in several areas, affecting guidance, control, and ordnance, which led to production slippages.

--When the decisions to proceed into production before completing development were under consideration for the first three successive model types of Sensor A, the views of the in-house Navy laboratory which designed Sensor A were not presented to the decisionmaker. Analysis made by the laboratory indicated that, at the time the most recent model was approved for production, all requirements had not been met and tests of the equipment's ability to meet some of these requirements had not even been made.

DESIRABILITY OF GREATER CONSIDERATION OF THE PRODUCIBILITY OF EQUIPMENT

We found that the risks of concurrent development and production are considerably greater if the contractor's ability to produce the equipment on a large-scale basis has not been tested. The ability to produce an item under regular production conditions is called the producibility of the item. To establish producibility it is necessary to show that equipment manufactured on the assembly line will perform in a manner consistent with the performance of handcrafted models produced on a developmental basis. Although the assessment of the producibility of an item would, in our view, be an important matter for the decisionmakers to consider in deciding whether to go into large-scale production concurrent with development, we found that there was no requirement that such information be presented for the decisionmakers' consideration.

Our review has showed that problems in producing a development item on a quantity basis can be a cause of delays, considerable cost increases, and other problems when concurrent development and production is attempted. For example:

In the case of Missile Control System A, so far as we could ascertain, no assessment of the producibility of the development design was made prior to award of the production contract. Because of subsequent problems with producibility, significant delays in production were encountered and considerable costly redesign was required.

Typical contractor's comments regarding the producibility problems in translating development design into production hardware follow:

> "Until manufacturing techniques are developed and more production test tools are available it is necessary to use a high labor grade in areas such as cable development and point-to-point wiring as well as sub-assembly and unit test areas. It is not possible to obtain additional personnel with the desired skills.
>
> "Some of the subassemblies used in the *** [Missile Control System A] *** are pushing the 'state-of-the-art'. This has resulted in slow deliveries of these items as well as the scrappage of many parts used in these devices. Although we feel that as of today we have a pretty good handle on these areas, large backup quantities of some of these devices are still lacking.
>
> "Many unforeseen manufacturing problems have also arisen which have contributed to schedule delays."

In the regular development and production cycle, the Navy provides for determination of producibility through the use of pilot production. The Navy's instruction on this point defines pilot production as the controlled manufacture of limited numbers of an item, using manufacturing drawings and specifications which have been developed for

quantity production, and with tooling which is at least representative of that to be used in full production. This instruction contains the following principal objectives of pilot production:

> "1. To verify the producibility of the design, including the accuracy and adequacy of the manufacturing drawings and specifications;
>
> "2. To provide complete and adequate manufacturing documentation in reproducible form suitable for production, and to support competition for production;
>
> "3. To provide sufficient numbers of the new equipment or system to permit a realistic evaluation of performance and reliability; and
>
> "4. To permit the determination and correction of design deficiencies affecting producibility or reliability for incorporation in specifications and documentation in support of large quantity production for service use."

Although information on producibility is provided for when the regular, sequential development and production cycle is followed, the Navy instruction on the information to be considered in decisions involving concurrent development and production does not call for submitting any data on this matter. Admittedly, such data may be limited when decisions to go into production are made before development and testing is completed, because the design is not stabilized until these phases are completed. We believe, however, that an assessment of the probability of producing the item successfully would be valuable to the decisionmakers along with the assessments of technical feasibility, practicability of logistics support, and other factors which the decisionmakers now require that project managers supply.

CONCLUSION

We believe it is prudent to avoid concurrent development and production whenever it is feasible to do so. We noted that the Blue Ribbon Defense Panel in its report of July 1, 1970, recommended that:

> "A new development policy for weapon systems and other hardware should be formulated and promulgated to cause the reduction of technical risks through demonstrated hardware before full-scale development, and to provide the needed flexibility in acquisition strategies."

The Panel report stated that the new policy should provide for:

> "A general rule against concurrent development and production, with the production decision deferred until successful demonstration of developmental prototypes."

In those instances where concurrency cannot be avoided, we believe that the significant amounts of money involved make it imperative that concurrency decisions receive the most careful scrutiny and unbiased judgment obtainable. Accordingly, we believe that the instructions pertaining to the use of concurrency should be revised to require consideration of more factors than are currently required to be considered and that steps should be taken to be sure that such additional requirements are effectively implemented into the concurrency evaluation process.

RECOMMENDATIONS

We recommend that the Secretary of Defense take action to have the Navy's instruction relating to concurrent development and production (NAVMAT Instruction 3960.2) revised to provide for submission of the following data to the Assistant Secretaries for consideration in making concurrency decisions.

1. A comparison of design performance requirements and actual performance data (based on testing) which will show factually, at the time the decision is to

be made, how nearly the equipment meets required performance goals.

2. An assessment of the essentiality of an unproven component to the weapon system and the feasibility of delaying production of the weapon system or the use of a substitute for the component.

3. Documented views of Government activities and contractors involved in the project, as well as the project manager, as to the feasibility of proceeding on a concurrent basis.

4. An assessment of the producibility of the equipment.

We also recommended that additional information be presented by the Secretary of Defense to appropriate congressional committees in any case where production of a new major weapon system, or modification of an existing system, is authorized before all its significant components have satisfactorily met all prescribed development tests.[1]

AGENCY COMMENTS AND OUR EVALUATION

The Navy concurred generally with our recommendations related to reviewing and revising directives governing concurrency. The Navy advised us that it would review and revise its directives governing concurrency in weapon system acquisition. The Navy stated, however, that because of the complexity of management for major weapon system acquisition, the precise wording of the four data-gathering items might not be appropriate for across the board application in the directives system.

For example, the Navy stated that actual performance data in most cases would be impossible to gather in advance

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[1]This suggestion was previously made in our report to the Congress entitled "Need for Management Improvement in Expediting Development of Major Weapon Systems Satisfactory for Combat Use, Department of the Army" (B-163058 dated November 17, 1969).

of operation of the equipment and that other aspects such as the essentiality determination, and an assessment of producibility might require more visibility. The Navy further advised us that obtaining documented views of all Government activities and contractors involved in the project, as well as the project manager, would be unacceptable in any management chain.

We believe that the Assistant Secretaries who make the concurrency decisions must have accurate data on each data element listed in our proposal, including a comparison of design performance requirements and actual performance data based upon testing and inclusive of documented views from Government activities, contractors, and the project manager. Although the Navy has advised us that actual performance information is usually not available at the time of the concurrency decision, we believe that such data, at least on subsystems or components, is available from test results and should be furnished the decisionmaker so that the best decision can be made.

In addition, the Navy seems to have interpreted our recommendation on obtaining documented views as including everyone, at all levels, ever associated with the project. Our recommendation was not intended to be so broad and to result in the generation of such voluminous information as the Navy's interpretation suggests but instead was designed to point out the necessity of soliciting views from several different sources so that an unbiased decision could be made.

MATTER FOR CONSIDERATION BY THE CONGRESS

In our November 1969 report cited on page 32 we suggested that, as a means of exercising appropriate legislative controls over pending major weapon systems, the Congress may wish to require that (1) determination be made by the Secretary of Defense, prior to authorizing production of a new system or major modification of an existing system, that all its significant components have satisfactorily met all prescribed developmental tests and (2) in any case where the Secretary of Defense considers that authorization of production is essential even though not all developmental tests have been satisfactorily completed, a certification to that

effect be furnished by the Secretary of Defense to the appropriate congressional committees--such certification to include the reasons for authorizing concurrent development and production and the status of development of each significant component.

We believe that this report on the Navy's extensive use of concurrency further demonstrates the need for the Congress to be apprised of the weapon systems on which the concurrency technique is deemed essential.

With respect to our recommendation that additional information be presented to the Congress in concurrency situations, the Director of Defense Research and Engineering advised us of two actions recently taken to strengthen and improve the management of major weapon system acquisitions including:

--The establishment of a Defense Systems Acquisition Review Council to review major programs at critical milestone points and to make recommendations to the Secretary of Defense as to the status and readiness of the program to proceed to the next phase of development or production.

--The use of a Development Concept Paper by top-level management. The Development Concept Paper, according to the Director:

> "assesses the important factors in each decision, including risks, full military and economic consequences, alternatives including pros and cons of each and provides explicit decision-review thresholds for key factors such as cost, schedule and operational performance."

Although these actions should lead to improved management of weapon system programs, they are, however, both internal to the Department of Defense. Consequently, they do not provide the Congress with the additional information which we believe the Congress should have.

CHAPTER 5

INTERNAL AUDITS

We were informed that the established Navy review organizations have not conducted examinations into the practice of concurrent development and production, nor have they included such examinations in their current plans. Because of the extent and significance of this practice we recommended that the Naval Audit Service give consideration to making regularly scheduled audits into this aspect of procurement at all levels of Navy management.

AGENCY COMMENTS

The Navy, in commenting on our report, concurred in the desirability of periodic independent examinations of the use of concurrent development and production. The Navy advised us that the appropriate organization would be charged with the responsibility for making periodic audits of Navy projects involving concurrent development and production and that such audits or examinations as are feasible in this area would be incorporated into future Navy plans.

CHAPTER 6

SCOPE OF REVIEW

In performing our review, we examined pertinent instructions of the Department of Defense and the Department of the Navy and internal review reports regarding the use of concurrency in Navy procurements. To the extent deemed necessary, we examined files at the Office of the Chief of Naval Operations, at the Naval Material Command and its systems commands, and at project offices relating to the five items of equipment we selected for review.

The systems we examined were selected knowing that each system was under concurrent development and production and that cost growth was experienced. Aware of these problems, we made this review to ascertain the extent and results of concurrency in the Navy, how concurrency was being managed, and how the Navy decided concurrency was necessary and likely to be successful.

We reviewed selected aspects pertaining to these items at the U.S. Naval Ordnance Laboratory, White Oak, Maryland; the U.S. Navy Underwater Sound Laboratory, New London, Connecticut; the Operational Test and Evaluation Force, Norfolk, Virginia; the Johns Hopkins University Applied Physics Laboratory; and the offices of the Assistant Secretaries of the Navy for Research and Development, and for Installations and Logistics.

We also discussed the results of our work with officials of the Department of the Navy. We determined whether established Navy review organizations have examined into concurrency practices.

Further, we reviewed the results of a Navy study of the development and production of 13 weapons and reviewed the results of the Blue Ribbon Defense Panel study on the Department of Defense.

APPENDIXES

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301

31 MAR 1970

Mr. C. M. Bailey
Director, Defense Division
United States General Accounting Office
Washington, D. C. 20548

Dear Mr. Bailey:

On behalf of the Secretary of Defense, I am responding to your memorandum of January 7 which forwarded copies for DoD review of your draft report to the Congress on large scale production of major weapon systems.

In general your draft report is a fair appraisal of the risks involved in concurrency and we certainly agree that when a conscious management decision is made to use this concept that all of the factors involved should be carefully considered prior to such decision. I do want to emphasize, however, that concurrency, properly decided upon and applied, is a necessary management tool.

The Department of the Navy in their comments on subject draft report (attachment 1) has addressed your recommendations both generally as well as in some detail. As indicated in their response they will review and revise their directives governing concurrency which you had recommended that the Secretary of Defense take action to have accomplished. Other actions which the Navy proposes to take in terms of your other recommendations seem appropriate and responsive.

As brought out by the Navy document, as I'm sure you are aware, the DoD has, over the past several months, taken many steps to strengthen and improve its management of weapon programs. Some of these steps should eliminate inappropriate use of concurrency.

One of the major steps we have taken is to establish a Defense Systems Acquisition Review Council (DSARC) which is comprised of the Director

of Defense Research and Engineering and the Assistant Secretaries of Defense (Installations and Logistics), (Comptroller), and (Systems Analysis). The Council is to review major programs, at critical milestones, to make recommendations as to the status and readiness of the program to proceed to the next phase of effort in the acquisition cycle. These reviews will occur at three critical points including when it is desired to transition from development to production for Service deployment. The factors which you have recommended be considered at this time would certainly be considered if concurrency is proposed.

Contributing to the DSARC consideration is the Development Concept Paper (DCP) which is a summary top-management document used for Secretary of Defense level decisions at the phase transition points of major development programs. The DCP assesses the important factors in each decision, including risks, full military and economic consequences, alternatives including pros and cons of each and provides explicit decision-review thresholds for key factors such as cost, schedule and operational performance. The DCP, coupled with DSARC reviews, provides the Secretary of Defense with important elements of information and the views of key people. They help minimize biased "advocacy" views. As used together, the DCP and DSARC systems cause a continuing restraint on programs which might otherwise move too quickly without firm basis for doing so.

I believe that the management actions we have taken, such as those discussed above, should be sufficient to insure that GAO and Congress that we will carefully control any future authorization of concurrency.

Sincerely,

E Rechtin

for John S. Foster, Jr.

Attachment 1

Department of the Navy Comments

on

GAO Draft Report of 7 January 1970

on

Large Scale Production of Major
Weapon Systems Undertaken Before
Completion of Development and Testing

(OSD Case No. 3063)

GAO note: We have deleted certain parts of the Navy comments because of their volume. To the extent appropriate the Navy comments have been reflected in the body of the report as revised.

II

SUMMARY OF THE NAVY POSITION

The GAO Report of "Large Scale Production of Major Weapon Systems Undertaken Before Completion of Development and Testing" is thought provoking and timely in that it gives visibility to a management tool of military weapon system acquisition. "Concurrency," of itself, can have significant cost implications either positive or negative; can speed up or delay product delivery; can increase or decrease weapon efficiency; and despite the uncertainty of successful application, offers to the Defense decision maker the hope that its application will permit the introduction of a necessary weapon system in time to meet a threat to the security of the country.

The Navy has long recognized the complexity of the factors leading to successful application of the management tool known as "Concurrency," in which a normally succeeding phase of the research, development, and production sequential process is deliberately prosecuted in advance of the completion of the preceding phase. A Navy Management Study in 1963 and a directive from the Secretary of the Navy in 1964 point out the cost and risk hazards and the observed tendency for managers to try to institute the process as a means to achieve difficult goals.

> "The decision to practice concurrency must be tempered by a very careful analysis of the costs and benefits, the particular management tools to be used in the course of the development, and a clear assurance that the costs and risks are in the national interest. ---- The practice of concurrency in the development of Naval and Marine Corps material will be utilized only under conditions of time urgency or important operational needs, and on an exception basis." (SECNAVINST 3900.30 of 31 July 1964)

There is ample justification for the application of concurrency as a management tool on a case basis. Indeed, concurrency in the development of some complex systems is a necessity, i.e., must be the normal mode of operation. This is particularly true in ship construction, where long lead times and the nature of the overall system normally preclude prototype construction. There can be no question, however, that its use must be controlled and regulated in a manner commensurate with its uncertainties, risks, and the hoped for rewards. The Navy system has heretofore included the checks and balances implicit in the requirement that concurrency

implementation must be the subject of review and approval at the Assistant Secretary of the Navy level.

In the last two years, the Secretary of Defense has developed and refined review procedures which are designed to provide him the basic program information and the perspective to permit him to make the basic and milestone decisions required for major weapon system acquisition. Prime among these are the Development Concept Paper (DCP) and the Defense System Acquisition Review Council (DSARC). One of the program characteristics specified in the DOD procedures as requiring review in major or otherwise important programs is that of concurrency of development and production.

It is clear from the progression to the higher level of decision making that concurrency merits the attention it has received in the past and, based on the GAO delineation of areas of concern, close scrutiny of the directive and management system is indicated.

The Department of the Navy takes issue with certain of the GAO findings, particularly some concerning the degree of success attained for specific weapon systems, and some which relate cost and concurrency without qualification. In addition, it is considered that the report, as written contains a possibly unintended bias in that it (1) does not recognize positively that concurrency, properly used, is a necessary tool of management, and (2) creates the impression that Navy management procedures have been almost wholly ineffective in the area of concurrency. Furthermore, it is considered that the report does not sufficiently recognize the point that prudent judgment exercised at a time of decision may in some cases show its fallibility when examined in the light of subsequent events.

Despite the areas of disagreement applicable to the findings, the Department of the Navy concurs generally with the recommendations of the report as they relate to reviewing and revising directives governing concurrency; with the need for reviewing Navy policy for qualification, training, assignment and professional development of project managers, all directed toward achieving continuity of project management; and for the general need to establish periodic auditing as a means of controlling the practice of concurrency.

The Department of the Navy completed the NAVSHIPS SCN Pricing and Cost Control Study in April 1969 which included the problems of adequate management of concurrency decisions involved in the shipbuilding program. Recommendations for improved management procedures from that study have been incorporated in the Shipbuilding and Conversion Improvement Program. The recommendations of the GAO report are generally consistent with and extend the findings of the above report.

PRINCIPAL OFFICIALS

OF

THE DEPARTMENT OF DEFENSE

AND THE DEPARTMENT OF THE NAVY

RESPONSIBLE FOR ADMINISTRATION OF ACTIVITIES

DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
DEPARTMENT OF DEFENSE		
SECRETARY OF DEFENSE:		
Melvin R. Laird	Jan. 1969	Present
Clark M. Clifford	Mar. 1968	Jan. 1969
Robert S. McNamara	Jan. 1961	Feb. 1968
DEPUTY SECRETARY OF DEFENSE:		
David M. Packard	Jan. 1969	Present
Paul H. Nitze	July 1967	Jan. 1969
Cyrus R. Vance	Jan. 1964	June 1967
Roswell L. Gilpatric	Jan. 1961	Jan. 1964
DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING:		
Dr. John S. Foster, Jr.	Oct. 1965	Present
Dr. Harold Brown	May 1961	Sept. 1965
ASSISTANT SECRETARY OF DEFENSE (INSTALLATIONS AND LOGISTICS)		
Barry J. Shillito	Jan. 1969	Present
Thomas D. Morris	Sept. 1967	Dec. 1968
Paul R. Ignatius	Dec. 1964	Aug. 1967
Thomas D. Morris	Jan. 1961	Dec. 1964

PRINCIPAL OFFICIALS

OF

THE DEPARTMENT OF DEFENSE

AND THE DEPARTMENT OF THE NAVY

RESPONSIBLE FOR ADMINISTRATION OF ACTIVITIES

DISCUSSED IN THIS REPORT (continued)

	Tenure of office	
	From	To
DEPARTMENT OF THE NAVY		
SECRETARY OF THE NAVY:		
John H. Chafee	Jan. 1969	Present
Paul R. Ignatius	Sept. 1967	Jan. 1969
Charles F. Baird (acting)	Aug. 1967	Sept. 1967
Robert H. B. Baldwin (acting)	July 1967	Aug. 1967
Paul H. Nitze	Nov. 1963	June 1967
Fred Korth	Jan. 1962	Nov. 1963
CHIEF OF NAVAL OPERATIONS:		
Adm. Elmo R. Zumwalt, Jr.	July 1970	Present
Adm. Thomas H. Moorer	Aug. 1967	June 1970
Adm. David L. McDonald	Aug. 1963	July 1967
CHIEF OF NAVAL MATERIAL:		
Adm. Jackson D. Arnold	July 1970	Present
Adm. Ignatius J. Galantin	Mar. 1965	June 1970

U.S. GAO Wash., D.C.