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Report to the Chairman, Subcommittee on Readiness, Committee on Armed Services, House of Representatives

September 1991

OPERATION DESERT STORM

Army's Use of Water Purification Equipment

GAO/NSIAD-91-325

GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

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September 26, 1991

The Honorable Earl Hutto
Chairman, Subcommittee on Readiness
Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

As you requested, we reviewed the Army's use of Reverse Osmosis Water Purification Unit (ROWPU) equipment during Operation Desert Storm.[1] Specifically, we reviewed (1) the production capability and performance of the equipment deployed to Operation Desert Storm, (2) the Army's projections of ROWPU production capability during the operation, and (3) the status of the Army's program to buy 3,000-gallon-per-hour (gph) ROWPU equipment.

We conducted our review between October 1990 and January 1991. Although hostilities ceased on February 27, 1991, the experience gained and lessons learned during this conflict are valuable in that they will apply in future scenarios.

Results in Brief

The Army took the action necessary to provide the troops deployed to Operation Desert Storm with adequate water supplies through a combination of host nation water sources and ROWPU production. The Army relied almost exclusively on host nation water supplies during the initial phase of the operation. The Army estimated that, although it continued to rely heavily on this support, by mid-January it had deployed and set up sufficient ROWPU equipment to provide most of its water needs.

The Army did not monitor the actual water production output of ROWPU equipment or collect and analyze data on ROWPU equipment's performance during Operation Desert Storm, although it has a material condition status reporting system available for reporting such data. Thus, the Army could not determine how much water support the ROWPU equipment actually provided or how well it performed. Without this data, the Army lacked important information it could have used to quickly detect

[1]With the onset of military action on January 16, 1991, Operation Desert Shield became known as Operation Desert Storm. For the purposes of this report, we refer to the overall operation as Operation Desert Storm.

and resolve any potential problems with ROWPU performance, production, or parts availability. The Army's projection of the ROWPU equipment's capability to produce water for Operation Desert Storm was based on several questionable assumptions, including the following:

- Some ROWPU equipment would be operated at levels higher than the rated capacity of the unit.
- Operational readiness would be maintained at a level unsupported by experience with the equipment.
- All required spare parts would be readily available.
- Trained and qualified Army personnel would be available to operate the equipment.

Because the Army believed it had solved the technical problems with the 3,000-gph ROWPU, it expedited production. It did so even though required testing was not completed. The Army plans to complete required testing by September 1991, at which point the contractor will have 42 units ready for delivery to the Army.

The Army is considering waiving the requirement that the 3,000-gph ROWPU be capable of undergoing nuclear, biological, chemical (NBC) decontamination because the system will likely not meet this requirement. The Army has no specific plans to compensate for this shortcoming.

Background

In accordance with its doctrine, the Army relied almost exclusively on host nation water support during the early days of troop deployment to the Persian Gulf. Although the Army continued to obtain water support for deployed forces from a variety of sources, its plans called for achieving the capability to satisfy the total Army force water requirement through its own ROWPU production.

In 1974, the Army first approved a required operational capability document for a family of water purification equipment using reverse osmosis for the removal of dissolved solids. Reverse osmosis is a membrane separation process by which, under pressure, pure water is separated from raw water, removing most soluble salts and all particulate matter. The Army determined that the 3,000-gph ROWPU, to be positioned at the corps level, would be its primary water purification system in the field. This system was to be supplemented by 600-gph ROWPUs positioned at the division level and below.

The Army has experienced difficulties with the 3,000-gph ROWPU program since it began developing the equipment in 1984. At the time Operation Desert Storm began, the Army was continuing to experience technical and production difficulties with the unit, which was not yet in production. Only three units produced for testing were available for use. As a substitute, the Army, for Operation Desert Storm, used commercially developed 150,000-gallon-per-day (gpd) ROWPU equipment positioned at the corps level. The Army also used additional 600-gph ROWPUs and two 54,000-gpd units donated to the United States by Japan.

Actual ROWPU Production and Performance Data Not Available

Army Regulation 700-138, "Army Logistics Readiness and Sustainability," provides a mechanism for collecting and reporting logistics, readiness, and sustainability information on ground equipment. Such information is an important management tool for quickly identifying and resolving potential problems with performance, production, or the availability of spare parts. This information could also be used to project equipment capability. However, the Army did not use this mechanism to monitor the actual production of water by the ROWPU equipment in Saudi Arabia; nor did it collect or analyze ROWPU performance data during Operation Desert Storm.

In the absence of actual production information, the Army's Central Command/Rear (ARCENT/Rear) logistics management specialist in charge of planning and expediting water support for Operation Desert Storm provided us with a projection of ROWPU production capability. The specialist based his projection on the ROWPU equipment available in Saudi Arabia as of mid-January 1991. His estimate of the equipment's ability to produce 5.1 million gallons of potable water per day compares to an estimated total requirement of about 4.6 million gallons per day for 230,000 Army soldiers. According to Army doctrine, each soldier in an arid environment requires about 20 gallons of water per day.

The Army's ROWPU project manager told us he did not agree with the ARCENT/Rear specialist's projections of ROWPU production capability. The project manager estimated ROWPU production capability at about 4.3 million gallons per day based on changes in the quantity of equipment available and in production rates.

Certain Projection Assumptions Are Questionable

Both of these projections were based on questionable assumptions. They were based on judgmental factors and not on analysis or actual experience with the equipment. Army officials expressed some concern about the conclusion that Army ROWPU equipment would be able to achieve production rates well above rated capacity over an extended period of time and without increased equipment maintenance demands.

Army representatives also expressed concern about the availability of spare and repair parts for the 600-gph ROWPUs, and the ARCENT/Rear logistics specialist told us the Army could have faced a shortage of skilled water purification specialists. Our work did not include an independent assessment of the availability of trained personnel.

Army Authorizes Production of 3,000-gph ROWPU Equipment Before Testing Is Completed

Although the Army's 3,000-gph initial production ROWPUs failed an expanded first article test program conducted between June and October 1989, the Army authorized production of the equipment to begin in September 1990. Project office representatives told us that, while this plan involved some risk, they had taken this step because they were confident that changes made to initial production units would correct the reasons for test failures and because of the need for the 3,000-gph ROWPU in support of Operation Desert Storm. In authorizing production, the Army waived test requirements for the three initial production 3,000-gph ROWPUs and deployed those units to Saudi Arabia. According to the project manager, the Army plans to delay the delivery of production units until the contractor successfully completes repeat testing of the next three production units in September 1991.

Unit May Not Meet NBC Decontamination Requirement

ROWPU requirements documents specify that the equipment must be capable of being decontaminated to the extent that it will pose no significant hazard to unprotected personnel. However, Army representatives told us that the 3,000-gph ROWPU will likely not be capable of meeting a requirement for decontamination in an NBC environment. Consequently, representatives of the Army Troop Support Command's Petroleum and Water Project Office told us the Army planned to request a waiver to that requirement. The representatives told us that they did not have a specific plan of action to compensate for the equipment's inability to satisfy this requirement.

Recommendations

We recommend that the Secretary of the Army take the following actions:

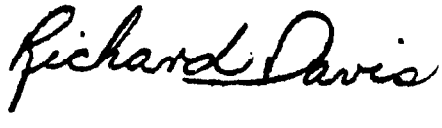
- Direct the Army to use the material condition status reporting system identified in Army Regulation 700-138 during future deployments of ROWPU equipment to collect and analyze actual production and performance data. Such a system should facilitate the rapid identification and resolution of potential performance, production, or spare parts availability problems relative to this critical soldier support equipment.
- If a waiver to the ROWPU NBC decontamination requirement is granted, develop a plan of action that compensates for the equipment's inability to satisfy that requirement.

Appendix I provides more details on the Army's water support and equipment used during Operation Desert Storm. Our objectives, scope, and methodology are described in appendix II.

As arranged with your office, we plan no further distribution of this report for 30 days from the date of issuance, unless you publicly announce its contents earlier. At that time, we will send copies to the Chairmen of the Senate and House Committees on Armed Services and on Appropriations; the Secretary of Defense; and the Director, Office of Management and Budget. Copies may also be made available to others upon request.

Please contact me at (202) 275-4141 if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix III.

Sincerely yours,



Richard Davis
Director, Army Issues

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Abbreviations

ARCENT	Army's Central Command
EASI	Engineered Air Systems, Incorporated
gpd	gallons per day
gph	gallons per hour
MECO	Mechanical Equipment Company
NBC	nuclear, biological, chemical
ROWPU	Reverse Osmosis Water Purification Unit
TDS	total dissolved solids
TROSCOM	Troop Support Command

Army Water Support and Equipment Used During Operation Desert Storm

The Army deployed several different types of Reverse Osmosis Water Purification Unit (ROWPU) equipment in support of Operation Desert Storm. This equipment included the Army's 600-gallon-per-hour (gph) ROWPU equipment, commercially developed 150,000-gallon-per-day (gpd) ROWPU equipment, and three initial production 3,000-gph ROWPUs. Japan also donated two of its 54,000-gpd ROWPUs to the Army for use in the operation. Although it encountered some initial difficulties with the 150,000-gpd equipment, the Army was able to satisfy the water requirements of the troops deployed during the operation by using a combination of host nation water support and ROWPU production. Since the Army did not maintain any records to demonstrate the extent to which it relied on either host nation sources or ROWPU production for troop support, we were unable to determine how much water support the ROWPU equipment provided.

Army representatives told us that the 3,000-gph ROWPU equipment experienced technical and production problems at the time the operation began. Consequently, the Army relied to a great extent on the 150,000-gpd and 600-gph ROWPU equipment for support in Operation Desert Storm. With the ROWPU equipment available to the Army by mid-January 1991, Army representatives projected that they could essentially satisfy the water requirements of the deployed Army forces. The Army's ROWPU production projections were based, however, on several questionable assumptions. In addition, although the Army, because of Operation Desert Storm requirements, expedited production of the 3,000-gph ROWPU prior to completion of required testing, the Army's ROWPU project manager told us the 3,000-gph unit would likely not be capable of meeting a requirement for NBC decontamination.

Initial Difficulties With the 150,000-gpd ROWPU

The Army originally planned to use the 150,000-gpd ROWPU either on barges at sea or along the shoreline. However, the Army discovered that the salinity levels in the Gulf were significantly higher than the levels at which the Army ROWPUs were designed to operate. Specifically, all of the Army's ROWPU equipment is designed to process seawater with a total dissolved solids (TDS) content of up to 35,000 parts per million. The TDS level is a measurement of the amount of dissolved solid matter, including salt, found in water.

In the Persian Gulf, the Army encountered TDS levels as high as 80,000 to 100,000 parts per million. Army officials told us that the high TDS levels caused significant reductions in the 150,000-gpd ROWPUs' production capability. As a result, the Army relocated most of its 150,000-gpd

ROWPUs from the shoreline to well sites within Saudi Arabia. Army officials also told us that they had access to enough well sites within Saudi Arabia to support the operation of all the Army's 150,000-gpd, 3,000-gph initial production, and 600-gph ROWPU equipment. Thus, the Army planned to position most, if not all, of its ROWPU equipment on well sites for Operation Desert Storm. Army representatives also told us that the wells the Army used had TDS levels well below the 35,000-parts-per-million level.

As of mid-January 1991, the Army estimated that it had 25 of the 150,000-gpd ROWPUs available for use in Saudi Arabia in support of Operation Desert Storm requirements. This total included 21 land-based units and 4 units operating on two barges in the Persian Gulf. The Army expected that units operating at well sites would be capable of purifying water at rated capacity because of low TDS levels in the well water. However, because of high TDS levels in the Persian Gulf, the four 150,000-gpd ROWPU units on the barges were producing at about one-third to one-half of rated capacity, according to the Army Project Manager for Petroleum and Water Logistics, who acts as the ROWPU project manager.

The Army Used 600-gph ROWPU Equipment

The Army also used a large number of the 600-gph ROWPUs in Saudi Arabia. In June 1979, the Army had authorized the production of this equipment. The Army has awarded contracts to three vendors for the production of 600-gph units, and the ROWPU project manager estimated that as of October 1990, there were 139 units in the Army's inventory. That inventory included Army ROWPUs produced under contracts with two vendors, Univox California, Incorporated, and Mechanical Equipment Company, Incorporated (MECO).

Engineered Air Systems, Incorporated (EASI), began production of an additional 348 of the 600-gph ROWPUs in July 1990, with plans to deliver 94 units by December 1990. Because of Operation Desert Storm, in September 1990 the Army accelerated the delivery of 100 EASI 600-gph ROWPUs. As of December 31, 1990, the Army had accepted the delivery of 194 EASI model 600-gph ROWPUs.

The project manager estimated that as of mid-January 1991, the Army had 156 of the 600-gph ROWPUs available in Saudi Arabia to support Operation Desert Storm. The Army anticipated that the units would be capable of performing at a rate between 700 and 1,200 gallons per hour when operating at well sites.

Water Production Estimates Vary

The Army's Central Command/Rear (ARCENT/Rear) logistics management specialist in charge of planning and expediting water support for Operation Desert Storm provided us with a projection of ROWPU capability in Saudi Arabia that met the Army's requirement as of mid-January 1991. Specifically, the specialist projected that the Army had the capability to produce about 5.1 million gallons of potable water per day with the ROWPU equipment available in Saudi Arabia as of mid-January 1991. This amount compared to an estimated total requirement, calculated using a per-soldier requirement of 20 gallons per day, of about 4.6 million gallons per day for 230,000 soldiers. According to Army doctrine, the daily per-soldier requirement for water in an arid environment such as Saudi Arabia is 18.4 gallons. For planning purposes, the Army rounds this requirement to 20 gallons per day, according to the ROWPU project manager.

According to Army doctrine, the mission and production capability of each type of ROWPU equipment is based on the equipment's operating 20 out of every 24 hours. This allows 4 hours for normal equipment repair and maintenance, as well as time for required equipment backwash and soaking procedures.

Table I.1 displays the ARCENT/Rear specialist's projection.

Table I.1: The ARCENT/Rear Specialist's Projection of ROWPU Capability

		Gallons	
Type of ROWPU equipment	**Number of units**	**Daily production per unit**	**Total daily production[a]**
Barges[b]	2	117,000	**175,500**
150,000-gpd ROWPU[c]	21	150,000	**2,362,500**
54,000-gpd ROWPU[c]	2	54,000	**81,000**
3,000-gph ROWPU[d]	3	66,000	**148,500**
600-gph ROWPU[e]	132	24,000	**2,376,000**
Total projection			**5,143,500**

[a]Total multiplied by a 75-percent operational readiness factor.

[b]Barges carry two 150,000-gpd units that operate 20 hours per day.

[c]Both the 150,000-gpd and the 54,000-gpd units are estimated to operate 24 hours per day.

[d]Operating 20 hours per day at 3,300 gph.

[e]Operating 20 hours per day at 1,200 gph.

Although the ROWPU project manager directed us to the ARCENT/Rear specialist for projection of ROWPU production capability, the project manager did not agree with the specialist's projections. For example, the project manager told us that it was not realistic to plan for the 600-gph ROWPU to operate at 1,200 gph. He also said that Army engineers believed that the 600-gph ROWPU was capable of operating—without any problems and without requiring any additional maintenance or repair—at a 900-gph rate using either fresh or brackish source water. The project manager provided us an estimate of ROWPU production capability using what he believed were more realistic unit production levels. The project manager's estimate was based on 156 of the 600-gph ROWPUs, while the previous one was based on 132. Table I.2 displays the project manager's estimate of ROWPU production capability.

Table I.2: The Project Manager's Estimate of ROWPU Capability

		Gallons	
Type of ROWPU equipment[a]	**Number of units**	**Daily production per unit**	**Total daily production[b]**
Barges	2	156,000	**234,000**
150,000-gpd ROWPU	21	144,000	**2,268,000**
54,000-gpd ROWPU	2	45,000	**67,500**
3,000-gph ROWPU	3	60,000	**135,000**
600-gph ROWPU[c]	156	14,000	**1,638,000**
Total projection			**4,342,500**

[a]All equipment is estimated to operate 20 hours per day.

[b]Total multiplied by a 75-percent operational readiness factor.

[c]Operating at 700 gph.

Questionable Assumptions Form the Basis of the Army's Projections of ROWPU Production

Both the ARCENT/Rear specialist's and the project manager's projections were based on questionable assumptions. For example, they were based on an operational readiness factor that was judgmental; that is, it was not based on analysis or actual experience with equipment. Army messages from Saudi Arabia and concerns expressed by Army officials outline several questions, including the following:

- Could the Army's ROWPU equipment produce at levels well above rated capacity over an extended period of time?
- Would there be increased demands for equipment maintenance?
- Would enough spare and repair parts be available for the 600-gph ROWPUs?
- Would there be a shortage of skilled water purification specialists?

Unsupported Operational Readiness Factor

The Army's projections assume that the equipment will be operationally ready 75 percent of the time. The projected capability totals are multiplied by 75 percent to allow for the likelihood that all ROWPU equipment will not always be on site and ready for operation at any one point. The ARCENT/Rear logistics specialist told us that this operational readiness rate had been used for planning purposes and allowed some time for maintenance and repair. The specialist also told us that the 75-percent operational readiness factor was judgmental; that is, it was not supported by documented analysis or based on actual field experience.

Potential for Increased Maintenance Demands

The Army based projections of water purification equipment's capabilities on the assumption that the equipment would operate at higher-than-rated capacity. Specifically, the ARCENT/Rear specialist projected 600-gph ROWPU production at 1,200 gph, twice the rated capacity for that equipment. Other than its observations at the unit level, the Army was neither monitoring actual ROWPU water production nor collecting or analyzing data on ROWPU equipment's performance during Operation Desert Storm. Such important information is necessary for the early detection and rapid resolution of problems with ROWPU equipment's performance or production or the availability of parts. Likewise, this information would provide a sound basis from which to project the equipment's capability.

Army Regulation 700-138, "Army Logistics Readiness and Sustainability," provides for an established material condition status reporting system for ground equipment such as the ROWPU. The system is designed to provide Army staff, managers, and commanders with information to analyze and to predict equipment readiness, availability, and status. During Operation Desert Storm, the Army did not use this system for its ROWPU equipment.

Army engineers at Fort Belvoir told us that it was technically possible to operate ROWPU equipment at higher than its rated capacity by increasing the water pressure applied to the system. However, several other Army officials said that using the 600-gph ROWPU at twice its rated capacity over an extended period of time could cause the unit to break down more frequently than expected and increase unit maintenance demands. The project manager told us that the Army did not recommend operating the 600-gph ROWPU at 1,200 gph. However, he also said that operating the unit at 900 gph on fresh or brackish water should not result in any additional maintenance requirements. The project manager agreed

that operating ROWPU equipment at higher-than-rated capacity could increase the demand for certain spare and repair parts.

Availability of Spare and Repair Parts

Army officials also expressed concerns over the availability of spare and repair parts for the 600-gph ROWPU. In September 1990, the Army accelerated the delivery of 100 EASI model 600-gph ROWPUs in reaction to requirements for Operation Desert Storm. The ROWPU project manager told us that the Army had approved EASI for production knowing that the 600-gph EASI ROWPU equipment was not fully provisioned. That is, the EASI model entered production even though the Army did not have enough spare parts available to support initial requirements. According to representatives from the Army Troop Support Command (TROSCOM) Materiel Readiness Directorate, spare parts unique to the EASI model 600-gph ROWPU are not available at Army depots. However, they also told us that the EASI model had about 80-percent commonality with the MECO model and that the MECO model was about 90-percent provisioned. The representatives said that, therefore, most of the spare parts needed for the EASI models would be available in the inventory of MECO parts.

The Army's accelerated delivery contract for 100 of the 600-gph ROWPUs also includes a requirement for the supply of operational "overpacks," each of which contains a 120-day supply of spare parts, repair parts, and consumables for each of the 100 units to be delivered. However, because TROSCOM did not have the funds necessary to pay for the early delivery of the overpacks, it withdrew contractor approval for production of these items in late September 1990.

As a result, the EASI model 600-gph ROWPUs were fielded without the overpacks unique to the EASI model. In late November 1990, TROSCOM received funding for the additional overpacks and awarded a contract. The project manager told us that his office had expedited the delivery of 52 percent of the required contract line items by February 1, 1991, and expected the balance to be delivered according to schedule.

The ARCENT/Rear water logistics specialist told us that the Army needed the complete overpack inventory by January 15, 1991. The specialist told us the Army planned to keep 20 to 22 additional 600-gph ROWPUs in theater reserve so they could easily replace units that were not operational if problems with the availability of spare and repair parts occurred.

Possible Shortage of Water Purification Personnel

According to the ARCENT/Rear water logistics specialist, the Army could have a shortage of personnel trained in water purification. Because, in an arid environment, the Army needs additional water production and distribution equipment to augment the division's normal production and distribution capability, it also needs additional trained water purification personnel, according to the ARCENT/Rear water logistics specialist. The specialist told us he was not sure the Army had a sufficient number of water personnel remaining in the reserve component to provide necessary replacements for unit rotation or for estimated casualties. Because the principal focus of our review was on the ROWPU equipment, we did not expand our work to include an independent assessment of the availability of reserve personnel.

Army Authorized Production Contract Even Though the 3,000-gph ROWPU Failed Expanded Testing

Although the Army's 3,000-gph initial production ROWPUs failed an expanded first article test program conducted between June and October 1989, the Army authorized production of the 3,000-gph ROWPU to begin in September 1990. Project office officials told us that, while this plan involved some risk, they had taken this step because they believed that changes made to initial production units would correct the reasons for test failures and because the 3,000-gph ROWPU was needed to support Operation Desert Storm. In authorizing production, the Army waived test requirements for the three initial production 3,000-gph ROWPUs and deployed those units to Saudi Arabia. According to the project manager, the Army plans to delay the delivery of production units until the contractor successfully completes repeat testing of the next three production units in September 1991. Also, the project manager said that the unit will likely not meet a requirement for decontamination in an NBC environment.

Army Cites Eight Reasons for Test Failures

According to project office officials, the three initial production 3,000-gph ROWPUs failed the expanded testing program due to eight reliability or operational maintenance failures. Six of the eight failures were caused by faulty electrical connectors in six different locations on the units. One failure was caused by a hose leak found at the inlet to the high pressure pump, and one failure was caused by a bolt improperly torqued on the high pressure pump mounting. According to project office officials, the electrical connectors have been replaced; the hose leak has been repaired; and proper torquing instructions have been supplied for the pump bolt. In addition, one of the three units exceeded allowable noise levels, a condition corrected by rerouting some pipes to

the exterior of the unit and soundproofing others, according to project office representatives.

The Army determined that its experience with ROWPU water production rates during first article testing was inconclusive because technical manual instructions were unclear and the contractor had erroneously included backwash and soak time in calculating production flow rates. According to project office officials, the technical manuals have been revised to clarify instructions for calculating production flow rates.

Army Deployed Three Initial Production Units but Plans to Repeat Testing on Production Units

The Army had planned to conduct a repeat first article test between September 1990 and February 1991 to test fixes made to the three initial production units that failed the first article testing program between June and October 1989. However, the Army waived this test requirement and deployed these units to Saudi Arabia.

In September 1990, the Army authorized production of the 3,000-gph ROWPU to begin. Project office officials are confident that changes made subsequent to the 1989 first article test failures will resolve all problems and that the production units will pass a repeat first article test planned for the next three 3,000-gph units coming off the production line. In October 1990, the Army advised us that reliability issues and questions regarding water production will be resolved during the retest.

Production of the 3,000-gph ROWPUs will continue concurrent with the repeat testing, and by the completion of the testing in September 1991 the contractor is scheduled to have 42 units ready for delivery to the Army.

Army Plans to Request a Waiver to the Decontamination Requirement

The ROWPU project manager told us that the 3,000-gph ROWPU will not be capable of meeting its requirement for nuclear, biological, chemical (NBC) decontamination. Therefore, the Army plans to request that the U.S. Army Nuclear and Chemical Agency approve a waiver to that requirement. The Army's ROWPU requirements document specifies that the ROWPU and its auxiliary equipment must be capable of being decontaminated to the point that it poses no casualty-producing hazard to unprotected personnel exposed for an indefinite period of time. However, the Army's report dated May 1990, on the survivability assessment of the 3,000-gph ROWPU in an NBC environment, concludes that the unit will likely not satisfy decontamination requirements.

According to the assessment report, because many ROWPU materials readily absorb chemical agents and may continue to retain them following decontamination, complete decontamination is difficult. Further, electrical components in the pump area could be severely damaged by standard decontaminants.

The ROWPU project manager told us that the waiver request would not be submitted until the planned first article testing was conducted later in 1991. The Army plans to test an accelerated weathering decontamination process on the ROWPU during this test phase. However, the ROWPU survivability assessment states that the accelerated weathering approach to decontamination may be unacceptable in an operational situation and impossible in the field. The project manager agreed with the report and said that the unit likely would not meet the NBC decontamination requirement. The project manager also told us that the Army plans no further redesign of the ROWPU equipment to develop the decontamination capability and it has no specific plans to compensate for the equipment's inability to achieve this operational capability requirement.

Objectives, Scope, and Methodology

We reviewed the Army's efforts to provide water support to U.S. troops during Operation Desert Storm. More specifically, our objectives were to review (1) the production and performance of Army Reverse Osmosis Water Purification Unit equipment deployed to Operation Desert Storm, (2) the Army's projections of ROWPU production capability during the operation, and (3) the status of the Army's program to buy 3,000-gallon-per-hour ROWPU equipment.

To achieve our objectives, we conducted interviews and obtained and analyzed data at the Office of the Project Manager for Petroleum and Water Logistics and various other offices at the Army's Troop Support Command, St. Louis, Missouri, including the Emergency Operation Center and the Material Readiness Directorate. We also conducted interviews and obtained and analyzed data at the Army's Belvoir Research, Development and Engineering Center, located at Fort Belvoir, Virginia; the Army's Quartermaster School, located at Fort Lee, Virginia; the offices of the Deputy Chiefs of Staff for Logistics and Operations, both located at the Pentagon in Washington, D.C.; and the office of the ARCENT/Rear logistics management specialist in charge of planning and expediting water support for Operation Desert Storm, located at Fort McPherson, Georgia.

The Army had limited documentation that we could use to reconcile or corroborate verbal comments made regarding ROWPU equipment's performance during Operation Desert Storm or to support its projections of ROWPU production capability. We contacted an Army Materiel Command Logistics Representative in Frankfurt, Germany, who was TROSCOM's Senior Command Representative and primary focal point for water in Saudi Arabia from the earliest days of Operation Desert Storm until mid-January 1991, and have incorporated his comments as applicable. We also discussed with knowledgeable Army personnel the likelihood of equipment's performing at higher-than-rated capacity and the potential impact on the equipment and required maintenance support.

Much of the information we collected from messages originating in Saudi Arabia conflicted with verbal testimony provided by Army representatives we contacted in the continental United States. We discussed this conflicting and/or contradictory information with Army representatives and attempted to resolve differences. Wherever documentary evidence was either limited or unavailable, we attributed information presented in our report to the specific source of that data.

As requested, we did not obtain formal agency comments on our draft report, but we did discuss our observations with agency officials during the assignment. We conducted our work from October 1990 through January 1991 in accordance with generally accepted government auditing standards.

Major Contributors to This Report

National Security and International Affairs Division, Washington, D.C.	Henry Hinton, Associate Director John Henderson, Assistant Director Lou O. Morman, Secretary
Kansas City Regional Office	Gary Billen, Assistant Regional Manager John Wiethop, Evaluator-in-Charge George Lundy, Staff Member Diane Gadberry, Staff Member

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