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Report to the Secretary of the Army

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ARMY PROCUREMENT

Water Purification Equipment May Not Meet All Performance Requirements

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GAO

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General Accounting Office
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National Security and
International Affairs Division

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The Honorable Michael P. W. Stone
The Secretary of the Army

Dear Mr. Secretary:

We have reviewed the Army's program for the design and development of a 3,000-gallon-per-hour (gph) reverse osmosis water purification unit (ROWPU). This report discusses the development of the ROWPU, the prototype testing, and the Army's decision to award a $31 million production contract for 98 units.

Results in Brief

We found that the Army had awarded a production contract for the 3,000-gph ROWPU, even though it knew that the prototype design did not meet some critical performance requirements. Specifically, during development and operational testing, the Army discovered that the contractor's prototype design was not able to produce the required amounts of potable water[1] and exceeded the maximum specified noise level.

Although the contractor had designed changes intended to correct deficiencies identified during prototype testing, the redesigned units were not tested prior to the award of the first production contract. Testing of these changes will not occur until the first articles are produced.[2] Thus, at the time the production contract was awarded and after the expenditure of over $6 million in development funds, the Army had limited assurance that the contractor could produce a ROWPU to meet its performance requirements.

Background

Water purification equipment for providing military members with potable water for drinking and other uses has been in existence since World War I. The purification of polluted fresh water generally has been accomplished by coagulation, filtration, and chlorination, while seawater has been treated by distillation. The equipment in use today was developed following World War II.

[1]"Potable water" is water that is suitable for drinking.

[2]The "first articles" are the first production units. These units are subjected to first article testing to validate production techniques and demonstrate that the production units can meet the same performance requirements as the prototype units, which are largely handmade.

In March 1974, the Army approved a required operational capability document for a family of water purification equipment utilizing reverse osmosis for the removal of dissolved solids. These units, which would be able to produce potable water from all sources, including fresh, brackish, sea-, and contaminated water, were intended to replace all then-existing water purification equipment.

Development of the 3,000-gph ROWPU

In the spring of 1982, the Army expressed a need for a 3,000-gph ROWPU to use at echelons above the division level as soon as possible, and it developed an accelerated acquisition strategy. The strategy called for the award of two full-scale engineering development contracts. Each contractor was to design a 3,000-gph ROWPU and fabricate three prototypes, which would compete against those of the other contractor. The Army expected that both designs would meet the government's needs. The winning contractor would be selected on the basis of its design's demonstrated capability to meet the performance specifications listed in the purchase description, the completeness of its integrated logistics documentation, reliability and maintainability, and cost factors. The Army believed that having the contractors compete in this manner would result in lower development and production costs.

In April 1984, the Army awarded full-scale engineering and development contracts to Aqua-Chem, Incorporated, and the Brunswick Corporation. The contractors were paid more than $3 million each to design, develop, and fabricate three prototype units. Although, under the terms of the contracts, Aqua-Chem and Brunswick were to deliver to the Army all drawings and data necessary to solicit full and open competition for production quantities of the unit, the Army's acquisition strategy called for restricting competition on the initial production contract to the two development contractors. It was recognized, however, that this information would be needed to solicit competition for follow-on procurements.

Deficiencies Identified During Testing

During extensive testing conducted by the contractors and the Army over a 2-year period, between December 1984 and February 1987, it was discovered that neither of the contractors' prototype ROWPUs met all of the Army's performance requirements. In particular, both designs experienced difficulty meeting the Army's reliability, water production, and noise requirements. After the contractors modified the prototypes and additional testing was performed, the Army concluded that both prototypes met reliability requirements. The test reports, however, showed

that the prototype units continued to experience water production problems, especially the Aqua-Chem unit. Also, excessive noise continued to be a problem for both units.

Three of each contractor's prototype units were subjected to development testing to determine whether they met the requirements specified in the purchase description and required operational capability document. The units also underwent operational testing to assess their military suitability, operational effectiveness, and supportability in a realistic operational environment. Operational testing was performed by military personnel from May 16 to July 23, 1985, at Fort Story, Virginia, using seawater and at Fort Eustis, Virginia, using fresh and brackish waters.[3] Development testing was divided into two phases. Phase I was performed by the U.S. Army Combat Systems Test Activity from December 17, 1984, to March 28, 1985, at Aberdeen Proving Ground, Maryland. Phase II was performed at Aberdeen Proving Ground from August 22 through November 4, 1985. Cold weather testing was done at the U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, from October 18 through November 30, 1985. Warm weather testing was done by the U.S. Army Tropic Test Center, in the Republic of Panama, between November 1985 and July 1986, with additional testing performed during January and February 1987.

On May 7, 1986, the Directorate of Combat Developments, U.S. Army Quartermaster School, Fort Lee, Virginia, issued an independent evaluative report on the 3,000-gph ROWPU, based on the results of the completed operational and development testing. Its overall conclusion was that neither ROWPU design was ready to proceed into full production, primarily because both had failed to meet minimum water production and reliability requirements. The evaluative report, and a referenced development test report dated May 1985, also showed that neither design achieved the desired noise limitation but that the Brunswick design was measurably better than the Aqua-Chem design. The evaluators recommended that some form of follow-on test and evaluation be conducted before the Army made type classification[4] and production decisions.

[3]Fresh water is defined as having a total dissolved solids concentration of less than 1,500 milligrams per liter. The total dissolved solids of brackish water are considered to be between 1,500 and 15,000 milligrams per liter.

[4]When the Army "type classifies" a product, it certifies that the product is acceptable for service use.

In a report dated January 1987, covering the results of the warm weather testing performed on the 3,000-gph ROWPU in Panama from November 1985 to July 1986, the U.S. Army Tropic Test Center reported that, while both units had achieved the required product flow rates, there were several instances in which both units' product water was not potable. The Aqua-Chem unit's product water did not meet the chemical specifications for potable water when seawater was used as the source. Furthermore, it was found that some bacteriological samples of both units failed to meet the potability standards.

Because neither ROWPU met required potability standards during development testing conducted by the U.S. Army Tropic Test Center, the Center conducted additional performance testing from January 1987 to February 1987. Each unit was to perform two 24-hour missions with seawater followed by two 24-hour missions with fresh water. The units were required to achieve 20 hours of actual water production during each 24-hour mission. The Brunswick unit produced potable water during all four of its missions while operating at the required production rate, but it was able to achieve the required 20 production hours within a 24-hour time period on only one of the four missions. The Aqua-Chem unit produced potable water during the first of its missions with seawater, but on the second mission it did not meet the chemical specification for potable water. Because the Aqua-Chem unit failed to produce potable water from seawater, the scheduled fresh water missions were not performed.

The Army, because of continuing concern with the performance of the ROWPUs, required the contractors to perform an additional 1,500 hours of testing. More than 1,100 hours of this testing was performed primarily from the mid to latter part of 1986 to demonstrate the prototypes' reliability. An Army official advised us that this testing was witnessed by Army representatives. On the basis of raw data compiled by the contractors, Army officials concluded that both ROWPUs could achieve the Army's reliability goal.

The last 300-plus hours of testing was conducted from January to February 1987 at Fort Lee, Virginia, to test for water production. During this phase of retesting, the units, which were operated by contractor technicians with Army observers, processed fresh water only. Each ROWPU was operated for one 10-day mission during which it was allowed to operate 24 hours a day, followed by five 20-hour missions. Production goals were 600,000 gallons for the 10-day mission and 60,000 gallons for each of the 20-hour missions.

During the 10-day mission, the Brunswick ROWPU produced 685,617 gallons of water and, during the 20-hour missions, consistently produced over the 60,000-gallon goal. The Aqua-Chem ROWPU produced only 583,450 gallons of water during the 10-day mission and produced 60,000 gallons or more only during the first 3 days of the mission. Production by the Aqua-Chem ROWPU during the five 20-hour missions steadily declined from about 60,000 gallons on the first mission to less than 50,000 gallons on the final mission.

Army Awards Production Contract Before Correcting Prototype Deficiencies

Although Aqua-Chem's prototype ROWPU did not meet water production and other requirements during development and operational testing, the Army awarded Aqua-Chem a production contract. The Army plans to rely on expanded first article testing under the production contract to determine whether Aqua-Chem's substantially modified design will meet its performance requirements.

In July 1987, the Army issued a request to Brunswick and Aqua-Chem for proposals for the production of 98 units of the 3,000-gph ROWPU, with an option for the production of 49 additional units. Brunswick did not respond to the request for proposals. After concluding that Aqua-Chem's proposal was acceptable, the Army awarded a contract to Aqua-Chem, Incorporated, in November 1987. The contract was for $31,374,978, with an option price of $15,629,986.

In evaluating Aqua-Chem's technical proposal, Army technical representatives acknowledged that the development and operational tests had shown deficiencies, the most critical of which were in the areas of water production, reliability, and noise. They stated that the 1,500 hours of testing conducted after completion of the development and operational testing had shown that the reliability goal could be met. The representatives concluded that Aqua-Chem's unit had marginally achieved the production goal of 600,000 gallons of water during the 10-day mission but in the process had severely fouled the reverse osmosis elements to the extent that water production goals could not have been met using normal operating procedures. They further stated that, while noise levels had been reduced, the standards set in the performance specifications had not been met.

The Army technical representatives expressed the opinion that the extensive modifications proposed for Aqua-Chem's ROWPU during the initial production contract amounted to a major redesign and that, consequently, development and operational testing done during research and

development (the full-scale engineering and development contract) might not be valid for the proposed production model. They concluded that, since the Aqua-Chem unit was only marginally acceptable at the conclusion of the reliability growth test, conducted as part of the engineering development contract, to accept the many modifications without full-scale testing would require that the military accept a higher risk than it would if a full-scale test were run on the prototype unit.

Army officials advised us that any risk associated with this procurement will be minimized by limiting Aqua-Chem's initial production to three units that will be subjected to an expanded first article testing program and one unit needed by the contractor to conduct a physical configuration audit.[5] Army officials told us that Aqua-Chem will be permitted to begin full production only after the expanded first article test results have been analyzed by a special in-process review group. These officials also told us that the Army's options include acceptance of the first articles, acceptance with modifications, or rejection of the first articles and review of all feasible alternatives to meet the Army's requirements for a 3,000-gph ROWPU.

Conclusions

Because the Army awarded the initial production contract to Aqua-Chem before proposed corrections to significant design deficiencies had been completed and validated, there is still doubt whether the design will meet Army requirements. For this reason, the first article testing of the first production units will have a far greater significance than usual. Therefore, it is critical that thorough testing be carried out and that a determination be made that the ROWPU fully meets all operational requirements before the contractor is permitted to proceed with production.

Recommendation

We recommend that you direct procurement officials to take the action necessary to ensure that the planned expanded first article testing is carried out and that the tests are carefully analyzed to ensure that all critical requirements are addressed.

[5]The purpose of the physical configuration audit is to establish that the drawings accurately define the design and details of construction of the built parts and assembled modules, subassemblies, and assemblies.

Objective, Scope, and Methodology

The objective of our review was to determine whether the Army had placed the 3,000-gph ROWPU into production prematurely and, if so, what impact premature production had on costs and other factors.

In performing our work, we reviewed the complete history of this acquisition program, including applicable regulations, documents produced during the planning and development of the system, tests performed on prototype units, the Army's use of the test results, and the rationale behind management decisions. We interviewed the project manager, the contracting officer, and various other officials associated with the program, located at the U.S. Army Troop Support Command, St. Louis, Missouri, and the U.S. Army Belvoir Research, Development and Engineering Center, Fort Belvoir, Virginia.

For criteria on the reasonableness of the Army's actions, we relied in part on Army Regulation 70-61, covering the type classification of Army materials, and Army Regulation 70-1, covering systems acquisition policy and procedures.

Our work was performed from September 1988 through June 1989 in accordance with generally accepted government auditing standards. We did not obtain official comments from the Department of Defense, but we did discuss our work with responsible officials from the Department of the Army and incorporated their views where appropriate.

As you know, 31 U.S.C. 720 requires the head of a federal agency to submit a written statement on actions taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report. A written statement must also be submitted to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the Chairmen of the above Committees and of the House and Senate Committees on Armed Services; the Secretary of Defense; and the Director, Office of Management and Budget. We will also make copies available to others upon request.

Major contributors to this report were John Henderson, Assistant Director, and John Kuykendall, Evaluator-in-Charge. Please contact me at (202) 275-4141 if you or your staff have any questions concerning this report.

Sincerely yours,

Richard Davis

Richard Davis
Director, Army Issues