THE DEVELOPMENT OF A COMPUTER PROGRAM FOR TROUBLESHOOTING AN ACTIVATED SLUDGE WASTEWATER TREATMENT PLANT

BY

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1984

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
July, 1986

THE DEVELOPMENT OF A COMPUTER PROGRAM FOR TROUBLESHOOTING AN ACTIVATED SLUDGE WASTEWATER TREATMENT PLANT

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ACKNOWLEDGMENTS

I would like to express my appreciation to my major adviser, Dr. Don F. Kincannon, for his constant guidance and advice in every aspect of this study. Appreciation is also expressed to Dr. William F. McTernan and Dr. John Veenstra as committee members and for their instructions during my study. I also wish to thank my Chinese bible study friends, for their encouragement and praying during the course of this study.

Special thanks are extended to Minter Cheng, Chi-Chung Chang, Hwan-Chang Chu, Johnny Hwang, Kien Hoon Poon, Cindy Lin and Victor Wu for their consecutively encouragement and valuable help. Appreciation is extended to my classmates, Taiwan and Malaysia friends for their considerable friendship.

I would like to thank my parents, Mr. and Mrs. Tsann-Ching Chen, for their continuously finacial support, understanding, and encouragement. Thanks to my sisters and brother for taking care of my feelings. Many thanks to some ones for their loving.

Last, but most importantly, I would like to honor my Lord. Thankful for what He has done and what He has given to me. Everything that I got is from Him. Now it is the best time to return back. Thanks to the almighty God.

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CHAPTER I

INTRODUCTION

The activated sludge process is one of the most popular and efficient wastewater treatment systems utilized today (1). It has been used widely since its inception by Arden and Lockett (2) in 1914. There are several advantages, but also some disadvantages to the process (3). One of the disadvantages is that to operate the process requires more skilled operator than the trickling filter process.

As we know, the activated sludge process is a biological process. If one of the operational conditions changes, such as influent BOD, influent flow rate, pH value, or temperature, certain adjustments should be made in the process in order to meet the plant's effluent criteria. Many options are available to the operator and in many cases he has trouble recalling all of these options. Therefore, a troubleshooting guide for the operator could mean better operation of the treatment plant.

In fact, the Environmental Protection Agency (EPA) has published a troubleshooting manual for aeration processes (4). The manual offers possible procedures to go through for troubleshooting. However, it is difficult for the operator to use. The objective of this study was to

develope a user friendly computer program to assist the operators of activated sludge wastewater treatment plants in making operation decisions.

CHAPTER II

LITERATURE REVIEW

There have been a lot of efforts made to improve the activated sludge process. Research has been conducted on modeling, sludge handling, treatment efficiency improvement, and operational control. At the same time, consulting companies have developed computer software to assist in the control of wastewater treatment plants.

Start-Up and Maintenance

Hossein S. Banijamali (3) felt that start-up and system maintenance are the major problems in activated sludge waste water treatment plants. He developed a guideline for a successful start-up and outlined some important items to maintain activated sludge system.

Foaming

Wells and Garret (5) consider foaming problems. They believed that foaming problems were associated with the food to microorganism (F/M) ratio. In their opinion a F/M ratio around 0.2 can cause a forming problem in the activated sludge plant. After few years, Bhupinder S. Dhalisal (6) proved this concept depending on their plant and pointed out

that prior to the appearance of foam the F/M ratio was at a range of .24 to .36 with a median value of .31.

Bulking

Bulking is a serious problem which causes high suspended solids in effluents. In 1980, David Jenkins (7) suggested several criteria to follow for successful application of chlorination for controlling bulking in activated sludge plants. In 1981, the Water Research Centre held a "Bulking of Activated Sludge: Prevention or Cure" Conference (8) in Cambridge. This conference covered all aspects of the bulking problem and many authors presented the results of their original research.

General Problems of Troubleshooting Guides

EPA published a manual (4) for troubleshooting aeration processes. This manual offered seven general trouble-shooting guides that were categorized between the aeration basin and secondary clarifier. It can help operators to solve common operating problems in activated sludge process. D. E. Grimestad and R. L. Wetegrove (9) discussed in detail bulking, dispersed floc, deflocculation, and floating secondary sludge. They provided a guide for solutions to improve wastewater plant operation.

Computer Software Survey

Process Control

Numerous consulting firms supply software to control wastewater treatment plants. For example, Milwaukee Metropolitan Sewerage District is one of them. Its results were presented by J. R. Grinker and R. F. Meagher (10). The control system included primary sludge pumpage, dissolved oxygen in aeration tank, mixed liquor suspended solids control, automatic final clarifier wasting, dissolved air flotation thickener loading, digester feed and withdrawal, acid feed for phosphorus control, and sampler flow pacing.

Report

"Operator 10" (11) contains seven packages for treatment plants, in which two available today. One of these is a process monitoring and NPDES reporting package. It provides a complete lab report, operator reports, and a permit violations report.

Maintenance

The other "Operation 10" package presently available is an inventory management maintenance scheduling package.

George Sutton(12) was assigned to develope a maintenance management system (MMS) and staffing for St. Petersburg's water and wastewater treatment plants. This MMS was designed to control cost, and help staff schedule, track and report their work quality and quantity.

CHAPTER III

MATERIALS AND METHODS

The computer used in this study was an IBM - PC with 256 K of memory and two disk drives.

The program was written in BASICA language for the IBM - PC or IBM BASICA compatible.

Eight problem areas were selected. These problem areas, plant observations associated with these problem areas, the probable causes of the problems, and the operational solutions to these problems were based upon information available in the literature and information obtained from related course work at Oklahoma State University. The eight selected problems are:

Aeration Tank

1. Aeration System Problems
2. Foaming Problems

Secondary Clarifier

3. Solids Washout/Billowing Solids
4. Bulking Sludge
5. Sludge Clumping
6. Cloudy Secondary Effluent
7. Ashing, Pinpoint/Straggler Floc

Effluent

8. Effluent Does Not Meet Criteria

After the eight problem areas were selected, a basic flow diagram was designed. A sub flow diagram was designed for each probable cause of each observation in each trouble-shooting problem area.

After the sub flow diagrams were designed the basic computer program was written in BASICA. A major problem developed during the writing of the program. The program exceeded the capacity allowed for BASICA. BASICA has a 64 k memory limition. Therefore, the program was divided into four files, each file containing different problem areas. As the user goes from one file to another file, the file must be reloaded on the computer. The computer program was saved on a floppy disk.

CHAPTER IV

RESULTS

Flow Diagrams

The basic flow diagram that was designed for this program is shown in Figure 1. It is seen that the program is structured that the user can select any of eight problem areas that he may encounter at an activated sludge wastewater treatment plant. After selecting a problem area, the program displays one or several observations that the operator may observe at the plant. The user can then select the observation of his choice. Probable causes are then given for each observation. The program then asks for data input so that operational parameters may be checked. After the operational parameters are checked the program will provide suggested remedies or if there is no problem, the program will ask the user whether he wishes to go back to the main index or to quit the program.

Figure 2 shows the sub flow diagram for boiling action under aeration system problems. The diagrams show the steps that the program takes the user through for this remedies to this problem. This sub flow diagram is presented to show the general structure for all sub flow diagrams. The presentation of all sub flow diagrams would be confusing.

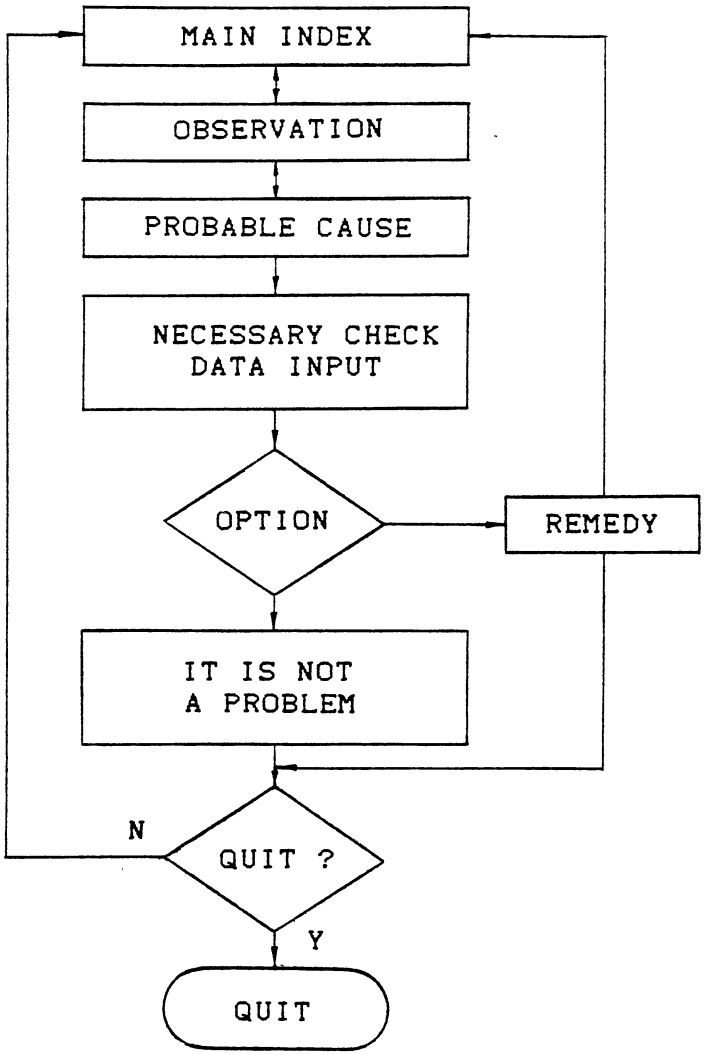

Figure 1. Basic Flow Diagram

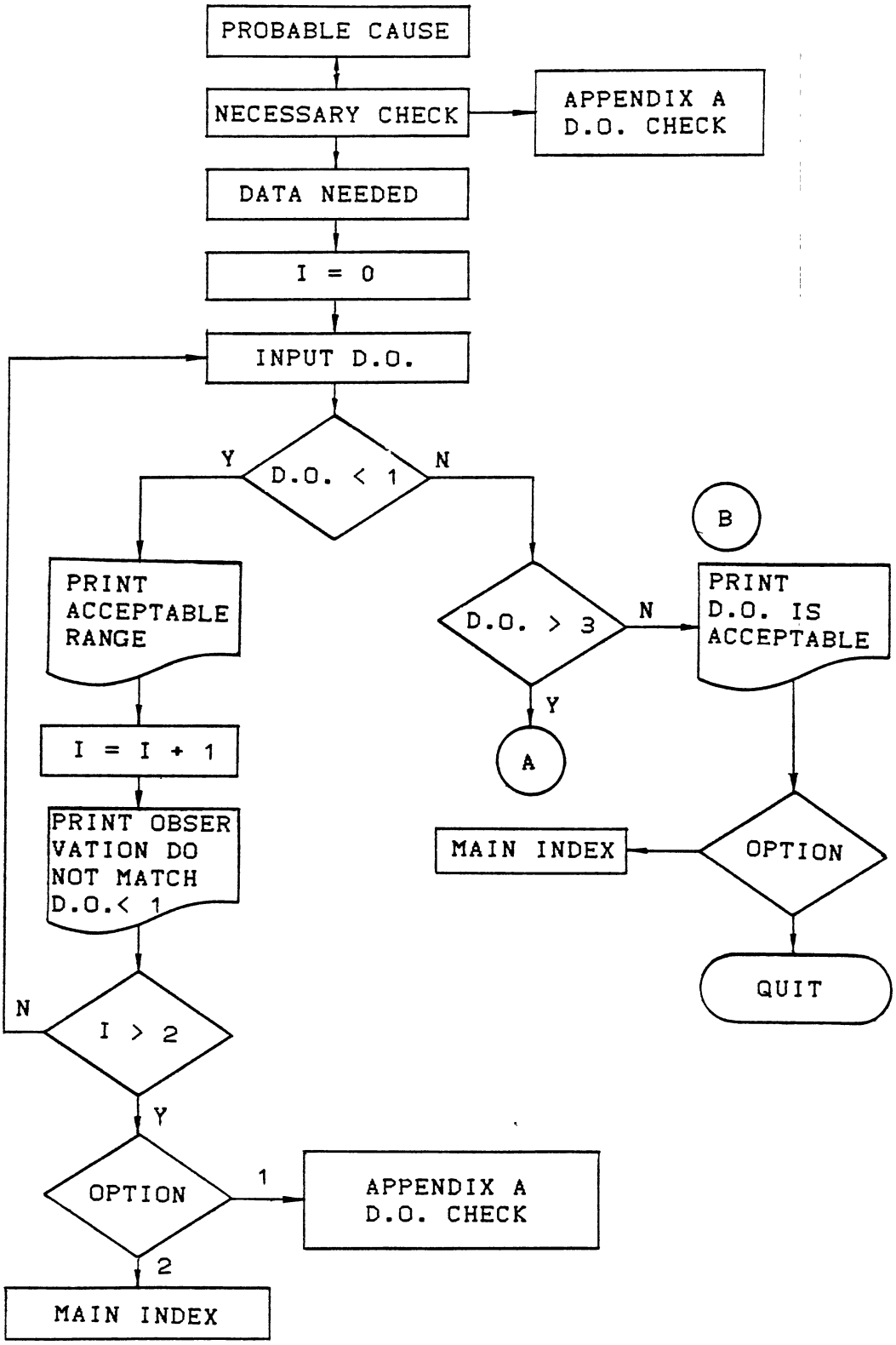

Figure 2. Flow Chart of Troubleshooting #1, Observation #1 Aeration System Problems - Boiling Action

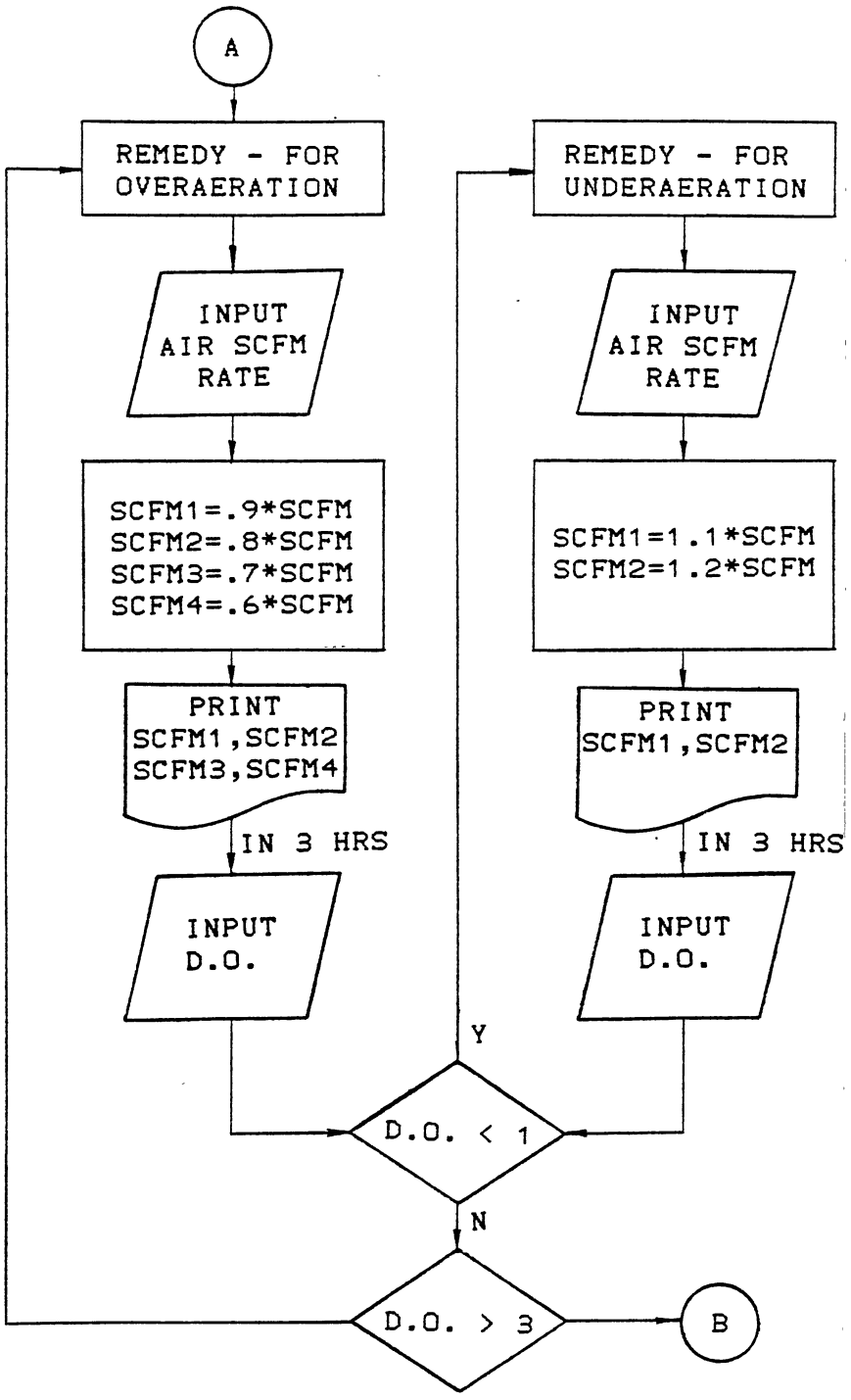

Figure 2. (Continued)

Example

A user friendly program which is interactive has been developed. The software will guide the user through the program. When the program is executed, the software's name (Fig. 3), conventional activated sludge plant's diagram (Fig. 4), and the main index (Fig. 5) will show on the monitor. The user can check and select one of the options which are listed on the screen to find the possible problem at the user's plant. There are eight problem areas to select from. The possible operational observations will be listed on the screen, when the user has picked a possible problem from the main index.

All troubleshooting guides are designed similarly. Observation #1 of each problem area is illustrated for demonstration. Detailed descriptions of the printouts are discussed only for problem #1, observation #1, which is the aeration system problems for boiling action. Its flow chart is shown in Figure 2.

When the user chooses #1 of the "Main Index", the screen will change to Possible Observation (Fig. 6). If #1 of this manual is choosen, the probable cause will be shown. Since there is only one probable cause for boiling action, the program automatically displays "Necessary Check" and "Data Needed" and asks for the dissolved oxygen (D.O.) in the aeration tanks. This is shown in Figure 7.

For this example, a D.O. value of 0.7 mg/l has been entered. If the input D.O. value is less than 1 mg/l, the

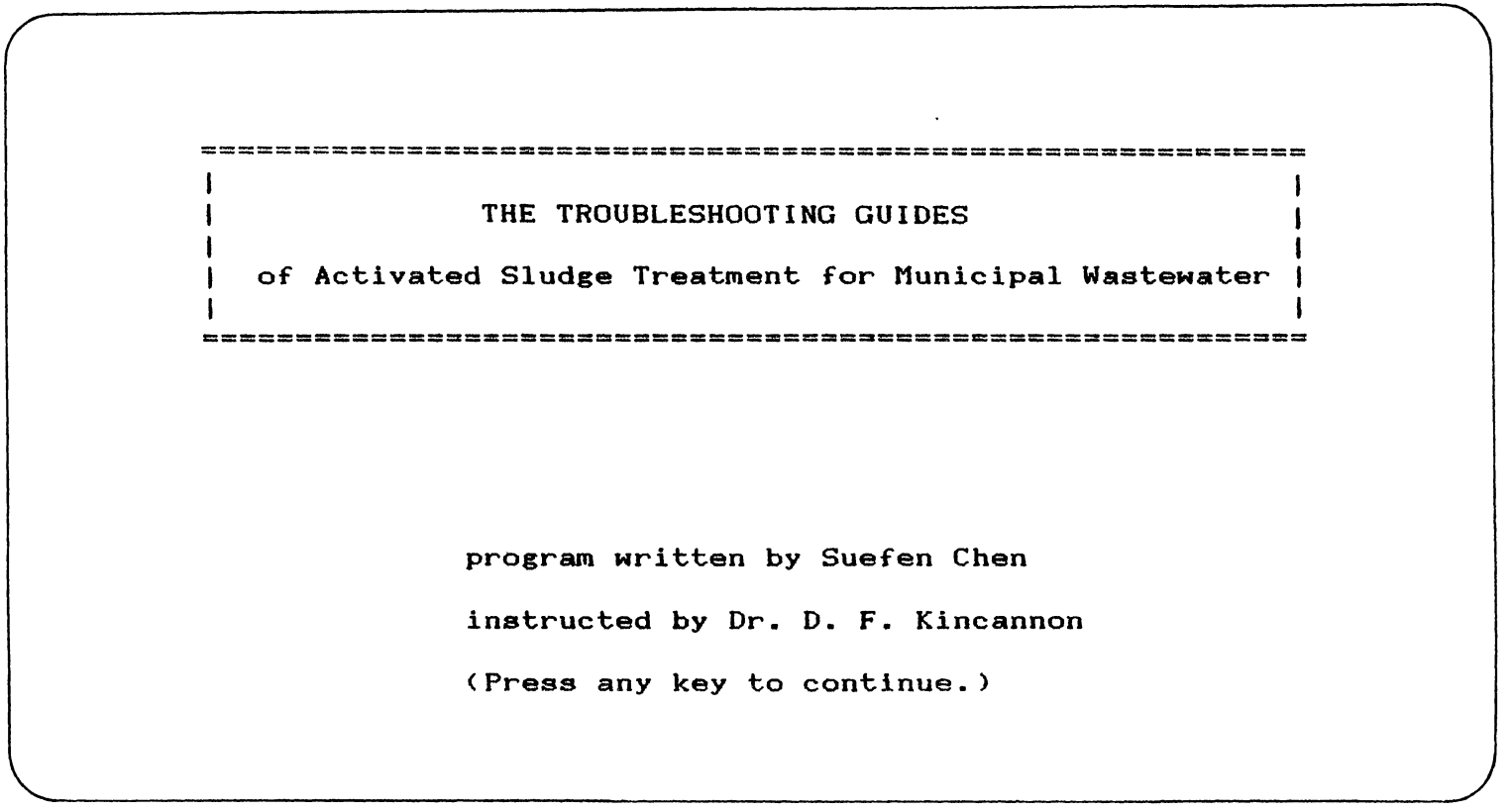

Figure 3. Software's Name

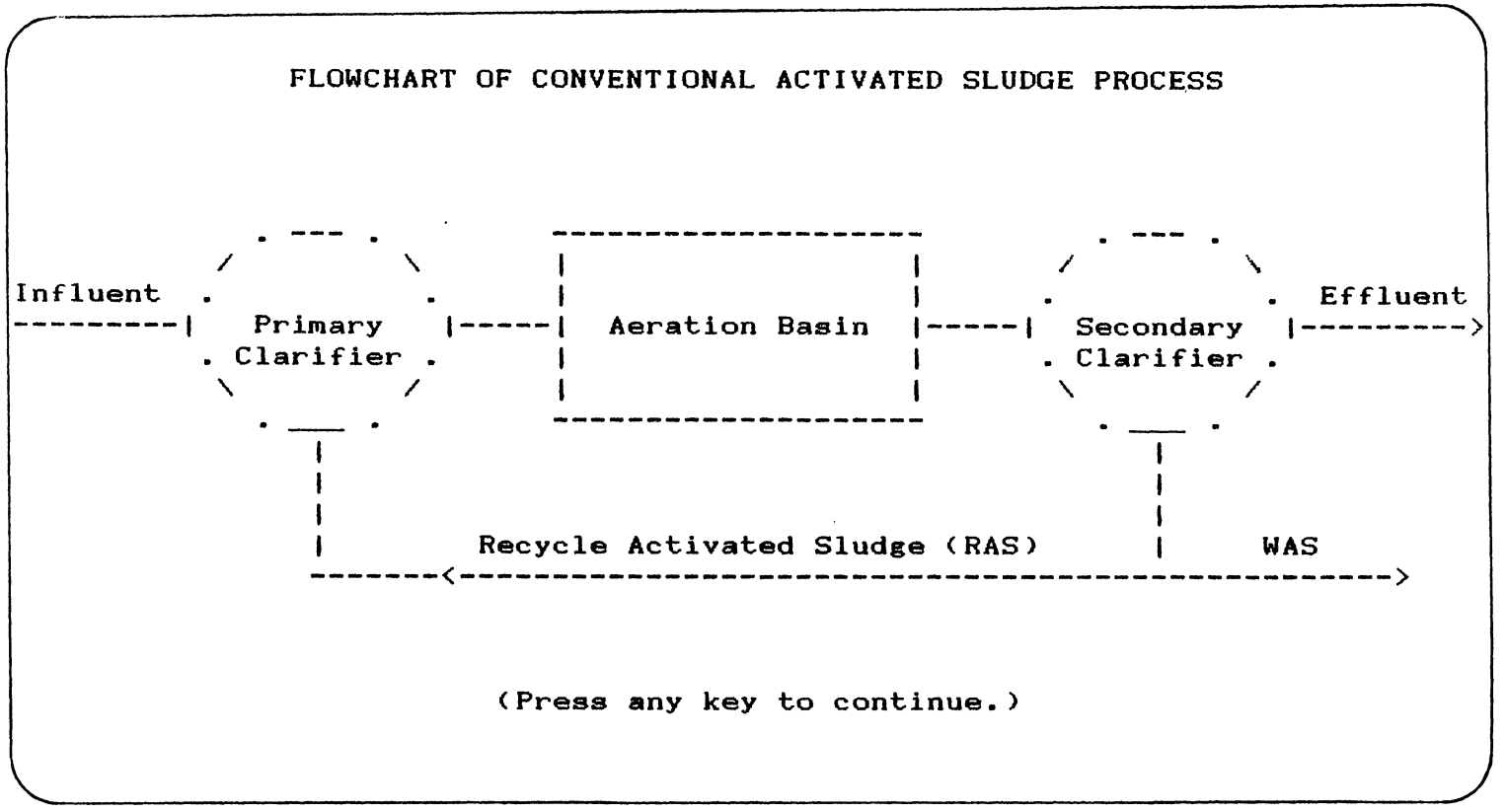

Figure 4. Conventional Activated Sludge Plant's Diagram

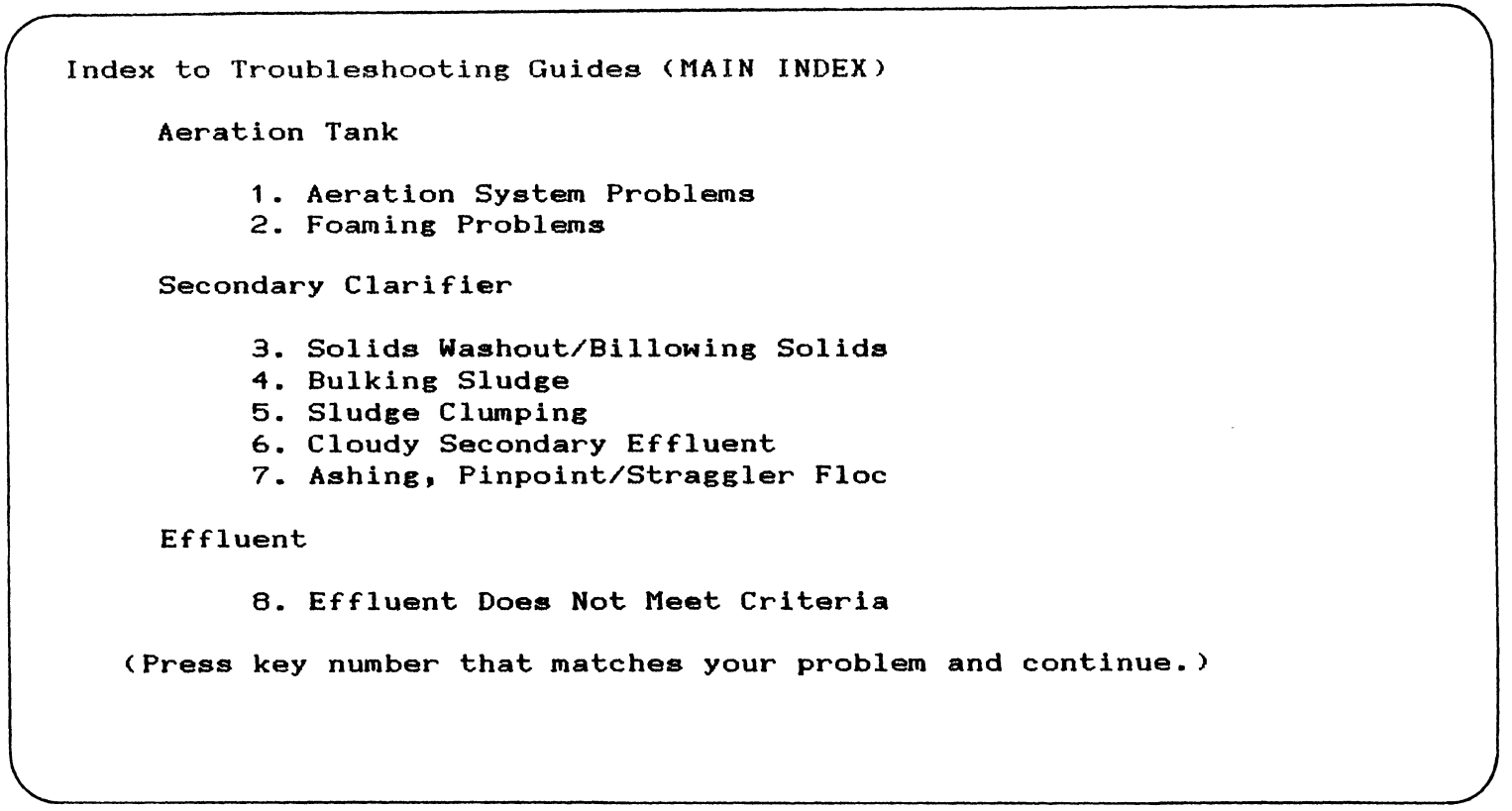

Figure 5. Main Index

TROUBLE SHOOTING GUIDE NO. 1 - AERATION SYSTEM PROBLEMS.

What Obervation Do You See in Your Aeration Tanks?

1. Boiling action, violent turbulance throughout aeration tank surface. Large air bubbles, 1/2 inch or greater, apparent

2. Uneven surface aeration pattern. Dead spots or inadequate mixing in some areas of tank

3. Excessive air rates being used with no apparent change in organic or hydraulic loading. Difficult to maintain adequate D.O. level.

(Press key number that matches your problem and continues or press 'Esc'to return to MAIN INDEX.)

Figure 6. The Observations of Problem #1

PROBABLE CAUSE

Overaeration resulting in high D.O. and/or floc shearing.

NECESSARY CHECK

You need to check D.O. in your plant.

(Do you need more information that would tell you how to run D.O. test? Press key A to go to 'Appendix A - Dissolved Oxygen Test', press 'Esc' key to return to Troubleshooting Guide No. 1, or press any other than these two keys to CONTINUE.)

DATA NEEDED - for checking D.O. in aeration tank.

What D.O. do you measure ? .7

Figure 7. The Probable Cause, Necessary Check, and Data Needed of Observation #1, Problem #1 (D.O. = 0.7 mg/l)

program will ask for the D.O. again (Fig. 8). It is quite doubtful that the D.O. is lower than 1 mg/l if boiling action would be observed. However, this has been used to illustrate what the program will do under this condition. After asking three times for D.O. data, the program will give the user two options, as shown in Fig. 9. The user can choose either #1 to check the procedure of measuring D.O., instruments problems, or chemicals interference, or choose #2 to select another option.

If the input D.O. is greater than 3 mg/l (Fig. 10 shows an example of 5.0 mg/l) the program gives "REMEDY - for overaeration". It asks for air flow rate and suggests user possible air flow rates (Fig. 11). If the user chooses to reduce the air flow rate too much, "REMEDY - for decreasing too much" (Fig. 12) will show on the screen. The program will move forward and backward until the D.O. is between 1 and 3 mg/l. The final screen of this option is shown in Fig. 13. This states that "Your D.O. is in acceptable range.". If that is the only problem, then the user can press any other key than 'Esc' key to "quit".

Screen printouts for other problem areas are shown in Fig. 15 to Fig. 21.

```
MEASURED DATA =   .7

   Generally D.O. should be in the range of 1.0 to 3.0 mg/l thoughout

   tanks.  Since you have the obervation, it is very doubtful to get
   D.O. less than 1.

   Please check D.O. again.


   What D.O. do you measure ? .7
```

Figure 8. Inquiry of D.O. Again (Problem #1, Observation #1)

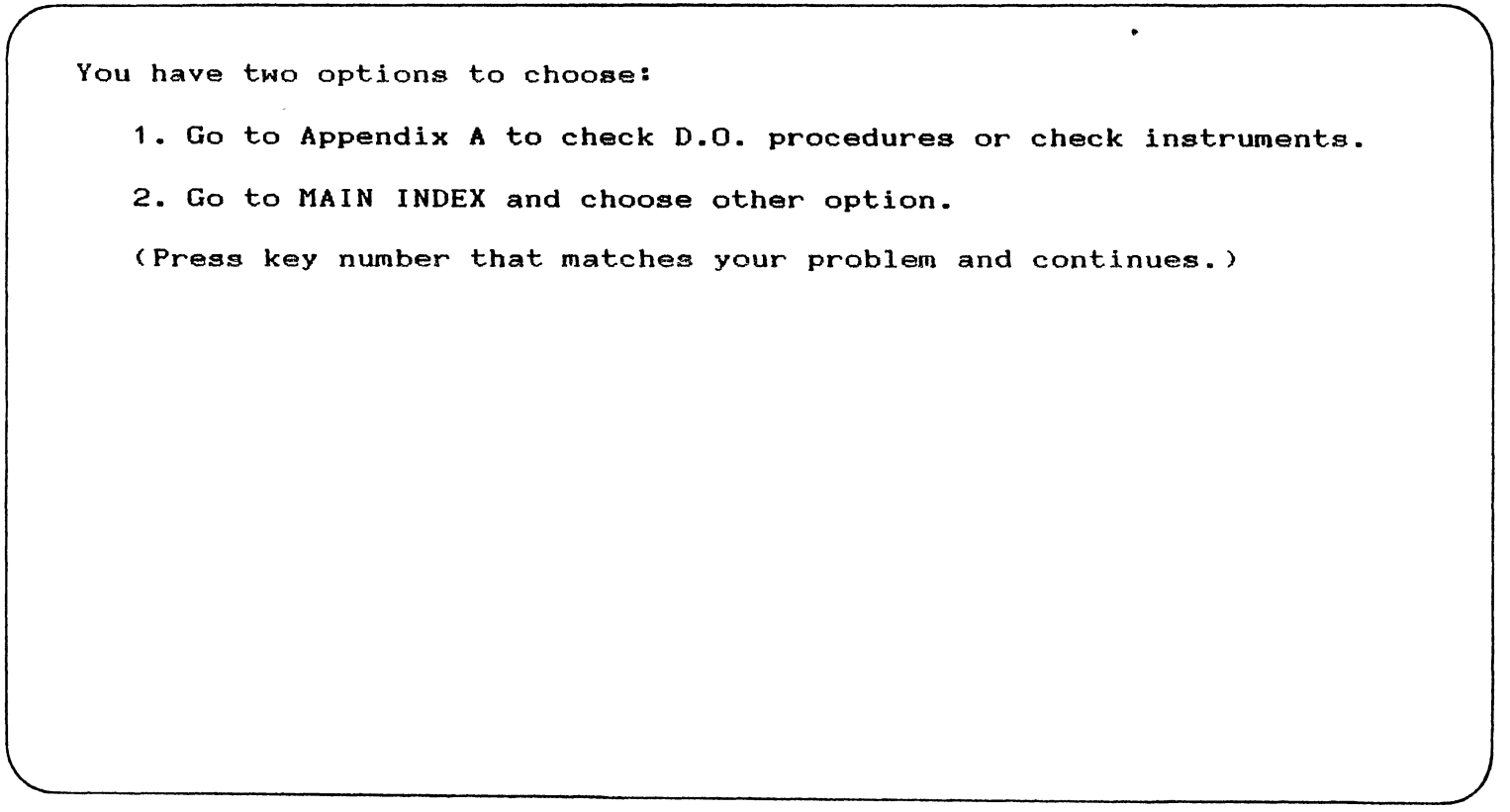

Figure 9. Options for having D.O. too low (Problem #1, Observation #1)

PROBABLE CAUSE

Overaeration resulting in high D.O. and/or floc shearing.

NECESSARY CHECK

You need to check D.O. in your plant.

(Do you need more information that would tell you how to run D.O. test? Press key A to go to 'Appendix A - Dissolved Oxygen Test', press 'Esc' key to return to Troubleshooting Guide No. 1, or press any other than these two keys to CONTINUE.)

DATA NEEDED - for checking D.O. in aeration tank.

What D.O. do you measure ? 5

Figure 10. The Probable Cause, Necessary Check, and Data Needed of Observation #1, Problem #1 (D.O. = 5 mg/l)

```
REMEDY - for overaeration.

   The remedy is based upon adjusting air flow rate.

   Input air flow rate (SCFM) ? 5

   If your D.O. is much higher above 3 mg/l , you would like to
   adjust 30% or 40% off. However, if your D.O. is little higher,
   you will prefer to adjust 10% or 20% off

       Adjust air flow rate 10% off to **4.5
       Adjust air flow rate 20% off to **4.0
       Adjust air flow rate 30% off to **3.5
       Adjust air flow rate 40% off to **3.0

   In 3 hours, go and check D.O. again.

   What D.O. do you measure?? .9
```

Figure 11. Remedy for Overaeration of Observation #1, Problem #1 (D.O. = 0.9 mg/l after reduced air flow rate)

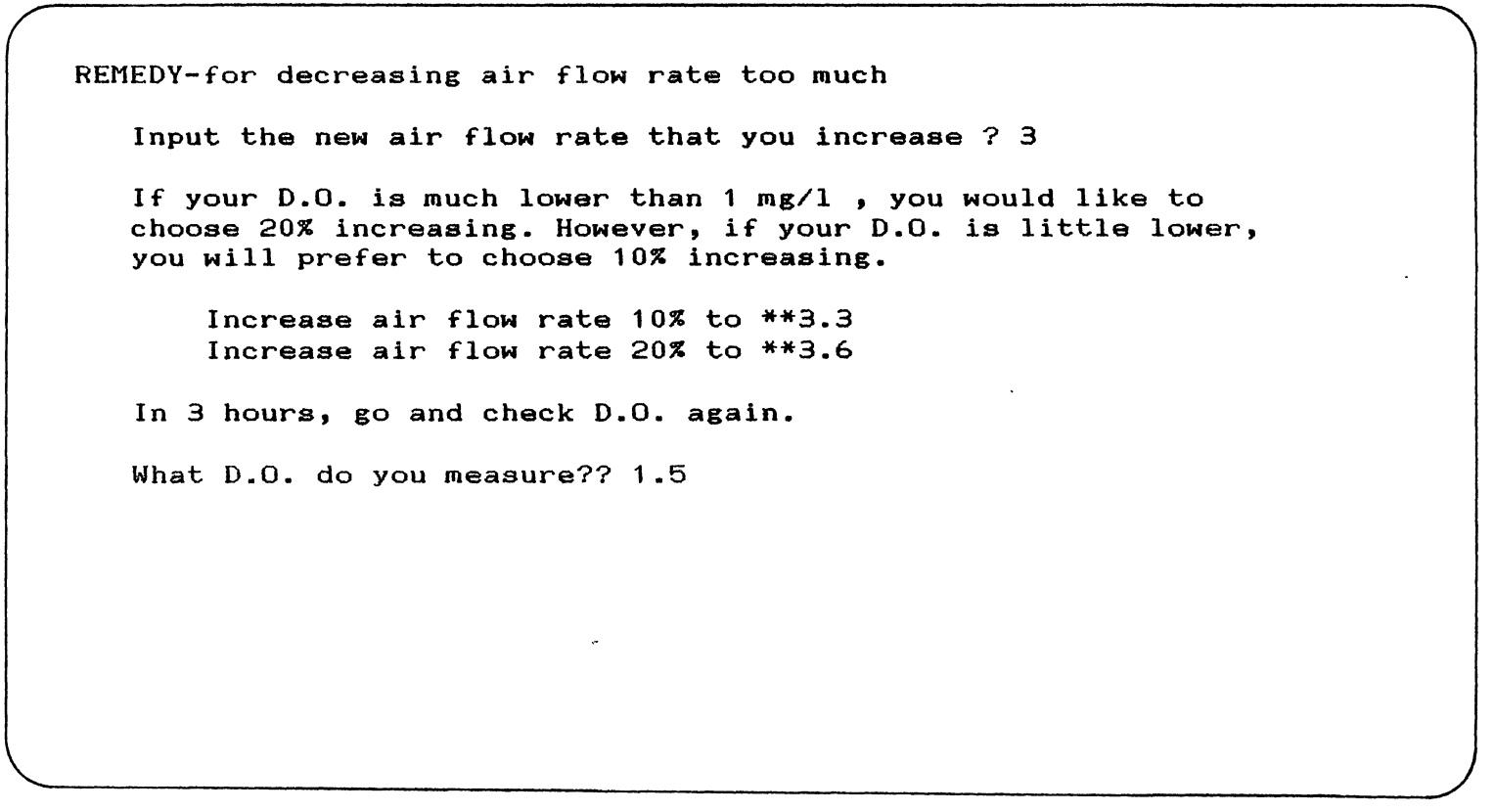

Figure 12. Remedy for Decreasing Too Much of Observation #1, Problem #1 (D.O. = 1.5 mg/l after increase air flow rate)

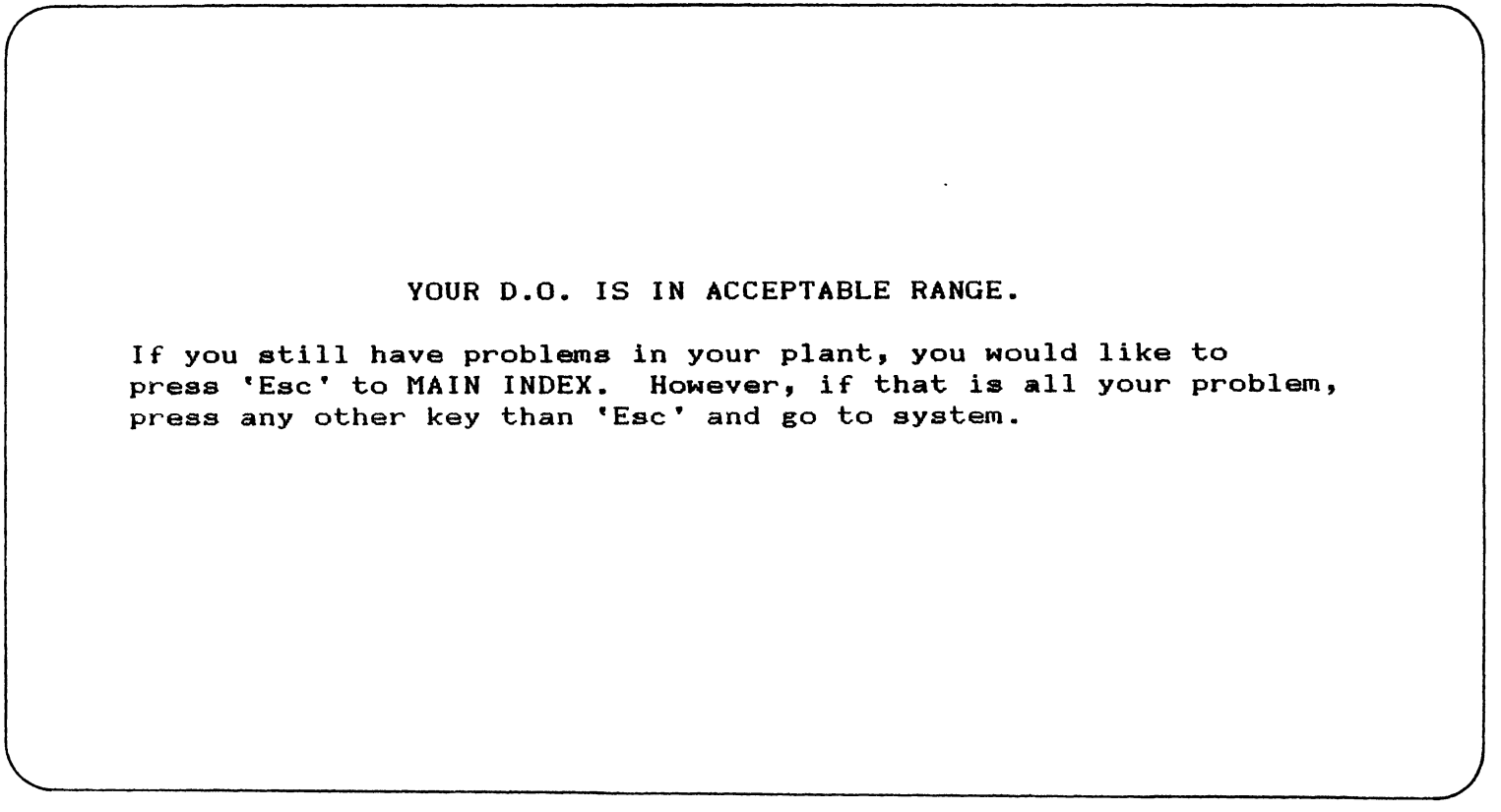

Figure 13. Acceptable Range (1 < D.O. < 3 mg/l)

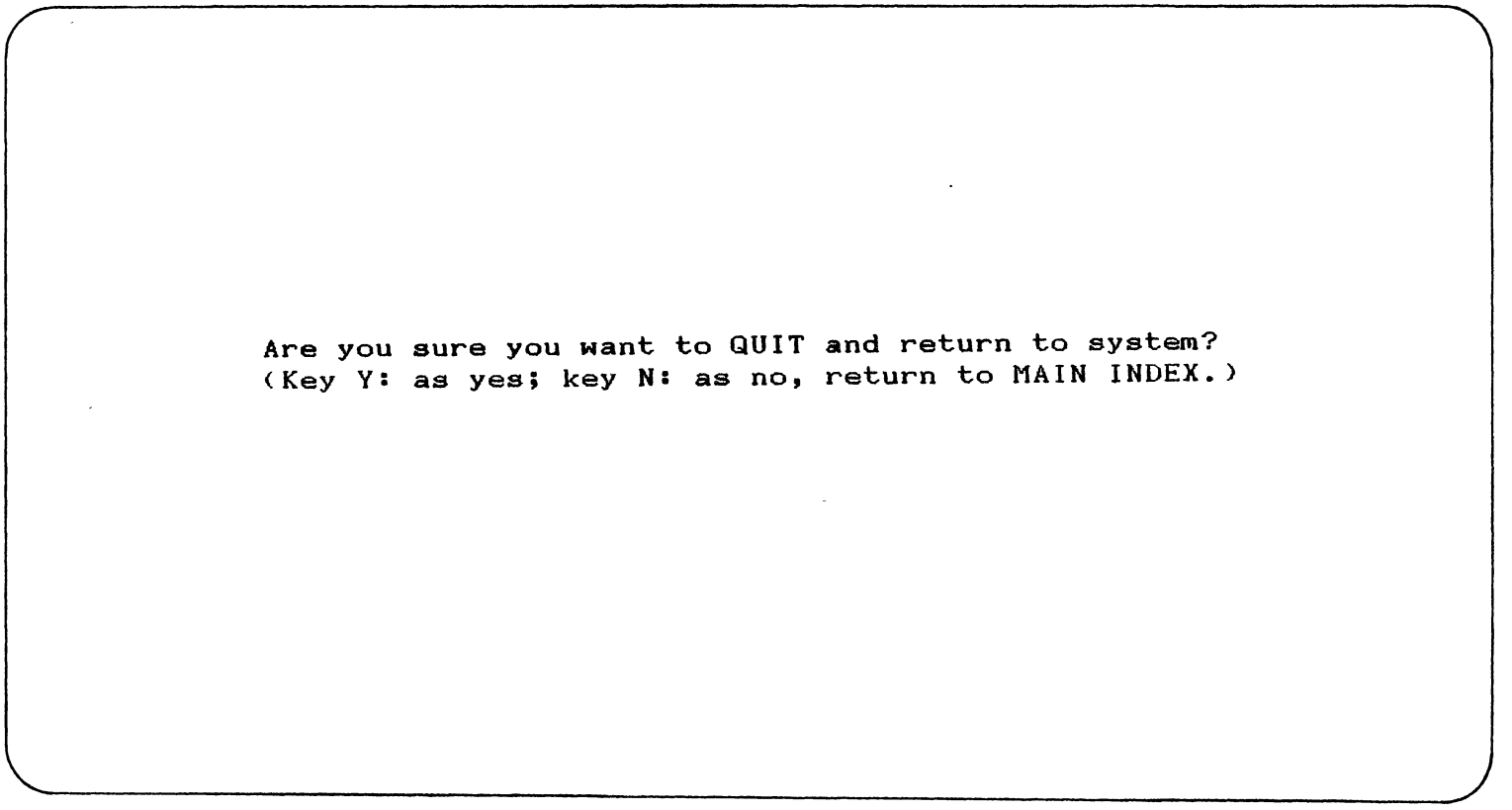

Figure 14. Double Check of "QUIT"

TROUBLE SHOOTING GUIDE NO.2 - FOAMING PROBLEMS

What Obervation Do You See in Your Aeration Tanks?

1. White, thick, billowing or sudsy foam on aeration tank surface.

2. Shiny, dark-tan foam on aeration tank surface.

3. Thick, scummy dark-tan foam on aeration tank surface.

4. Dark-brown, almost blackish sudsy foam on aeration tank surface. Mixed liquor color is very dark-brown to almost black. Detection of septic or sour odor from aeration tank.

(Press key number that matches your problem and continues or press 'Esc'to return to MAIN INDEX.)

Figure 15. Problem #2, Observation #1, Probable Cause #1

PROBABLE CAUSE

1. Overloaded aeration tank(low MLSS) due to process start-up. Do not be alarmed, this problem usually occurs during process star-up.

2. Excessive sludge wasting from process causing overloaded aeration tank(low MLSS).

3. Highly toxic waste, such as metals or bacteriocide, or colder wastewater temperatures, or severe temperature variations resulting in reduction of MLSS

4. Hydraulic washout of solids from secondary clarifier.

5. Improper influent wastewater and/or RAS flow distribution causing foaming in one or more aeration tanks.

(Press key number that matches your problem and continues or press 'Esc' to return to Troubleshooting No. 2.)

Figure 15. (Continued)

```
NECESSARY CHECK - overloaded aeration tank usually due to process start-up

   Check aeration tank BOD loading and MLVSS in aeration tank.

   (Press 'Esc' to return to PROBABLE CAUSE, or press any other key
    than 'Esc' to continue.)

DATA NEEDED - for checking F/M ratio.

   The default value will be ZERO, if you do not input any data.

   Input number of aeration basin? 1
   Input influent BOD (in mg/l)? 100
   Input influent flow rate (in MGD)? 7.5
   Input MLSS of aeration basin (in mg/l)? 2000
   Input volumn of aeration basin ( in MG)? 1.26

RESULT

   F/M ratio =  .2976191    (Press any key to continue.)
```

Figure 15. (Continued)

IT IS NOT A PROBLEM.

press 'Esc' key to go to MAIN INDEX, or any other key to go back to PROBABLE CAUSE again.

Figure 15. (Continued)

```
NECESSARY CHECK - overloaded aeration tank usually due to process start-up

   Check aeration tank BOD loading and MLVSS in aeration tank.

   (Press 'Esc' to return to PROBABLE CAUSE, or press any other key
    than 'Esc' to continue.)

DATA NEEDED - for checking F/M ratio.

   The default value will be ZERO, if you do not input any data.

   Input number of aeration basin? 1
   Input influent BOD (in mg/l)? 200
   Input influent flow rate (in MGD)? 7.5
   Input MLSS of aeration basin (in mg/l)? 1000
   Input volumn of aeration basin ( in MG)? 1.26

RESULT

   F/M ratio =  1.190476    (Press any key to continue.)
```

Figure 15. (Continued)

REMEDY - for overloaded aeration tank

1. Do not waste sludge from the process or maintain the minimum WAS rate possible if wasting has already started.

2. Maintain sufficient RAS rates to minimize solids carryover especially during peak flow periods.

3. Try to maintain D.O. levels between 1.0 to 3.0 mg/l. Also be sure that adequate mixing is being provided in the aeration tank while attempting to maintain D.O. levels.

(Press key Q to QUIT, or any other key than key Q to go to MAIN INDEX.)

Figure 15. (Continued)

TROUBLE SHOOTING GUIDE NO. 3 - SOLIDS WASHOUT/BILLOWING SOLIDS

What Obervation Do You See in Your Seconary Clarifier(s)?

1. Locilized clouds of homogenous sludge solids rising in certain areas of the clarifier. Mixed liquor in settleability test settles fairly on the surface and discharging over the weirs. Mixed liquor in

2. Localized clouds of fluffy homogenous sludge rising in certain areas of the clarifier. Mixed liquor in settleability test settles slowly, leaving stragglers in supernatant.

(Press key number that matches your problem and continues or press 'Esc' to return to MAIN INDEX.)

Figure 16. Problem #3, Observation #1, Probable Cause #1 Necessary Check #1

PROBABLE CAUSE

1. Equipment malfunction.

2. Air or gas entrapment in sludge floc or denitrification occuring.

3. Temperature currents.

4. Soilds washout due to hydraulic overloading.

5. Soilds washout due to solids overloading.

(Press any key number that matches your problem and continues or press 'Esc' to return to 'Troubleshooting No. 3'.)

Figure 16. (Continued)

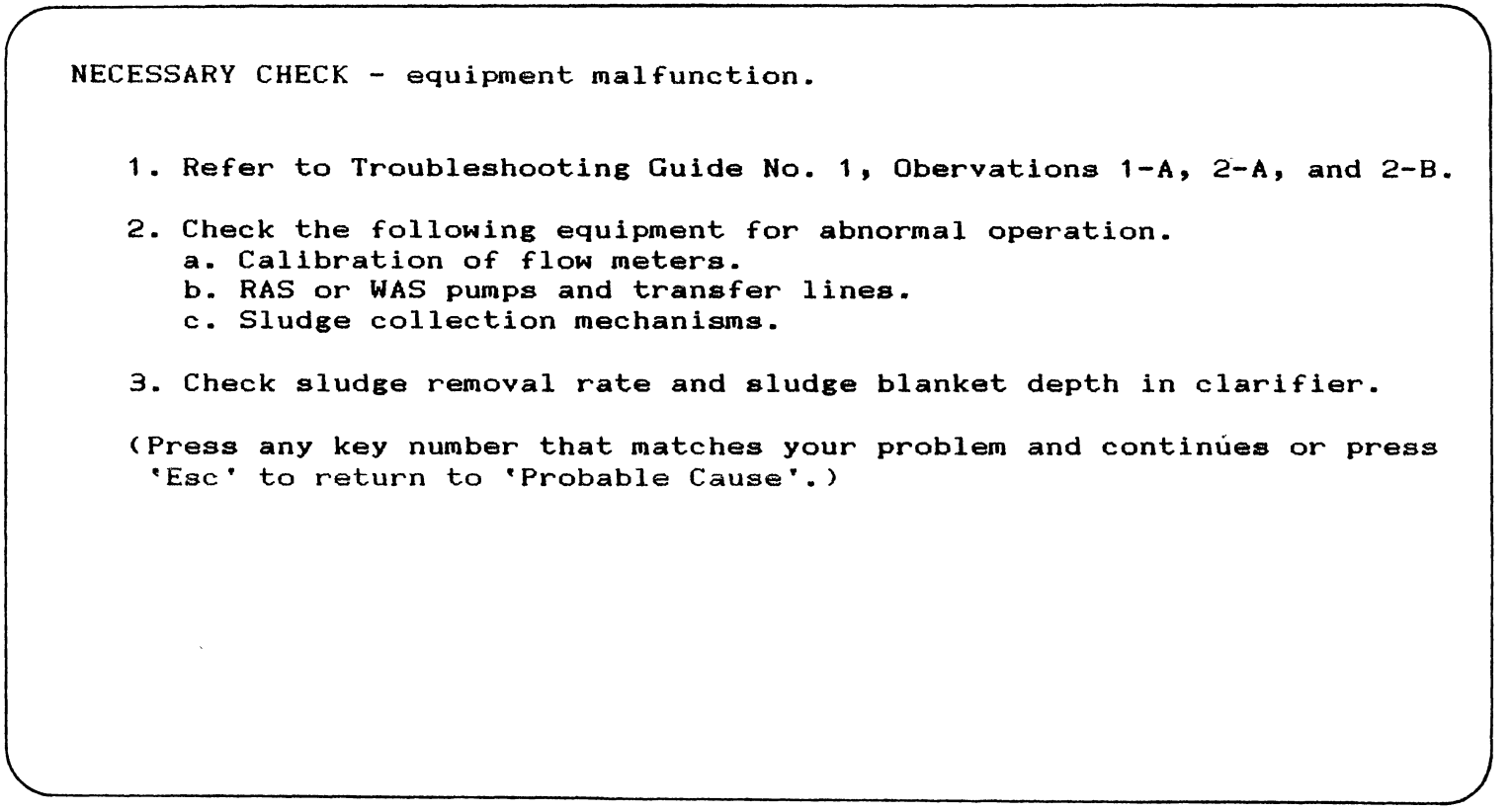

Figure 16. (Continued)

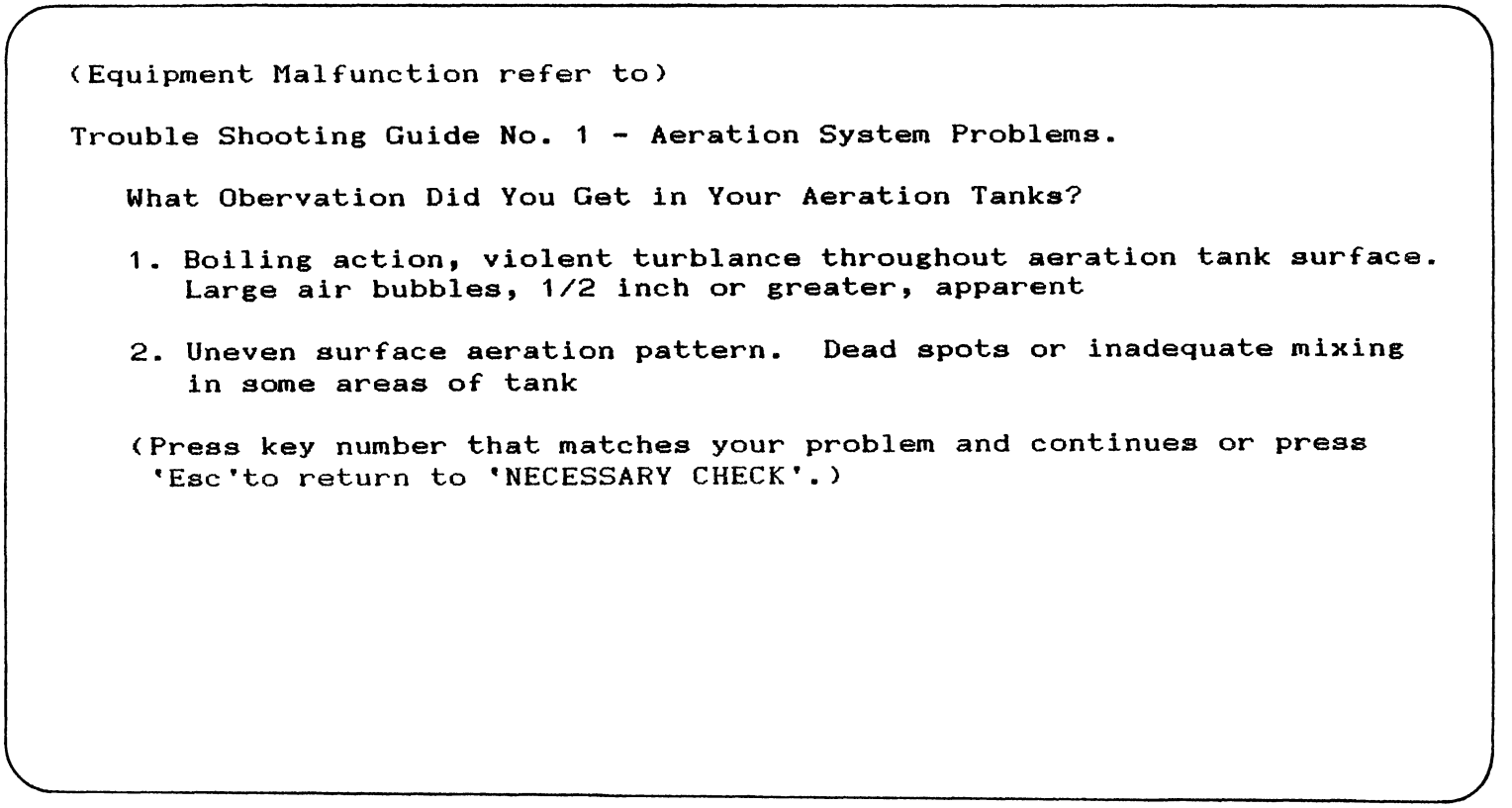

Figure 16. (Continued)

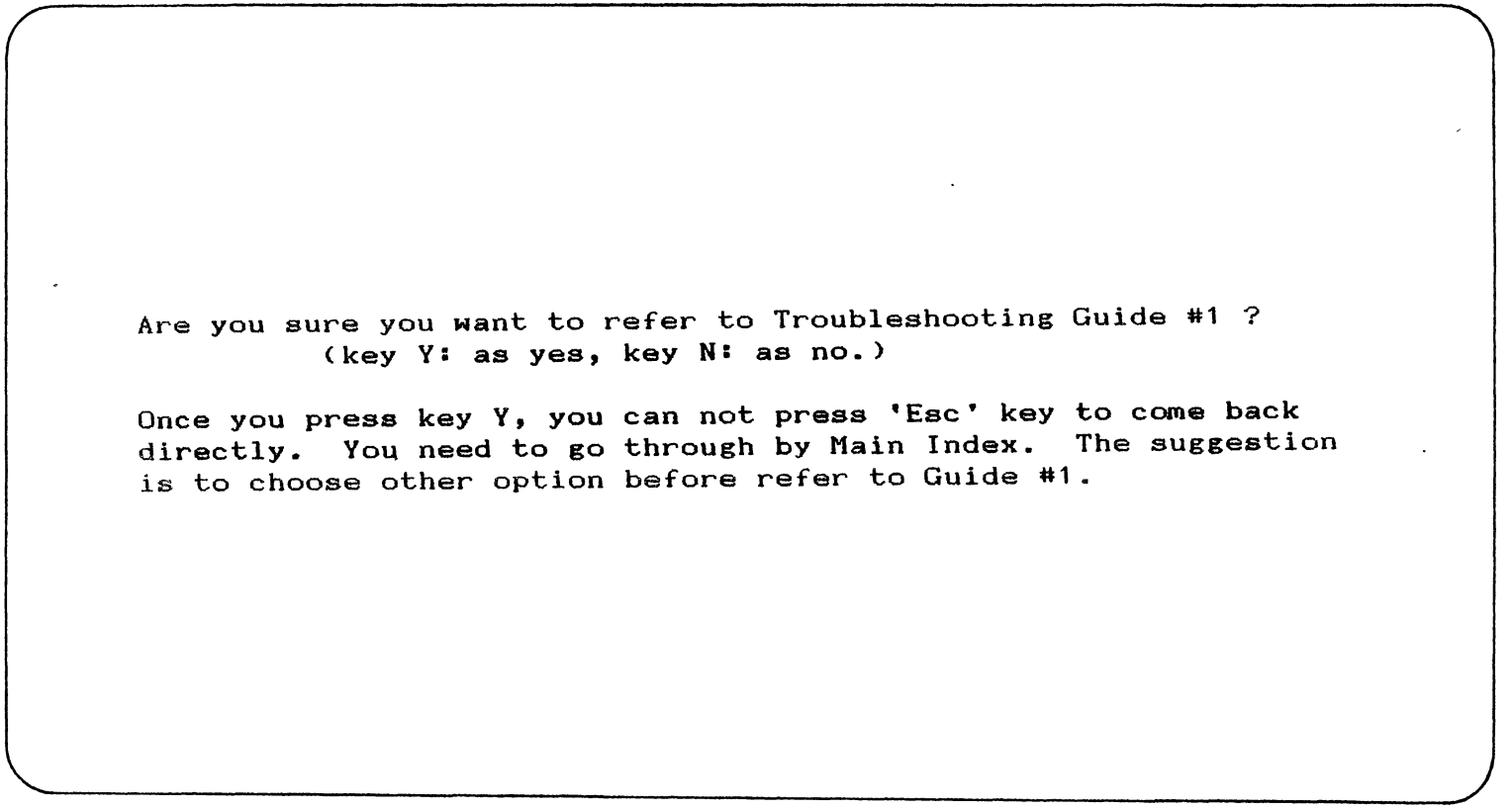

Figure 16. (Continued)

TROUBLE SHOOTING GUIDE NO. 4 - BULKING SLUDGE

Do You See the obervation described below in Your Seconary Clarifiers?

Clouds of billowing homogenous sludge rising and extending throughout the clarifier tank. Mixed liquor settles slowly and compacts poorly in settleability test, but supernatant is fairly clear.

(Key B: Appendix B - Sludge Volumn Index.(Settleability test.)
Key 'Esc': return back to MAIN INDEX.
other key than key B & key 'Esc': to continue.)

PREEQUIRED INFORMATION

Perform microscopic examination of mixeded liquor and return sludge. If possible, try to identify type of filamentous organisms, either fungal or bacterial.

Does your plant have filamentous organisms? (Key Y: as yes, key N: as no.)

Figure 17. Problem #4, Observation, Probable Cause #1

PROBABLE CAUSE - for having filamentous organisms.

1. Low D.O. in aeration tank.

2. Wastewater nutrient deficiencies.

3. pH in aeration tank is less than 6.5

4. Massive filamentous organisms.

(Press any key number that matches your problem and continues or press 'Esc' to return to 'Troubleshooting No. 4'.)

Figure 17. (Continued)

NECESSARY CHECK - Low D.O. in aeration tank.

If the average D.O. is less than 1 mg/l, there is insufficient dissolved oxygen in the aeration tank.

DATA NEEDED - grabing samples at various locations & depths during peak flow conditions.

(The default value for D.O. will be zero. Use D.O. unit in mg/l.)

Input D.O. on the left side of aeration tank at 0.5 foot depth? 4
Input D.O. on the left side of aeration tank at 1 foot depth? 5
Input D.O. on the front side of aeration tank at 1.5 foot depth? 4
Input D.O. on the rear side of aeration tank at 2 foot depth? 4

Do you want to reinput your data? (key Y: as yes, key N: as no.)

In this situtaion, it is doubtful to get overaeration.
Please press any key to check D.O. again.

Figure 17. (Continued)

TWO OPTIONS:

1. Decrease the air flow rate until the D.O. levels to 1 to 3 mg/l throughout the tank.

2. Go to MAIN INDEX to choose other option.

Figure 17. (Continued)

```
NECESSARY CHECK - Low D.O. in aeration tank.

   If the average D.O. is less than 1 mg/l, there is insufficient
   dissolved oxygen in the aeration tank.


DATA NEEDED - grabing samples at various locations & depths during
              peak flow conditions.

   (The default value for D.O. will be zero.  Use D.O. unit in mg/l.)

   Input D.O. on the left side of aeration tank at 0.5 foot depth? 4
   Input D.O. on the left side of aeration tank at 1 foot depth? 2
   Input D.O. on the front side of aeration tank at 1.5 foot depth? 2
   Input D.O. on the rear side of aeration tank at 2 foot depth? .7

   Do you want to reinput your data? (key Y: as yes, key N: as no.)
```

Figure 17. (Continued)

REMEDY - D.O. levels are very low, but are higher in other locations.

1. If the air distribution system is out of balance, try to balance it.

2. If your plant use diffusers, it may need to be clean.

(Press key Q to QUIT, or any other key than key Q to go to MAIN INDEX.)

Figure 17. (Continued)

```
NECESSARY CHECK - Low D.O. in aeration tank.

   If the average D.O. is less than 1 mg/l, there is insufficient
   dissolved oxygen in the aeration tank.


DATA NEEDED - grabing samples at various locations & depths during
              peak flow conditions.

   (The default value for D.O. will be zero.  Use D.O. unit in mg/l.)

   Input D.O. on the left side of aeration tank at 0.5 foot depth? .8
   Input D.O. on the left side of aeration tank at 1 foot depth? .5
   Input D.O. on the front side of aeration tank at 1.5 foot depth? .5
   Input D.O. on the rear side of aeration tank at 2 foot depth? .7

   Do you want to reinput your data? (key Y: as yes, key N: as no.)
```

Figure 17. (Continued)

```
REMEDY - for underaeration.

   Input the air flow rate (SCFM) ? 3

   If your D.O. is much lower than 1 mg/l, you would like to
   increase air flow rate 30% or 40%.  However, if your D.O. is
   little lower, you will prefer to adjust 10% or 20% increasing.

       Increase air flow rate 10% to **3.3
       Increase air flow rate 20% to **3.6
       Increase air flow rate 30% to **3.9
       Increase air flow rate 40% to **4.2

   In 3 hours, go and check D.O. again.(Press any key to continue.)
```

Figure 17. (Continued)

NECESSARY CHECK - Low D.O. in aeration tank.

If the average D.O. is less than 1 mg/l, there is insufficient dissolved oxygen in the aeration tank.

DATA NEEDED - grabing samples at various locations & depths during peak flow conditions.

(The default value for D.O. will be zero. Use D.O. unit in mg/l.)

Input D.O. on the left side of aeration tank at 0.5 foot depth? 3
Input D.O. on the left side of aeration tank at 1 foot depth? 4
Input D.O. on the front side of aeration tank at 1.5 foot depth? 3
Input D.O. on the rear side of aeration tank at 2 foot depth? 4

Do you want to reinput your data? (key Y: as yes, key N: as no.)

Figure 17. (Continued)

```
REMEDY - for overaeration.

   Input the air flow rate (SCFM) ? 4.2

   If your D.O. is much higher than 3 mg/l, you would like to
   adjust 30% or 40% off.  However, if your D.O. is little higher,
   you will prefer to decrease 10% or 20%.

       Decrease air flow rate 10% to **3.8
       Decrease air flow rate 20% to **3.4
       Decrease air flow rate 30% to **2.9
       Decrease air flow rate 40% to **2.5

   In 3 hours, go and check D.O. again. (Press any key to continue.)
```

Figure 17. (Continued)

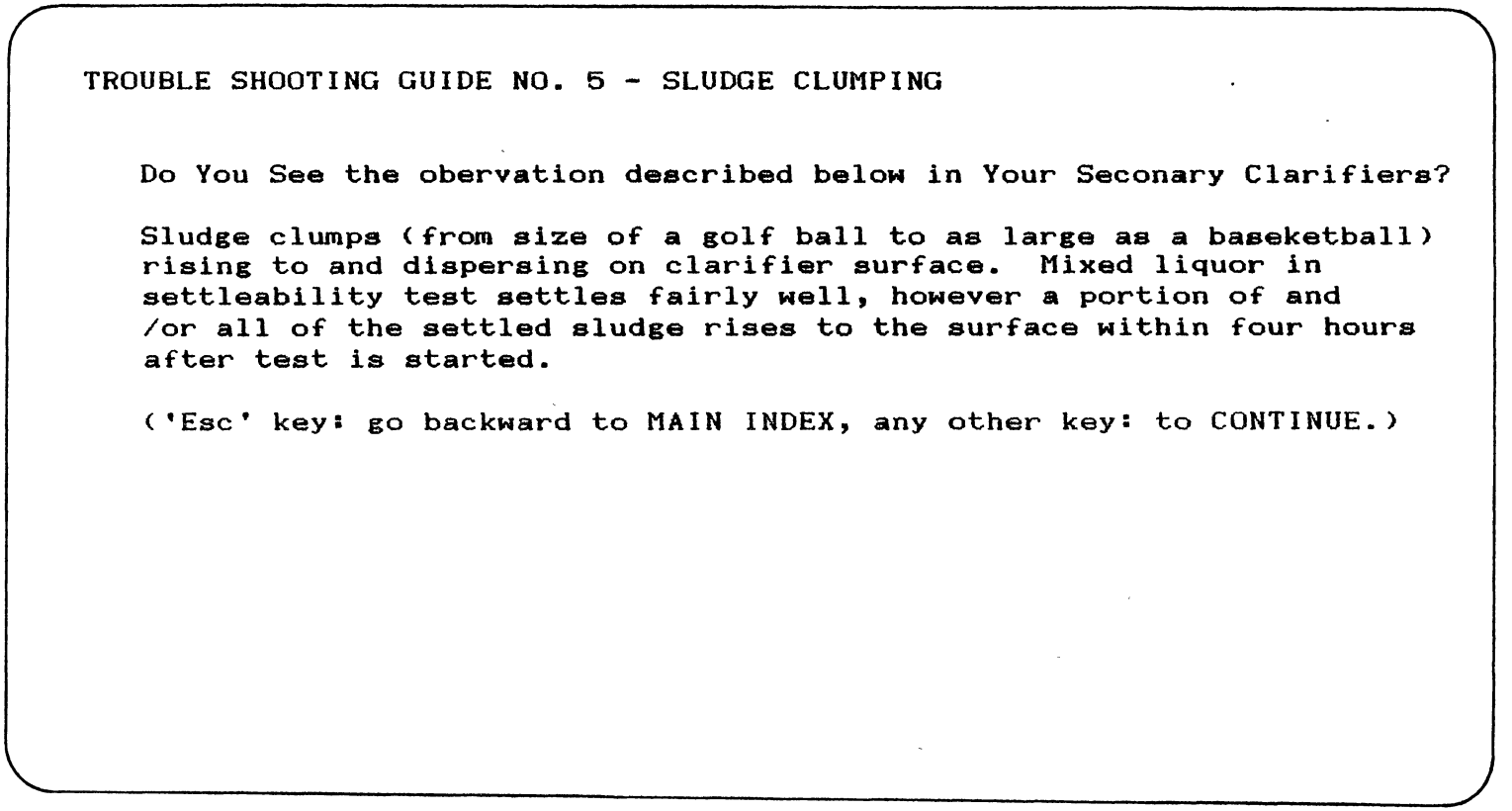

Figure 18. Problem #5, Observation, Probable Cause #1

PROBABLE CAUSE

1. Denitrification in clarifier.

2. Septicity occuring in clarifier.

3. Hydrogen sulfide is produced in the clarifier.

(Press any key number that matches your problem and continues or press 'Esc' to return to 'Troubleshooting No. 5'.)

Figure 18. (Continued)

NECESSARY CHECK - denitrification in clarifier.

Check for decrease in secondary effluent nitrate level.
('Esc' key: go backward, any other key: to continue.)

DATA NEEDED

The default values will be zero if you do not input any data.

Input influent TKN of secondary clarifier (mg/l)? 3
Input effluent TKN of secondary clarifier (mg/l)? 1

Do you want to reinput your data? (key Y: as yes, key N: as no.)

RESULT

The nitrate concentration is decreasing in secondary calrifier, so the process is denitrifying. Please press any key to continue.

Figure 18. (Continued)

```
NECESSARY CHECK - denitrification in clarifier.

   Check for decrease in secondary effluent nitrate level.
   ('Esc' key: go backward, any other key: to continue.)


DATA NEEDED

   The default values will be zero if you do not input any data.

   Input influent TKN of secondary clarifier (mg/l)? 3
   Input effluent TKN of secondary clarifier (mg/l)? 3

   Do you want to reinput your data? (key Y: as yes, key N: as no.)

RESULT

   It is not denitrification problem, so you need to go back to MAIN INDEX
   and choose other option.  Please press any key to go back.
```

Figure 18. (Continued)

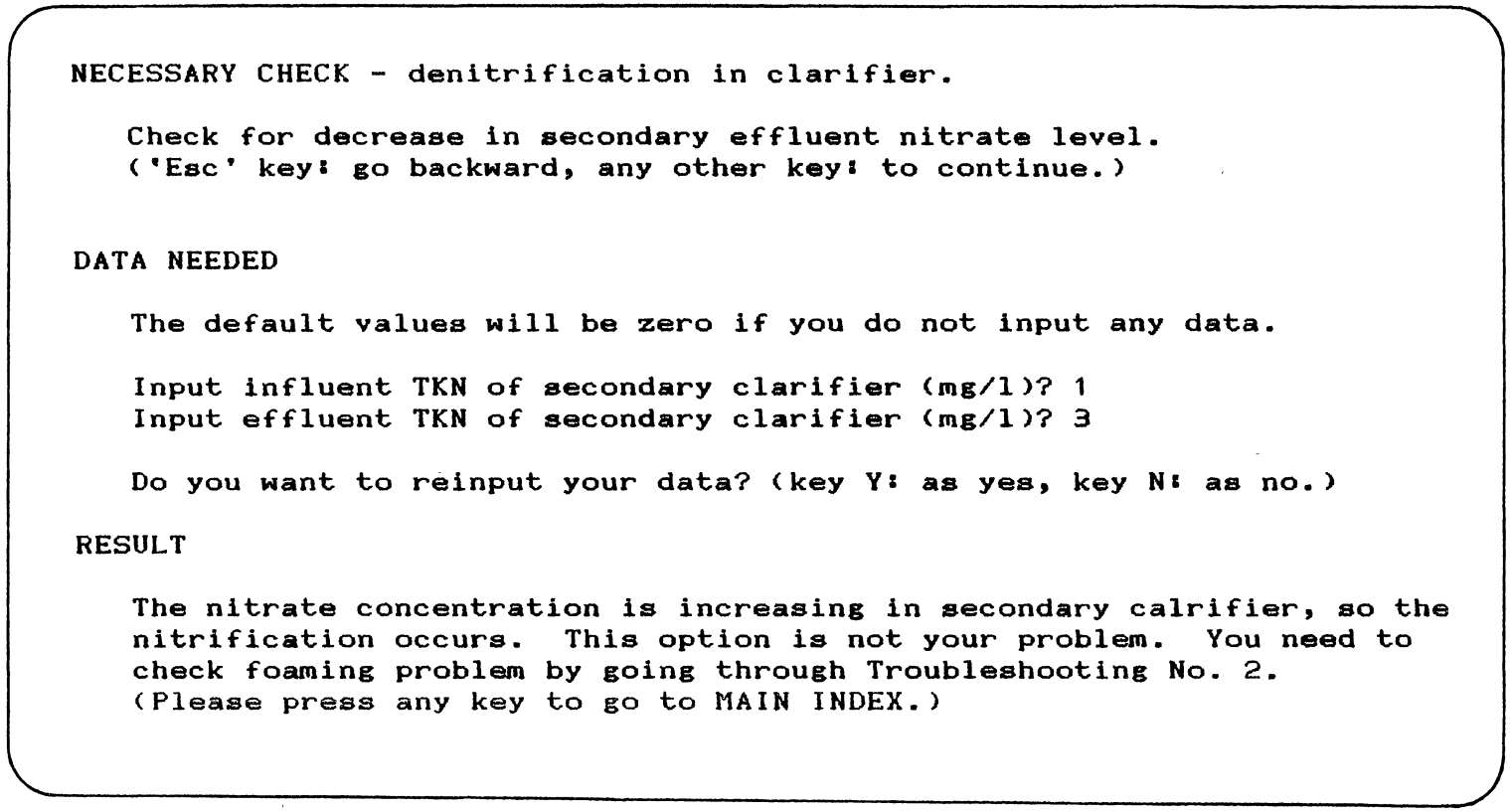

Figure 18. (Continued)

NECESSARY CHECK - for gas bubbles in clarifier.

1. Check sludge holding time in secondary clarifier.

2. Check low D.O. below sludge blanket in secondary clarifier.

3. Check low F/M ratio in aeration tank.

(Press one key number that could be your plant's problem or press 'Esc' key to go backward.)

Figure 18. (Continued)

CHECK PROCEDURE - for sludge holding time.

1. Check RAS rates and sludge blanket depth in clarifier.

2. Check WAS rates. See whether it is waste properly.

3. Check secondary clrifier capacity was designed to handle sludge.

REMEDY

1. Adjust RAS rate to maintain sludge blanket depth of 1 to 3 feet in If the RAS is batch process, make sure not to hold sludge too long. clarifier(at least waste once every 4 hours).

2. Maintain WAS rates to keep process within proper SRT or F/M ratio.

3. If the sludge is overloading in clarifier, you need to report to your supervisor or hire engineer to add more clarifier.

(Key 'Esc': go backward. Key Q: quit. any other key: MAIN INDEX.)

Figure 18. (Continued)

DATA NEEDED - checking D.O.

The default value is ZERO, if you do not input any data.
Input D.O. measured below sludge blanket in secondary clarifier? .5

PROBABLE CAUSE - low D.O. below sludge blanket.

1. The sludge is being held too long in the clarifier and consequently all the available dissolved oxygen has been used by the micro-organisms. The return sludge should have a D.O. content of not less than 0.2 mg/l.

2. Higher than normal wastewater temperature resulting in a higher rate of microorganism activity which cause the process to nitrify at a higher F/M ratio. A higher rate of microorganism activity will also result in a faster depletion of the dissolved oxygen in the clarifier sludge and consequently a greater potential for septicity and denitrification.

(Key #1: sludge holding time. Key # 2: F/M ratio. Key Q: quit.
Key 'Esc': to go backward. Any other key: to go back to MAIN INDEX.)

Figure 18. (Continued)

```
DATA NEEDED - for checking F/M ratio in aeration basin.

   The default value for each datum is ZERO.

   Input number of aeration basin? 1
   Input volume of aeration basin (MG)? 1.26
   Input MLSS of aeration basin (mg/l)? 4000
   Input influent flow rate (MG)? 7.5
   Input influent BOD (mg/l)? 100

   Do you want to reinput your data? (Key Y: as yes, key N: as no.)


RESULT

   F/M ratio =    0.1
   (Please press any key to continue.)
```

Figure 18. (Continued)

REMEDY - for low F/M ratio in aeration basin.

Increase WAS rate by not more than 10% per day to reduce or eliminate level of nitrification. If nitrification is required, reduce to allowable mimimum.

(Key Q: to QUIT, or any other key than key Q: to go to MAIN INDEX.)

Figure 18. (Continued)

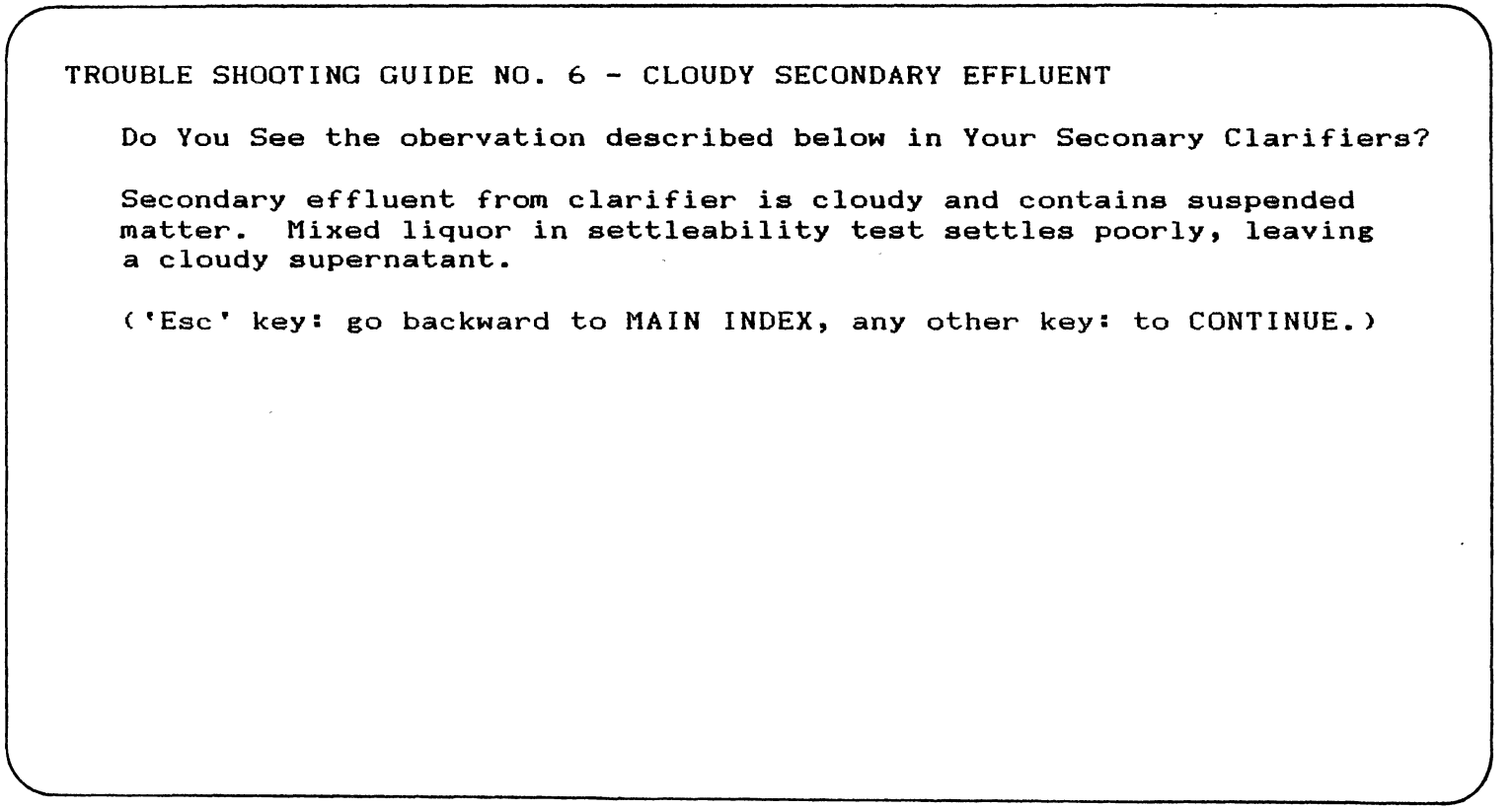

Figure 19. Problem #6, Observation, Probable Cause #1

PROBABLE CAUSE - cloudy secondary effluent.

1. MLSS in aeration tank low due to process start-up.

2. Increase in organic loading.

3. Toxic shock loading.

4. Improper D.O. levels in aeration tank.

(Press number key that matches your problem, or press 'Esc' key to return to go backward to 'Troubleshooting No. 6'.)

Figure 19. (Continued)

PREREQUIRED INFORMATION - MLSS in aeration tank low due to process start-up.

Since you choose this option, it is better to make sure that your plant do have this problem. Do you get white, thick, billowing or sudsy foam on aeration tank surface? (Key Y: as yes, key N: as no.).

NECESSARY CHECK - overloaded aeration tank usually due to process start-up.

Check aeration tank BOD loading and MLVSS in aeration tank.

(Press 'Esc' key to return to PROBABLE CAUSE, or press any other key than 'Esc' to continue.)

Figure 19. (Continued)

```
DATA NEEDED (for checking F/M ratio) - Number of aeration basin, BOD
          & flow rate of influent, and MLSS & volume of aeration basin.

   The default value will be ZERO, if you do not input any data.

   Input number of aeration basin? 1
   Input influent BOD (mg/l)? 100
   Input influent flow rate (MGD)? 7.5
   Input MLSS of aeration basin (mg/l)? 500
   Input volume of aeration basin (MG)? 1.26

   Do you want to reinput your data? (Key Y: as yes, key N: as no.)

RESULT

   F/M ratio =  1.190476      (Press any key to continue.)
```

Figure 19. (Continued)

REMEDY - for overloaded aeration tank.

1. Do not waste sludge from the process or maintain the minimum WAS rate possible if wasting has already started.

2. Maintain sufficient RAS rates to minimize solids carryover especially during peak flow periods.

3. Try to maintain D.O. levels between 1.0 to 3.0 mg/l. Also be sure that adequate mixing is being provided in the aeration tank while attempting to maintain D.O. levels.

(Key Q: to QUIT, or any other key than key Q: to go to MAIN INDEX.)

Figure 19. (Continued)

TROUBLE SHOOTING GUIDE NO. 7 - ASHING AND PINPOINT/STRAGGLER FLOC

What Obervation Do You See in Your Seconary Clarifiers?

1. Fine dispersed floc (about the size of a pinhead) extending throughout the clarifier with little islands of sludge accumulated settleability test, settles fairly well. Sludge is dense at bottom with fine particles of floc suspended in fairly clear supernatant.

2. Small particles of ash-like material floating on clarifier surface.

3. Particles of straggler floc about 1/4 inch or larger, extending throughout the clarifier and dischargeing over the weirs. Mixed liquor in settleability test, settles fairly well. Sludge does not compact well at the bottom with chunks of floc suspended in fairly clear suspernatant.

(Press key number that matches your problem and continues or press 'Esc' to return to MAIN INDEX.)

Figure 20. Problem #7, Observation #1

```
PROBABLE CAUSE

   Aeration tank approaching underloaded conditions (High MLSS) because
   of old sludge system.

   (Press any other key than 'Esc' to continue or press 'Esc' key to
    return to 'Troubleshooting Guide No. 7'.)


NECESSARY CHECK - for decreasing F/M loading.

   The default value will be ZERO, if you do not input any data.

   Current Data:

   Input flow rate of aeration tank (MGD)? 7.5
   Input influent BOD of aeration tank (mg/l)? 100
   Input volume of aeration tank (MG)? 1.26
   Input MLSS of aeration tank (mg/l)? 2000

   Do you want to reinput your data? (Key Y: as yes, key N: as no.)
```

Figure 20. (Continued)

```
PROBABLE CAUSE

   Aeration tank approaching underloaded conditions (High MLSS) because
   of old sludge system.

   (Press any other key than 'Esc' to continue or press 'Esc' key to
    return to 'Troubleshooting Guide No. 7'.)


NECESSARY CHECK - for decreasing F/M loading.

   The default value will be ZERO, if you do not input any data.

   The Satisfactory Period's Data

   Input flow rate of aeration tank (MGD)? 7.5
   Input influent BOD of aeration tank (mg/l)? 100
   Input MLSS of aeration tank (mg/l)? 3000

   Do you want to reinput your data? (Key Y: as yes, key N: as no.)
```

Figure 20. (Continued)

```
DERIVE INFORMAITON - from the input data.

   Current food                                =  750   lbs of BOD
   The satisfactory period's food              =  750   lbs of BOD

   Current microorganism                       =  2520   lbs of MLSS
   The satisfactory period's microorganism     =  3780   lbs of MLSS

   Current F/M ratio                           =  .2976191
   The satisfactory period's F/M ratio         =  .1984127


RESULT

   The F/M ratio is not decreasing. (Please press any key to continue.)
```

Figure 20. (Continued)

IT IS NOT A PROBLEM.

Press 'Esc' key to go to MAIN INDEX, or any other key to go back to PROBABLE CAUSE again.

Figure 20. (Conitnued)

PROBABLE CAUSE

Aeration tank approaching underloaded conditions (High MLSS) because of old sludge system.

(Press any other key than 'Esc' to continue or press 'Esc' key to return to 'Troubleshooting Guide No. 7'.)

NECESSARY CHECK - for decreasing F/M loading.

The default value will be ZERO, if you do not input any data.

Current Data:

Input flow rate of aeration tank (MGD)? 7.5
Input influent BOD of aeration tank (mg/l)? 100
Input volume of aeration tank (MG)? 1.26
Input MLSS of aeration tank (mg/l)? 3000

Do you want to reinput your data? (Key Y: as yes, key N: as no.)

Figure 20. (Continued)

```
PROBABLE CAUSE

   Aeration tank approaching underloaded conditions (High MLSS) because
   of old sludge system.

   (Press any other key than 'Esc' to continue or press 'Esc' key to
    return to 'Troubleshooting Guide No. 7'.)


NECESSARY CHECK - for decreasing F/M loading.

   The default value will be ZERO, if you do not input any data.

   The Satisfactory Period's Data

   Input flow rate of aeration tank (MGD)? 7.5
   Input influent BOD of aeration tank (mg/l)? 100
   Input MLSS of aeration tank (mg/l)? 2000

   Do you want to reinput your data? (Key Y: as yes, key N: as no.)
```

Figure 20. (Continued)

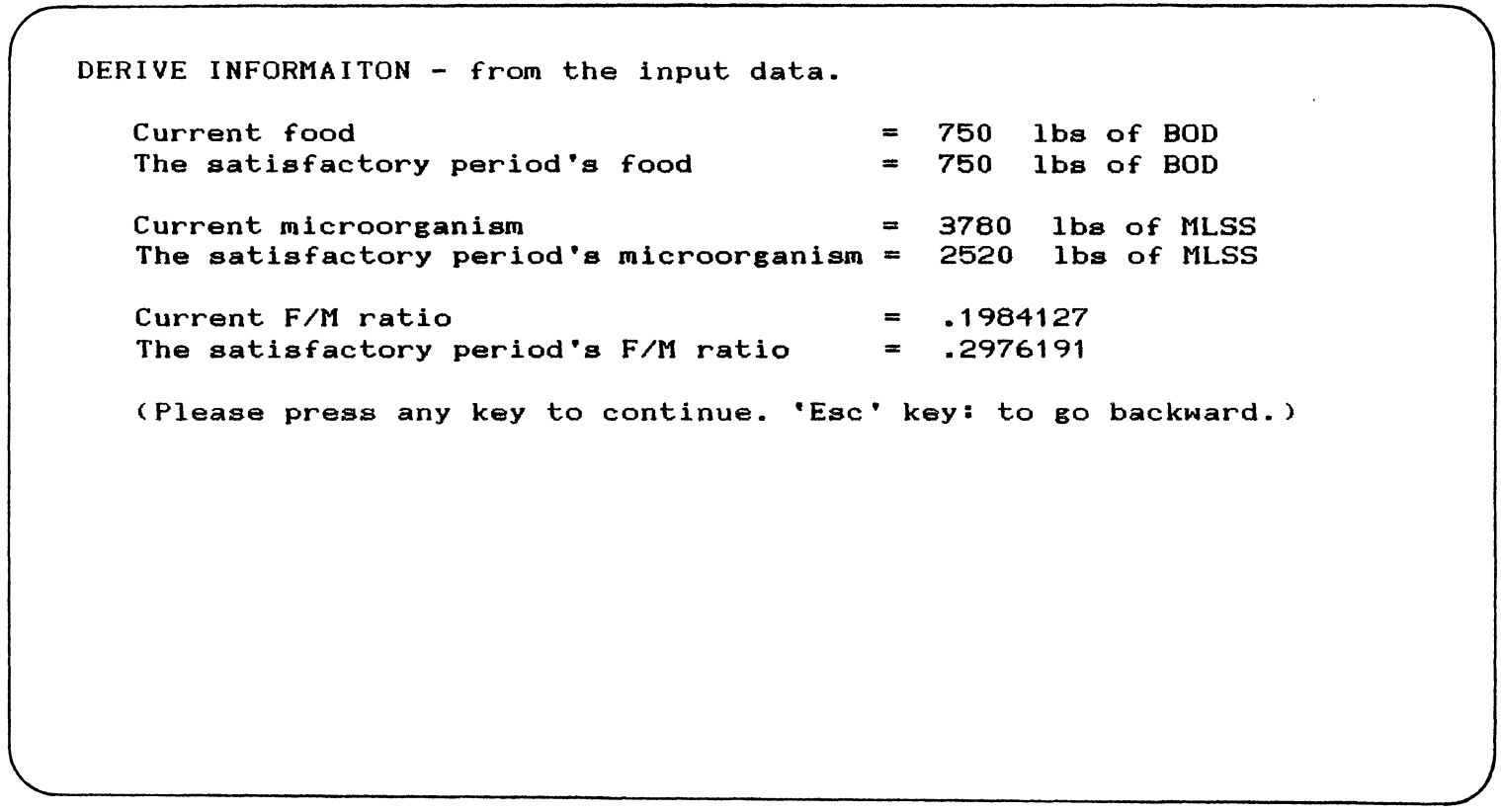

Figure 20. (Continued)

RESULT - decreasing F/M ratio.

The MLSS is too high for the organic loading. Old sludge could cause the settleing problem.

REMEDY - for having too much MLSS.

Increase WAS rates by not more than 10% per day to bring process back to optimum control parameters for average organic loaing.

('Esc' key: go backward. Key Q: to QUIT, or any other key: MAIN INDEX.)

Figure 20. (Continued)

TROUBLE SHOOTING GUIDE NO. 8 - EFFLUENT DOES NOT MEET CRITERIA

Desired Plant Control Method Based On:

1. Constant F/M.

2. Constant Gould Sludge Age.

3. Constant Sludge Retention Time.

4. Kincannon & Stover Model.

(Press one key number matching your plant's control method,
or press 'Esc' key to go backward to MAIN INDEX.)

PROBABLE CAUSE

The MLSS & WAS were not controlled properly.

('Esc' key: to go backward, or other keys: to continue.)

Figure 21. Problem #8, Method #1

```
RESULT - for desired F/M being equal to  .29

   Required MLVSS =    21569 lbs
   Required MLSS  =     2932 mg/l
   WAS flow rate  =    0.159 mgd (assume WAS is from RAS system.)


FURTHER INFORMATION

   The required MLSS concentration is in reasonable range.


PREDICTION - based on Kincannon & Stover model.

   Theoretical effluent BOD =     7 mg/l

   (Key Q: to QUIT, or any other key than key Q: to go to MAIN INDEX.)
```

Figure 21. (Continued)

TYPICAL RANGES FOR F/M LOADINGS

	Conventional AS Range F/M	Extended Aeration F/M	High Rate Range F/M
BOD	0.1 to 0.5	0.05 to 0.1	0.5 to 2.5

DATA REQUIRED - (The default values will be ZERO.)

```
Input desired F/M ? 0.29
Input influent BOD concentration of aeration tank (mg/l) ? 100
Input influent flow rate of aeration tank (mgd) ? 7.5
Input aeration tank volume (mg) ? 1.26
Input the percent of MLVSS in MLSS ? 70
Input MLSS concentration in aeration tank (mg/l) ? 3000
Input RAS concentration (mg/l) ? 7500

Do you want to reinput your data? (Key Y: as yes, key N: as no.)
```

Figure 21. (Continued)

CHAPTER V

DISCUSSION

The program has been developed for use on an IBM personal computer due to its availability. BASICA language for used because it is easy to be designed and tested interactively on the screen. The program need not to be complied whenever any change is being made in the satatements. Since this troubleshooting guide does not have a great amount of calculations, the excutional process is still considerably fast. Compared with FORTRAN language, the BASICA is more convenient for interactive operation, so BASICA is preferable.

The program is user friendly and therefore should be useable by most wastewater treatment plant operators. It provides a means of giving an operator suggested remedies to operational problems. Currently, this type of applicational program is not readily available to the plant operators; thus, this program can be very beneficial to the improved performance of activated sludge wastewater treatment plants.

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