Instructor Guide Planning for Maintenance

PLANNING FOR MAINTENANCE

Instructor Guide

GENERAL INFORMATION FOR THE INSTRUCTOR

Module Use and Content

The "Planning for Maintenance" module may be used as an independent instructional unit, or in conjunction with the other modules in EDI's two-week seminar on "Water Supply and Sanitation."

The module includes the following presentation materials:

- An Instructor Guide
- A Participant Manual
- A slide/tape program
- Suggested supplementary materials

Time required

The module requires approximately three hours to complete.

Participant Manual and Instructor Guide

The Participant Manual contains all the information and instructions required to complete the module activities.

The Instructor Guide is organized so that Instructor Notes appear on the left-hand pages, opposite the Participant Manual pages printed on the right. (The Participant Manual pages in the Instructor Guide are identical to those in the actual Participant Manual.) The Instructor Notes include suggested time requirements, steps for conducting the module activities, discussion guidelines and suggestions on presentation. The time requirements are approximate, but following the suggested times will ensure that the module does not require more than three hours to complete.

The Instructor Guide and Participant Manual both contain reference copies of the visuals and the narrative text from the slide/tape program.

Slide/Tape program

Most of the instructional content for this module is presented in the slide/tape program, "Planning for Maintenance." The slide/tape program includes 80 35mm slides synchronized with the narration on the accompanying audiocassette. The module package includes two identical tapes, one of which is simply a back-up duplicate. The slides are inserted in a carousel tray that most projectors will accommodate. The narration on the audiocassette is pulsed with audible tones. These tones are cues that the slide projector should be advanced immediately to the next slide. The narration is recorded on Side 1 of the audiocassette; Side 2 is blank.

Equipment and Materials

Presentation of the module by an instructor to a group of participants requires the equipment and materials listed below:

For the instructor:

- One copy of the Instructor Guide
- A flipchart easel, pad and markers, or chalkboard and chalk
- One copy of the slide/ tape program (slides and one audiocassette)
- One slide projector and white projection screen
- One audiocassette player
- One copy of the supplementary materials

For the participants:

- A copy of the Participant Manual for each participant
- Paper and pencils for each participant

Optional:

- Copies of the supplementary materials for each participant

Instructor Preparation

The "Planning for Maintenance" module is not a self-instructional program. It requires an instructor who is well versed in the various issues of the water supply and sanitation sector.

Instructor preparation involves a review of the Instructor Guide to become familiar with the topics, sequence of activities and the content of the presentations. It is also useful to preview the slide tape program in order to become familiar with the content and the synchronization of the slides with the audio-cassette. If possible, the program should be previewed on the equipment that will be used during the actual presentation.

Equipment and Facilities Preparation

Preparation of the audiocassette for play requires rewinding it completely to the beginning and ensuring that the cassette is loaded into the player with "Side 1" showing at the top.

Preparation of the carousel tray of slides for viewing requires four steps. First, it is important to ensure that all the slides are inserted into the tray in sequential order, with the printed number

showing at the top right corner, along the outer edge of the carousel tray. Second, the black plastic lock ring must be turned in the direction of the arrow marked "Lock" until the ring is secured on the tray. Third, the tray is placed in operating position by lowering it onto the projector and turning it clockwise until the tray drops down securely. Fourth, the projector must be advanced so the first slide, the title slide, appears on the screen.

Operation of the slide projector and audiocassette player should be checked prior to the presentation. At that time, it is advisable to arrange for power cords required to operate the projector and cassette player, extension cords and extra projector bulbs. It is also useful to determine who should be contacted if assistance is needed from an engineer or audiovisual specialist.

It is important to check that each participant will be able to see and hear the slide/tape program easily. To view the slides clearly, overhead and back lighting should be kept to a minimum.

INSTRUCTOR NOTES

Introduction

Time required: 10 minutes

1. Refer participants to the Introduction in their manuals. Review the purpose of the module and the topic outline with them.

2. Introduce the slide/tape program and inform participants that it is approximately 15 minutes in length.

3. Explain that participants will not need to take extensive notes during the slide/tape program because copies of the visuals and narrative text from the slide/tape program are provided in their manuals.

4. Turn on the equipment and make sure the title slide is projected when the music at the start of the program begins. When you hear the first tone, advance the slide projector immediately to the next slide. Continue advancing the slides at the sound of the tone until program completion.

Introduction

This module, "Planning for Maintenance", has been designed to increase awareness of the importance of a sound maintenance plan as an integral part of a project. Topics covered in this module include:

- The importance of maintenance (linked to operations)
- Types of maintenance
  - corrective
  - preventive
- Consequences of insufficient maintenance
  - reduced benefits
  - higher costs
- Factors affecting maintenance
  - location
  - age and condition of equipment
  - availability of trained personnel
  - misuse and abuse
  - funding
- Components of a maintenance system
  - program*
  - personnel
  - parts
  - records

*Example shown: Annex 1 of this manual

INSTRUCTOR NOTES

Discussion of Maintenance Issues — Time required: 30 minutes

1. After participants have viewed the slide/tape program, ask them if they have any questions about the content.

2. Divide the class into groups of four to seven participants. Refer participants to the discussion questions in their manuals. Ask them to take fifteen minutes to record individual responses to each question and then to discuss them with the other members of their group. Instruct the group to select a representative who will summarize the group's discussion.

3. After fifteen minutes, stop the discussion. Ask the representative of each group to summarize the discussion. You or the group's representative can record the key points on the flip chart or board.

DISCUSSION OF MAINTENANCE ISSUES

These questions are provided to stimulate discussion of the content presented in the slide/tape program.

1. What are the primary problems affecting maintenance in your country?

2. Which is emphasized in your sector--preventive maintenance or corrective maintenance? Why?

3. Does your sector have an ongoing training program for maintenance staff? In class or on-the-job? Who is responsible for implementing the program?

4. In your view, what policies should be observed for ordering spare parts? What inventory policies are necessary to ensure that spare parts are always available?

Evaluation of Maintenance — Time required: 30 minutes

1. Explain to participants that there is a need for a set of criteria for evaluating maintenance activities within projects.

2. Refer participants to the list of criteria on pages P-3 and P-4 of their manuals. Ask participants to consider their own institutions and indicate how well these meet the maintenance criteria. Allow 5 minutes for them to record their observations.

3. Invite participants to share their observations and compare situations for the benefit of the whole group. Point out that the activities indicated in Items 1-10 will bring about the results described in Items 11, 12, and 13.

4. Ask participants for suggestions of additional criteria to be added to the list. You may wish to list these on the flipchart or board.

CRITERIA FOR EVALUATION OF MAINTENANCE

	Yes	No	Do not Know
1. Is there a maintenance program in place which is comprehensive and covers all facilities?			
2. Is there a central maintenance unit which has over-all responsibility within the organization for supervising, monitoring, and analyzing all maintenance activities set forth in the maintenance program?			
3. Does every operator have in his job description, detailed directions concerning his maintenance responsibilities?			
4. Has every operator received training on how to perform all those maintenance tasks for which he is responsible?			
5. Does every operator or operational unit have on hand or at its disposal at all times, those tools and materials required to permit accomplishment of the maintenance tasks as scheduled?			
6. Is there a stores unit accessible to all operators from which parts, supplies and and materials can be drawn to permit servicing of every unit listed in the maintenance program?			
7. Does a system of reporting exist which provides that there is a current, up to date card or equivalent mechanism for listing basic data for all items in the maintenance program?			
8. Does the system of reporting involve every operator who has maintenance responsibilities and include a means for reporting problems and conditions requiring the attention of repair crews and others outside the local maintenance personnel?			

CRITERIA FOR EVALUATION OF MAINTENANCE
(continued)

	Yes	No	Do not Know
9. Is the system functioning as evidenced by current referral cards, recently recorded data and recent actions responding to referrals?			
10. Are all equipment, buildings, grounds and facilities clean, orderly and showing evidence of frequent cleaning and attention?			
11. Is the frequency of outages, breaks, and emergency repairs declining?			
12. Are costs of repairs declining?			
13. Is equipment life increasing?			

INSTRUCTOR NOTES

Calculating Maintenance Options — Time Required: 30 minutes

1. Refer participants to the exercise on Calculating Maintenance Options beginning on page P-5 of their manuals. Explain that their task will be to determine which is the preferred alternative for maintenance in the purchasing situation described.

2. Instruct participants to first review the three options listed for consideration in purchasing a pump.

3. When participants have reviewed the options on page P-5, they should go on to the tables which follow (on pages P-6 to P-8) to calculate the present-value costs and totals, as indicated. Following that, participants should record their observations about the preferred alternative on their summary sheet (page P-9).

4. Note to Instructor: Calculations for each table are presented for your convenience. These should not be shared with the group until the completion of the entire exercise.

CALCULATING MAINTENANCE OPTIONS

Imagine that you are considering buying a pump costing $200,000. You have three options.

Option 1: Routine maintenance only. As a result, the expected lifetime of the pump is about 7 1/2 years (rather than 15 years when full maintenance is carried out.)

Option 2: Full maintenance performed, including inspecting and replacing worn parts. All spare parts are purchased at the time of the initial purchase of the pump. The expected lifetime of the pump is 15 years.

Option 3: Full maintenance performed, as in Option 2. Spare parts are bought every year rather than at the time of the purchase of the pump.

Determine which is the preferred alternative, considering present-value costs and using a discount rate of 12% and constant prices (in the tables which follow).

CALCULATING MAINTENANCE OPTIONS
(continued)

(Calculations are presented here for Instructor's reference).

Option 1: Routine Maintenance and Replacement Every 7 1/2 years.

Year	Present Value Cost
0	200,000
1	360
2	320
3	280
4	260
5	230
6	200
7	180
8	80,160
9	140
10	130
11	120
12	100
13	90
14	80
15	36,070
16	60
17	60
18	50
19	50
20	40
21	40
22	30
23	14,030
24	20
25	20
26	20
27	20
28	20
29	20
30	10
TOTAL	333,000

CALCULATING MAINTENANCE OPTIONS
(continued)

Option 1: Routine Maintenance and Replacement Every 7 1/2 years

(Thousands of US $ in Constant Prices)

Year	Investment	Labor	Total	Discount Factor	Present Value Cost
0	200,000	400	200,400	1.00	
1	-	400	400	0.89	
2	-	400	400	0.80	
3	-	400	400	0.71	
4	-	400	400	0.64	
5	-	400	400	0.57	
6	-	400	400	0.51	
7	-	400	400	0.45	
8	200,000	400	200,400	0.40	
9	-	400	400	0.36	
10	-	400	400	0.32	
11	-	400	400	0.29	
12	-	400	400	0.26	
13	-	400	400	0.23	
14	-	400	400	0.20	
15	200,000	400	200,400	0.18	
16	-	400	400	0.16	
17	-	400	400	0.14	
18	-	400	400	0.13	
19	-	400	400	0.12	
20	-	400	400	0.10	
21	-	400	400	0.09	
22	-	400	400	0.08	
23	200,000	400	200,400	0.07	
24	-	400	400	0.06	
25	-	400	400	0.06	
26	-	400	400	0.05	
27	-	400	400	0.05	
28	-	400	400	0.04	
29	-	400	400	0.04	
30	-	400	400	0.03	
				TOTAL:	

CALCULATING MAINTENANCE OPTIONS
(continued)

(Calculations are presented here for Instructor's reference)

Option 2: Parts Ordering and Rebuilding Every 15 years

Year	Present Value Cost
0	241,000
1	890
2	800
3	710
4	640
5	570
6	510
7	450
8	400
9	360
10	320
11	290
12	260
13	230
14	200
15	43,380
16	160
17	140
18	130
19	120
20	100
21	90
22	80
23	70
24	60
25	60
26	50
27	50
28	40
29	40
30	30
TOTAL:	292,000

CALCULATING MAINTENANCE OPTIONS
(continued)

Option 2: Parts Ordering and Rebuilding Every 15 years

(Thousands of US $ in Constant Prices)

Year	Investment	Spares	Labor	Total	Discount Factor	Present Value Cost
0	200,000	40,000	1,000	241,000	1.00	
1	-	-	1,000	1,000	0.89	
2	-	-	1,000	1,000	0.80	
3	-	-	1,000	1,000	0.71	
4	-	-	1,000	1,000	0.64	
5	-	-	1,000	1,000	0.57	
6	-	-	1,000	1,000	0.51	
7	-	-	1,000	1,000	0.45	
8	-	-	1,000	1,000	0.40	
9	-	-	1,000	1,000	0.36	
10	-	-	1,000	1,000	0.32	
11	-	-	1,000	1,000	0.29	
12	-	-	1,000	1,000	0.26	
13	-	-	1,000	1,000	0.23	
14	-	-	1,000	1,000	0.20	
15	200,000	40,000	1,000	241,000	0.18	
16	-	-	1,000	1,000	0.16	
17	-	-	1,000	1,000	0.14	
18	-	-	1,000	1,000	0.13	
19	-	-	1,000	1,000	0.12	
20	-	-	1,000	1,000	0.10	
21	-	-	1,000	1,000	0.09	
22	-	-	1,000	1,000	0.08	
23	-	-	1,000	1,000	0.07	
24	-	-	1,000	1,000	0.06	
25	-	-	1,000	1,000	0.06	
26	-	-	1,000	1,000	0.05	
27	-	-	1,000	1,000	0.05	
28	-	-	1,000	1,000	0.04	
29	-	-	1,000	1,000	0.04	
30	-	-	1,000	1,000	0.03	
TOTAL.....						

CALCULATING MAINTENANCE OPTIONS
(continued)

(Calculations are presented here for Instructor's reference)

Option 3: Gradual Ordering of Parts and Rebuilding

Year	Present Value Cost
0	204,000
1	3,560
2	3,200
3	2,840
4	2,560
5	2,280
6	2,040
7	1,800
8	1,600
9	1,440
10	1,280
11	1,160
12	1,040
13	920
14	800
15	36,720
16	640
17	560
18	520
19	480
20	400
21	360
22	320
23	280
24	240
25	240
26	200
27	200
28	200
29	160
30	120
TOTAL	272,000

CALCULATING MAINTENANCE OPTIONS
(continued)

Option 3: Gradual Ordering of Parts and Rebuilding

(Thousands of US$ in Constant Prices)

Year	Investment	Spares	Labor	Total	Discount Factor	Present Value Cost
0	200,000	3,000	1,000	204,000	1.00	
1	-	3,000	1,000	4,000	0.89	
2	-	3,000	1,000	4,000	0.80	
3	-	3,000	1,000	4,000	0.71	
4	-	3,000	1,000	4,000	0.64	
5	-	3,000	1,000	4,000	0.57	
6	-	3,000	1,000	4,000	0.51	
7	-	3,000	1,000	4,000	0.45	
8	-	3,000	1,000	4,000	0.40	
9	-	3,000	1,000	4,000	0.36	
10	-	3,000	1,000	4,000	0.32	
11	-	3,000	1,000	4,000	0.29	
12	-	3,000	1,000	4,000	0.26	
13	-	3,000	1,000	4,000	0.23	
14	-	3,000	1,000	4,000	0.20	
15	200,000	3,000	1,000	204,000	0.18	
16	-	3,000	1,000	4,000	0.16	
17	-	3,000	1,000	4,000	0.14	
18	-	3,000	1,000	4,000	0.13	
19	-	3,000	1,000	4,000	0.12	
20	-	3,000	1,000	4,000	0.10	
21	-	3,000	1,000	4,000	0.09	
22	-	3,000	1,000	4,000	0.08	
23	-	3,000	1,000	4,000	0.07	
24	-	3,000	1,000	4,000	0.06	
25	-	3,000	1,000	4,000	0.06	
26	-	3,000	1,000	4,000	0.05	
27	-	3,000	1,000	4,000	0.05	
28	-	3,000	1,000	4,000	0.04	
29	-	3,000	1,000	4,000	0.04	
30	-	3,000	1,000	4,000	0.03	
TOTAL						

5. When the participants have completed recording the requested data, ask them to review the results of their calculations. (Check their answers against yours, listed on pages I-6 to I-8)

6. Invite participants to present their opinions regarding which option is the preferred alternative for maintenance.

7. Point out to participants that since the present-value cost (of approximately $272,000) in Option 3 is lower than that of either Option 1 or Option 2, it would appear -- in theory, at least -- that Option 3 might be the preferred alternative. The actual decision, however, would also take into consideration the cost of labor, the availability of spare parts, and other factors.

SUMMARY

As a result of your calculations, which option do you believe to be the preferred alternative for maintenance? Please use this space to explain your opinion, and be prepared to share your views with the other participants.

Economic Return of Maintenance — Time Required: 60 minutes

1. Inform participants that the next exercise deals with the economic return of maintenance. Specifically, they will be required to calculate the internal rate of return on road maintenance.

2. Point out consequences of inadequate maintenance for a road:
   a) The road will need to be reconstructed.
   b) Vehicles traveling over such roads will require more repairs.

3. Review the assumptions and table regarding road reconstruction, on page P-10 of participants' manuals.

ROAD RECONSTRUCTION

Assumptions:

- Good (or adequate) maintenance is about 1% per annum of the replacement cost. The replacement cost is assumed to be $100,000 per km. Hence, the maintenance cost is $1,000 per km per year.
- Without maintenance, the road will fall apart in 10 years and would then need to be reconstructed.
- Maintenance expenditures are assumed to be triple every third year to reflect periodic maintenance.

Thus, since avoided reconstruction costs constitute a benefit, we can construct the following table:

Year	Costs	Benefits	
1	1,000		
2	1,000		
3	3,000		
4	1,000		
5	1,000		
6	3,000		
7	1,000		
8	1,000		
9	3,000		
10	1,000	100,000	avoided reconstruction

4. Review the assumptions and graph regarding increased vehicle operating costs, on page P-11 of participants' manuals.

5. Ask participants whether they have any questions on the materials presented.

INCREASED VEHICLE OPERATING COSTS

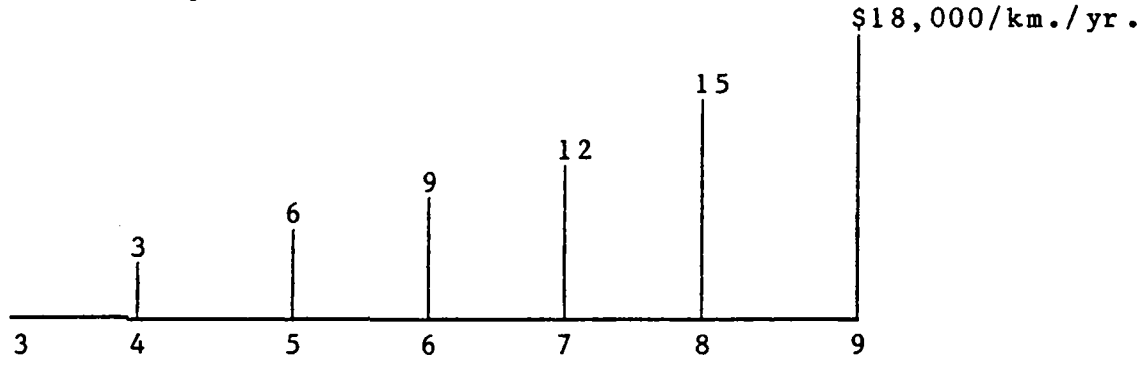
Assumptions:

- o 200 vehicles per day
- o Vehicle Operating Costs
  - Paved US$ 0.25/km.
  - Unpaved US$ 0.50/km.
- o Deterioration only sets in, in Year 3 and the road is completely reduced to "Unpaved" state by Year 9. (This assumption of no deterioration until Year 3 is probably very conservative.)

Thus, in Year 9, the Vehicle Operating Cost "Savings" by applying good maintenance are:

(0.50-0.25) (200) (365) $/km/Yr. = $18,000/km. Yr.

Assume we build up to this figure uniformly from Year 3 to Year 9 as the road breaks up. Thus:



6. Refer participants to the combined data in the Cost/Benefit table on page P-12 in their manuals.

7. Explain that participants will need to refer to these data when calculating the internal rate of return -- required in this exercise.

8. Tell participants to turn the page and follow instructions for calculating the internal rate of return.

Thus, the Cost/Benefit table for the situation described:

Year	Costs	Benefits	
1	1,000		
2	1,000		
3	3,000	0	
4	1,000	3,000	Avoided
5	1,000	6,000	Vehicle
6	3,000	9,000	Operating
7	1,000	12,000	Costs
8	1,000	15,000	
9	3,000	18,000	
10	1,000	100,000	-Reconstruction

This Cost/Benefit table and the table of Discount Factors which follows will be useful data for calculating the Internal Rate of Return (IRR).

DISCOUNT FACTORS

Yr.	70%	80%	90%	100%
1	0.588	0.556	0.526	0.500
2	0.346	0.309	0.277	0.250
3	0.203	0.172	0.146	0.125
4	0.120	0.095	0.077	0.063
5	0.070	0.053	0.040	0.031
6	0.041	0.030	0.021	0.016
7	0.024	0.016	0.011	0.008
8	0.014	0.009	0.006	0.004
9	0.008	0.005	0.003	0.002
10	0.005	0.003	0.002	0.001

9. After participants have completed their calculations, review their answers. (Data are provided here for Instructor's convenience.)

CALCULATION BASED ON 70% DISCOUNT RATE

YR	COSTS		BENEFITS	
1	1,000 x 0.588	588		
2	1,000 x 0.346	346		
3	3,000 x 0.203	609		
4	1,000 x 0.120	120	3,000 x 0.120	360
5	1,000 x 0.070	70	6,000 x 0.070	420
6	3,000 x 0.041	123	9,000 x 0.041	369
7	1,000 x 0.024	24	12,000 x 0.024	288
8	1,000 x 0.014	14	15,000 x 0.014	210
9	3,000 x 0.008	24	18,000 x 0.008	144
10	1,000 x 0.005	5	100,000 x 0.005	500
		1,923		2,291

CALCULATION BASED ON 80% DISCOUNT RATE

YR	COSTS		BENEFITS	
1	1,000 x 0.556	556		
2	1,000 x 0.309	309		
3	3,000 x 0.172	516		
4	1,000 x 0.095	95	3,000 x 0.095	285
5	1,000 x 0.053	53	6,000 x 0.053	318
6	3,000 x 0.030	90	9,000 x 0.030	270
7	1,000 x 0.016	16	12,000 x 0.016	192
8	1,000 x 0.009	9	15,000 x 0.009	135
9	3,000 x 0.005	15	18,000 x 0.005	90
10	1,000 x 0.003	3	100,000 x 0.003	300
		1,662		1,590

Calculate the internal rate of return, by determining the discount rate at which the present-value costs are equal to the present-value benefits.

(Hint: Begin with the 70% Discount Rate.)

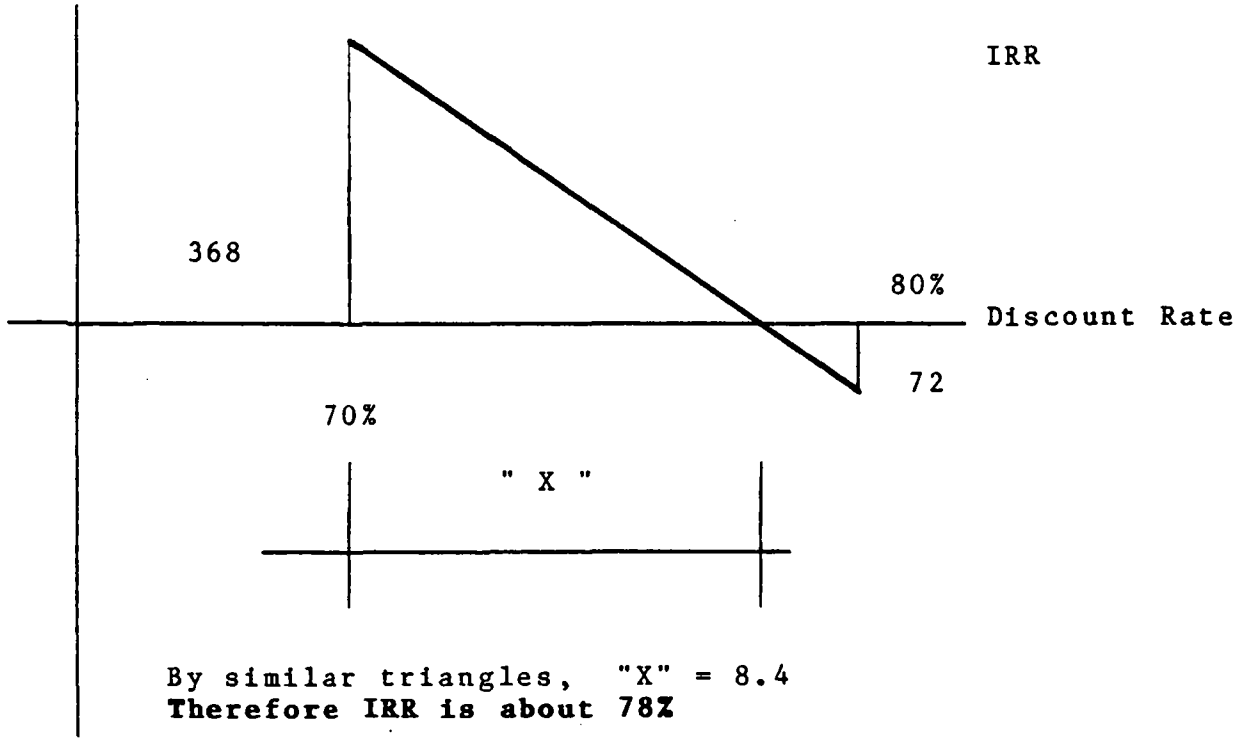
Year	Cost x Discount Rate	Present-Value Cost	Benefit x Discount Rate	Present-Value Benefit
1	1,000			
2	1,000			
3	3,000			
4	1,000		3,000	
5	1,000		6,000	
6	3,000		9,000	
7	1,000		12,000	
8	1,000		15,000	
9	3,000		18,000	
10	1,000		100,000	

TOTAL: _____ TOTAL: _____

10. Assist participants to interpolate results.

a) Discount rate of 70%:
N.P.V. = + 2,291 - 1,923 = + 368
Therefore, we must increase the discount rate to determine the IRR.

b) Discount rate of 80%:
N.P.V. = + 1,590 - 1,662 = - 72
Therefore, we have used the discount rate slightly higher than the IRR.



By similar triangles, "X" = 8.4
Therefore IRR is about 78%

You may wish to use this space for calculating the figures required in this exercise.

MAINTENANCE SCHEDULE

Frequency of Activity

Daily	Weekly	Monthly	Quarterly	Semi-Annually	Annually
	*				
					*
	*				
*					

Sludge Pumps

The following general provisions apply to all reciprocating sludge pumps discussed in this section as well as others in use at installation.

a. Check Shear-Pin Adjustment. Set eccentric by placing shear pin (a common 8d or 10d nail) through proper hole in eccentric flanges to give required stroke. Tighten the two 5/8 - 7/8-inch hexagonal nuts on eccentric flanges just enough to take spring out of lockwashers.

b. Check Cause of Shear-Pin Failure. Failures are caused by one of the following: a solid object lodged under the piston; a clogged discharge line; or a stuck or wedged valve. When shear pin fails, the eccentric moves to the neutral position, preventing damage to pump. Remove cause of failure and insert new shear pin.

c. Check Packing Adjustment. Give special attention to packing adjustment because packing which is too tight reduces the unit's efficiency and scores piston walls. Keep packing just tight enough at all times to keep sludge from leaking through gland. Before pump is operated, especially after it has been standing idle for a time, loosen all nuts on packing gland.

d. Check Lubrication of Packing. A sightfeed oil cup is usually provided for lubrication between plunger and stuffing box. Keep cup filled with 4065 oil. One filling should be enough for about 10 hours of operation. In addition, squirt oil frequently around

Daily	Weekly	Monthly	Quarterly	Semi-Annually	Annually
					*
			*		
					*
*					

the plunger. Run the pump with sludge line closed and valve covers open for a few minutes to break packing in. Turn down gland nuts no more than necessary to keep sludge from getting past packing. Tighten all packing nuts uniformly.

e. Renew Packing. When no takeup is left on packing gland bolts, replace packing. Remove old packing and thoroughly clean cylinder and piston walls. Place new packing in cylinder and tamp each ring into place. Make sure joints on packing rings are staggered. Adjust packing as explained above. When chevron type packing is used, see that nuts holding gland are only finger tight because excessive pressure quickly ruins packing and scores plunger.

f. Check Ball Valves. Replace valve balls which are so worn that they are small enough to jam into guides in valve chamber. This will not occur until original diameter of ball has been decreased 1/2 inch. Check the valve chamber gaskets. They are usually designed to act as a safety valve and blow out when excessive pressure is developed in a pump. Keep additional gaskets on hand for replacement.

g. Check Eccentric Adjustment. Remove brass shims from eccentric strap to take up babbitt bearing. After removing shims, operate pump for at least 1 hour and check to see that eccentric is not running hot.

h. Note Unusual Noises. Check piping arrangement and head conditions for noticeable water hammer when pump is operating. Water hammer is pronounced when pumping water or very

Daily	Weekly	Monthly	Quarterly	Semi-Annually	Annually
*					
		*			
			*		
*					
4					

thin sludge and decreases or disappears when pumping heavy sludge. Eliminate noise by opening the 1/4-inch petcock on pump body slightly. This draws in a slight amount of air, keeping discharge air chamber full at all times. Some installations require air chambers approximately 6 inches in diameter and 36 inches high on the suction side.

i. Check Control-Valve Positions. A plunger pump may be damaged if operated against closed valves in the pump line, especially in the discharge line. Make all changes in valve setting with pump shut down because a pump may be installed to pump from two sources or deliver to several tanks different times. This eliminates danger of all sunction-line valves or all discharge-line valves being closed at the same time causing pump breakage.

j. Check Gear Motor. Follow closely factory instructions attached to gear motor.

k. Service Electric Motor. Follow procedure below.

l. Check Gear Transmission:
(1) Keep gear transmission filled to proper level. Use 6135 in summer and 3080 in winter if pump is affected by seasonal temperature changes.
(2) Change Oil. Change quarterly or more if necessary to prevent sludging. Open drain monthly to eliminate accumulated moisture.

m. Lubricate Bearings and Gear Transmission. All bearings will be fitted with grease fittings. Grease with pressure gun at least once each shift, and more often if pump runs steadily for long periods. Use CG 1 grease unless manufacturer's instructions specify other type of grease.

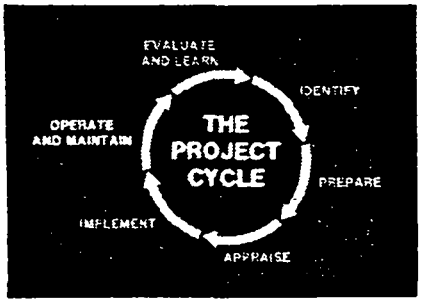
PLANNING FOR MAINTENANCE

SLIDE/TAPE PROGRAM VISUALS AND NARRATION

PLANNING FOR MAINTENANCE

1. 

TITLE SLIDE: Planning for Maintenance

2. 

NARRATOR:
Maintenance is an integral part of the cycle of a project. If a project is to yield its intended benefits, it must have a well-planned maintenance program behind it.

3. 

Operations and maintenance are inseparable. A new road is of no value until it carries vehicles which transport people and goods.

4. 

But that value diminishes when the condition of the road deteriorates. Maintenance preserves the maximum benefits.

5. 

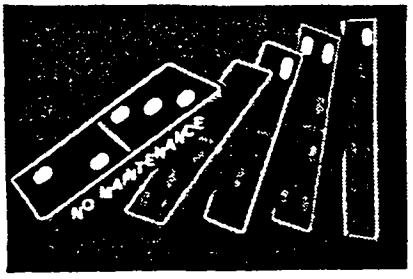
There are two types of maintenance -- corrective and preventive.

6. 

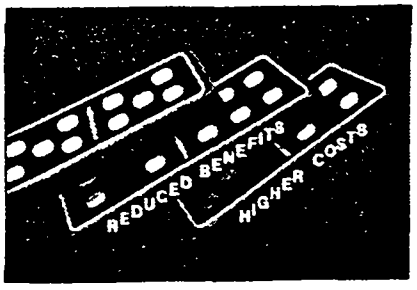
Corrective maintenance is undertaken to repair something or restore it to normal operating order. (When such corrective maintenance becomes extensive, it is called rehabilitation.)

7. 

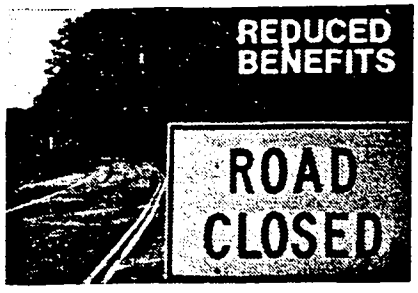
Preventive maintenance, as the term implies, includes work and measures that are taken to <u>prevent</u> facilities or equipment from malfunctioning or breaking down.

8. 

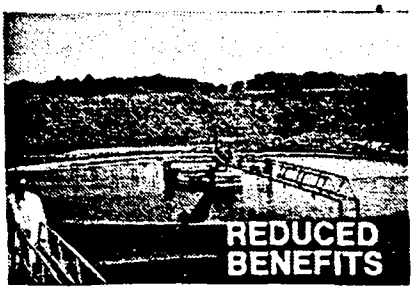
It is this preventive maintenance that is sometimes overlooked -- or perhaps underestimated in terms of importance. Unfortunately, improper maintenance creates a domino effect.

9. 

Consequences include reduced benefits and higher costs.

10. 

For example, a poorly maintained road surface causes vehicles to drive too slowly, wasting productive time -- or indeed, if it becomes <u>too</u> damaged, it may need to be closed altogether. If freight and passengers cannot move on a road, the road produces no benefits at all.

11. 

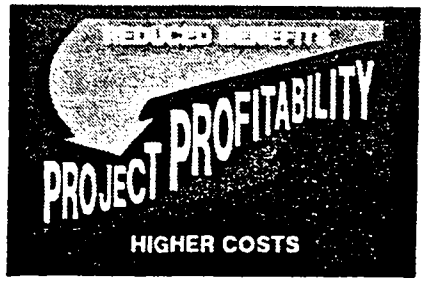
A water treatment plant that does not have a sound routine maintenance program cannot produce the quantity and quality of water for which it was designed.

12. 

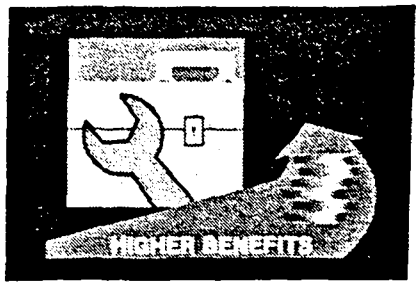
Higher operating costs can result, as in the example of an encrusted pipe increasing friction and pumping costs.

13. 

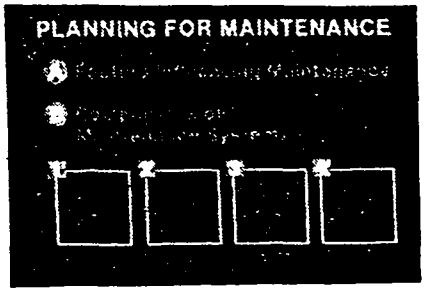
Deficient maintenance also shortens the useful life of equipment and facilities, leading to premature replacement with higher investment costs as a result.

14. 

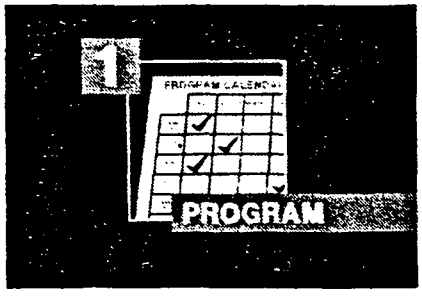
The combined result of higher costs and reduced benefits is to squeeze the project profitability and in reality, can make the project economically unjustified.

15. 

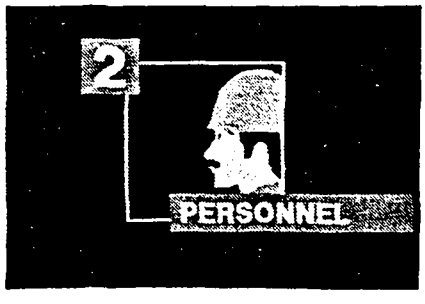
If neglected maintenance has such adverse effects, it follows that investing in <u>good</u> maintenance -- both corrective and preventive -- is highly worthwhile in terms of cost-efficiency.

16. 

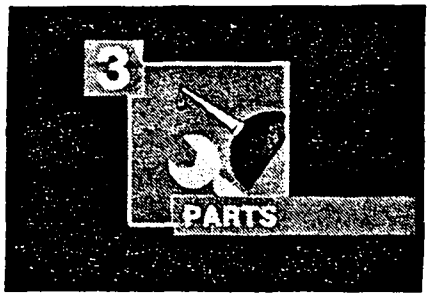
The purpose of this program is to examine the factors influencing maintenance and to describe the fundamental components of a good maintenance system and how it should be carried out.

17. 

Those four components of a good maintenance plan include a program,

18. 

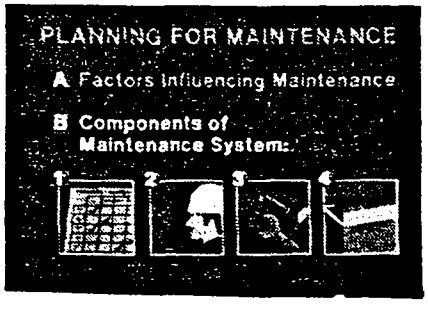
-- personnel,

19. 

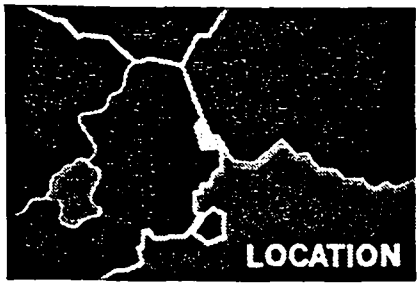
-- parts,

20. 

-- and records. We'll examine each of these in greater detail later in this presentation.

21. 

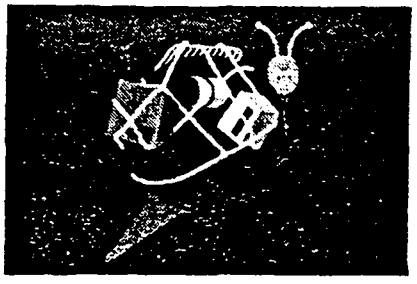
For now, let's turn our attention to some factors that influence maintenance and that must be taken into account when planning an effective program.

22. 

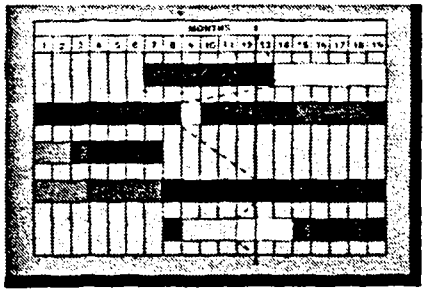
Location, for example, can have a significant effect on the maintenance to be provided.

23. 

A remote and isolated area may suffer in achieving good consistent maintenance. This is due partly to the difficulty in attracting and retaining qualified resident technicians. If such people are not kept on staff, then there might also be a problem in outside maintenance personnel, gaining access to such an area on a periodic basis.

24. 

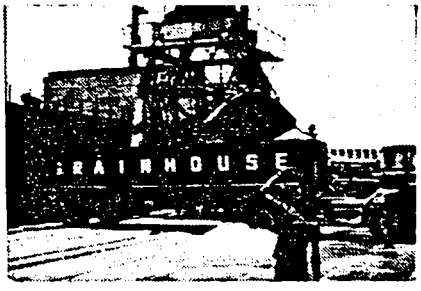
Often too, spare parts and replacements for equipment and facilities <u>can</u> suffer significant delays in delivery to a remote location.

25. 

For these problems to be resolved, careful maintenance <u>planning</u> is needed.

26. 

Another factor which affects maintenance planning is the <u>age and condition of the equipment and facilities</u>.

27. 

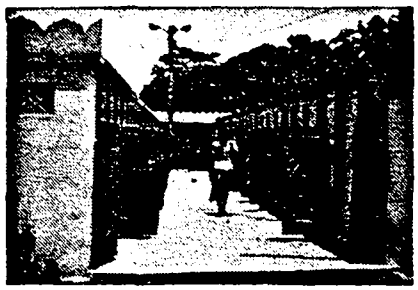
Much equipment, through previous neglect, often has deteriorated to a point where either replacement or complete rebuilding is necessary.

28. 

The next factor to consider in maintenance planning is the <u>availability of trained personnel</u>.

29. 

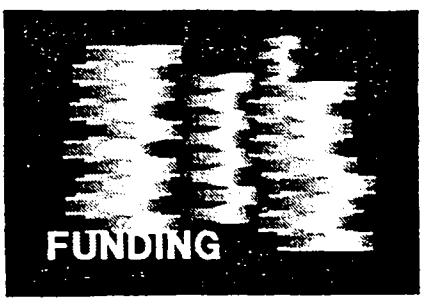
<u>Misuse and abuse of equipment</u> is another condition that impacts a maintenance plan and may take various forms.

30. 

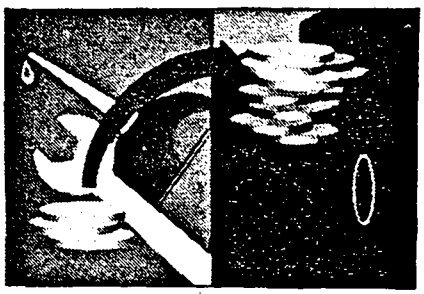
For instance, facilities which are used by the public (such as public standpipes or public toilets), generally receive not only hard usage but frequently abuse and vandalism.

31. 

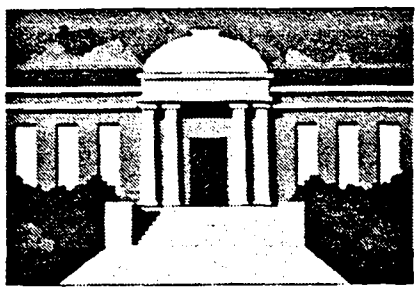
Another example of misuse can be seen when vehicles are overloaded or driven at excessive speeds over poorly maintained roads.

32. 

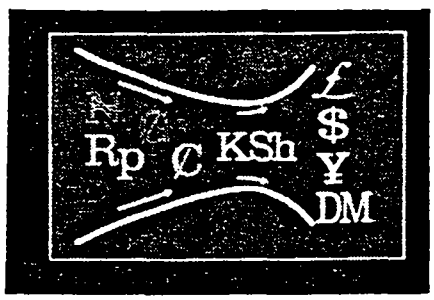
Funding will also affect maintenance. The first difficulty comes in committing sufficient funds for maintenance.

33. 

Even when maintenance funds are included in the budget, these are frequently diverted for construction instead. Investing in new facilities is more glamorous than maintaining what already exists.

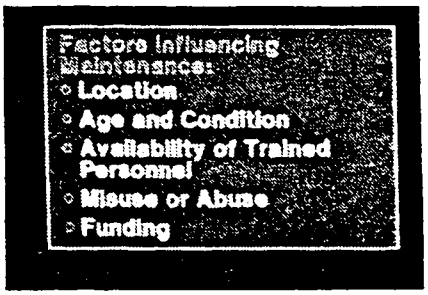
34. 

Much of public infrastructure is operated and maintained by institutions that are not financially autonomous. This creates an additional problem in obtaining sufficient maintenance funds on a timely basis.

35. 

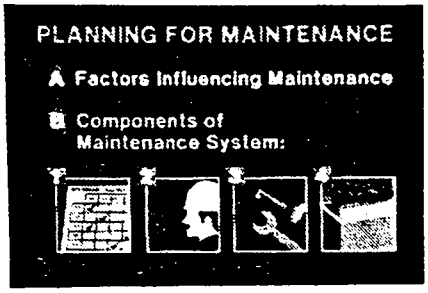
Even when domestic funds are available for importing spare parts, they frequently cannot be easily converted to the foreign exchange needed for procurement abroad.

36.



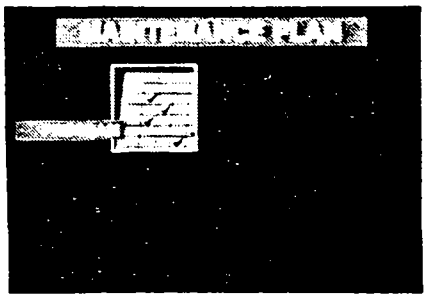
In planning for maintenance, then, one must consider the location where maintenance is to be performed, the age and condition of the equipment or facilities in question, the availability of trained personnel, the potential misuse or abuse of the equipment, and funding made available for maintenance.

37.

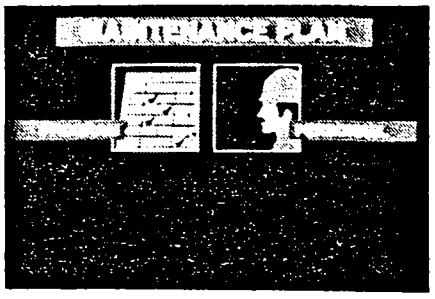


Let's turn our attention next to the four components that are fundamental to a good maintenance plan --

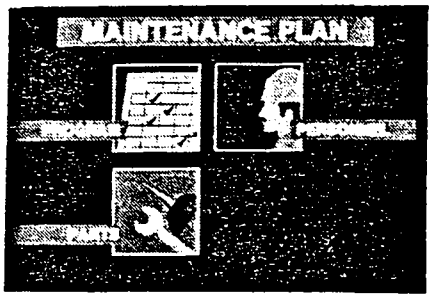
38.



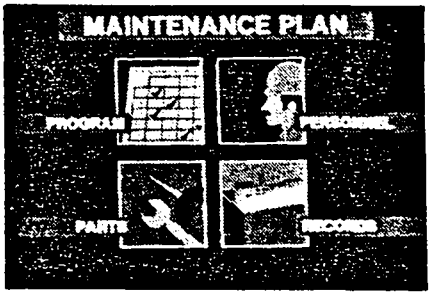
-- program,

39. 

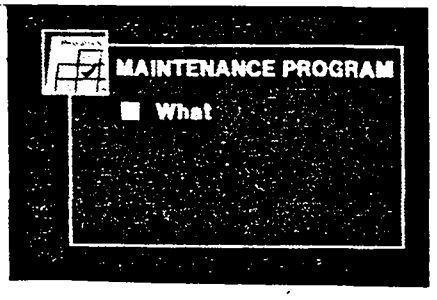
-- personnel,

40. 

-- parts,

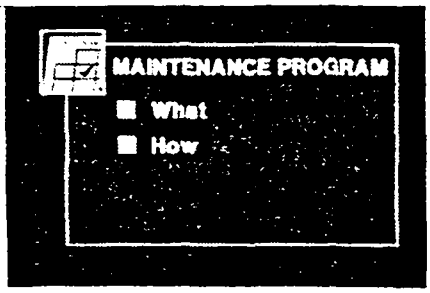
41. 

-- and records.

42. 

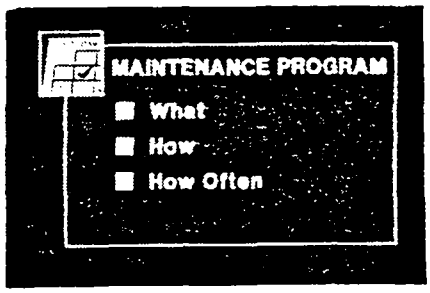
Let's look first at the maintenance program itself. It is made up of a list of individual maintenance activities -- that is, what is to be done.

43.



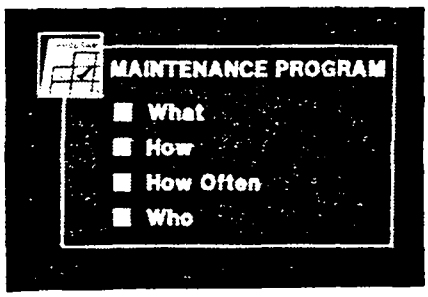
It also designates the ways and means by which each activity should be conducted -- that is, how it is to be done.

44.

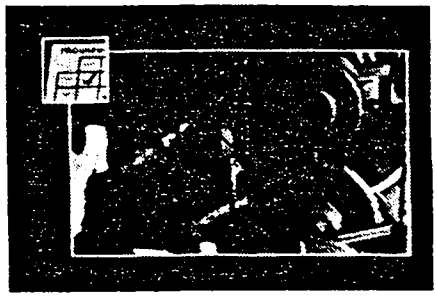


These maintenance activities range from routine daily inspections and tasks -- to others done weekly, monthly, quarterly, semi-annually, or annually. Recommendations and manuals on how often to service each item are generally supplied by the manufacturer, engineers, or contractors who designed the equipment or facilities.

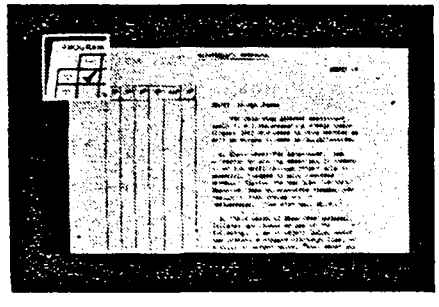
45.



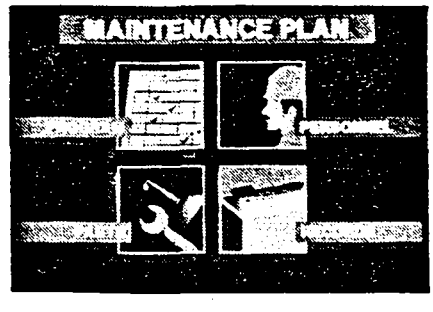
The program also specifies who is responsible for each task or activity.

46. 

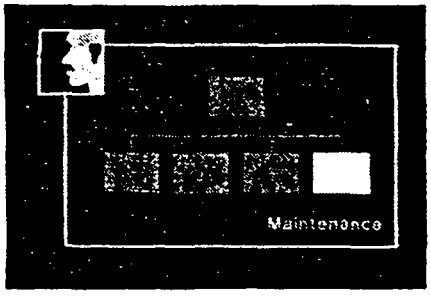
For example, part of the maintenance program for an electric motor may specify that the operator should check the motor condition daily, that he should lubricate the sleeve bearings weekly, and that the maintenance technician should flush the anti-friction bearings semi-annually.

47. 

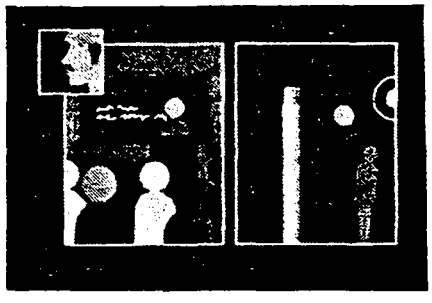
A maintenance program for an entire facility would be made up of a collection of these individual instructions covering all units.

48. 

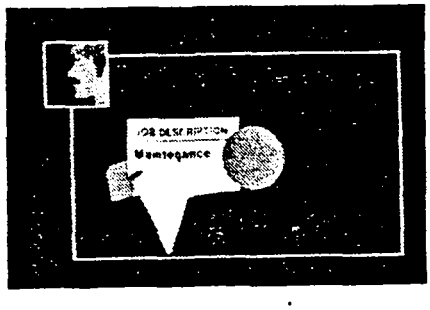
The second element to consider in establishing a good maintenance plan is personnel.

49. 

A specific department or position in an institution should have the unique responsibility for planning and supervising maintenance. Responsible staff should consist of managers, technicians, and operators.

50. 

They should gain not only a knowledge of what needs to be done but also an understanding that the maintenance function is absolutely critical.

51. 

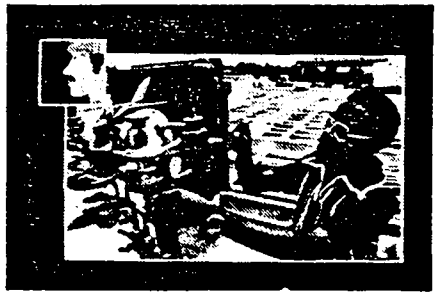
Each job description should include specific responsibilities for implementing maintenance.

52. 

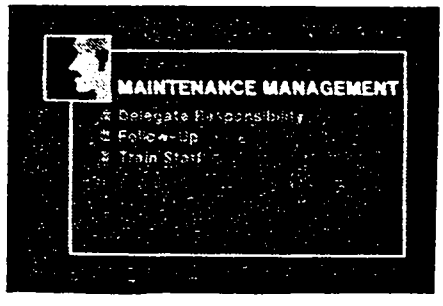
Where qualified maintenance personnel are unavailable, well-managed utilities provide training of their own staff through special courses for their maintenance personnel.

53. 

On-the-job training, conducted on a continuing basis, is also effective, particularly to ensure that semi-skilled people will become familiar with proper maintenance procedures.

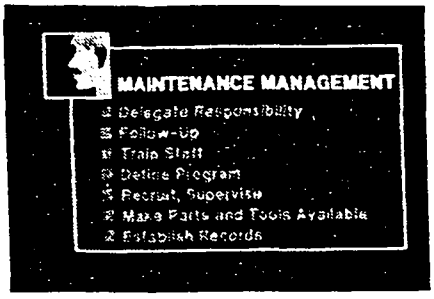
54. 

The importance of training cannot be overemphasized, particularly considering the inevitable turnover of personnel from time to time. Keeping a staff competent in operating and maintaining a facility can yield large rewards.

55. 

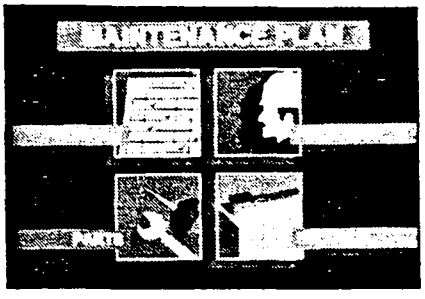
Managing the maintenance organization involves the ability to delegate responsibility, to follow-up on assigned work, and to train and develop the staff.

56.



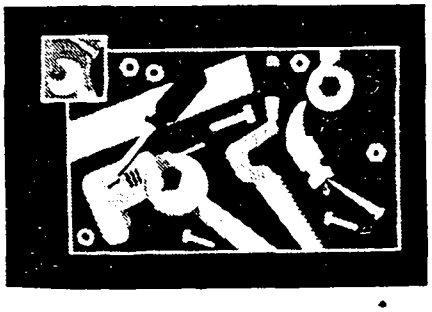
Furthermore, management has the responsibility to define the maintenance program; recruit, train, and supervise appropriate personnel; ensure that spare parts and tools are available when needed; and establish and use a record system to cover all equipment and facilities.

57.



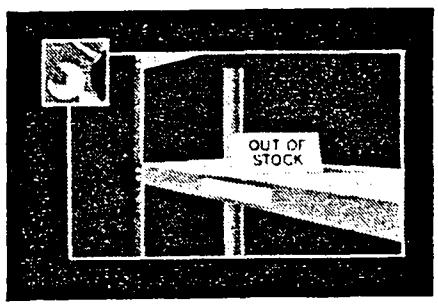
The availability of spare parts and tools necessary to adjust, repair, and correct routine problems constitutes the third element of a good maintenance plan.

58.



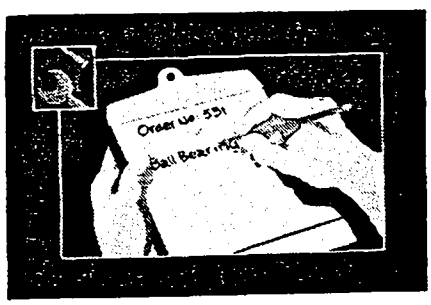
Organizations may have good maintenance programs and well-trained personnel, but unless the tools, parts, and materials necessary to do the work are on hand, good maintenance will not come about.

59.



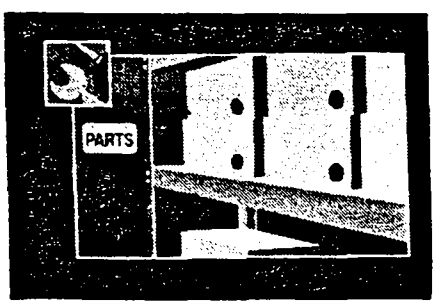
As noted previously, one of the characteristics of operations in developing countries is that spare parts are often not available, because they are not purchased in time and routinely stored.

60.



Managers therefore need to determine what is feasible under their circumstances and order parts and supplies sufficiently in advance that they can be absolutely certain they will be available when needed.

61.

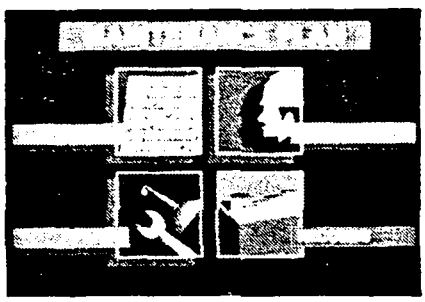


There will be instances when spare parts will need to be ordered at the time equipment is initially purchased. Even though such parts will have to be carried in the inventory over a five or ten-year period, this may be a worthwhile expense.

62.

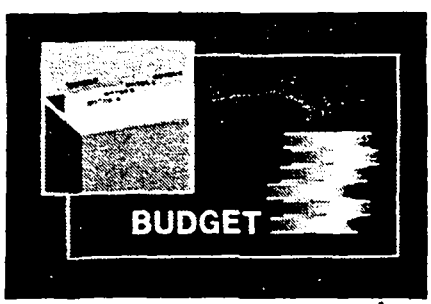
The ordering and delivery of spare parts and supplies must be attended by a good warehouse unit with a sound inventory system. Good records are indispensable in keeping management informed as to costs, usage, availability of parts, and the need for advance ordering.

63.

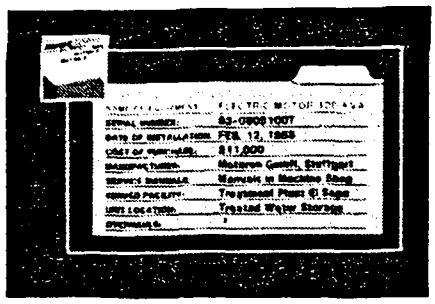


Of all the components of the maintenance plan under discussion here, records are probably the most neglected.

64.

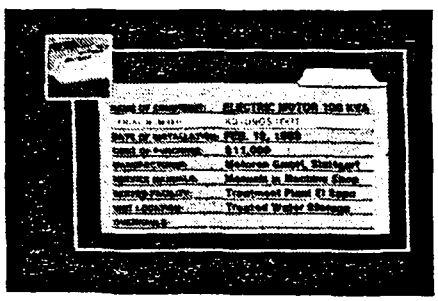


Records are particularly useful when budgeting annually for various maintenance activities. They documenmt past levels of maintenance expenditure necessary to keep facilities operating efficiently.

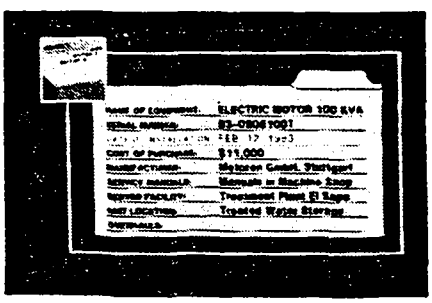
65. 

A good record system should include, as a minimum, the following information:

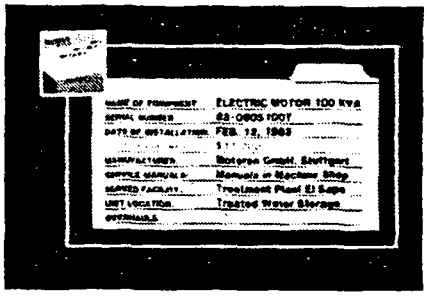
-- the name of the equipment or facility;

66. 

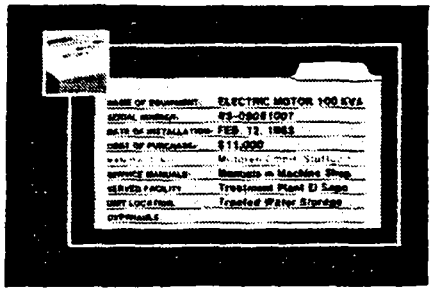
-- its serial number, type, and class;

67. 

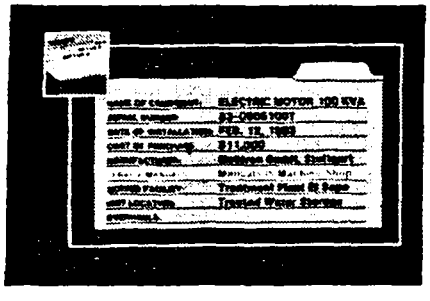
-- the date of installation;

68. 

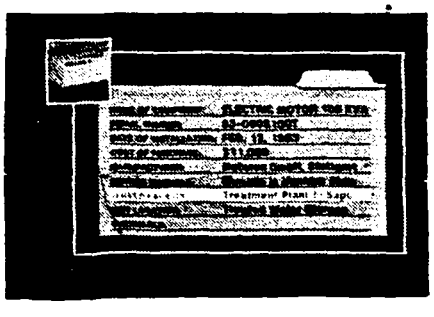
-- the cost of purchase;

69. 

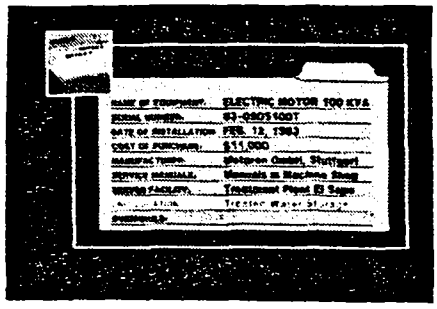
-- the name and address of the manufacturer or builder and the name and address of any service organization or distributor from whom the equipment or part was purchased;

70. 

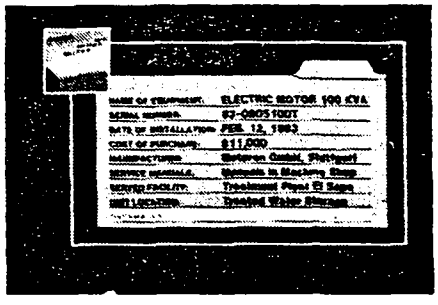
-- the availability and location of service manuals;

71. 

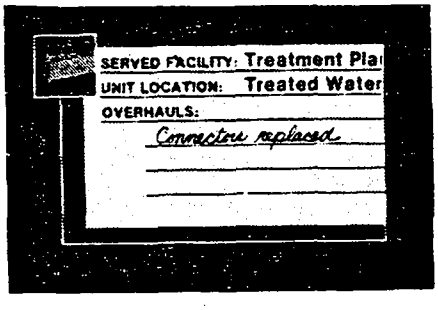
-- the name of the facility which the unit serves; and

72. 

-- the location of the unit (that is, the building, room number, and so forth);

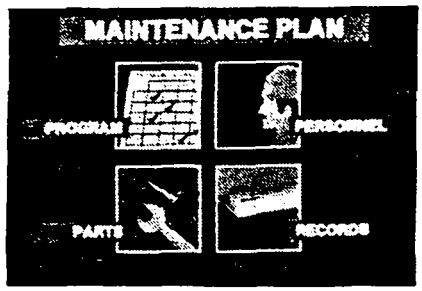
73. 

-- then the records should indicate the date and nature of any problems and overhauls that have occurred.

74. 

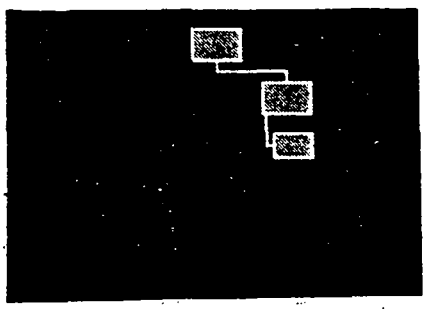
When repairs have been made, the quantity, type and cost of th new parts should be indicated, together with the amount of labor input required to make the repair or adjustment.

75.



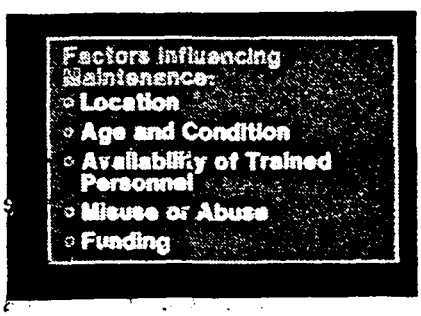
A good maintenance plan will include all four fundamentals: program, personnel, parts and records.

76.

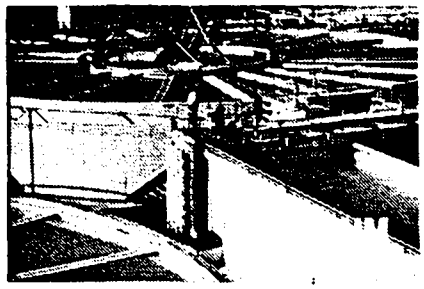


And to be effective, it will need a commitment regarding the actions and attitudes necessary starting from management levels and cascading down the organization.

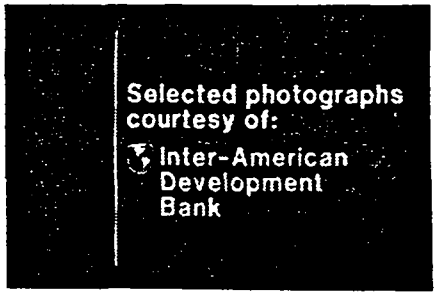
77.



Careful planning will be required at the start, taking into consideration the many factors that influence the maintenance plan, including the location where the maintenance is to be performed, the age and condition of the equipment or facilities in question, the availability of trained personnel, the potential misuse or abuse of the equipment or facility, and funding available for maintenance.

78. 

A carefully planned, well-executed maintenance plan will optimize operations of a facility so that the maximum benefits may be realized.

79. 

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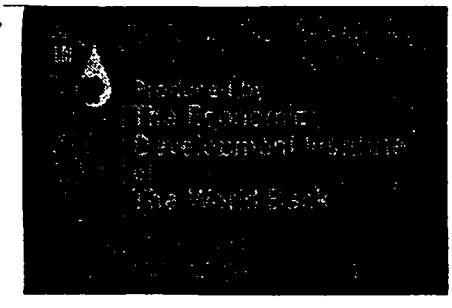
80. 

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