WATER AND SANITATION
FOR HEALTH PROJECT

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MAINTENANCE OF BASIC VILLAGE SERVICES PROJECT WATER SUPPLY EQUIPMENT

WASH FIELD REPORT No.152

AUGUST 1985

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Prepared for
USAID Mission to the Arab Republic of Egypt
Activity No. 158

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Prepared for the USAID Mission to the Arab Republic of Egypt
under WASH Activity No. 158

by

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ACRONYMS

BVS	Basic Villages Services Project
CM	Corrective maintenance
DFS	Decentralization Support Fund
GOE	Government of Egypt
LD II	Local Development II Project
MCC	Motor control center
MMC	Markaz maintenance center
MMS	Maintenance management system
NUS	Neighborhood Urban Services
O&M	Operations and maintenance
ORDEV	Organization for the Reconstruction and Development of the Egyptian Village
PM	Preventive maintenance
TA	Technical assistance
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WASH	Water and Sanitation for Health Project

EXECUTIVE SUMMARY

From October through December 1984, thirteen Egyptian engineers participated in management and technical training in the United States. The technical component of the training was conducted by a team of engineers provided by the Water and Sanitation for Health (WASH) Project. The Egyptian engineers have governorate or markaz* level management positions and are responsible for the design, construction, operation, and maintenance of water supply schemes in rural areas of Egypt. All have participated in the Basic Village Services (BVS) Project (see WASH Field Report No. 141).

In April, 1985 the United States Agency for International Development mission in Cairo (USAID/Egypt) requested that the technical trainer specializing in operations and maintenance travel to Egypt to carry out an assignment having the following scope of work:

1. Determine the impact of the U.S.-based technical training on the engineers.

2. Recommend possible improvements in the maintenance plan developed by the AID technical assistance (TA) contractor Chemonics and suggest courses of action for the balance of their contract period.

3. Recommend staffing for the Local Development II Project (LD II) to support its maintenance component.

Jim Jordan, Operations and Maintenance Specialist for the WASH Project, spent three and one-half weeks in Egypt visiting the rural areas of four governorates and a number of markaz maintenance centers (MMCs), villages and water pump stations (see Appendix A for a list of people contacted and sites visited). Four of the engineers who participated in training in the United States were interviewed to determine if they had initiated any specific actions since returning from the United States and to solicit their ideas on improving the training. The findings of this consultancy can be summarized as follows:

Training in the United States

1. The classroom training would be as effective in Egypt, but the opportunity for the engineers to view life, discuss technical topics with numerous U.S. engineers and, see water facilities in the United States would be lost.

2. The management component of training is too long and is not integrated with the technical training component.

3. The participating engineers have not had contact with each other since they returned from the United States.

*Governorates are subdivided into a number of markaz. Qena Governorate, for example, is made up of six markaz.

4. Two of the four engineers have made direct use of training. These two engineers are governorate-level engineers responsible for all of the MMCs.

Chemonics-Developed Maintenance Plan

1. The maintenance plan is basically sound with respect to specific maintenance tasks and delegation of responsibilities to markaz and village workshops, but it needs strengthening in the areas of reporting procedures and top official support and responsibility.

2. The three governorates participating in the plan are not ready to assume full responsibility for maintenance.

Equipment Maintenance

1. Simple preventive maintenance (PM) tasks are being performed and equipment is in operation, although not efficiently.

2. None of the MMCs are able to perform higher levels of PM. Several have no equipment or tools.

3. Housekeeping is a major problem. Very few pump stations or pumps were kept clean.

4. Problems with water scheme design and utilization were observed.

Local Development II

1. An emphasis on maintenance, particularly maintenance planning, is needed.

2. The TA contractor for LD II will need significant maintenance staffing to be successful.

These findings have led to the following recommendations:

U.S. Training of Egyptian Engineers

1. Training in the United States is valuable and should be continued, but should be shortened to no more than six weeks.

2. The management and technical portions should be handled by one organization and integrated so that the relationship between the application of management skills and handling of technical problems is firmly established.

3. A two- to three-day workshop for the engineers should be held at a central point in Egypt approximately nine months after their return to enable them to share ideas.

Chemonics Future Efforts

1. Continuing support for the three governorates is essential. The field visits could be limited to bi-monthly with emphasis placed on the governorate- and markaz-level engineers responsible for maintenance.

2. The maintenance program should be expanded to include two governorates and only two markaz within each of these governorates.

3. The governor, secretary or assistant secretary general should appoint one governorate-level engineer to oversee the program. The designation of this engineer should be a condition for including the governorate in the maintenance program. Since the Housing Departments of each governorate are responsible for water project equipment maintenance, this engineer should be from this department.

4. The designated engineer should accompany the Chemonics engineer on each governorate visit. They should jointly prepare a list of accomplishments and problems to be submitted to the secretary general after each Chemonics field trip.

Local Development II and USAID

1. USAID should direct the current and future TA contractors to emphasize that the maintenance program cover all water supply equipment, not just that funded through BVS.

2. USAID should direct Chemonics to work with one of the markaz selected to participate in the maintenance program expansion to develop a prototype maintenance budget. This will be one of the LD II requirements.

3. The new TA contractor must be staffed by at least one expatriate engineer skilled in the development and implementation of maintenance management systems. An Egyptian engineer with some maintenance experience should also be included in the team to learn from the expatriate engineer and provide support to implement an effective maintenance system throughout Egypt's rural areas.

Chapter 1

INTRODUCTION

1.1 Purpose of Technical Assistance

During the last three months of 1984, USAID/Egypt arranged for 20 engineers who are participating in the Basic Village Services (BVS) Project to travel to the United States for specialized training. The training consisted of five weeks of management training by the United States Department of Agriculture (USDA) Graduate School and five weeks of technical training by the WASH Project (see WASH Field Report No. 141.)

Thirteen of the twenty Egyptian engineers are involved in water supply projects and participated in the WASH training workshop. The other seven are involved in road construction and maintenance and, therefore, attended a separate workshop on this aspect of the BVS Project.

The engineers who participated in the WASH workshop were asked to evaluate the training by responding to a questionnaire prepared by the WASH training team. The questionnaire was filled out by the engineers on the last day of the technical training workshop. The subsequent analysis of the results revealed that maintenance of water supply systems was of considerable interest and importance to the workshop participants and covered technology that was new to them. This result affirmed USAID's directive that the workshop pay particular attention to the elements of an effective maintenance program. Appendix B is a summary of the results of the questionnaire relating to the topics covered in the workshop.

Olivier Carduner, USAID/Egypt Project Officer for BVS, met with John Austin and Jim Jordan at the WASH office to discuss the recommendations made by WASH concerning future workshops for BVS engineers (WASH Field Report No. 141). Dr. Austin is the WASH Project Manager for AID, and Jordan, WASH's Operations and Maintenance (O&M) Specialist, conducted the maintenance component of the workshop. One of the recommendations was to follow up the workshop with a visit by one of the technical trainers to evaluate the effectiveness of the technical training in providing useful information to the BVS engineers who participated.

In addition, USAID/Egypt had directed the BVS technical assistance contractor, Chemonics/Cairo, to develop maintenance programs for the subprojects financed by the BVS project. Chemonics has prepared the program and is currently implementing the program in three governorates. AID requested WASH to review the maintenance program, and recommend possible improvements to the Chemonics' plan.

Finally, AID/Egypt is preparing a project paper to support the second phase of the decentralization program, Local Development II (LD II). LD II is designed to integrate previously funded programs into a single project. One of the primary aims of LD II is to develop and reinforce the ability of local governments to provide adequate maintenance for the subprojects funded previously as well as those constructed during LD II. USAID/Egypt requested

that WASH review the maintenance component of LD II and help develop strategies for improving subproject maintenance during LD II.

USAID/Egypt requested that WASH's O&M Specialist carry out these tasks during a four-week visit to Egypt. These tasks (see Appendix C for Scope of Work) are summarized as follows:

1. Evaluate the effectiveness of the BVS workshop,

2. Suggest possible improvements to the Chemonics maintenance plan; and

3. Assist with the development of the maintenance component of LD II.

1.2 Background Information

1.2.1 The Basic Village Services Project

The goal of the BVS Project is to assist the Government of Egypt (GOE) in carrying out its program of decentralizing and improving the development process in rural communities in Egypt. The project is achieving this goal by funding a multitude of subprojects that are selected and planned at the markaz and village levels of government. The project was introduced in 1979 in three governorates and has since been expanded to include all 21 rural governments in Egypt. One of the primary targets of the BVS project is to support the installation and expansion of water schemes in Egyptian villages.

The team that participated in the fourth year evaluation noted that the BVS project is a major success in promoting rural development in Egypt (Chetwynd, E. et al., 1984, p. 5). A field trip to the majority of the villages that have participated in the BVS project will verify the accuracy of this comment. Yet the authors of this same report also noted that maintenance is the weak link in the technical chain. Water and sewage subprojects, in particular, are prone to malfunction without constant maintenance (Chetwynd, E., et al., 1984, p. 18).

Only recently has the need for better maintenance of subprojects, particularly water schemes and roads, been forcefully addressed by the local development group of USAID/Egypt. This report will focus primarily on the maintenance of the equipment utilized in water supply schemes, building on the maintenance programs started by Chemonics/Cairo, and on the training of Egyptian engineers who have maintenance responsibilities.

1.2.2 BVS Overseas Training Component

While the BVS Project does provide significant funds for the construction and expansion of water supply schemes, a major effort to train the many thousands of rural Egyptian people, both technical and non technical, who have participated in the project, is also part of the program.

One of the training components involves training in the United States for the officials and engineers who are directly reponsible for implementing BVS subprojects in the markaz and villages.

1.2.2.1 WASH Training Workshop

The WASH Project was requested to design, prepare and deliver a workshop on the technical aspects of the work performed by selected engineers who fill positions as middle managers in their governorates. The workshop was designed to cover the following general topics:

1. Water supply
2. Groundwater and sewerage
3. Equipment maintenance

WASH assembled a four-person team consisting of a course coordinator and three technical specialists. Approximately three weeks were devoted to classroom training, and two weeks to field investigations.

1.2.2.2 Recommendations for Future Workshops

A review of the workshop by the training team along with the post-course evaluation by the Egyptian engineers results in several recommendations for future workshops. These are given in WASH Field Report No. 141 and can be summarized as follows:

1. Have one of the trainers visit the participants approximately six months after the course to assess its value and provide encouragement to the engineers to use the knowledge gained in the course.

2. Integrate the technical and management components to emphasize the role of good management in resolving day-to-day job-related problems.

3. Conduct a needs assessment in Egypt prior to preparing and giving the workshop.

4. Distribute a pre-course packet of materials to the participants to help them prepare for the course by being aware of its content.

These recommendations are then to be reassessed by the WASH consultant after visiting a number of governorates and discussing the impact of the overseas training on the way the engineers are now doing their jobs.

1.2.3 Chemonics/Cairo and BVS

Approximately two years after the start of the BVS Project, USAID employed the services of Chemonics to provide technical assistance with the management of the BVS contract. In December of 1981 and in June of 1982, Chemonics produced

two reports outlining procedures for the preventive maintenance of water pumpsets and for proper utilization of the 10 percent maintenance fund*.

The 10 percent fund has been productively used in some cases to purchase tools and equipment, yet in many cases the fund remains unused. The recommendations made in the report concerning preventive maintenance have largely been ignored until recently. In 1984, Chemonics was directed to develop a more detailed maintenance plan and implement this plan in three governorates. The plan (A Village Infrastructure Maintenance Program, February 1985) was designed and a workshop held to introduce the principles behind it. Chemonics has supported the maintenance plan by making several field trips to the governorates to encourage the responsible officials and engineers and to check on progress.

1.2.4 Local Development II

The aid provided by USAID to the local government has generally been successful. Consequently, USAID is proposing that the several projects directed toward local government and decentralization of authority be combined in a single project, Local Development II. The project paper to support this effort is completed and is currently under review. AID has recognized that infrastructure maintenance remains a serious problem and is proposing that a major effort be made in LD II to develop the capacity of local governments to effectively operate and maintain all of the equipment in their governorates. For example, projects to construct and outfit maintenance workshops are to be specifically encouraged under LD II. LD II will also include TA provisions similar to those currently provided by Chemonics.

1.3 Field Trips

Several field trips were completed during the first three weeks of this consultancy. The sites were selected according to the following criteria, all of which were met during the visit:

1. A BVS engineer who participated in the WASH workshop in the United States could be interviewed,

2. A number of markaz maintenance centers (MMCs), village workshops and water pump stations could be visited, and,

3. At least two of the three governorates where the Chemonics maintenance plan was introduced would be included in the itinerary.

Field trips were completed to four governorates, two in lower Egypt, one in upper Egypt and one in a desert governorate. Eight MMCs, thirteen village workshops and fourteen pump stations were visited.

*Funds provided by the GOE to finance the recurrent costs of operating and maintaining BVS subprojects.

Chapter 2

EFFECTIVE OPERATIONS AND MAINTENANCE

2.1 Maintenance Programs: BVS and LD II

Efforts to develop and implement maintenance programs for the water supply equipment and roads funded by the BVS Project have been started by Chemonics/Cairo within the past twelve months. In addition, USAID/Egypt, recognizing the need to improve subproject maintenance, has placed considerable emphasis on fostering better maintenance practices at the village and markaz levels in the new LD II project.

A number of reports have been prepared describing equipment maintenance as one of the key problems facing the BVS and other decentralization projects. However, none of these reports have specifically viewed equipment maintenance as a group of activities or elements that need to be integrated under strong management control. There is need, therefore, to first define the elements of an effective maintenance system, determine how current maintenance programs conform to the requirements for adequate systems and only then propose alternate or additional steps for improving current approaches as well as training techniques relating to equipment maintenance.

2.2 Elements of an Effective O&M System

2.2.1 Maintenance and Operations Dependency

The maintenance and operations functions go hand-in-hand. Operators of water supply equipment at the village level in Egypt are generally responsible for several simple, yet vital, functions with respect to maintenance, these are:

1. Keep equipment clean;
2. Check fluid levels;
3. Inspect the equipment during operation for unusual conditions such as leaks and excessive vibration or heat; and
4. Report non-normal conditions to the village workshop.

The responsibilities of the village, markaz and government maintenance workshops will vary according to the skill of the mechanics, available tools and governorate policies. In any case, the goal of maintenance is to support operations by maintaining equipment in a reliable, efficient manner.

2.2.2 Successful Maintenance Management Systems (MMS)

While maintenance systems can be designed to function in a number of ways, some elements are essential for an effective system, these are:

1. Simplicity: the system must be easy to understand by those who use it and the paperwork required should be minimized;

2. Consistency: the system must provide periodic, reliable information concerning the status of all maintenance work that is pending or in progress. This includes preventive and corrective maintenance (PM and CM) work;

3. Responsibility for operating the maintenance system should be as decentralized as possible;

4. Both preventive and corrective maintenance work should be reported and tracked under the same system and be managed under the same supervision;

5. Information flow must be in both directions. If a village requests assistance from the markaz, the response from the markaz should be as rapid as possible; and

6. Upper management and appropriate top officials in the governorate must provide active support. This is particularly true in the early stages of a maintenance program. Without such active support, the program will surely fail to reach its objectives.

2.2.3 Specific Requirements for a MMS

While the elements in Section 2.2.2 are fundamental for a successful MMS, they may be better described as guidelines that must be followed when designing and implementing a program.

When a maintenance program is being designed for a particular situation such as one to cover the water schemes or rolling stock in a particular governorate, the format of additional, more specific elements in the program needs to be established. These elements are:

1. Equipment must be inventoried and specifications (e.g., spare parts, operating characteristics) identified;

2. An orderly identification number technique is needed;

3. An organized filing system for maintenance work is needed;

4. The PM tasks and their frequency of performance for each piece of equipment must be established along with the responsible workshop (e.g., village or markaz);

5. Appropriate records of equipment operation and maintenance must be kept;

6. A clear method for operators and village-level mechanics to notify higher level workshops of maintenance needs is required;

7. A work order system is needed, and

8. A work order log book, particularly at the markaz level, should be established.

A successful maintenance program requires that pertinent records be kept, that responsible officials be informed of significant maintenance problems, that required PM work be consistently performed and, most important, that governorate, markaz and village officials actively support the program.

Chapter 3

OPERATIONS AND MAINTENANCE OF BVS PROJECTS

3.1 History

USAID and the Organization for the Reconstruction and Development of the Egyptian Village (ORDEV) recognized early in the BVS program that equipment maintenance was not being performed properly, and that this failure could jeopardize the long-term success of the decentralization programs. Chemonics prepared a working paper in 1981 outlining a PM program for water pumpsets. However, no specific action resulted from this plan, and, except for some training activities in maintenance, no attempts were made to introduce detailed maintenance plans to the governorates.

Subsequently, other USAID-funded decentralization programs -- Neighborhood Urban Services (NUS) and Decentralization Support Fund (DFS) -- were evaluated by outside consultants. These evaluation teams noted that maintenance of equipment, structures and rolling stock remains a serious problem. Further, in 1984, a team evaluated the BVS Project (Chetwynd, E., et al., March 1984) and concluded that problems with equipment maintenance continue and generally result from:

1. A lack of awareness of the importance of maintenance;
2. Failure to use the 10 percent maintenance fund;
3. Insufficient tools and equipment; and
4. Lack of leadership to promote maintenance activities.

The evaluation team also noted that "no effective maintenance plans seem to have been drawn up anywhere in Egypt." (Chetwynd, E., et al., Appendix III c, p. 26).

3.2 Current Status

In mid-1984, USAID directed Chemonics to develop a maintenance program and initially implement this program in three governorates. The Chemonics plan was published early in 1985 and steps immediately taken to introduce the plan in the Governorates of Menufiya, Beni Suef and New Valley.

The Chemonics plan for the maintenance of water scheme equipment is primarly directed toward identifying the specific PM and CM tasks to be done for water pumpsets and pinpointing the responsible workshop (i.e., village, markaz, or private). Each of the governorates selected the model III version of the plan, which required that the village mechanics perform daily P1 and P3 preventive maintenance and simple CM repair. P3-level PM tasks would be done by the MMC, and repairs beyond the capability of the village mechanics would be the responsibility of the MMC or private workshops. Appendix D is an excerpt from the Chemonics report describing the PM and CM tasks in detail.

Village workshop mechanics frequently do not have the tools needed to perform simple PM and CM tasks. In some cases, tools, where available, had not been used. Another significant problem lies with poor housekeeping of the water

pump stations. Though a few sites were tidy, many had debris including trash and discarded parts and material strewn around creating safety hazards for the operators. The equipment itself was not wiped down and nameplates were unreadable. It would be difficult for the operator to detect an oil leak due to the accumulation of grease and oil on the equipment. Equipment records generally contained only information on operating hours, fuel consumed and in some cases, oil and filter changes.

The primary problem (excluding financial considerations), however, lies in the lack of direction given to governorate and markaz engineers by responsible officials in the governorate. These officials are not aware of the importance of maintenance, do not view maintenance as a system of activities that must be planned and integrated, and have not generally set up an organization to deal with maintenance. As noted before, a maintenance program will not achieve its objectives without direct support from top officials. With official support, however, much can be done.

A review of the maintenance program in Menufiya supports this view. M. Sabry, governorate engineer in charge of the MCCs and participant in the WASH workshop, was directed by the secretary general to take charge of maintenance activities in the governorate. Mr. Sabry has taken several positive steps to implement a better maintenance program.

The Chemonics maintenance plan also presented a maintenance monitering system (Chemonics International, February 1985, Annex II) describing some techniques for keeping maintenance records and tracking maintenance progress. The requirements for keeping monthly progress reports, records of equipment specifications, PM schedules and repair histories are given. The results of efforts to implement this program have been mixed and will be discussed in Chapter 4 of this report.

Chapter 4

FINDINGS

4.1 Equipment Maintenance

This consultant reviewed a number of reports and met with representatives of USAID and Chemonics prior to visiting any of the water pumping schemes in Egypt. The general impression received was one of breakdown maintenance* only with virtually no preventive maintenance being performed. It was, therefore, encouraging to find that field people are generally performing the minimal required PM tasks such as lubrication and changing oil and filters.

Some of the engineers, particularly those with training in maintenance management, are capable of implementing adequate maintenance programs. One markaz in Qalubiya, for example, was in the process of rebuilding a diesel unit. The overall picture is, however, far from satisfactory. Very little PM is done between the simplest operation tasks and equipment failure. The MMCs are performing virtually no P3-level PM as defined by Chemonics (see Appendix D), and, for some of the PM tasks, cannot do so due to lack of tools and test equipment. In some cases (e.g., New Valley), water is pumped directly into the distribution system, bypassing existing storage tanks. This not only limits services to selected hours during the day, but poses potential health problems due to contaminant infiltration.

4.2 U.S. Training of BVS Engineers

4.2.1 General

Interviews were conducted with five of the thirteen BVS engineers who participated in the WASH workshop. One of those interviewed, Ali El-Sayeed Mousa, is attached to the ORDEV office in Cairo and has no line responsibilities in maintenance. The impact of training on his work is minimal. Thus, one third of the participants in a management position were interviewed. Two are responsible for maintenance in the governorate and two are chiefs of MMCs. A questionnaire was developed to determine the effect of the technical training on the work of the participants. The questionnaire was used as a general guideline to interview the participants and solicit the required information. All cooperated freely, and the interviews lasted approximately one hour. A copy of the questionnaire is given in Appendix E.

Since a consensus was reached on several areas, these conclusions will be addressed first.

*Breakdown maintenance means that the equipment is operated with no attempt at maintenance until the equipment fails.

4.2.2 Consensus Facts and Opinions

The following facts and opinions applied to all interviewees:

1. None had changed jobs, nor had they met or talked with any of the other participants since they returned from the United States.

2. All of the four participants sincerely appreciated this consultant's visit and were pleased to show the work that they were doing. Their response supports the recommendations in WASH Field Report No. 141 that a follow-up visit by one of the trainers to provide encouragement and support to the participants is helpful.

3. The classroom training could be done in Egypt. However, the opportunity to visit the United States, see the way work is done and learn something about U.S. culture was very valuable.

4. The management component of the course should be shortened to, perhaps, three weeks.

5. The maintenance component of the workshop helped them to better understand the need for maintenance.

4.2.3 Individual Responses

There were clear differences among the participants in several areas addressed in the questionnaire. In general, as compared with the markaz engineers, the two governorate-level engineers:

- have a higher level of authority and more responsibility in their jobs.
- made better use of the U.S. training.
- were among the top five participants in the workshop subjectively measured by skill, enthusiasm and willingness to participate.
- have more opportunity in their work to cause policy changes.
- are closer to and have more influence with top governorate officials.

4.2.4 USAID Concerns

The AID group in Cairo in charge of the BVS Project requested that information on specific activities of the WASH-trained BVS engineers be gathered. A combination of field observations, meetings with Chemonics and AID personnel, report reviews and, primarily, the interviews with selected BVS engineers have resulted in the following answers to the questions posed by USAID/Egypt.

1. Have the BVS engineers who participated in the training taken any specific action as a result of training?

   - Several have met with village councils and with their immediate supervisors to discuss the need for better maintenance.

   - One has taken steps to set up an O&M training center in his governorate.

   - Two have started to delegate work to their subordinates. This exercise of authority was confirmed by discussions with the engineers' staffs.

   - One of the engineers has prepared a maintenance plan for the main pumping station in his markaz.

   - One has implemented a maintenance program at three village pumping stations. This approach is one that was recommended in the workshop.

   - Two have taken steps to ensure that markaz maintenance centers have the required tools.

   - Two of the engineers have improved the recordkeeping aspect of their maintenance program. Examples include the posting of PM requirements and logging of information on work done. The engineers who have made the best use of the WASH training have received substantial support and direction from their governor. This reinforces the belief of this consultant that the support of top officials is necessary for a successful maintenance program.

2. Did the training increase the engineers' understanding of their jobs? In what areas of their work?

   - All stated that they understand the benefits from effective maintenance, although only two have taken significant actions in this area.

   - Two noted the need to delegate authority.

   - One of the engineers stated that he now better understands the need to consider alternate solutions to problems.

   - One reported that he understands the need to check up on the work that his mechanics are assigned to perform.

3. Have the engineers received additional responsibility in their current jobs or changed jobs as a result of training?

   - None have changed jobs.

   - One was given the responsibility to develop and implement a governorate maintenance program.

- One is now joining the governor for his weekly meeting with village people and is usually asked to respond to technical questions that are posed during these meetings.

4. Can any increase in local development capacity be detected as a result of the training?

   The BVS engineers trained in the United States do not have responsibility or authority to approve or disapprove village projects. They can, however, influence design, construction, and maintenance of village water projects. Clearly, some have used their training to introduce or improve infrastructure maintenance, particularly if the engineer has governorate level responsibility.

The other questions concerning the feasibility of in-country training and recommendations for future training are considered in Chapter 5.

4.2.5 Comments on Technical Training

The engineers commented on other aspects of the WASH workshop.

- One would like to see more information on water system design and construction; particularly the use of computers for system design.

- One recommended that the technical training be more practical and less theoretical.

- Several stated that they thought that the content of the technical component was good.

4.3 Chemonics and Water Equipment Maintenance

4.3.1 The Chemonics Maintenance Program

The approach taken by Chemonics to improve the maintenance of BVS subprojects is basically sound with respect to assigning responsibility for maintenance between markaz and village workshops. Their specification of particular PM and CM maintenance tasks is also good.

However, their approach focuses on periodic PM and CM activities and gives too little consideration to the other requirements of a maintenance management system. Recordkeeping is discussed briefly as an appendix to their maintenance report. This immediately relegates this aspect of maintenance to a secondary position. It should be given greater emphasis.

During their field trips, Chemonics makes a major effort to visit various MMCs and village workshops. This is commendable. However, visits with top officials are frequently handled as a courtesy call without substantive discussions. The governorate engineers in charge of the MMCs are frequently left out of discussions on maintenance. The development of a maintenance attitude must begin with the active support of top officials. Part of this support includes the designation of one engineer in the governorate who is responsible for the

establishment of the maintenance program and reports progress directly to the secretary general or his assistant. Ultimately, the responsibility for establishing the maintenance program must come from within the governorate and cannot be assumed by Chemonics.

Chemonics is charged with a major effort in a short time frame. Three to four months is not adequate to establish and foster a maintenance program where none existed before. The development of an attitude of maintenance is a slow process.

4.3.2 Maintenance Management and the Chemonics Plan

It is not realistic to expect the rural governorates to immediately implement a comprehensive maintenance management program. Nor, in fact, is this needed. The water schemes funded through the BVS program are relatively simple and do not require complicated maintenance procedures.

There are, however, several elements of effective maintenance that are not specifically addressed in the Chemonics plan. These are:

1. Good housekeeping for workshops and pump stations;
2. The need for involvement of high-level officials;
3. The need for an organized way of inventorying equipment, including spare parts needs and operating data;
4. The need for information on maintenance activities to flow in both directions; and
5. The need to expand specific PM tasks to include more water supply equipment such as motor control centers (MCCs).

Note: The equipment noted in No. 5 above is not funded by the BVS Project and is found only in large water plants.

4.4 Local Development II and Maintenance

LD II has addressed the major issues concerning the maintenance of subprojects:

- Adoption of a formula-based financing system for recurrent costs of operating and maintaining subprojects.
- Emphasis on hardware, e.g., maintenance workshops, needed for good O&M.
- Development of maintenance management systems and the management skills needed to operate them.

- Requirement that any proposed subproject include information on the cost of operating and maintaining the subproject and the means by which O&M will be performed.

These are ambitious goals and will require that a technical assistance contractor be employed by USAID to help them achieve them. The make-up of the TA team is, therefore, vital and will be addressed in Chapter 5 of this report.

Chapter 5

RECOMMENDATIONS

5.1 BVS Overseas Training

U.S. training of Egyptian engineers is valuable and should continue. The engineers are given an opportunity to view the way people live in the United States, to experience another culture, to visit water facilities and to discuss technical concepts with a variety of American counterparts. The U.S. visit is also viewed as a way of recognizing that the engineers are performing well in their jobs in Egypt.

5.1.1 Selection of Participants

The committee that nominates engineers for training in the U.S. should include individuals with experience in management and engineering to enable the committee to better select engineers who can benefit from this type of training.

5.1.2 Duration of Trip

The length of stay in the United States should be reduced to no more than six weeks. This consultant believes that the value of training quickly diminishes after this amount of time with a five day per week schedule.

5.1.3 Course Content

The management and technical components should be integrated and handled by one group. For example, the value of delegating authority could readily be linked to the maintenance management of water schemes in Egypt.

The effort of the TA contractor should be better coordinated with the content of the workshop. The maintenance component would have been better if up-to-date information on Chemonics' plans in this area were available.

Two weeks covering fundamental management concepts, three weeks of technical training and a one-week field trip is as much training as can reasonably be absorbed by the participants.

5.1.4 Workshop Planning

The workshop schedule in the United States should be better organized. One approach is to conduct full-day sessions from Sunday through Thursday since Friday afternoon is an Islamic holiday. The engineers should be advised in the beginning of the workshop that the classroom schedule is firm.

Any interpreter assigned to the course should have a technical background in order to correctly convey the course content to the participants. The interpreter should also travel with the engineers on their field trips.

5.2 Follow-up Workshop in Egypt

Approximately nine months after the engineers return from the United States, a two- or three-day workshop should be held in Egypt to bring the engineers together to share ideas and experiences. They would have the opportunity to discuss how they have used the training, what programs they have started, and which of their newly learned skills have worked and which haven't. In addition to the engineers, the TA contractor, a representative of ORDEV and one of the technical trainers from the United States would participate. Several of the sessions would be conducted by the engineers. Mr. A. Allam of Qalubiya has, for example, expressed willingness to conduct one of the sessions.

5.2.1 Needs Assessment

A needs assessment is extremely helpful when planning the course. The assessment for the next workshop could be readily done by the technical trainer who participates in the follow-up workshop in Egypt. The trainer could also make arrangements to distribute pre-workshop materials to the next group of participants while he is in Egypt.

5.3 Chemonics Maintenance Strategy for 1985-86

5.3.1 Maintenance Program Coverage

Chemonics and USAID should emphasize that the maintenance program is designed to cover all water supply equipment in the rural governorates. This will require that the maintenance PM task list be expanded to include some electrical gear such as MCCs. Appendix F contains a list of PM tasks for a MCC as an example.

Note: The U.S.-trained engineers have received the PM task lists for a number of pieces of equipment including MCCs.

5.3.2 Current Program in Three Governorates

The three governorates -- Menufiya, New Valley, Beni Suef -- have made varying degrees of progress, but none is ready to assume full responsibility for equipment maintenance. Support for their efforts must continue with at least bi-monthly visits.

5.3.3 Specific Recommendations for These Governorates

New Valley

1. Request that the secretary or assistant secretary general designate a governorate engineer to oversee the maintenance program with assistance from Chemonics staff.

2. As a model, develop a semi-annual PM schedule for P3 maintenance for Kharga.

Beni Suef

1. Develop a PM schedule for two markaz, including that of Engineer Metwally.

2. Work through the governorate engineer in charge of MMCs to develop plan.

3. Request through the secretary general or another top official that the governorate maintenance engineer prepare similar plans for other markaz.

4. Show the governorate engineer how to prepare a short (one to two pages) monthly report on progress and problems with implementation of the program. The report should be addressed to the secretary general or other appropriate top officials.

Menufiya

1. Work with governorate engineer, M. Sabry, to obtain tools to enable the markaz to perform P3 maintenance.

2. Show M. Sabry how to prepare a monthly report as detailed above for Beni Suef.

5.3.4 Expansion of Maintenance Program

The maintenance plan should be expanded to four markaz within two governorates. These should be developed as model programs. One prerequisite for inclusion in the program would be the appointment of a governorate-level engineer to work with Chemonics and be responsible for the implementation and expansion of the program to the other markaz.

5.3.5 Support of Top Officials

With assistance from AID and ORDEV, Chemonics should request that the secretary general of those governorates in the maintenance program prepare and send a letter to each village council briefly explaining and supporting the maintenance program.

5.3.6 Preparatory Workshop to Introduce Maintenance Program

Chemonics should conduct one- to two-day workshops to explain the program. The governorate engineer, MMC engineers and heads of town councils should participate. An opening address by the secretary general would be very helpful.

5.3.7 Technical Notes

For future field trips, Chemonics should place greater emphasis on proper recordkeeping and housekeeping. In addition, the PM tasks associated with the pump unit could be expanded in the maintenance program. Appendix F contains a sample PM list for centrifugal pumps.

5.4 Local Development II

5.4.1 TA Requirements

The contractor employed for LD II should include a senior engineer skilled in the development of maintenance management systems. Knowledge of the concepts presented in Chapter 2 of this report would be a basis for evaluating the capabilities of this engineer. This person should be devoted to maintenance engineering full-time and must have international experience if the goals of LD II with respect to maintenance are to be achieved.

5.4.2 Egyptian Counterparts

If the senior maintenance engineer is an expatriate, an Egyptian engineer with some maintenance experience should be employed to work with him to learn the concepts behind effective maintenance. In any case, a two-person team will be required if an effective maintenance program is to be expanded throughout the rural governorates affected by LD II.

5.4.3 Maintenance Budgeting

USAID should take the first step toward giving the governorates the capability of developing a budget for maintenance by directing Chemonics to prepare a sample maintenance budget for one markaz. A markaz already included in the maintenance program should be selected for this purpose.

In addition, it would be helpful if Chemonics would identify a single subproject and develop the O&M requirements for that subproject. This could be used as a training tool to help village councils adhere to the LD II requirement that they provide maintenance backup information before ORDEV and USAID approve new projects.

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11. WASH Field Report No. 141, by John Pettit, Technical Training for Basic Village Services Project Engineers, January 1985.

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APPENDIX A

List of People Contacted and Places Visited

CONTACTS

USAID	Fred Tinsler
	Olivier Carduner - BVS Project Manager
	Fred Pollock
	Graham Kerr
	Mervat Sallam
ORDEV	Dr. Ahmed Rashid - Chairman
Chemonics	Bob Johnson - Chief of Party
	Frank Edvlin
	A. Saad
	P. Farid
Workshop Participants	Ahmed Allam
	Mohamed Aly Metwally
	Hussein Aly Hassan
	Mohamed Sabry Abu Omer
	Ali El-Sayeed Mousa

Field Trips

GOVERNORATE	MARKAZ	VILLAGE
Beni Suef	Beni Suef	Beni Suef
	Beba	Helia Seds El Omraa
Menufiya	Tala	Kafr Rabei Toukh Delka
	Berket El Sabaa	Shen El Hagar
New Valley	Dakhla	Balatt El Maasra El Rashda El Qasr El Gilida
	Kharga	Paris Bulaq
Qalubiya	Banha	Sheblanga Tahla
	Tokh	Shobra Haris
	Tough	Beltaw

APPENDIX B

Course Assessment Summary

Course Assessment Summary

Question/Topic	Response
Yes/No Questions	
1. Were the general objectives of the course clear?	33% - yes
2. Did your previous experience or training in English adequately prepare you to	
a. Read materials?	67% - yes
b. Understand lectures?	33% - yes
c. Participate in discussions?	58% - yes
3. Was this course appropriate for your professional responsibilities?	100% - yes
4. Were you satisfied with the degree to which you were able to share your ideas and experiences with the group?	92% - yes
Topics Rated from 1 (Least Favorable) to 5 (Most Favorable)	
5. Satisfaction with George Mason Metro campus as training site.	3.7
6. Satisfaction with administrative support by training site personnel.	3.2
7. Achievement of training objectives in:	
a. Water supply component.	Range: 2.0 - 3.4
b. Groundwater and wastewater.	Range: 1.8 - 2.7
c. Maintenance.	Range: 3.5 - 4.0
d. Process simulation.	4.3
8. Helpfulness of the training techniques used:	
a. Lectures.	3.5
b. Large group discussions.	3.7
c. Small group work.	3.8
d. Field trips.	3.8
e. Individual consultations with instructors.	3.9
9. Adequacy of field trip arrangements:	
a. Preparatory information.	4.7
b. Transportation.	1.8
c. Helpfulness of professional staff accompanying participants.	1.1
d. Responsiveness of field site personnel to participants' needs:	
• San Diego	1.2
• Phoenix	4.9
• New Orleans	3.6
e. Overall coordination.	2.8
10. Adequacy of written materials.	2.8
11. Overall satisfaction with course.	3.7

APPENDIX C

Scope of Work
O&M Assessment - BVS Project

SCOPE OF WORK

O & M Assessment - BVS Project

This activity requires that WASH provide a consultant to AID/Cairo with experience in the Operations and Maintenance of piped water supply systems. The consultant will visit Egypt for four (4) weeks and undertake three activities concerning the operation and maintenance of projects funded through USAID's decentralization program. The activities are to:

1. Assess impact of BVS overseas training conducted by WASH in November, 1984 by answering the following questions:

   A. Have the BVS engineers who participated in the training taken any specific action as a result of the training?

   B. Did the training increase the engineers' understanding of their jobs? In what areas of their work?

   C. Have the engineers received additional responsibility in their current jobs or changed jobs as a result of training?

   D. Is in-country training feasible and will this improve the program?

   E. Can any increase in local development capacity be detected as a result of the training?

   F. What are recommendations for future training programs?

2. Review and assess O & M improvement strategies for BVS project that have been developed by the USAID TA contractor chemonics. Make recommendations regarding possible improvements and desirable directions of second year work plan efforts for September, 1985 to September, 1986.

3. Assist AID Mission with the development of strategies for rural infrastructure maintenance for the next phase of the AID Decentralization Program.

4. The consultant will prepare a report covering the BVS workshop follow up and O&M current and future strategies. A copy of the report will be left with the Mission prior to the consultant's departure from Egypt.

APPENDIX D

Maintenance Functions and Their Technical Components

MAINTENANCE FUNCTIONS AND THEIR TECHNICAL COMPONENTS

This annex presents a detailed outline of the technical components of a maintenance program for BVS subprojects. Two types of projects are distinguished : water projects (including potable water supply and sewage and drainage systems) and road projects. For each type of project, a classification of necessary maintenance operations is set out. For each type of operation, technical components - personnel, equipment, tools, materials and frequencies at which the activity should be performed are specified.

A. Maintenance of Water Projects

1. Maintenance of Diesel Engines

a. Daily Maintenance (D)

These are operations carried out to make sure that the engine will run efficiently over the next 24 hours.

Frequency : Daily

Personnel : Operator

Tools : Screw driver, pliers, spanners

Materials and parts : Gaskets, cleaning cloth

Operations :
- Cleaning and removal of dust.
- Checking the oil and water level in water cooled engines.
- Inspection for leakage of fuel, oil, and water.
- Operating the engine to check for unusual sounds.

b. Preventive Maintenance I (P1)

Frequency : Every 50 working hours or every week.

Personnel : Operator, mechanic, electrician.

Tools : One set of technician's tools, one set of electrician's tools, funnel oilcans, hydrometer, voltimeter, torque wrench.

Materials and parts : Motor oil, grease, water,

cloth, distilled water, sand paper and gaskets.

Operations :

- Cleaning all parts.
- Fastening of all parts and all bolts.
- Refastening of cylinder head according to the sequence and with recommended torque.
- Greasing all parts which need greasing.
- Changing engine oil, air filter oil, cleaning filtering element.
- Checking the battery solution level, voltage, and solution density with the hydrometer.
- Checking the starter and the generator and lubricating them.
- Checking the vee belts of the water pump and the fan.
- Checking the coupling components for operation and tightness.
- Operating the engine to check for proper operation.
- Cleaning after maintenance.

c. Preventive Maintenance II (P2)

Frequency : Every 200 working hours or every one month.

Personnel : Operator, mechanic, electrician, pipe fitter.

Tools : One set of technician's tools, one set of electrician's tools, pipe fitter's tools, funnel, oil cans, hydrometer, voltimeter, torque wrench, vise, work bench.

Materials and parts : Engine oil, grease, water distilled water, cloth, oil filter element, air filter element, fuel filter element, generator brushes,

starter brushes, gaskets, sand paper.

Operations : All steps as described in Preventive Maintenance I plus the following:

- Changing the filtering elements in the oil, fuel, and air filters.
- Checking the generator and starter brushes and changing them if necessary.
- Checking water pump for leakage.
- Checking cooling fan for tightness

d. Biannual preventive maintenance (P3)

Frequency : every 1000 - 1200 hours or every 6 months

Personnel : same personnel as in P2

Tools : same tools as in P2, plus filler and injector adjusting device.

Materials and parts : same as P 2 plus injector nozzles

Operations : Same operations as in P 2 plus the following:

- Adjust the injector pressures and change nozzles if needed.
- Adjust the intake and exhaust valves of the engine.

e. Remedial Maintenance

This type of maintenance includes repair of parts or aggregates and it is carried out according to:

1. Calculated life-span of part or aggregate.
2. Indications from warning devices (e.g. red lamp, alarm,) e.g. clogging of the oil filter, or in the lubricating system.
3. Part or aggregate failure to operate.

Three types of remedial maintenance may be distinguished :

i. Current repairs : (C)

This is defined as the simple repair of any part of the engine; this type can be carried out by the operator alone or with assistance from the mechanics. e.g.

- Changing vee belts
- Repair of leakage in pipes or parts of the fan, cooling and lubricating systems.

ii. Medium repairs : (M)

This is defined as repair or replacement of an aggregate i.e. one or more injectors, fuel pump, starter, and/or water pump. This type of repair can be carried out by the mechanic and/or the electrician.

iii. Capital repairs : (K)

This type of repair is done for the engine and calls for engine overhaul. The work will be done in a workshop, by specialized personnel using special tools and equipment.

2. Maintenance of Electric Motors :

a. Daily Maintenance : (D)

Frequency : daily

Personnel : operator

Tools : Insulated pliers, screw driver

Materials and parts : Cloth, P.V.C. tape

Operations : Cleaning and removal of dust

- Turning the motor by hand
- Running the motor to check for disturbances

b. Preventive Maintenance I (P1)

Frequency : Every 50 - 75 working hours or every week

Personnel : Operator and electrician

Tools : One set of electrician's tools, multimeter

Materials and parts : P.V.C. tape, esterling tape,

cloth, alcohol

Operations:

- Clean down external parts of motor and blow out air ducts.
- Check holding bolts for tightness.
- Clean out technical box and check terminal connections for tightness.
- Renew silica gel dryer if fitted.
- Check earthing strips for security and earth continuity.
- Check that there is no spark between the brushes and the commutator segments.
- Check the operation of the cooling air fan.

c. Preventive maintenance II (P2)

Frequency : Every 200 working hours or every month

Personnel : Operator, electrician

Tools : One set of electrician's tools, multimeter, grease gun

Materials and parts : P.V.C. tape, insulating materials, esterling tape, cloth, cables, grease, oil, alcohol.

Operations : As in P1

- Greasing motor bearings with approved grease using a gun.
- If the motor is fitted with sleeve bearings, inspect bearing leads, and record readings before reassembly.
- Cleaning the rotor, stator, and the commutator.
- Cleaning brushes with sand paper.
- Operating the motor and check for quiet operation.

d. Biannual Preventive Maintenance (P3)

Frequency : Every 6 months or every 1000 - 1200 working hours

Personnel : Electrician, operator

Tools : Same as in P2, plus 500 V megger

Materials and parts : Same as in P2

Operations : Same operations as in P2 plus

- Checking insulation resistance and continuity of windings with a 500 volt megger and recording reading before replacing terminal box cover.
- Cleaning out bearings with flushing oil and refilling to correct level, using the specified grade of oil.
- On a motor with sleeve bearings, checking air gap reading at all point provided and recording the results. If the motor compling alignment is suspect, this should be checked.
- Operating the motor and checking for quiet operation.

e. Remedial Maintenance

i. Current repairs : (C)

This is the simplest type of repair and can be carried out by the operator and the electrician. It is done when faulty operation or failure is noticed.

ii. Medium Repairs : (M)

This includes repairs to parts of the motor or connections, removal of damaged cables, replacing of ball bearings. The work is done by skilled electricians.

Frequency : As failure occurs

iii. Capital Repairs : (K)

Repairs carried out on motor in the workshop

Frequency : 1-2 years

Personnel : Skilled laborers

Location : Workshop

Operations :

- Clean down motor exterior and blow out air ducts.
- Disconnect main motor main cables, alarms, and auxiliary wiring, and mark the cables for easy reconnection.
- Ensure that the cables are protected from moisture and mechanical damage.
- Disconnect motor from drive unit and transport to the workshop, making sure that all packed pieces are identified and kept in a safe place.
- Draw caupling or pulley from the shaft and check that the key way key and shaft are free from burns, check caupling for wear.
- Check sleeve bearings for wear, scores and mesure oil clearance, check that the lubricant holes and all conductors are not blocked.
- Remove motor end covers.
- Check ball and roller bearing if fitted and renew bearings if necessary.
- Remove rotor and check that rotor bars and end shorting rings are free from cracks and are tight.
- Check that rotor laminations are tight and look for signs of abrasion between stator and rotor.
- Examine stator winding for signs of loose or charred insulation and damaged binding tape.
- Check that stator laminations are free from burrs and that the stator frame is clean and

the airways are unobstructed.

- Reassemble the motor and refit the caupling.
- Replace the motor on the bed plate and realign to the caupling of the driven pumps.
- Reconnect the cables and test the motorand cables for insulation resistance and continuity with megger.
- Grease the bearings with the specified oil.
- Run the motor uncaupled to check rotation and listen to the bearings with a "sonascope". If this is satisfactory, recauple the motor to the driven pump.
- Check holding bolts for tightness.
- Grease the bearing with approved grease using a gun.
- If there is a leakage from the stuffing, renew it.
- Run the pump and listen to the bearings.
- Drive the unit for operation.

3. Maintenance of water pumps, pipes, and valves

The water pumps, pipes, and valves are attached to the diesel engines or the electric motors. Since the hydraulic apparatus is attached to its power source, source and apparatus really compose a single machine. It is sensible therefore to carry out maintenance of the apparatus at the same times as maintenance of the power source is carried out.

Personnel : Operator, mechanic, plumber

Tools : Mechanic tools, plumber tools, grease gun.

Materials and parts : Gaskets, stuffing materials, cloth for cleaning, grease

Operations :

- Clean all parts
- Check holding down bolts for tightness
- Grease the bearing with approved grease using the grease gun.
- Renew stuffing if there is leakage.
- Run the pump and listen to the bearings. Drive the unit for operations check

APPENDIX E

Survey Questions for BVS Engineers

Survey Questions for BVS Engineers

1. What topic in the training workshop was most helpful to you?

2. With respect to this topic, what specific actions have you taken as a result of training?

3. What actions have you taken with respect to your other duties as a result of the training?

4. Has your understanding of your job changed as a result of training?

   a) Management
   b) Technical

5. Have you been given additional responsibility in your present job?

6. Have you changed job since the workshop? if so, why?

7. If so, was training you received the reason (or part of the reason) for the change?

8. How has your working relationship with your immediate manager been affected?

9. Has your working relationship with your subordinates changed? With your colleagues?

10. Has the way the village leaders (council) work with you changed? For what way? Do they know you visited to the U.S. for training?

11. What is your view of maintenance?

12. Have you had the chance to talk to anyone about maintenance since you returned?

13. If so, who and what aspects of maintenance?

14. If no, why?

15. Do you think your colleagues appreciate O&M in the same way you do?

16. How would you try to explain the need for better maintenance of projects to:

    a) Your manager?
    b) The village councils?

17. Have you started an improved maintenance of projects in your governorate? What have you done?

18. If not, have you made any plans to do so? What specifically are they?

19. Since returning to your job and looking back on training, are there topics that you think should have been covered in more detail?

20. If a colleague of yours, is nominated to take similar training in the U.S., what topics on subjects should the course cover for him?

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APPENDIX F
Examples of Preventive Maintenance Task Lists

EQUIPMENT: Motor Control Centers
MANUFACTURER: ITE Imperial Corporation, Westminster, Maryland

Maintenance Requirements

WEEKLY

1. Check for loose parts, warping and undue vibration.
2. Check for condensation build-up. Assembly should be kept dry at all times.
3. Remove dust or dirt with vacuum cleaner or air hose.

SEMI-ANNUALLY

1. Disconnect power source and de-energize all interlock circuits.
2. All devices should be hand or electrically operated to determine their operating conditions.
3. Badly-worn starter contacts should be replaced.
4. Do not lubricate contactor or starter bearings.
5. Do not file starter contacts.
6. A check should be made of the instantaneous trip on breakers to verify that settings agree with specifications.
7. Inspect all bolt connections, nuts and screws for tightness.
8. Inspect all wiring for signs of damage.
9. Examine the insulation systems for evidence of heating.
10. Open all hinged panels and remove all bolted panels for a thorough inspection of all internal devices.

EQUIPMENT: Centrifugal Pumps, Custom VII
MANUFACTURER: Allis-Chalmers, Milwaukee, Wisconsin

Maintenance Requirements

DAILY

1. Chek bearing temperature using a thermocouple or thermometer.
2. Listen for increasing bearing noise and pump vibration.

MONTHLY

1. Check pump vibration with test equipment

QUARTERLY

1. Wipe pump clean.
2. Check grease-lubricated bearings for saponification.
3. Check bearings for lubrication.
4. Check stuffing box and bearing seals for excessive leakage.

ANNUALLY

1. Check alignment of pump and driver.
2. Flush bearings.
3. Check packing.
4. Disassemble pump and inspect impeller, bearings, sleeves, and rings for wear.