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SECTION VII

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

This section is comprised of problems encountered in which policy or management decisions were involved. No attempt is made to historically justify the decisions reached, but rather a retrospect view of results is presented of those areas in which more desirable results could have been obtained.

THEORY OF CONCURRENCY

Many of the unusual problems encountered throughout the Ellsworth Titan I project, such as the large number of modifications issued and the substantial increase in the current construction estimate, were directly attributable to concurrency of design and construction. In effect, under this theory, up-grading and validation of design was accomplished concurrently with construction. Although concurrency was a recognized necessary evil in view of the priority of this National Defense project, perhaps detrimental effects could have been reduced by more closely timing the initiation of required changes. This could have been accomplished by earlier determinations that the changes were essential, better utilization of experience from other Areas, and reduction in delays in initiating changes after they were determined essential. The latter could have been accomplished by faster engineering action by the Design Agency and elimination of funding delays.

ACCELERATION

The concept of buying time in modifications, through payment of acceleration costs, was not always completely successful, in that there was a hidden effect that basic contract work sometimes suffered. This occurred because a flexible labor pool was not available locally to meet short term increases in labor requirements, and was compounded by limited space in work areas. More consideration should have been given toward granting, and settling, the time extensions concurrently with the negotiation of each modification.

JOINT OCCUPANCY

The original concept of joint occupancy was based on Associate Weapons System Contractors getting advance limited occupancy on a schedule closely phased to the Construction Contractor's completion dates for the various structure. This phasing was based solely on the scheduled completion of the original contract work, and did not take into consideration the delays encountered through the issuance of more than two hundred (200) modifications. Joint occupancy did commence on or close to its originally scheduled dates. This caused considerable congestion in many areas and damage to already completed work, resulting in both increased costs and in delays to the Construction Contractor. A compounding factor in scheduling of work areas resulted from the use of cost plus contracts for Associated Weapon System Contractors and fixed price contract for the Construction Contractor. In certain cases, it is questionable if the time saved by the early entry of Associate Weapons System Contractors actually resulted in an

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overall program time savings. In retrospect, it would have been economical in both time and money to have more closely related the entry of the Associate Weapon System Contractors to the actual completion status of each structure.

WORK SCHEDULES

The Construction Contractor's work schedules proved to be unrealistic in that a major portion of the electrical and mechanical work was compressed into a short time span close to the completion date for various structures. Thus several crafts were competing for the limited work space available, with the resultant effect that the Prime Contractor's control of his sub-contractors deteriorated and certain interim completion dates were missed. A more realistic spread out of the mechanical and electrical work would have resulted in an orderly completion of each structure.

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ACCESS

The completions of the Portal Silos were scheduled for 1 July, 1 August and 1 September 1961, for Complex 1B, 1A and 1C respectively. Other structures, such as Powerhouses, Control Centers, and Antenna Terminals and Silos were scheduled for earlier completion and corresponding beneficial occupancy, so that there was a rather constant required movement of equipment to these structures. Also, the Tunnels were closed for backfill operations prior to completion of the Portal Silos, so that access to the complexes was a serious problem and resulted in congestion and delays. This would have been avoided if the entry portals, (including elevators), had been scheduled for completion five to six months earlier.

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TESTING

a. Acceptance Tests

Acceptance and performance test requirements were not detailed in the contract specification, and were, apparently, appreciably more extensive and exacting than anticipated by the Construction Contractor in the preparation of his bid. Further, the Government unilaterally established detailed test procedures, rather than requiring the Contractor to prepare proposed procedures in accordance with the contract plans and specifications. These unilaterally established procedures were based more upon engineering requirements than upon contract requirements.

To expedite completion and turnover of the facilities, acceptance tests were permitted to be run without sufficient preparations by the Contractor. Therefore, scheduling was difficult and attempted tests were frequently aborted. Many test deficiencies were discovered at the time of tests, or on evaluation of test results, which should have been corrected in pre-test checkouts. Correction of these test deficiencies lagged, with a major contributing factor being the post-test office-evaluation procedure used, principally in the early stages of testing.

Acceptance test problems would have been appreciably reduced if specific contractual test requirements and procedures had been established prior to testing, to include a requirement for the Contractor to perform adequate pre-test checkouts, and if test evaluations and correction of deficiencies had been conducted on-the-spot to the maximum possible extent.

b. Validation Testing

Tests to validate adequacy of design were conducted at the last complex to be completed. If the first complex completed had been validated, and a limited open-end modification established to correct minor required changes, the overall test program would have benefited.

FIELD INVESTIGATION

Experience in settlements of Modifications and Claims showed that more detailed and accurate records should have been maintained by the Resident Offices. It would have been of assistance if early in the project, an aggressive educational program had been pursued, beginning with formalized instruction and following with periodic on-the-job refresher training, to insure that inspectors were thoroughly oriented on the proper methods and importance of keeping accurate and detailed daily logs and other essential documentation, to include specific information on contractor personnel and equipment by number, craft, shift information, area worked and modification work performed.

PHOTOGRAPHIC COVERAGE

Regulations for photographic coverage were fully complied with by the Area. However, a more complete centrally controlled photographic coverage of both progress and potential claims areas, fully identified, would have been beneficial. This could have been accomplished by alerting Resident Engineers of possible claims and areas of possible disputes, and have the Resident Engineers personally supervise photo coverage in his Residency.

APPROVAL OF SHOP DRAWINGS

The procedure followed in which shop drawings were reviewed and approved by the Architect Engineer proved at times to be cumbersome and time consuming, and ultimately resulted in claims. A compounding feature was a tendency on the part of the approving agency to consider only one engineering aspect involved, so that subsequent conflicts evolved. A local, adequately staffed, review office, under direct control of the Area, would have minimized these problems.

MODIFICATIONS

The theory of concurrency of construction and up-dating of design, together with the extreme technical complexity of the project with "built-in" interferences in the contract, generated more than two hundred (200) modifications to the construction contract. Many of these modifications were so complex in nature and scope that it was difficult for both the Contractor and the Government to estimate the cost involved. To further compound this problem, changes often required removal or alterations of existing work, which could be in various stages of construction at any one time. For example, each of the nine missile silos could be in different stages of construction, and each had some individual characteristics due to the Contractor's option to field route or field locate portions of the work.

The adequate staffing of Government estimating personnel was not accomplished early enough in the job to prevent a backlog of modifications to be settled, and to provide the estimators with a thorough background of the project conditions and the work involved. This was overcome partially by use of a detailed reporting form prepared for the

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Estimating Section by the Resident Engineer or his inspectors. On the more complicated modifications, one individual was assigned the responsibility to coordinate all phases of the modification.

INSPECTIONS AND MANAGEMENT

The accomplishment of inspections of all types (normal job inspections, prefinal and final turnover inspections, and testing) was severely complicated in that sundry agencies were involved, using a multitude of personnel of various levels of competence and training. In addition to the normal adequate Corps of Engineers inspection effort, construction surveillance was practiced to varying extents, under Air Force sponsorship, by personnel of the SATAF, the Base Civil Engineer, the SAC Missile Squadron, the Architect-Engineer and The Martin Company.

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The problems of split responsibilities for design and construction, and actual or surmised dual commands and approval authorities, were obstacles to be overcome. More positive management and economics would have been experienced if the number of agencies associated with management and inspection were reduced, and if pure control of the facility construction had been vested in the Corps of Engineers Agencies involved.

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