Research and Development Technical Report

ECOM-4382

# OPERATIONAL PROCEDURES FOR OPTIMIZED RELIABILITY AND COMPONENT LIFE ESTIMATOR (ORACLE)

Jerry Kastning
Product Assurance Directorate

December 1975



DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

**ECOM**

US ARMY ELECTRONICS COMMAND FORT MONMOUTH, NEW JERSEY 07703

## NOTICES

### Disclaimers

The findings of this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

The citation of trade names and names of manufacturers in this report is not to be construed as official Government indorsement or approval of commercial products or services referenced herein.

### Disposition

Destroy this report when it is no longer needed. Do not return to the originator.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|---|---|
| 1. REPORT NUMBER<br>ECOM-4382 | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle)<br>Operational Procedures for Optimized Reliability and Component Life Estimator (ORACLE). | | 5. TYPE OF REPORT & PERIOD COVERED<br>Final Report |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s)<br>Jerry Kastning | | 8. CONTRACT OR GRANT NUMBER(s) |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Product Assurance Directorate<br>Reliability/Maintainability Division<br>US Army Electronics Command, Ft. Monmouth, NJ 07703 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS<br>~~5799.00.00.110.0000~~ TCEZZ6 |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>Reliability/Maintainability Division<br>Advanced Methodology Branch<br>ATTN: AMSEL-PA-RAM | | 12. REPORT DATE<br>Dec[redacted]975 |
| | | 13. NUMBER OF PAGES<br>73 |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) | | 15. SECURITY CLASS. (of this report)<br>UNCLASSIFIED |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; Distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

(1) Failure-Rate, (2) Cost-Analysis, (3) Component-Reliability, (4) Data Base, (5) Reliability, (6) Tradeoffs, (7) Predictions, (8) MIL-HDBK-217B, (9) MTBF (Mean-Time-Between-Failure), (10) Estimations

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Optimized Reliability And Component Life Estimator (ORACLE) is a software program which determines the failure rate of integrated circuits, discrete semiconductors, capacitors, resistors and inductors. In determining individual component failure rates, ORACLE follows the procedures prescribed in MIL-HDBK-217B. Thus ORACLE eliminates the most tedious parts of producing a reliability analysis for military equipment; namely, the looking up of the myriad of individual component parameters and formulas needed to determine component failure rates. The data base is restricted to components with a (Cont)

DD FORM 1473, 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

037 620

~~20. Abstract (Cont)~~ > military part number. Those components currently found in the data base include integrated circuits, transistors, various types of diodes, capacitors, and inductors. Resistors, some styles of capacitors and some styles of inductors do not need to be in the data base as their individual part number contains enough information to allow ORACLE to decode and determine the failure rate without further information from a data base. ORACLE produces: (1) the total failure rate for a module (a set of related parts that together perform a specified function); (2) The MTBF for the module; (3) the price for each component if purchased in small quantities; and (4) the price for each component if purchased in quantities of 1000 or more. The component part input formats provide for the submission of component application dependent information such as the operating temperature, the operating environment, the component screening level, the duty cycle or usage, and other specific information uniquely applicable to each part. After an initial total failure rate has been determined for a set of parts one can then modify any or all of the application conditions under which the components were initially assigned to operate. The purpose of this procedure is to perform a tradeoff analysis. Thus within minutes one will know the effect on the module failure rate if, for example, the operating temperature is lowered by 10°C. ORACLE's tradeoff capability is a powerful attribute for reliability prediction analysis.

## Table of Contents



## ACKNOWLEDGMENT

The author would like to thank Messrs. S. Grubman, J. Hess, and M. Zsak for their thoughtful comments and suggestions leading to improvements in the presentation of the information. Many thanks are also extended to Mrs. P. Axtell for her generous assistance in my preparation of this manuscript. Her efforts were greatly appreciated.

ORACLE was designed and written under contract to the US Army at Fort Monmouth by W.W. Gaertner Research, Inc. of Stamford, Connecticut. The contractor's software project engineer on this contract was Mr. William Schreyer. A great deal of mutual coordination was conducted between the author and Mr. Schreyer in our efforts to eliminate all of the inadvertent "bugs" in ORACLE and to establish the final working version. Many thanks are extended to Mr. Schreyer for his cooperation in this effort.

## INTRODUCTION

### Objective and Capability

This paper describes the procedures and operations and the results of executing those procedures and operations on the Optimized Reliability And Component Life Estimator (ORACLE) software program. The operations described in this paper are based on the ORACLE program which has been installed on the CDC 6600 system located at the Picatinny Arsenal. This program is running under the Intercom 4.2 remote time-share software and the Scope 3.4.1 Operating System. However, even though ORACLE may be modified for execution on another system, the procedures and operations delineated herein will remain basically the same.

The general objective of ORACLE is to obtain the failure rate of individual parts or components, following the procedures prescribed in MIL-HDBK-217B.[1] Thus this program eliminates the most tedious parts of the reliability analysis, namely, the looking up of the individual component parameters and algorithms needed to determine the failure rate. Normally a group of parts or components which constitute a complete module will be entered into ORACLE simultaneously. Thus the summation of the individual component failure rates will allow ORACLE to also calculate the module's MTBF.

ORACLE will accept and calculate the failure rate for integrated circuits, transistors, a variety of diodes, thyristors, capacitors, inductors

[1]Military Standarization Handbook, Reliability Prediction of Electronic Equipment. MIL-HDBK-217B; 20 September 1974, Department of Defense.

and resistors. In order for the failure rate to be calculated for integrated circuits, transistors, and diodes their part number, etc., must be located in the data base. Resistors are not required to be in the data base, as the information given in each individual resistor part number is adequate for the program to determine the specific individual resistor failure rate. However, in entering the part number, one must follow the specific procedure described under "type designation" for each resistor as delineated in MIL-STD-199A. With the exception of four styles, capacitors are not required to be in the data base either. Consequently one must enter the capacitor part number using the methods described under "type designation" (sometimes referred to as "part number") in MIL-STD-198B. The exceptions are styles (Specification Number): CYR (MIL-C-23269), CSR (MIL-C-39003), CLR (MIL-C-39006), and CU (MIL-C-39018). In order to obtain a failure rate for each of these four styles their part number must be located in the data base. When this is the situation, a slightly different notation must be used when one enters any of these four capacitors into the input format. For example, the part number for a MIL-C-39003 must be entered as M39003/XX-XXXX. This notation, for the entry of the part number into the input format, is preferred for the CKR (MIL-C-39014) and the CHR (MIL-C-39022) styles of capacitor also. However, if this notation is used, then, in order to obtain a failure rate, these parts must also be found in the data base. With respect to inductors, the part number for the TF (MIL-T-27) style must be located in the data base if one is to obtain a failure rate. However, the part number of the LT (MIL-C-15305) and the TP (MIL-T-21038) styles of inductor contains sufficient information to determine the specific individual failure rate without residing in the data base.

In the near future ORACLE will also calculate the failure rate for hybrid devices, rotating devices, relays, switches, connectors, and miscellaneous parts. The miscellaneous items include tubes, lasers, quartz crystals, fuses, neon lamps, incandescent lamps, meters, wire wrap connections, and hand soldered connections. Until then the failure rate for these parts/ components must be calculated manually.

The specific results eminating from ORACLE are: (1) the total failure rate for each case; (2) the MTBF for each case; (3) the total component price in small quantities for each case; and (4) the total component price in quantities of 1000 for each case. (Note that "a case" refers to a group of parts or components that have been entered together and comprise a specific piece of equipment or module.) Other results emanating from ORACLE include a listing of each of the individual failure rates for each part and a listing of all of the parameters used in determining that failure rate (see Figures 8 and 9).

A great variety (more than 11,000) of parts can currently be found in the data base, however, these parts are restricted to those with military part numbers. The parts currently in the data base include integrated circuits, transistors, various types of diodes, capacitors and inductors. Those parts which are not in the data base can readily be added by following the procedure described in Appendix 5. It should also be noted that, at present, the pricing information, although provided for in the data base, is not included and must be entered on an individual basis. The cost information is entered in column 116 thru 127 of each of the formats used to enter information into the data base (see formats in Appendix 5).

(It will be noted and explained subsequently that one can only enter those ~~parts not found in the full data base and any pricing~~ information, after the BINNY routine has been run and that these entries must be made into the abstracted data base.) When the nouns "operator" or "user" are used in this paper, they are referring to the person who has entered the parts and is executing ORACLE.

## The Input Formats

All part information and external parameter data must be entered into the program in one of the prescribed input formats. These formats are apart from and completely different from the formats one uses to enter information into the data base. There is one input format for each of the following class of parts: integrated circuits, discrete semiconductors, resistors, capacitors, and inductors. Each of these formats is shown in Appendix 1. The first eleven columns of each of the input formats contain the same information for a group of parts which constitute a particular module or piece of equipment. Columns 2 thru 7 contain information on the Module Number, while columns 8 thru 11 could contain either the Module Part Number or a "quantity factor". (Column 1 is always left blank.) Thus, should one have a particular part which occurs a multiple number of times in the same module and has the same conditions (such as the operating temperature, operating environment, duty cycle, stress, screening level, etc.) placedupon it, one simply enters this part once and notes the number of multiple uses in Columns 8 thru 11. Quantities smaller than 1000 must be preceded by zeros or blanks. Whichever option is chosen, the user must be completely consistent with the information entered into columns 8 thru

11 for each and every part that constitutes a related group of parts being entered into ORACLE simultaneously. That is, if a Module Part Number is entered in columns 8 thru 11 for one part, the Module Part Number must be entered for each and every part that is entered into ORACLE simultaneously. In this case quantity factors will not be recognized. (The reason will be delineated in the section entitled RELIABL.) However, if a quantity factor is entered into columns 8 thru 11 for one part a quantity factor - even 0001 - must be entered for each and every part that constitutes a related group of parts being entered into ORACLE simultaneously. Thus a mix of entries into these columns will cause erroneous results.

Columns 12 thru 14 always contain the Component Type. A list of the various types of components that can be entered is given in Appendix 2. Columns 15 thru 17 always contain the Manufacturer's Code. A list of manufacturers that ORACLE will recognize is given in Appendix 3. Columns 18 thru 27(for integrated circuits and discrete semiconductors) while Columns 18 thru 32 (for resistors, capacitors, and inductors) contain the Part Number information. This is the most critical information one will enter into ORACLE. ORACLE searches on Columns 15 thru 17 and on Columns 18 thru 27 (or 32 depending on the component type) to determine if the Manufacturer Code and the Part Number, respectively, are represented in the data base. Should the part be found in the data base, a failure rate can then be calculated for that part. However, many styles of inductors, many styles of capacitors, and all styles of resistors do not need to be in the data base and will not be found in the data base. The failure rate for these parts will be determined through ORACLE's direct decoding of the information in their individual part number. Beyond Column 27 (or 32) the formats contain application dependent information and the screening level of the part used. The application dependent information is directed at delineating the conditions under which the part will operate. These include the operating environment (see a list of codes in Appendix 4), the operating temperature, the duty cycle or usage, the stress, and other specific information unique to the part under consideration. This information together with the information stored in the data base, is used to determine the appropriate parameters needed to calculate the failure rate for each part. These calculations are made in accordance with the requirements and procedures prescribed in MIL-HDBK-217B. As will be discussed more thoroughly under the section entitled "The 'What-if' Game", the information that is entered beyond Column 27 (or 32 depending on the component type) can be altered for a subsequent run.

## THE PROCEDURE

ORACLE is composed of five basic routines. They are (1) SORTMRG, (2) BINNY, (3) RELIABL, (4) SUMICTX, and (5) TRADEOF. A brief description/definition of these routines are as follows:

SORTMRG - accepts as input a list of part numbers with specific, individual, application dependent information and produces the same list of parts sorted by part number.

BINNY - accepts as input the sorted list of parts produced by SORTMRG and performs a binary search on the full data base to extract from the full data base each of those input part numbers that are represented in the full data base. Those parts extracted from the full data base form a smaller, abstracted data base. In addition, BINNY produces simple lists of those input part numbers that were found in the full data base and those part numbers that were not found in the full data base. BINNY also produces a diagnostic file that can be used to inquire as to which individual part numbers were not decodable or were not matched with a part number in the full data base and why.

RELIABL - accepts as input the sorted list of parts produced by SORTMRG as well as the abstracted data base produced by BINNY and produces the failure rate for each part listed in the abstracted data base. It is in this routine where the MIL-HDBK-217B calculations are performed. RELIABL produces two output files. They are FOUNDO and DIAGNOSTIC. For each part found in the abstracted data base, the FOUNDO file lists the part number, some of the application dependent information inserted by the user and extracted from the input formats, some information found in the full data base, the cost information, and the failure rate. RELIABL also produces a file called DIAGNOSTIC. This file lists the part application dependent information, the parameters found in MIL-HDBK-217B and used in calculating the failure rate, the base failure rate, and the final failure rate for each part.

SUMICTX - accepts as input the FOUNDO file. SUMICTX then adds all of the individual part failure rates listed in FOUNDO and produces the total failure rate. After having obtained the total failure rate, SUMICTX then produces the MTBF for these parts. It is in the file produced by SUMICTX that one can also find the price of the input parts in small quantities and the price in quantities of 1000 or more.

TRADEOF - accepts two files which contain different total failure rates and MTBFs, as summed-up by SUM1CTX. TRADEOF then performs an analysis which produces a numerical and a percentage difference between the two cases.

Figures 1 and 2 show the order in which the individual segments of ORACLE are executed. The order of execution is: (1) SORTMRG, (2) BINNY, (3) RELIABL, (4) SUM1CTX, (5) Results, (6) Changes, (7) RELIABL, (8) SUM1CTX, (9) Results, and (10) TRADEOF.

Figure 1 depicts, in block diagram form, the basic procedure which must be followed if one is to obtain the failure rate for each of the parts that are entered into ORACLE. Figure 2 shows the procedure to be followed in obtaining a tradeoff analysis. Specifically, Figure 1 shows those input files which must be entered into each of the four ORACLE routines (cross hatched boxes) as well as those output files which will eminate from these routines. Subsequently, in this paper, specific names and IDs will be assigned by the user and the program, to each of these input and output files. In order to link this figure with the specific names and IDs used throughout the example execution of ORACLE described in this paper, Table 1 has been constructed.

The following explicitely describes the procedures and operations that must be followed to obtain the failure rate and MTBF of any list of parts.

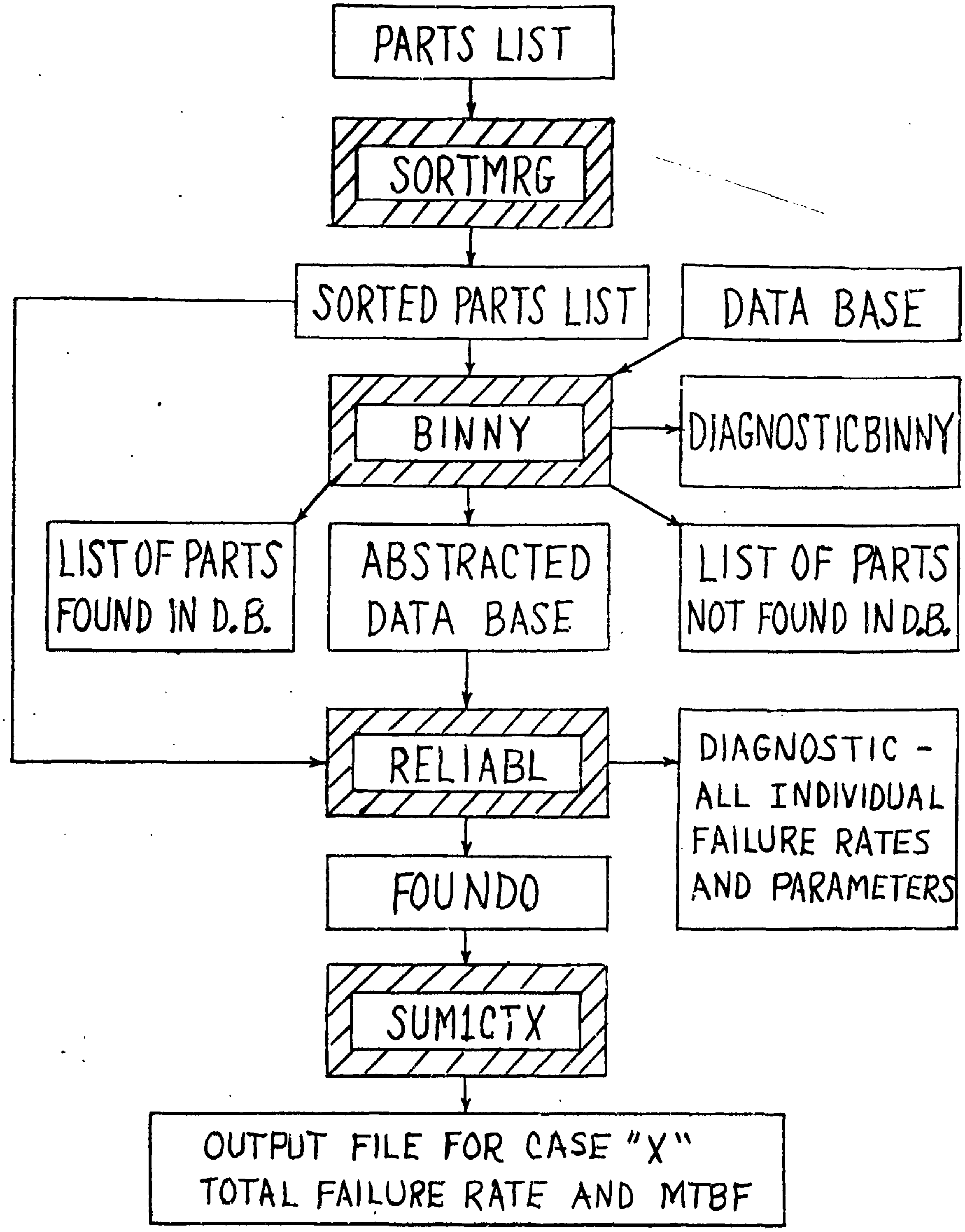


Figure 1. Block diagram of the reliability predicition program routines (cross hatched boxes), the required inputs and the resulting output files.

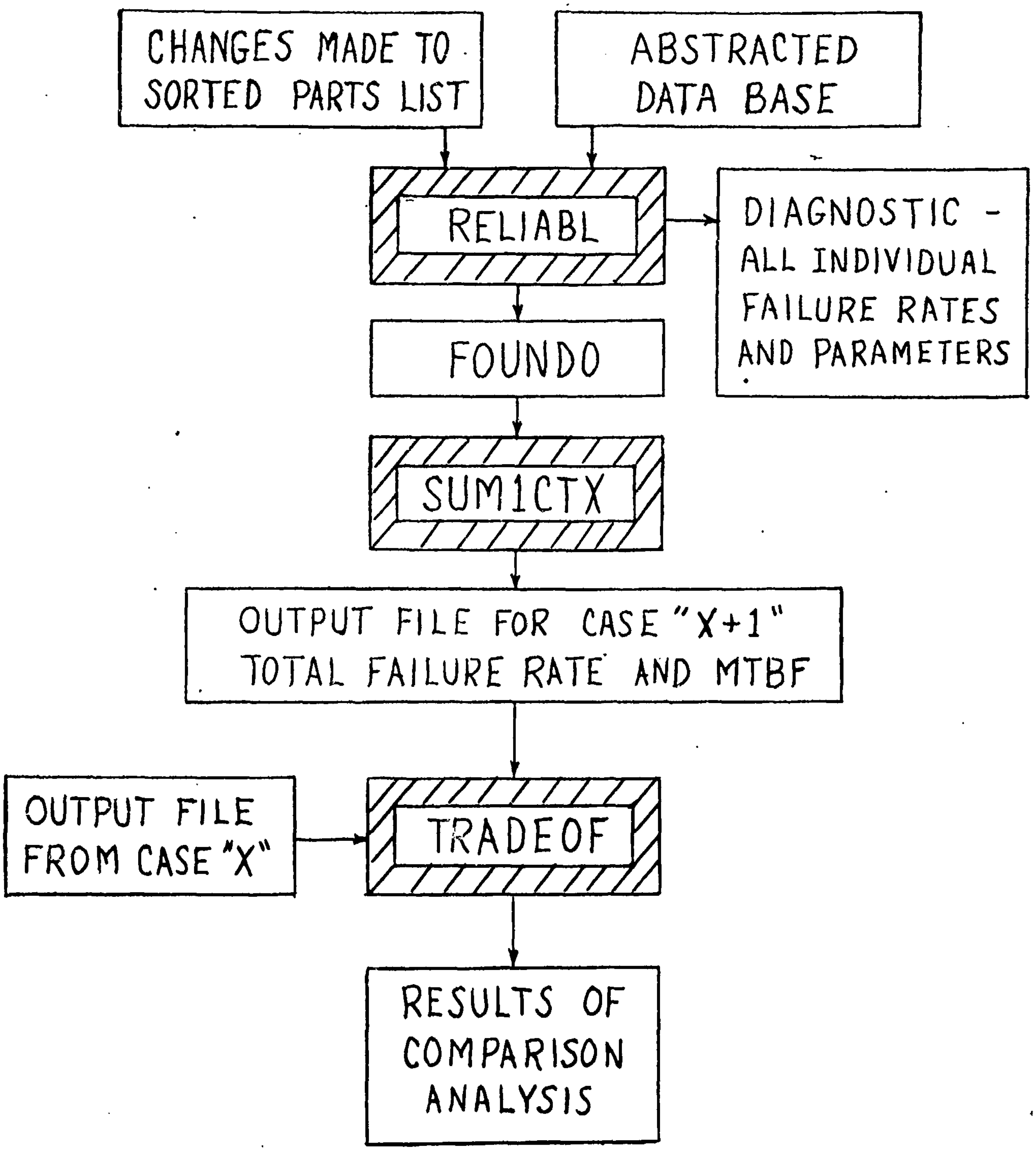


Figure 2. Block diagram of the procedure to be followed in obtaining a tradeoff analysis.

| Name of Block in Figure 1 | ORACLE Routine from which file is output | ORACLE Routine to which file is input | File name assignor | File Name Assigned in text example | ID assignor | ID assigned | Applicable Figures |
|---|---|---|---|---|---|---|---|
| Parts List | -- | SORTMRG | User | SAMPTS2 | User | EQPMT2 | 4,5 |
| Sorted Parts List | SORTMRG | BINNY | User | SORTEDXXSAMPTS2 | User | EQPMT2 | 5,6,7 |
| DIAGNOSTICBINNY | BINNY | -- | ORACLE | DIAGNOSTICBINNY | ORACLE | EQPMT2* | 6 |
| List of Parts Found in D.B. | BINNY | -- | User | FOUNDXXSAMPTS2 | ORACLE | EQPMT2* | 6 |
| Abstracted Data Base | BINNY | RELIABL | User | ABSDBXXSAMPTS2 | ORACLE | EQPMT2* | 6,7 |
| List of Parts not Found in D.B. | BINNY | -- | ORACLE | TAPE4 | -- | -- | 12 |
| DIAGNOSTIC | RELIABL | -- | ORACLE | DIAGNOSTIC | ORACLE | EQPMT2** | 7 |
| FOUNDO | RELIABL | SUM1CTX | ORACLE | FOUNDO | ORACLE | EQPMT2** | 7,13 |
| Output File for Case "X" | SUM1CTX | TRADEOF | User | OUT1XXSAMPTS2 | ORACLE | EQPMT2*** | 13,14 |

* Assigned as a result of the users response to a prompt in BINNY
** Assigned as a result of the users response to a prompt in RELIABL
***Assigned as a result of the users response to a prompt in SUM1CTX

**Table 1.** Relationships between block diagram of Figure 1 and the names of the corresponding files actually assigned by the user and ORACLE in the example execution of the program described throughout this paper.

## The Data

In order to facilitate the explanation of the operations and the execution of ORACLE an example list of parts has been assembled and inserted into the program. The list of the parts entered into ORACLE is shown in Figure 3. This list of parts consists of an example of all possible styles of integrated circuits (IC-), capacitors (CAP), inductors (IND), resistors (RES), transistors (XR-), general purpose diodes (D--), zener diodes (ZD-), voltage reference diodes (RD-), varactor diodes (VD-), and thyristors (DCR). This list also demonstrates the numerous variations of operating environment, operating temperature, screening levels, duty cycle, etc., that can be placed on any component. One should also note that comment information has been entered in Column 81 and beyond. In this instance the information noted here points out which specific MIL-STD-198 capacitor, MIL-STD-199 resistor, or MIL-C or MIL-T inductor is being exemplified. ORACLE ignores all information in Column 81 and beyond. Also note that in the case of capacitors, where two methods of representing the same style of capacitor are given, it is not intended that the part number convey the same information (resulting in the same failure rate), but simply to show that there are two different ways to enter the part number for this particular style of capacitor. For example, the part number for a MIL-C-39014 capacitor can be entered using the CKR notation or the M39014 notation.

```
MOD001JK01IC-F8CCA3016-50M+1.00      +080GD-M      A
MOD001JK01IC-NATLM2208---F+1.00      +080GD-M      B
MOD001JK01IC-F8CLM101A-3FM+1.00      +080GD-M    B-1
MOD001JK01IC-NATLM205----H+1.00      +080GD-M    B-2
MOD001JK01IC-NATLM206----F+1.00      +080GD-M      A
MOD001JK01IC-FSCLM301A-6AC+1.00      +080GD-M    B-2
MOD001JK01IC-NATLM748C---H+1.00      +080AR-T    B-1
MOD001JK01IC-MOTMC1410---G+1.00      +080AB-U      A
MOD001JK01IC-MOTMC1456C--G+1.00      +080GD-B      C
MOD001JK01IC-MOTMC1458---G+1.00      +080GD-F      C
MOD001JK01IC-MOTMC15482--L+1.00      +080GD-M      B
MOD001JK01IC-TI-SN54L85--J+1.00      +080NV-S      B
MOD001JK01IC-TI-SN54180--J+1.00      +080NV-U      B
MOD001JK01IC-MOTMC2059---F+1.00      +080MS-L      B
MOD001JK01IC-TI-SN54123--J+1.00      +080SPFL      B
MOD001JK01IC-MOTMC9601---L+1.00      +080GD-M    B-1
MOD001JK01IC-SIGN74S113--F+1.00      +080GD-M    B-1
MOD001JK01IC-SIGN74S114--A+1.00      +080GD-M    B-1
MOD001JK01IC-FSC54H00--3IM+1.00      +080GD-M    B-1
MOD001JK01IC-FSC54M183-7AM+1.00      +080GD-M    B-2
MOD001JK01IC-FSC54H08--6AM+1.00      +080GD-M    B-2
MOD001JK01IC-FSC5404---6AM+1.00      +080GD-M    B-2
MOD001JK01IC-SIGN8263----Y+1.00      +080GD-M    B-1
MOD001JK01CAP    M23269/01-2001  +0.70+080AB-U                       1.00 E.G. OF MIL-C-23269
MOD001JK01CAP    M39003/01-5601  +0.70+080GD-F              2.00     1.00 E.G. OF MIL-C-39003
MOD001JK01CAP    M39006/01-3026  +0.70+080NV-S                       1.00 E.G. OF MIL-C-39006
MOD001JK01CAP    CKR07BX100KP    +0.70+080NV-U                       1.00 E.G. OF MIL-C-39014
MOD001JK01CAP    M39014/01-1399  +0.70+080MS-L                       1.00 E.G. OF MIL-C-39014
MOD001JK01CAP    M39018/03-0492  +0.70+080SPFL                       1.00 E.G. OF MIL-C-39018
MOD001JK01CAP    CHR09BINV223JP  +0.70+080GD-B                       1.00 E.G. OF MIL-C-39022
MOD001JK01CAP    M39022/07-1022  +0.70+080GD-M                       1.00 E.G. OF MIL-C-39022
MOD001JK01CAP    CB50R9050J      +0.70+080GD-M UPPER                 1.00 E.G. OF MIL-C-10950
MOD001JK01CAP    CC20AK0R5G      +0.70+080GD-MMILSPC                 1.00 E.G. OF MIL-C-20
MOD001JK01CAP    CE11C050C       +0.70+080GD-B UPPER                 1.00 E.G. OF MIL-C-62
```

Figure 3. List of the parts inserted into ORACLE. This list gives an example of each of the parts that can be entered and of the various conditions that can be placed on these parts.

```
MOD001JK01CAP   CK05BX100K        +0.70+080GD-B                                 1.00 E.G. OF MIL-C-11015
MOD001JK01CAP   CL21BH060KPG      +0.70+080GD-M                                 1.00 E.G. OF MIL-C-3965
MOD001JK01CAP   CM05EC100GP3      +0.70+080GD-M                                 1.00 E.G. OF MIL-C-5
MOD001JK01CAP   CMR01C050DDDM     +0.70+080GD-B                                 1.00 E.G. OF MIL-C-39001
MOD001JK01CAP   CMR01C050DFDR     +0.70+080GD-F                                 1.00 E.G. OF MIL-C-39001
MOD001JK01CAP   CPV09A1KC562JR    +0.70+080GD-M                                 1.00 E.G. OF MIL-C-14157
MOD001JK01CAP   CQ09D1KC102G3     +0.70+080GD-M                                 1.00 E.G. OF MIL-C-19978
MOD001JK01CAP   CQR01D1KC102G3R+0.70+080NV-S                                    1.00 E.G. OF MIL-C-19978
MOD001JK01CAP   CQR09A1NC152K1M+0.70+050GD-F                                    1.00 E.G. OF MIL-C-19978
MOD001JK01CAP   CV11D070          +0.70+080GD-MMILSPC                           1.00 E.G. OF MIL-C-81
MOD001JK01CAP   PC38J1R8          +0.70+080GD-M UPPER                           1.00 E.G. OF MIL-C-14409
MOD001JK01RES   RC42GF102J        +0.70+080GD-M                          1.00        E.G. OF MIL-R-11
MOD001JK01RES   RCR20G103JM       +0.70+080GD-M                          1.00        E.G. OF MIL-R-39008
MOD001JK01RES   RN60B1001F        +0.70+080GD-M                          1.00        E.G. OF MIL-R-10509
MOD001JK01RES   RL42B102J         +0.70+080AB-I                          1.00        E.G. OF MIL-R-22684
MOD001JK01RES   RLR32C103JP       +0.70+080AR-U                          1.00        E.G. OF MIL-R-39017
MOD001JK01RES   RNR55H1003FM      +0.70+080GD-B                          1.00        E.G. OF MIL-R-55182
MOD001JK01RES   RD65P1002G        +0.70+080CD-F UPPER                    1.00        E.G. OF MIL-R-11804
MOD001JK01RES   RW55U1002D        +0.70+080GD-M                          1.00        E.G. OF MIL-R-26
MOD001JK01RES   RBR57L500R0BP     +0.70+080NV-S                          1.00        E.G. OF MIL-R-39005
MOD001JK01RES   RE77G1000         +0.70+080NV-U                          1.00        E.G. OF MIL-R-18546
MOD001JK01RES   RWR80S5000FM      +0.70+080MS-L                          1.00        E.G. OF MIL-R-39007
MOD001JK01RES   RER65F1001P       +0.70+080SPFL        B                 1.00        E.G. OF MIL-R-39009
MOD001JK01RES   RV4TAYSA501A      +0.70+080GD-M LOWER                    1.00        E.G. OF MIL-R-94
MOD001JK01RES   RJ24FX103         +0.70+080GD-M LOWER            9.00    1.00        E.G. OF MIL-R-22097
MOD001JK01RES   RA20TASA500A      +0.70+080GD-MMILSPC            8.00    1.00        E.G. OF MIL-R-19
MOD001JK01RES   RP062SB101KK      +0.70+080GD-M UPPER           10.00    1.00        E.G. OF MIL-R-22
MOD001JK01RES   RR2100A3C9A501    +0.70+080GD-MMILSPC            6.00    1.00      5 E.G. OF MIL-R-12934
MOD001JK01RES   RT26C2P102        +0.70+080GD-M                  5.00    1.00        E.G. OF MIL-R-27208
MOD001JK01RES   RK09SAC8101       +0.70+080GD-M LOWER           10.00    1.00        E.G. OF MIL-R-39002
MOD001JK01RES   RTR12DY102M       +0.70+080GD-M                  5.00    1.00        E.G. OF MIL-R-39015
```

Figure 3. (Cont) List of the parts inserted into ORACLE. This list gives an example of each of the parts that can be entered andof the various conditions that can be placed on these parts.

```
MOD001JK01IND   TF4RX01JB008    +0,60+080AB=IMILSPC        1.00                E.G. OF MIL=T=27
MOD001JK01IND   TF4RX02LB002    +0,60+080AB=U UPPER        1.00                E.G. OF MIL=T=27
MOD001JK01IND   TF4RX03MB004    +0,60+080GD=B LOWER        1.00                E.G. OF MIL=T=27
MOD001JK01IND   TF4RX04KB211    +0,60+080GD=FMILSPC        1.00                E.G. OF MIL=T=27
MOD001JK01IND   TF4RX10AJ001    +0,60+080GD=M UPPER        1.00                E.G. OF MIL=T=27
MOD001JK01IND   TF4RX13AJ003    +0,60+080NV=S LOWER        1.00                E.G. OF MIL=T=27
MOD001JK01IND   TF5RX15ZZ011    +0,60+080NV=UMILSPC        1.00                E.G. OF MIL=T=27
MOD001JK01IND   TF4SX01GA209    +0,60+080MS=LMILSPC        1.00                E.G. OF MIL=T=27
MOD001JK01IND   TF4RX16AJ002    +0,60+080SPFLMILSPC        1.00                E.G. OF MIL=T=27
MOD001JK01IND   TF4RX15AJ001    +0,60+080GD=MMILSPC        1.00                E.G. OF MIL=T=27
MOD001JK01IND   LT5V003         +0,60+080GD=MMILSPC        1.00                E.G. OF MIL=C=15305
MOD001JK01IND   LT4K001         +0,60+080GD=M UPPER        1.00                E.G. OF MIL=C=15305
MOD001JK01IND   LT10K107        +0,60+080GD=M LOWER        1.00                E.G. OF MIL=C=15305
MOD001JK01IND   LT10V063        +0,60+080GD=MMILSPC        1.00                E.G. OF MIL=C=15305
MOD001JK01IND   TP4QX1100BC001  +0,60+080GD=MMILSPC        1.00                E.G. OF MIL=T=21038
MOD001JK01IND   TP6RX4410CZ     +0,60+080GD=M UPPER        1.00                E.G. OF MIL=T=21038
MOD001JK01IND   TP7SX1100MZ     +0,60+080GD=M LOWER        1.00                E.G. OF MIL=T=21038
MOD001JK01IND   TP7SX5310AZ     +0,60+080GD=MMILSPC        1.00                E.G. OF MIL=T=21038
MOD001JK01IND   TP7SX1100MZZ    +0,60+080GD=MMILSPC        1.00                E.G. OF MIL=T=21038
MOD001JK01IND   TP7SX1110JAA    +0,60+080GD=MMILSPC        1.00                E.G. OF MIL=T=21038
MOD001JK01D==SOD1N1128RA  +0,80+0,50+080GD=M JANTXSMS                5.00
MOD001JK01D==MIC1N21WG     +0,80+0,50+080GD=M JANTXLIN                5.00
MOD001JK01D==GES1N93A      +0,80+0,50+080GD=M    JANSMS                4.00
MOD001JK01D==ALP1N830A     +0,80+0,50+080GD=MJANTXVSMS                3.00
MOD001JK01D==ALP1N268M     +0,80+0,50+080GD=M    JANSMS                6.00
MOD001JK01RD=TSC1N430A     +0,80+0,50+080GD=M    JANVRF                4.00
MOD001JK01RD=MOT1N1530A    +0,80+0,50+080GD=MJANTXVVRF                8.00
MOD001JK01RD=STC1N829      +0,80+0,50+080GD=B    JANVRF                5.00
```

Figure 3. (Cont) List of the parts inserted into ORACLE. This list gives an example of the parts that can be entered and of the various conditions that can be placed on these parts.

```
MOD001JK01ZD=NAE1N2985RB   +0.80+0.50+080GD=M JANTXVRG        4.00
MOD001JK01ZD=DIC1N977B     +0.80+0.50+080GD=M    JANVRG       3.00
MOD001JK01ZD=MOT1N982B     +0.80+0.50+080GD=MJANTXVVRG        4.00
MOD001JK01ZD=MSC1N4968     +0.80+0.50+080GD=M    JANVRF       4.00
MOD001JK01ZD=UNI1N4995     +0.80+0.50+080GD=M JANTXVRG        4.00
MOD001JK01ZD=NON1N5546B    +0.80+0.50+080GD=MJANTXVVRF        4.00
MOD001JK01VD=TCY1N5146A    +0.80+0.50+080GD=M    JANVRG       4.00
MOD001JK01VD=TCY1N5476C    +0.80+0.50+080GD=MJANTXVVRG        4.00
MOD001JK01VD=TRW1N4815B    +0.80+0.50+080GD=M JANTXVRF        5.00
MOD001JK01DCRMOT1N5283     +0.80+0.50+080GD=M    JAN          5.00
MOD001JK01DCRMOT1N5291     +0.80+0.50+080GD=M JANTX           4.00
MOD001JK01DCRMOT1N5300     +0.80+0.50+080GD=MJANTXV           5.00
MOD001JK01DCRMOT1N5314     +0.80+0.50+080GD=M    JAN          5.00
MOD001JK01DCRMOT1N5299     +0.80+0.50+080GD=M JANTX           4.00
MOD001JK01XR=ITT2N2219     +0.80+0.50+080GD=M    JANLIN       5.00
MOD001JK01XR=FSC2N2219A    +0.80+0.50+080GD=M    JANLGS       4.00
MOD001JK01XR=RTN2N2481     +0.80+0.50+080GD=M    JANLIN       5.00
MOD001JK01XR=TSC2N2905     +0.80+0.50+080AB=I    JANHFQ       4.00
MOD001JK01XR=TI=2N1050A    +0.80+0.50+080AB=U    JANHFQ       3.00
MOD001JK01XR=TI=2N117      +0.80+0.50+080GD=B    JANHFQ       4.00
MOD001JK01XR=APX2N2084     +0.80+0.50+080GD=F JANTXLGS        4.00
MOD001JK01XR=RTN2N2920     +0.80+0.50+080GD=M JANTXLIN        4.00
MOD001JK01XR=RCA2N3439     +0.80+0.50+080NV=S    JANLGS       3.00
MOD001JK01XR=AMC2N3996     +0.80+0.50+080NV=U    JANLIN       4.00
MOD001JK01XR=RCA2N5918     +0.80+0.50+080MS=L    JANHFQ       3.00
MOD001JK01XR=UNI2N2151     +0.80+0.50+080SPFL    JANLGS       3.00
MOD001JK01XR=SPC2N3771     +0.80+0.50+080GD=M    JANLIN       3.00
MOD001JK01XR=SIX2N4859     +0.80+0.50+080GD=M    JANLGS       3.00
MOD001JK01XR=RTN2N718A     +0.80+0.50+080GD=M JANTXHFQ        4.00
MOD001JK01XR=APX2N987      +0.80+0.50+080GD=M JANTXLIN        4.00
MOD001JK01XR=RTN2N930      +0.80+0.50+080GD=MJANTXVLGS        5.00
```

Figure 3. (Cont) List of the parts inserted into ORACLE. This list gives an example of each of the parts that can be entered and of the various conditions that can be placed on these parts.

The ID

The operations shown in Figure 4 demonstrate the procedure used, in the edit mode of the CDC 6600 system, to catalog a previously established file of parts called ICRIDX1 onto a permanent file called SAMPTS2. The name SAMPTS2 is assigned by the user. The last part in the ICRIDX1 file is listed and the user has requested the CDC editor to truncate the number of characters in this file to 80. The ID given to SAMPTS2 is EQPMT2. The CDC system displays, through the "Initial Catalog" listing, all of the information one will need when it is desired to retrieve this file. All files except SAMPTS2 are removed from local file condition through the RETURN command.

The ID name attached to each of the files created throughout ORACLE should not contain more than nine (9) characters and the same ID should be used for all ID names associated with a given set of parts or module throughout the entire ORACLE program. This ID name should, in some significant way, describe and/or identify the particular piece of equipment associated with the parts or module. The maintenance of a constant, unique ID associated with all ORACLE files related to the same set of parts or module is important because this will allow for all files associated with these parts or this module to be cataloged under one permanent file ID. Thus subsequent determination of the location in memory of any desired file or information associated with these parts or this module, can readily be found.

In this case, the ID = EQPMT2. Upon cataloging TAPE2 in the subsequent SORTMRG routine, this is the ID that one should use. Also this ID name will be the response expected when the interactive BINNY, RELIABL, SUMICTX, and TRADEOF routines ask the operator to "ENTER EQUIPMENT NAME".

```
COMMAND- EDITOR

..EDIT,ICRIDX1,SEQ

..LIST,LAST

  1330= MOD001JK01XR-RTN2N930     +0.80+0.50+080GD-MJANTXVLGS
            5.00
..F,CH=80

..SAVE,PARTS1,N

LINES TRUNCATED: CH= 80 CHARS, LONGEST LINE WAS 100
..CATALOG,PARTS1,SAMPTS2,ID=EQPMT2

 INITIAL CATALOG
 RP = 090 DAYS
 CT ID=   EQPMT2 PFN=SAMPTS2:
 CT CY= 001  00001024 WORDS.:
..FILES

--LOCAL FILES--
 *PARTS1   *ICRIDX1
..RETURN,PARTS1,ICRIDX1

..BYE
```

Figure 4. Cataloging the parts, that are to be inserted into ORACLE, onto a permanent file.

SORTMRG

Now that the data is located on a permanent file, ORACLE can access it and we can then initiate the SORTMRG routine. The purpose of this routine is simply to sort the part numbers into an order such that the subsequent routine (BINNY) will only have to scan the data base from top to bottom once. This will be the fastest way to match-up each individual part number input to ORACLE, with its stored information located in the full data base. The sorted results will be located on TAPE2. The procedure one must follow to obtain the sorted parts list on TAPE2 is shown in Figure 5. The response to the first COMMAND prompt will always be as shown with the exception of the file name (SAMPTS2) and the ID (EQPMT2) which must always be the file name and ID assigned by the user in Figure 4. The response to the next six COMMAND prompts will always be the same as shown for all executions of ORACLE. This is standard input information needed by ORACLE for execution on the CDC 6600 system. The information shown after the SORTMRG response was entered by the user, is printed out without user interaction. Subsequently, the system again prompts with the word COMMAND. It is at this time that one catalogs TAPE2 onto a permanent file, the name of which the operator assigns at that time. The name one assigns should in some way describe or identify the parts. One can use up to 40 characters. It should be noted, in connection with this file name assignment, that this is the file which will be referred to in the BINNY and RELIABL routines when these interactive routines ask the user to "ENTER SORTED PARTS FILE NAME:". In this case the assigned name is SORTEDXXSAMPTS2. The ID used

```
COMMAND- ATTACH,TAPE1,SAMPTS2,ID=EQPMT2

 PF CYCLE NO. = 001
COMMAND- REQUEST,TAPE2,*PF

COMMAND- CONNECT,OUTPUT

COMMAND- FILE,TAPE1,BT=C,RT=Z,MRL=140

COMMAND- FILE,TAPE2,BT=C,RT=Z,MRL=140

COMMAND- ATTACH,INPUT,SORTCOMMANDS,ID=GAERTNER

 PF CYCLE NO. = 001
COMMAND- SORTMRG



        7 C   D I R E C T I V E S
T/MERGE 4.1-P383  08/05/75  15.24.55.       PAGE      1


      1  SORT.
      2  FILE,INPUT=TAPE1,OUTPUT=TAPE2.
      3  FIELD,K1(18,7,DISPLAY),K2(25,3,DISPLAY),K3(15,3,DISPLAY).
      4  KEYS,K1(A,DISPLAY),K2(A,DISPLAY),K3(A,DISPLAY)
      5  END.

  ** INSERTIONS DURING INPUT    **********0
  ** DELETIONS DURING INPUT     **********0
  ** TOTAL RECORDS SORTED       ********124
  ** INSERTIONS DURING OUTPUT   **********0
  ** DELETIONS DURING OUTPUT    **********0
  ** TOTAL RECORDS OUTPUT       ********124
  **END SORT RUN
COMMAND- CATALOG,TAPE2,SORTEDXXSAMPTS2,ID=EQPMT2

 INITIAL CATALOG
 RP = 090 DAYS
 CT ID=   EQPMT2 PFN=SORTEDXXSAMPTS2
 CT CY= 001  00001088 WORDS.:
COMMAND- FILES

--LOCAL FILES--
 *TAPE1    *TAPE2    $OUTPUT   *INPUT
COMMAND- RETURN,INPUT,TAPE1,TAPE2

COMMAND- DISCARD,OUTPUT
```

Figure 5. SORTMRG routine, the cataloging of TAPE2, and the clean-up of the local files.

should be the same as that used to catalog the original list of parts onto a permanent file. This was done in Figure 4 and the ID assigned there was EQPMT2.

Following the completion of each of the ORACLE routines one must "clean-up" the local files only. It will be demonstrated throughout the procedure which specific local files are to be removed. However, in general, the INPUT file and each of the TAPEs must always be removed through use of the RETURN command while OUTPUT must always be removed separately through use of the DISCARD command. If those files designated to be removed are NOT removed, subsequent operations will be impared. However, before removing the local files one may want to look at what is located on each of these files or TAPEs. The resultant local files which emerge after the SORTMRG routine are shown in Figure 5. The only two files which do not have obvious names are TAPE1 and TAPE2. TAPE1 simply contains a list of the data as it was initially inserted by the operator. TAPE2 simply contains the sequential listing by part number of the inserted data. Removal of the local files are shown at the bottom of Figure 5.

BINNY

The purpose of BINNY is to match the sorted parts list with the data base and to produce a smaller, abstracted data base with only those items in it which represent all ramifications of the matched input parts list. The operator will give the abstracted data base a specific name for future reference - in this example the assigned name was ABSDBXXSAMPTS2. This is one of the two files which will be used by the RELIABL routine in calculating the failure rate of each individual part. (See Figure 1) BINNY will generate three other output files. One is a list of parts that will have been found on the data base. Again, the operator will give this file a specific name and in this example the name given was FOUNDXXSAMPTS2. Another eminating file will be a diagnostic file which can be used for debugging purposes. The system gives this file the name DIAGNOSTICBINNY. The fourth file eminating from BINNY will be a list of the parts NOT found on the data base. This file will be located on TAPE4.

Both BINNY and RELIABL are interactive routines and the first five prompts require the same information in response. When a file is cataloged or stored as a permanent file - as opposed to a local file - one needs three pieces of information to store or access that permanent file. The first is the identification (ID) name associated with the file, while the second piece of information is the name of the file itself. The third piece of information one needs is the cycle number of this file. In BINNY and RELIABL the first three prompts ask for all the information that defines an existing file so that it can be accepted as an input file. The first prompt asks for the file ID, the second prompt asks for the file name, and the third prompt asks for the file cycle number. The fourth and fifth prompt in BINNY ask the user to assign a name and cycle number, respectively to the abstracted data base. This is one of the files that will be generated as output by BINNY. In RELIABL the fourth and fifth prompts are asking the user for the name and cycle number, respectively, of the abstracted data base assigned earlier in the BINNY routine. With this information RELIABL can then accept the abstracted data base as input.

The BINNY routine is shown in Figure 6 while the RELIABL routine is shown in Figure 7. The first three prompts for both BINNY and RELIABL will be as follows. The first prompt is "ENTER EQUIPMENT NAME:". The expected response is the file ID which, in this case, is ::::EQPMT2. This response must be composed of ten (10) characters. A colon must precede the nine (9) characters comprising the ID. However, should the ID be composed of fewer than nine characters, colons are to be used to pad the ID to the left. The second prompt is "ENTER SORTED PARTS FILE NAME:". The file name that must be entered in response to this prompt is the name the user gave to the file onto which TAPE2 was cataloged after the execution of the SORTMRG routine (See Figure 5). For this example that name is SORTEDXXSAMPTS2. The third prompt requests the user to "ENTER CYCLE OF SORTED PARTS, LIKE 001:". The particular cycle to be used in this response can be found where the SORTEDXXSAMPTS2 file was last cataloged. In this example the cycle number can be found after the CY notation under the "Initial Catalog" listing in Figure 5. The fourth prompt in BINNY is "ENTER ABSTRACTED DATA BASE FILE NAME:". It is at this point that the user assigns a name to the abstracted data base. In this example the user assigned the name ABSDBXXSAMPTS2. The fifth prompt is "ENTER CYCLE OF ABSTRACTED DATA BASE FILE, LIKE 001:". On the CDC 6600 a cycle number between 001 and 005 can be assigned. In this example the user entered 001. (Note that the abstracted data base file will have as ID the user's response to the first prompt "ENTER EQUIPMENT NAME:".)

The last two prompts in BINNY are: "ENTER PARTS FOUND FILE NAME:" and "ENTER CYCLE FOR PARTS FOUND FILE, LIKE 001:". These two prompts are

```
COMMAND- ATTACH,BINNY,ID=GAERTNER

 PFN IS
 BINNY
 PF CYCLE NO. = 001
COMMAND- BINNY

ENTER EQUIPMENT NAME :      ::::EQPMT2

::::EQPMT2
ENTER SORTED PARTS FILE NAME:        SORTEDXXSAMPTS2

SORTEDXXSAMPTS2
ENTER CYCLE OF SORTED PARTS, LIKE 001:         001

    1
ENTER ABSTRACTED DATABASE FILE NAME: ABSDBXXSAMPTS2

ENTER CYCLE OF ABSTRACTED DATABASE FILE, LIKE 001:        001

ENTER PARTS FOUND FILE NAME:
 REQUEST(TAPE2,*PF)FOUNDXXSAMPTS2

ENTER CYCLE FOR PARTS FOUND FILE, LIKE 001:    001

 REQUEST(TAPE9,*PF)
 REQUEST(TAPE7,*PF)
SUMMARY OF REASONS PARTS NOT FOUND IN DATABASE
   0 PARTS NOT MANUFACTURED BY SPECIFIED MANUFACTURER
   0 PARTS NOT AVAILABLE IN SPECIFIED PACKAGE TYPE
   0 PARTS NOT JAN PART NUMBERS
   0.0% OF PARTS WERE NOT FOUND
BINNY DIAGNOSTIC FILE NAME=DIAGNOSTICBINNY

:::::::
CYCLE=    1 EQUIPMENT =::::EQPMT2
 CT ID=    EQPMT2 PFN=DIAGNOSTICBINNY
 CT CY= 001   00010368 WORDS.:
 CT ID=    EQPMT2 PFN=ABSDBXXSAMPTS2
 CT CY= 001   00002304 WORDS.:
 CT ID=    EQPMT2 PFN=FOUNDXXSAMPTS2
 CT CY= 001   00001728 WORDS.:
      END  BINNY
     10.597 CP SECONDS EXECUTION TIME
COMMAND- FILES
--LOCAL FILES--
  INPUT     *BINNY     OUTPUT
COMMAND- RETURN,INPUT

COMMAND- DISCARD,OUTPUT
```

Figure 6. The interactive BINNY routine, the summary of results, the listing of the resulting files, and the clean-up of the local files.

asking the user to assign a name and cycle number to the file which will be generated by BINNY and contain the list of parts that were found in the data base. The response given, in this example, for this file name was FOUNDXXSAMPTS2, while the response to the cycle number assignment was 001. This file also has as its ID the response given to the first prompt in the BINNY routine, that is, EQPMT2. (Note that the "REQUEST (TAPE2*PF)" is not an intended prompt and should be ignored. This is an idiosyncracy of the CDC 6600 system.)

Following the successful execution of BINNY, a "SUMMARY OF REASONS PARTS NOT FOUND IN DATA BASE" is printed. The "package type" in the statement "PARTS NOT AVAILABLE IN SPECIFIED PACKAGE TYPE" refers to character numbers 8, 9, and 10 of every Part Number, that is, to Columns 25, 26, and 27 in each of the input formats. One can observe which particular part had a "package type" which was not matched in the data base by scanning through the output file labeled DIAGNOSTICBINNY. The statement informing us as to the number of "PARTS NOT JAN PART NUMBERS" simply tells us the total number of parts whose part numbers were not decodable or were not matched in the data base. If a Part Number - for example a resistor or a capacitor which are not supposed to be in the data base - is decodable it will not be included in the list of "non-jan parts". Thus any part which is not in the data base - but should be - will be noted as a "non-jan part". These parts will be flagged in the DIAGNOSTICBINNY file. The "jan part number" is referring to the Part Number given in Columns 18 through 27 (or 32, depending on the Component Type) in the input format.

Further on in the print-out, or listing, of BINNY, one notices a list of files that have been placed in permanent file condition. In addition to the DIAGNOSTICBINNY file, the abstracted data base file, ABSDBXXSAMPTS2, and the parts found file, FOUNDXXSAMPTS2, have also been placed in permanent file condition. One can move any of these files into a local file condition for immediate inspection. Before one proceeds to the RELIABL routine, the local files must be cleaned-up. This is shown at the bottom of Figure 6. Note that all files are removed except BINNY.

RELIABL

RELIABL accepts as input the sorted parts list which eminated from SORTMRG, in this case SORTEDXXSAMPTS2, and the abstracted data base which eminated from BINNY, in this case ABSDBXXSAMPTS2, and produces two files with the names FOUNDO and DIAGNOSTIC (See Figure 1). The names given to each of the files produced by RELIABL are assigned by the system and are the same for all executions of the RELIABL routine.

The procedure to be followed in the execution of the RELIABL routine is shown in Figure 7. Of course the response to the "ENTER EQUIPMENT NAME" must be the ID name, that is, ::::EQPMT2. The response to the "ENTER SORTED PARTS FILE NAME" is the same as in BINNY, that is, SORTEDXXSAMPTS2. The response to the "ENTER ABSTRACTED DATA BASE FILE NAME" must be the same response as was given in the BINNY routine. In this case that is ABSDBXXSAMPTS2 (See the RELIABL responses shown in Figure 7 and compare these with the BINNY responses in Figure 6). The only additional responses required in RELIABL which were not required in BINNY, are those to the "quantity" and the PC BOARD inquiries. In this case module Part Numbers are used and therefore the operator responded to the "quantity" prompt with a two.

```
COMMAND- ATTACH,RELIABL,ID=GAERTNER

 PFN IS
 RELIABL:
 PF CYCLE NO. = 001
COMMAND- RELIABL

ENTER EQUIPMENT NAME :      ::::EQPMT2

::::EQPMT2
ENTER SORTED PARTS FILE NAME:        SORTEDXXSAMPTS2

SORTEDXXSAMPTS2
ENTER CYCLE OF SORTED PARTS FILE LIKE 001:     001

  1
ENTER ABSTRACTED DATABASE FILE NAME: ABSDBXXSAMPTS2

ABSDBXXSAMPTS2
ENTER CYCLE OF ABASTACTED DATABASE LIKE 001:   001


  1
TYPE 1 IF QUANTITIES ARE USED
TYPE 2 IF MODULE PART NUMBERS ARE USED         2

ENTER NUMBER OF TWO-SIDED PC BOARDS LIKE 0001: 0001

  1
ENTER NUMBER OF MULTI-LAYERED PC BOARDS LIKE 0001:       0001

  1    GO

 CT ID=   EQPMT2 PFN=DIAGNOSTIC
 CT CY= 001  00004928 WORDS.:
 CT ID=   EQPMT2 PFN=FOUNDO
 CT CY= 001  00001920 WORDS.:
      END  RELIABN
      6.274 CP SECONDS EXECUTION TIME
COMMAND- FILES

--LOCAL FILES--
  INPUT     OUTPUT   *BINNY    *RELIABL
COMMAND- RETURN,INPUT

COMMAND- DISCARD,OUTPUT
```

Figure 7. The interactive RELIABL routine, the resulting files -- DIAGNOSTIC and FOUNDO -- and the clean-up of the local files.

The most significant information contained in the FOUNDO file is that of the failure rate for each part entered into ORACLE and found in the data base or found to be decodable. In the situation where a multiple of the same part number has been entered with one entry of that part, the failure rate shown will be the single part failure rate multiplied by the number of multiple entries. The sum of the complete list of failure rates shown in FOUNDO will add up to the total displayed as a result of executing the subsequent routine, SUM1CTX. Figure 8 shows some representative components from the FOUNDO file. Columns "A" thru "K" repeat the information placed in the first 51 columns of the input formats for each of the parts. An interpretation of this information will not be discussed here as it was described earlier in this document. Columns "L" thru "Y" show some of the information that is located in the data base for each respective part. With the exception of Columns "O" and "P", which are for the Failure Rate and the duty cycle or usage, respectively, the information located beyond column 51 in the FOUNDO file is unique to each component type and is identical with the information located beyond Column 51 in the data base for that part.

Thus one can obtain the exact interpretation of each column, beyond Column 50, for any particular component type, by looking in Appendix 5 under the corresponding columns. Therefore, each of the columns shown in the FOUNDO file will not contain the same information from top to bottom.

For integrated circuits Columns "L", "M", and "N" contain the supply voltage, the nominal current, and the maximum current, respectively. For discrete semiconductors these columns contain a maximum rated voltage,

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOD001 | 10 | IC- | FSC | CA3018 | -5GM | +1.00 | 0.00 | 80 | GD-M | A | .150E+02 | 0. | .500E-01 | 1.09E+00 | 1.00 | 4 | 4 | | 120 | 0 | 0 | 0.00 | 0.00 | 0 |
| MOD001 | 5 | CAP | | CKR07BX100PK | | | .70 | 80 | MS-L | | .150E+02 | 0. | .500E-01 | 3.33E+00 | 1.00 | 0 | 0 | | 10 | 0 | 0 | 0.00 | 0.00 | 0 |
| MOD001 | 10 | IC- | NAT | LM2208 | ---F | +1.00 | 0.00 | 80 | AB-I | B | .200E+02 | .300E-03 | .600E-03 | 6.01E+00 | 1.00 | 18 | 18 | | 160 | 0 | 0 | 0.00 | 0.00 | 2 |
| MOD001 | 10 | IC- | NAT | LM2208 | ---F | +1.00 | 0.00 | 80 | AB-I | B | .200E+02 | .300E-03 | .600E-03 | | | 0 | 0 | | 0 | 0 | 0 | | | 0 |
| MOD001 | 4 | IND | | LTSV003 | | | .60 | 80 | GD-M | LO-ER | 0. | 0. | .0 | 4.69E-01 | 1.00 | 0 | 0 | | 0 | 0 | 0 | 0.00 | 0.00 | 0 |
| MOD001 | 10 | IC- | MOT | MC1410 | ---G | +1.00 | 0.00 | 80 | NV-S | B-2 | .600E+01 | .138E-01 | .183E-01 | 1.73E+01 | 1.00 | 8 | 8 | | 80 | 0 | 0 | 0.00 | 0.00 | 2 |
| MOD001 | 10 | IC- | MOT | MC1410 | ---G | +1.00 | 0.00 | 80 | NV-S | B-2 | .600E+01 | .138E-01 | .183E-01 | | | 0 | 0 | | 0 | 0 | 0 | | | 0 |
| MOD001 | 5 | CAP | | M23269/01-2001 | | | .70 | 80 | AB-U | | .600E+01 | .138E-01 | .183E-01 | 4.19E+00 | 1.00 | 0 | -1 | | 10 | 514 | 0 | 0.00 | 0.00 | 0 |
| MOD001 | 5 | CAP | | M39014/01-1399 | | | .70 | 80 | NV-U | | .600E+01 | .138E-01 | .183E-01 | 2.21E+00 | 1.00 | 0 | -1 | | 10 | 18 | 0 | 0.00 | 0.00 | 0 |
| MOD001 | 10 | IC- | SIG | N74S114 | --A | +1.00 | 0.00 | 80 | GD-B | C | .500E+01 | .300E-01 | .500E-01 | 2.74E+00 | 1.00 | 16 | 16 | | 140 | 0 | 0 | 0.00 | 0.00 | 0 |
| MOD001 | 7 | RES | | FC42GF102J | | | .70 | 80 | GD-M | | 0. | 0. | .0 | 1.84E+00 | 1.00 | 0 | 0 | | 14 | 0 | 0 | 0.00 | 0.00 | 0 |
| MOD001 | 7 | RES | | RD65P1002G | | | .70 | 80 | GD-B | UPPER | 0. | 0. | .0 | 7.11E-01 | 1.00 | 0 | 0 | | 14 | 0 | 0 | 0.00 | 0.00 | 0 |
| MOD001 | 10 | IC- | TI- | SN54L85 | --J | +1.00 | 0.00 | 80 | BPFL | B-1 | .500E+01 | .400E-02 | .770E-02 | 2.21E+00 | 1.00 | 33 | 33 | | 160 | 0 | 0 | 0.00 | 0.00 | 0 |
| MOD001 | 4 | IND | | TF4RX01JB008 | | | .60 | 80 | AB-I | MILSPC | 0. | 0. | .0 | 9.16E-01 | 1.00 | 0 | 0 | | 0 | 0 | 0 | 0.00 | 0.00 | 0 |
| MOD001 | 4 | D-- | MIC | 1N21WG | | +0.80 | .50 | 80 | NV-U | JANTX | 0. | 0. | .0 | 3.67E+01 | .80 | 0 | 0 | SD | 8 | 0 | 1 | 0.00 | 0.00 | 0 |
| MOD001 | 4 | ZD- | NAE | 1N2985RB | | +0.80 | .50 | 80 | GD-M | JANTX | 0. | 0. | .0 | 8.37E-01 | .80 | 0 | 0 | SD | 8 | 55 | 1 | 0.00 | 0.00 | 0 |
| MOD001 | 4 | RD- | TSC | 1N430A | | +0.80 | .50 | 80 | GD-M | JAN | 0. | 0. | .0 | 6.27E+00 | .80 | 0 | 0 | SD | 8 | 0 | 1 | 0.00 | 0.00 | 0 |
| MOD001 | 4 | VD- | TCY | 1N5146A | | +0.80 | .50 | 80 | GD-M | JANTXV | 0. | 0. | .0 | 4.18E-01 | .80 | 0 | 0 | SD | 8 | 0 | 1 | 0.00 | 0.00 | 0 |
| MOD001 | 4 | DCR | MOT | 1N5299 | | +0.80 | .50 | 80 | GD-M | JANTX | 0. | 0. | .0 | 1.04E+00 | .80 | 0 | 0 | SD | 8 | 0 | 1 | 0.00 | 0.00 | 0 |
| MOD001 | 4 | D-- | GES | 1N93A | | +0.80 | .50 | 80 | NV-S | JAN | .500E+01 | 0. | .0 | 6.28E+01 | .80 | 0 | 0 | SD | 8 | 0 | 1 | 0.00 | 0.00 | 0 |
| MOD001 | 4 | XR- | ITT | 2N2219 | | +0.80 | .50 | 80 | GD-M | JAN | .500E+01 | 0. | .0 | 1.49E+00 | .80 | 0 | 0 | SD | 12 | 25 | 1 | 0.00 | 0.00 | 0 |
| MOD001 | 4 | XR- | RCA | 2N3439 | | +0.80 | .50 | 80 | GD-M | JAN | .300E+01 | 0. | .0 | 6.94E-01 | .80 | 0 | 0 | SD | 12 | 25 | 1 | 0.00 | 0.00 | 0 |
| MOD001 | 1 | PCB | | PCBTWOSIDED | | | 1.00 | 80 | GD-M | | 0.000E 00 | 0.000E 00 | .000E 00 | 1.04E-02 | 435. | 00 | 00 | | 000 | 00 | 0 | 00.00 | 00.00 | 0 |
| MOD001 | 1 | PCB | | PCBMULTILAYERED | | | 1.00 | 80 | GD-M | | 0.000E 00 | 0.000E 00 | .000E 00 | 9.39E-01 | 435. | 00 | 00 | | 000 | 00 | 0 | 00.00 | 00.00 | 0 |

Figure 8. A sample of the FOUNDO file. See text for an explanation of each column labeled "A" thru "Y".

a maximum rated current and a maximum rated power, respectively. For capacitors Column "L" contains the rated voltage while Columns "M" and "N" are normally blank. For inductors and resistors these three columns are normally left blank. However, normally blank columns may contain information if the user has specifically entered this information somewhere beyond Column 51 in the input format.

Column "O" contains the FAILURE RATE while Column "P" contains the duty cycle or usage. The value shown in Column "P" corresponds to the value inserted by the user in the input format. The information shown in Column "P" which corresponds to rows that contain multi-layered or two sided PC boards, is the number of holes which will be drilled in each board.

If Column "Q" corresponds to an integrated circuit the information shown is the number of gates in each package. If Column "Q" corresponds to a discrete semiconductor, a capacitor, a resistor, or an inductor the contents should be zero.

If Column "R" corresponds to an integrated circuit the number shown represents the number of internal leads eminating from the chip itself - not the physical package. If Column "R" corresponds to a capacitor, the number shown will either be a zero or a -1. The -1 simply means that this capacitor has a non-essential quality level. (See Appendix 5 under Capacitors, Columns 102-105) A zero should be found in this column for all other capacitors, all inductors, and all resistors. This column has no significance for discrete semiconductors, capacitors, inductors, and resistors.

Column "S" contains the complexity code for discrete semiconductors. A list of these codes can be found in Appendix 5 under Discrete Semiconductors, Columns 107-108. This column may also contain a number in a row corresponding to a capacitor. If this is the case the number corresponds to the temperature at the knee of the derating curve of this capacitor and the number is in degrees centigrade.

Column "T" contains the number of pins emanating from the physical package housing the component, times the number of multiple uses of that component noted in Column "B". This number will be zero for inductors only.

Column "U" contains information significant to capacitors and discrete semiconductors only. If the row corresponds to a capacitor whose part number (Column "E") has the form MXXXXX/XX-XXXX, the information shown indicates the number of capacitors in the data base whose first ten characters are identical. (All other capacitors' part number forms will have a zero in this column.) If Column "U" corresponds to a discrete semiconductor the information shows the knee of the derating curve in degrees Centigrade. If the row corresponds to a discrete semiconductor and the column contains a zero, this means that the data base does not contain information on the knee of the derating curve. Rows corresponding to all other component types should be zero.

Column "V" shows the number of devices contained in each package. A digit greater than zero will be shown in rows corresponding to discrete semiconductors only.

Column "W" shows the small quantity prices at the specified screening level, while Column "X" shows the large quantity (i.e. in quantities of 1000 or more) prices at the specified screening level. Column "Y" shows the number of supply voltages necessary for integrated circuits only.

The Diagnostic file contains a list of each of the parts entered into ORACLE and found to be in the data base or to be decodable by ORACLE. Along with each part is a list of each of the MIL-HDBK-217B parameters used in calculating the part's failure rate, a repetition of some of the information found in the input format, the base failure rate and the resultant failure rate. The MIL-HDBK-217B parameters were derived as a result of noting the application information submitted by the user in the input formats and the stored information located in the data base. Examples are shown in Figure 9. DIAGNOSTIC will also contain comments, should they be necessary, at the beginning of the listing of each part. These comments concern specific information which was not explicitely included - but should have been - in the part input format by the user. It then notes the assumed value which was assigned by RELIABL to the effected parameter or parameters. The assumed value represents the worst case condition for that parameter.

Before proceeding with this example, <u>another example</u> describing the alternative which implements the "quantity" mechanism, will be described. However, before responding to the "quantity" prompt, the user must realize that if his response implements the mechanism which interpretes Columns 8 thru 11 of the input formats as quantities, <u>all</u> of the component parts entered into ORACLE will be assumed to have quantity information in these columns. An example of the implementation of this alternative in RELIABL is shown in Figure 10. (Note that this example is necessarily of <u>another</u> set of parts and was extracted from a different execution of ORACLE.)

```
MOD001:JK01:CAP:    :CKR07BX:100:KP   : /    .70:  80:NV=U:        :   : : :      =0.1
     =0.1       1.1

CKR07BX100KP
CAP
     FRB= 2.96086633E-02. A= 8.900E-04. STRESS=  .70
     NS=  .30. H= 3.00. S= 1.00. TEMP=  80
     NT= 398.. G= 1.00. TR=  7
    FR= 7.10607910E-02. PIF=   8.00. PIQ=    .30
       DUTY CYCLE= 1.00

MOD001:JK01:TC=:NAT:LM205---:--H:+1.0:0/ =0.00:  80:GD=M:   B=2:   : : :      =0.1
     =0.1       =0.1

LM205----H+1.00

     FR=    2.5306.PIL= 1.00.PIQ= 10.00.PIT=13.1644. T= 363.
      PIF= 4.00.C1=.012080.C2=.023509. USAGE= 1.00

MOD001:JK01:IND:    :LT10V06:3  :   : /   .60:  80:GD-M:MILSPC:   : : :       1.1
     =0.1       =0.1

LT10V063
IND
     FRB=  2.03808677E-03. A= 7.200E-04. THS=  80.0. NT= 352.. G= 14.0
       T=  80. STRESS=  .60. TRISE=   0.0
    FR= 7.33711238E-02. FRR=  .0020. PIE= 3.00. PIF=12.00. USAGE= 1.00
```

Figure 9. An Example of some of the results that are found in DIAGNOSTIC.

```
MOR001:ISO1:RES:   :RK098AC:S101:   : /   .70:  A::CP-V: LOAFR:   : : :       10.:
     1.:      -0.:

RK098ACS101
RES
     FRB=  4.36144149F-01, A= 3.580E-02, B= 1.00, T=  80, NT=355.
       G=  5.2A, STRESS=  .70, NS= 1.40, J= 4.46, H= 1.0, TB=  1
     FR= 3.83A06893E+01, FRA=  .4361, PTE= 20,000, PTP=  1.000
      , PT3=  0.000, PTV=  1.100, PITAPS=  1.000

4DR001:JK01:7D-:UNT:1N0995 :   :+0.8:07   .50:  A0:GD-M: JANTX:VRG: : :      -0.:
     -0.:      0.:

1N0995     +0.60
     1N0995
      , A=     .03,+T= -800.,TM= 008.,P= 10.0,DELT= 150.,T= 80.0,S= .5000
       .STRCF=1.0000 TCHPT=    57
     FR=      .200
     FRA=      .01AFTE= 25.0PTA=  1.0PTQ=  1.0USAGF=

MOR001:JK01:VR-:APC:2N3996 :   :+0.8:07   .50:  A0:NV-U:    JAN:LTN: : :      -0.:
     -0.:      0.:

2N3996     +0.80
     2N3996
      , A=     .13,+T=-1052.,TM= 008.,P= 10.5,DELT= 150.,T= 80.0,S= .5000
       .STRCF=1.0000 TDAPT=    92
     FR=      .372FRA=       .021PTF=     25.000PTA=      1.500
       PT.=      2.000PTS2=      .300PTC=      1.000 USAGE=  .80
```

Figure 9. (Cont) An example of some of the results that are found in DIAGNOSTIC.

```
COMMAND- ATTACH,RELIABL,ID=GAERTNER

 PFN IS
 RELIABL:
 PF CYCLE NO. = 001
COMMAND- RELIABL

ENTER EQUIPMENT NAME :      ::::EQPMT4

::::EQPMT4
ENTER SORTED PARTS FILE NAME:        SORTEDXXSAMPTS4

SORTEDXXSAMPTS4
ENTER CYCLE OF SORTED PARTS FILE LIKE 001:      001

  1
ENTER ABSTRACTED DATABASE FILE NAME: ABSDBXXSAMPTS4

ABSDBXXSAMPTS4
ENTER CYCLE OF ABASTACTED DATABASE LIKE 001:   001

  1
 REQUEST(TAPE3,*PF)
 REQUEST(TAPE4,*PF)GO

TYPE 1 IF QUANTITIES ARE USED
TYPE 2 IF MODULE PART NUMBERS ARE USED         1

1
ENTER NUMBER OF TWO-SIDED PC BOARDS LIKE 0001: 0001

  1
ENTER NUMBER OF MULTI-LAYERED PC BOARDS LIKE 0001:       0001

  1    GO
```

Figure 10. The prompts, including the "quantity" prompt, and responses in the RELIABL routine.

Figure 11 shows the results which eminate from RELIABL when the quantities mechanism has been implemented. The list of components shown are those for which the failure rate was not calcaulted. The percentage of parts -- based on the total quantity of components entered -- for which the failure rate was determined is shown following the above mentioned list. In this case that is 99.0%. This is the percent of parts which will be included in the total failure rate which will be observed after the SUM1CTX routine is executed. Thus one will readily know exactly which component types and how many were not included in the total failure rate. Further, based on the percentage given (in this case 99.0%) one will also know the extent of the accuracy of the total module failure rate when he observes the results which eminate from the SUM1CTX routine. In this peripherial example, TAPE4, which eminates from the BINNY routine, will have a list of exactly those parts which were not found in the data base or for which the part number could not be decoded. Figure 12 shows the information which was found on TAPE4. It should be noted that the component types listed in Figure 11 match the components listed in Figure 12. Now we will return to our original example and original parts.

The user will probably notice a longer than expected "pause" at the end of the prompt/response interaction in the RELIABL routine. When this occurs, simply patiently wait for 45, 60, 75 or more seconds, depending upon how many parts have been entered into the program, as the routine is in the process of performing its operations and calculations.

```
FAILURE RATES WERE NOT CALCULATED FOR THE FOLLOWING COMPONENT TYPES
TYPE QUANTITY
 IC-        2
 D--        1
 DCR        1
 VD-        1
 XR-        1
 RY-        1
 TUB        1
 LSR        1
 SW-        1
 ROT        1
 FUS        1


THE TOTAL QUANTITY OF PARTS REPRESENTED IS   1255
THE TOTAL QUANTITY WITH NO FAILURE RATE IS     12
   99.0% OF PARTS READ WERE PROCESSED
 CT ID=   EQPMT4 PFN=DIAGNOSTIC
 CT CY= 001   00005632 WORDS.:
 CT ID=   EQPMT4 PFN=FOUNDO
 CT CY= 001   00001920 WORDS.:
       END  RELIABL
       6.381 CP SECONDS EXECUTION TIME.
```

Figure 11. The resulting print out from RELIABL.when quantities are used. Note that the percent of parts which were processed is the percent of parts which will be included in the total failure rate eminating from the SUMICTX routine.

```
COMMAND- FILES

--LOCAL FILES--
  TAPE4      INPUT      OUTPUT    *BINNY
COMMAND- RETURN,INPUT

COMMAND- DISCARD,OUTPUT

COMMAND- EDITOR

..EDIT,TAPE4,SEQ

..LIST,ALL


   100= MOD0010001IC-NATLH0019---J+1.00         +080GD-M    B-1
   110= MOD0010001IC-SIGN74S114--G+1.00         +080GD-M    B-1
   120= MOD0010001D--FSC1N3071     +0.80+0.50+080GD-M JANTXSMS
   130= MOD0010001DCRMOT1N5414     +0.80+0.50+080GD-M    JAN
   140= MOD0010001VD-TCY1N5470A    +0.80+0.50+080GD-M    JANVRG
   150= MOD0010001XR-TEC2N2155     +0.80+0.50+080GD-M    JANLIN
   160= MOD0010001RY-GES3X1001     +0.60+0.50+080GD-M      B
   170= MOD0010001TUBRCA4X1002     +0.60+0.50+080GD-M      B
   180= MOD0010001LSRTI-5X1003     +0.60+0.50+080GD-M      B
   190= MOD0010001SW-GES6X1004     +0.60+0.50+080GD-M      B
   200= MOD0010001ROTWES7X1005     +0.60+0.50+080GD-M      B
   210= MOD0010001FUSWES8X1006     +0.60+0.50+080GD-M      B
..BYE

COMMAND- RETURN,TAPE4
```

Figure 12. The list of the parts not found in the data base. This list is located on TAPE4 and eminates from the BINNY routine. Note that the list of component types eminating from RELIABL corresponds with this list of parts.

## SUM1CTX

The primary purpose of the SUM1CTX routine is to sum each of the individual part failure rates and produce a total failure rate for the module, as well as determine the module MTBF. This routine will also yield the total component price in small quantities and the price in quantities of 1000. The only input file needed by SUM1CTX is the FOUNDO file which eminated from RELIABL, as it contains each of the individual part failure rates and price information.

With the local files once again cleared the system is now ready to accept SUM1CTX. The entire interactive format and responses are shown in Figure 13. The response to "ENTER INPUT FILE NAME:" will always be FOUNDO. However, the response to the cycle number associated with FOUNDO will correspond to the cycle number noted with the listing of the FOUNDO file at the end of the latest execution of the RELIABL routine. In this case the cycle number of 001. Again, the response to the "ENTER EQUIPMENT NAME:" must be ::::EQPMT2. The users response to the prompt "ENTER OUTPUT FILE NAME:" can be the same for up to five files with the same ID. (Of course, in this case that ID is EQPMT2.) When the same file name is used the user must then increment his response to the "ENTER OUTPUT FILE CYCLE NUMBER LIKE 001:". This output file will be used when the TRADEOF routine is run subsequently and it contains the most significant information of the analysis to this point in the process. It shows the total equipment failure rate in failures per million hours, the equipment MTBF in hours, the total component price in small quantities, and the total component price in quantities of 1000. These results can readily be observed by moving this file into an EDIT file status, as shown in Figure 14.

```
COMMAND- ATTACH,SUM1CTX,ID=GAERTNER

 PFN IS
 SUM1CTX:
 PF CYCLE NO. = 004
COMMAND- SUM1CTX



INPUT FILE INFORMATION

ENTER INPUT FILE NAME:     FOUNDO

FOUNDO
ENTER INPUT FILE CYCLE NUMBER LIKE 001:        001

 1
ENTER EQUIPMENT NAME:
       ::::EQPMT2

::::EQPMT2


OUTPUT FILE INFORMATION

ENTER OUTPUT FILE NAME:    OUT1XXSAMPTS2

OUT1XXSAMPTS2
ENTER OUTPUT FILE CYCLE LIKE 001:    001

 1
ENTER CASE NUMBER LIKE 001:          001

CASE=    1
 REQUEST(TAPE3,*PF)
 CT ID=   EQPMT2 PFN=OUT1XXSAMPTS2
 CT CY= 001  00000128 WORDS.:
      END  SUM137
       .622 CP SECONDS EXECUTION TIME
```

Figure 13. The interactive SUM1CTX routine and the resultant output file.

```
COMMAND- ATTACH,LOOK,OUT1XXSAMPTS2,ID=EQPMT2

 PF CYCLE NO. = 001
COMMAND- EDITOR

..EDIT,LOOK,SEQ

..LIST,ALL


   100= CASE NO.:    1
   110= TOTAL FAILURE RATE FOR CASE    1:       300.16 FAILURES PER MILLIO
N HOURS
   120= EQUIPMENT MTBF FOR CASE    1:       3331.6 HOURS
   130= TOTAL COMPONENT PRICE IN SMALL QUANTITIES FOR CASE    1: $
 0.00
   140= TOTAL COMPONENT PRICE IN 1000 QUANTITIES  FOR CASE    1: $
 0.00
..BYE

COMMAND- FILES

--LOCAL FILES--
 *LOOK     *3INNY     *RELIABL  *SUM1CTX    INPUT
  OUTPUT
COMMAND- RETURN,INPUT,LOOK

COMMAND- DISCARD,OUTPUT
```

Figure 14. A listing of the output file eminating from SUM1CTX. The total failure rate for all of the parts entered is shown as is the collective MTBF for these parts.

The "What-if" Game

Once a module failure rate and MTBF has been determined this becomes a basis for comparison and subsequently one can then change certain application conditions incumbent upon the parts or equipment. The purpose behind this procedure is to observe the effect on the individual and the collective failure rate and MTBF which results by changing the operating temperature and/or the operating environment and/or the part screening level, etc. After making these changes a new collective failure rate and MTBF, for the same parts, can be obtained under the modified conditions. We then have an alternate case for comparison with the initial case. A tradeoff analysis is then performed between the original conditions in the initial case and the modified conditions in the alternate case. The results will yield the numerical and percentage differences in the failure rates and the MTBFs between the two cases. This tradeoff analysis (see Figure 2) will be achieved thru utilization of the TRADEOF routine.

Now that the module failure rate and MTBF have been obtained for our list of parts we can play the "what-if" game. First one brings the original sorted parts list file into edit file condition and makes changes. This file is the sorted parts file named in the "CATALOG" statement shown immediately after the SORTMRG program in Figure 5. As an example of a typical change, one may want to modify the operating temperature. This modification is shown in Figure 15 with the temperature changed from "+080" to "+070". After making the changes one must first SAVE the modified data file and then "CATALOG" it onto a permanent file. In this case the assigned name is MODXXSORTEDXXSAMPTS2. After changes have been made one must then obtain the

```
COMMAND- ATTACH,SORTEDXXSAMPTS2,ID=EQPMT2

 LFN IS
 SORTEDX:
 PF CYCLE NO. = 001
COMMAND- EDITOR

..EDIT,SORTEDX,SEQ

..LIST,LAST

  1330= MOD001JK01IC-FSC5404---6AM+1.00      +080GD-M    B-2
..F,CH=80

../+080/=/+070/,ALL

  124 CHANGES
..SAVE,MPTS1,N

..CATALOG,MPTS1,MODXXSORTEDXXSAMPTS2,ID=EQPMT2

 INITIAL CATALOG
 RP = 090 DAYS
 CT ID=   EQPMT2 PFN=MODXXSORTEDXXSAMPTS2
 CT CY= 001  00001024 WORDS.:
..BYE

COMMAND- FILES

--LOCAL FILES--
 *BINNY    *RELIABL  *SUM1CTX  *MPTS1     *SORTEDX
COMMAND- RETURN,MPTS1,SORTEDX
```

Figure 15. Procedure used to change conditions incumbent upon the parts. In this case the operating temperature was changed from +080$^{0}$ C to +070$^{0}$C.

total failure rate and MTBF for the new case (in this situation, case 2) before one can make a comparison between the two cases. Thus one first repeats the execution of the RELIABL and the SUM1CTX routines (with the modified data) and then utilizes the TRADEOF routine. Of course the local files must again be cleaned up, as shown at the bottom of Figure 15.

RELIABL Repeated

The RELIABL format and responses are shown in Figure 16. It must be noted that the name entered in response to the prompt "ENTER SORTED PARTS FILE NAME:" must be the same as that given in the "CATALOG" statement immediately following the modification procedures. This statement is shown in Figure 15 and, in this case, the name is MODXXSORTEDXXSAMPTS2. The cycle number asked for is the one shown after the notation "CY" in the "INITIAL CATALOG" compilation shown in Figure 15. The response to the request for the abstracted data base must be the same as that used in the initial RELIABL program response. (See Figure 7) After the prompts have been given and the responses entered, the cataloging of the new DIAGNOSTIC and FOUNDO files will be shown. Because the names of the two files emanating from RELIABL will always be the same and be assigned by ORACLE and as long as the file ID assigned by the user is consistent for a given set of parts, ORACLE will automatically increment the cycle number assigned to each file by one (up ... 005) over the last execution of RELIABL on the same set of parts. As has been noted before, the "REQUEST (TAPE3*PF)" and the "REQUEST (TAPE4*PF)" shown in Figure 16, are not intended prompts, should not really be there, and are to be ignored.

```
COMMAND- RELIABL

ENTER EQUIPMENT NAME :     ::::EQPMT2

::::EQPMT2
ENTER SORTED PARTS FILE NAME:       MODXXSORTEDXXSAMPTS2

MODXXSORTEDXXSAMPTS2
ENTER CYCLE OF SORTED PARTS FILE LIKE 001:     001

  1
ENTER ABSTRACTED DATABASE FILE NAME: ABSDBXXSAMPTS2

ABSDBXXSAMPTS2
ENTER CYCLE OF ABASTACTED DATABASE LIKE 001:   001

  1
TYPE 1 IF QUANTITIES ARE USED
TYPE 2 IF MODULE PART NUMBERS ARE USED        2
ENTER NUMBER OF TWO-SIDED PC BOARDS LIKE 0001:
 REQUEST(TAPE3,*PF)
 REQUEST(TAPE4,*PF)0001

  1
ENTER NUMBER OF MULTI-LAYERED PC BOARDS LIKE 0001:      0001

  1    GO

 CT ID=   EQPMT2 PFN=DIAGNOSTIC
 CT CY= 002  00004928 WORDS.:
 CT ID=   EQPMT2 PFN=FOUNDO
 CT CY= 002  00001920 WORDS.:
      END  RELIABN
      6.386 CP SECONDS EXECUTION TIME
COMMAND- FILES

--LOCAL FILES--
  INPUT     OUTPUT   *BINNY    *RELIABL  *SUM1CTX
COMMAND- RETURN,INPUT

COMMAND- DISCARD,OUTPUT
```

Figure 16. Repeat of the RELIABL routine. Note that the modified sorted parts list is used.

SUM1CTX Repeated

After again cleaning-up the local files -- as shown at the bottom of Figure 16 -- one immediately proceeds to the SUM1CTX program (See Figure 17). Three things should be noted here. One is that the cycle asked for on the "ENTER INPUT FILE CYCLE NUMBER, LIKE 001:" prompt must correspond to the above FOUNDO cycle number--see bottom of Figure 16. In this case that number is 002. The second thing to note is that a new output file name is given in response to the "ENTER OUTPUT FILE NAME" prompt. However, if the user repeats the name he assigned to the output file in the previous execution of SUM1CTX, he must then respond to the "ENTER OUTPUT FILE CYCLE LIKE 001:" prompt, with 002 -- that is, an increment of one over his previous response to this prompt. This file corresponds to the newly changed data and will contain the statistical analysis resulting from the modified data file created in Figure 15. The third point is that the "CASE" number should be increment by one for each new case -- in this situation that will be 2. In order to observe the calculated failures per million hours and the MTBF, one proceeds as shown in Figure 18.

TRADEOF

Finally one, once again, cleans-up the local files and proceeds with the TRADEOF program. The TRADEOF program format is self-explanatory. The only things one must be aware of are the names of the two files which contain the resulting statistical analysis for each case -- i.e. the "reference case" and the "comparison case". The TRADEOF routine is shown in Figure 19, while Figure 20 shows the comparison analysis.

It should be noted that if one attaches TRADEOFF -- i.e. using two F's in the spelling -- one will obtain a cost tradeoff analysis also.

```
COMMAND- SUM1CTX


INPUT FILE INFORMATION

ENTER INPUT FILE NAME:     FOUNDO

FOUNDO
ENTER INPUT FILE CYCLE NUMBER LIKE 001:        002

 2
ENTER EQUIPMENT NAME:
       ::::EQPMT2

::::EQPMT2


OUTPUT FILE INFORMATION

ENTER OUTPUT FILE NAME:    OUT2XXMODXXSAMPTS2

OUT2XXMODXXSAMPTS2
ENTER OUTPUT FILE CYCLE LIKE 001:    001

 1
ENTER CASE NUMBER LIKE 001:          002

CASE=   2
 REQUEST(TAPE3,*PF)
 CT ID=   EQPMT2 PFN=OUT2XXMODXXSAMPTS2
 CT CY= 001  00000128 WORDS.:
      END  SUM137
       .613 CP SECONDS EXECUTION TIME
```

**Figure 17. Repeat of the SUM1CTX routine. Note that the cycle of the FOUNDO file must be the most recent one.**

```
COMMAND- ATTACH,OUT2XXMODXXSAMPTS2,ID=EQPMT2

 LFN IS
 OUT2XXM:
 PF CYCLE NO. = 001
COMMAND- EDITOR

..EDIT,OUT2XXM,SEQ

..LIST,ALL


   100= CASE NO.:    2
   110= TOTAL FAILURE RATE FOR CASE    2:       229.61 FAILURES PER MILLIO
N HOURS
   120= EQUIPMENT MTBF FOR CASE    2:       4355.2 HOURS
   130= TOTAL COMPONENT PRICE IN SMALL QUANTITIES FOR CASE    2: $
 0.00
   140= TOTAL COMPONENT PRICE IN 1000 QUANTITIES  FOR CASE    2: $
 0.00
..BYE

COMMAND- FILES

--LOCAL FILES--
  INPUT    *BINNY    *OUT2XXM  *RELIABL  *SUM1CTX
  OUTPUT
COMMAND- RETURN,INPUT,OUT2XXM

COMMAND- DISCARD,OUTPUT
```

**Figure 18.** A listing of the output file eminating from SUM1CTX after the modification of conditions on the parts.

```
COMMAND- ATTACH,TRADEOF,ID=GAERTNER

 PFN IS
 TRADEOF:
 PF CYCLE NO. = 002
COMMAND- TRADEOF

ENTER EQUIPMENT NAME :      ::::EQPMT2

::::EQPMT2
ENTER REFERENCE CASE FILE NAME:      OUT1XXSAMPTS2

OUT1XXSAMPTS2
ENTER CYCLE OF REFERENCE CASE LIKE 001:        001

  1
ENTER COMPARISON CASE FILE NAME:     OUT2XXMODXXSAMP"S2

OUT2XXMODXXSAMPTS2
ENTER CYCLE OF COMPARISON CASE LIKE 001:       001

  1 .
```

Figure 19. The interactive TRADEOF routine.

```
COMPARISON BETWEEN CASES    1 AND    2

TOTAL FAILURE RATE FOR CASE    1:      300.16 FAILURES PER MILLION HOURS

TOTAL FAILURE RATE FOR CASE    2:      229.61 FAILURES PER MILLION HOURS

DIFFERENCE IN FAILURE RATES
      BETWEEN CASES    1 AND    2:      -70.55 FAILURES PER MILLION HOURS

PERCENT CHANGE IN FAILURE RATE : -23.50%

EQUIPMENT MTBF FOR CASE    1:      3331.6 HOURS
EQUIPMENT MTBF FOR CASE    2:      4355.2 HOURS
DIFFERENCE IN EQUIPMENT MTBF
   BETWEEN CASES    1 AND   2:      1023.6 HOURS
PERCENT CHANGE IN MTBF: 30.72%

      END  TO14037
       .077 CP SECONDS EXECUTION TIME
COMMAND- FILES

--LOCAL FILES--
 *BINNY    *RELIABL   *SUM1CTX   *TRADEOF    INPUT
  OUTPUT
COMMAND-
```

Figure 20. Results of the TRADEOF routine.

## SUMMARY

The basic flow of ORACLE is shown in Figures 1 and 2. These two block diagrams provide one with a complete overview of the routines used in ORACLE and the order in which they are executed. ORACLE is basically an automated MIL-HDBK-217B, as it readily yields the failure rates for integrated circuits, transistors, a variety of diodes, capacitors, resistors, and inductors. Resistors, certain capacitors, and certain inductors, however, will not be found in the data base as their part number contains enough information to produce its individual failure rate without residing in the data base. In order to determine the failure rates of integrated circuits, transistors, diodes, some capacitors, and some inductors, their part number, etc. must be located in the data base. The BINNY routine will determine if an entered integrated circuit, transistor, diode, capacitor or inductor is decodable. This information can be obtained in the DIAGNOSTICBINNY file. For those parts which are not either "matched" in the data base or "decodable", BINNY will list them on a file labeled TAPE4. This file can be observed after BINNY has been executed. BINNY also generates the abstracted data base which is used by RELIABL to aid in the determination of the failure rate of each part which has been matched or determined to be decodable.

Probably the most interesting information generated by ORACLE is contained in the two files which eminate from the RELIABL routine. The file labeled DIAGNOSTIC contains a complete list of each and every parameter used in determining the failure rate, as well as the final failure rate itself, for each part that was found in the data base or found to be decodable. (Examples are shown in Figure 9.) FOUNDO contains a sorted (by part number) list of every part that was inserted into RELIABL. The format for each part is the same as its input format. In addition this file contains the calculated failure rate and quantity prices for each part. It is in this file that one can quickly and easily scan the list of parts and find each individual failure rate (See Figure 8). The sum of these failure rates will yield the total shown after the execution of the SUM1CTX routine (See Figure 14).

While SUM1CTX simply adds all of the individual part failure rates and then calculates an overall MTBF, TRADEOF is used to obtain a difference in failure rates and MTBFs between two cases. Each case consists of the same identical set of parts; however, the conditions incumbent upon these parts will be altered for each subsequent case. For example, the operating environment, operating temperature, duty cycle, stress, part screening level, etc. can be changed to observe the effect on the individual and resultant total failure rates. The tradeoff analysis is probably the nicest feature of ORACLE because one can readily play the "what-if" game in noting those application and environmental conditions which will yield different failure rates.

# APPENDIX I

## INPUT FORMATS

The following pages of this appendix contain a copy of each of the five input formats and notes which are necessary to aid the user in entering information into the format.

## INTEGRATED CIRCUITS

| MODULE NUMBER | MODULE PART NUMBER | COMPONENT TYPE | MANUFACTURER CODE | PART NUMBER | PACKAGE | DUTY CYCLE OR USAGE | STRESS | OPERATING TEMPERATURE | OPERATING ENVIRONMENT | SCREENING LEVEL | |
|---|---|---|---|---|---|---|---|---|---|---|---|

NOTE: The applicable screening levels are: A, B, B-1, B-2, C, and D. These are all right justified.

Figure A-1. Input format for integrated circuits.

DISCRETE SEMICONDUCTORS

| MODULE NUMBER | MODULE PART NUMBER | COMPONENT TYPE | MANUFACTURER | PART NUMBER | DUTY CYCLE OR USAGE | STRESS NOTE 3 | OPERATING TEMPERATURE | OPERATING ENVIRONMENT | SCREENING LEVEL | APPLICATION CODE, NOTE 1 | HEATSINK NOTE 4 | TEMP NOTE 5 | Q1 (NOTE 6) | Q2 (NOTE 6) | APPLIED VOLTAGE (NOTE 2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

Notes:
1. Enter the application code if the device falls into Groups I, II, IV, or V only.
2. Enter the applied voltage in volts for Groups I and IV only.
3. If stress is entered, there is no need to fill in Cols. 56 through 80 (except for applied voltage for Groups I and IV, as per Note 2).
4. If stress is not entered, enter "H" if the device is used with a heatsink.
5. If stress is not entered, enter "A" for ambient or "C" for case, indicating which temperature is given in the operating temperature field.
6. If stress is not entered, and the device is in Groups
   a. I, II or III, enter in field Q1 the power dissipated in watts in the side being evaluated. If it is a dual device, also enter in field Q2 the power dissipated in watts in the side not being evaluated.
   b. IV or VI, enter in field Q1 the average forward current in amps.
   c. V, enter either the power dissipated in watts in field Q1, or the operating current in amps in field Q2.
   d. VII, enter in field Q1 the operating spike leakage in ergs.
   e. VIII, enter in field Q1 the power dissipated in watts.

| GROUP | | DEVICE TYPE |
|---|---|---|
| I | TRANSISTORS | SI and GE NPN and PNP |
| II | TRANSISTORS | FET |
| III | TRANSISTORS | Unijunction |
| IV | DIODES | SI and GE General Purpose |
| V | DIODES | Zener/Avalanche |
| VI | DIODES | Thyristors |
| VII | DIODES | Microwave SI and GE detectors and mixers |
| VIII | DIODES | Varacter, step recovery and tunnel |

Figure A-2. Input format for discrete semiconductors.

The valid Application Codes for discrete semiconductors are as follows:

| Code | Application Description |
|---|---|
| LIN | Linear |
| LGS | Logic Switch (ING) |
| HFQ | High Frequency (RF 400 MHz) |
| SMS | Small Signal ( 500 ma) |
| PRS | Power Rectifier ( 500 ma) |
| PRH | Power Rectifier (H.V. Stacks) Vmax 600 |
| VRG | Voltage Regulator |
| VRF | Voltage Reference (Temp. Compensated) |

## CAPACITORS

| MODULE NUMBER | MODULE PART NUMBER | COMPONENT TYPE | MANUFACTURER | PART NUMBER (15 cols.) | STRESS | OPERATING TEMPERATURE | OPERATING ENVIRONMENT | SCREENING LEVEL (NOTE 2) | | OPERATING VOLTAGE (NOTE 1) | SERIES RESISTANCE (NOTE 3) | DUTY CYCLE OR USAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

Note: 1. If stress is not entered, enter the operating voltage in volts.
2. Screening level is necessary for only the following types of capacitors: CB, CC, CE, CV, and PC. All other types include the screening level as a code in the part number.
3. For type M39003/XX-XXXX the series resistance must be entered.

One must enter capacitor type CYR as M23269/XX-XXXX, CSR as M39003, CLR as M39006, and CU as M39018. The applicable screening levels are: UPPER, MILSPC, and LOWER. This information is right justified.

Figure A-3. Input format for capacitors.

RESISTORS

| MODULE NUMBER | MODULE PART NUMBER | COMPONENT TYPE | MANUFACTURER | PART NUMBER (15 cols.) | STRESS | OPERATING TEMPERATURE | OPERATING ENVIRONMENT | SCREENING LEVEL | | NOTE 3 | Q1 (NOTE 1,2) | DUTY CYCLE OR USAGE | Q3 (NOTE 4) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |

Note: 1. For all types, except RTH, if stress is not entered, the operating power, in watts, must be entered in field Q1. (entered information is right justified)

2. For Types RA, RJ, RK, and RP, both the stress and the operating power, in watts, must be entered in field Q1. For Types RR, RT, and RTH, both the stress and the operating voltage, in volts, must be entered in field Q1. (entered information is right justified)

3. For Type RER an "A" must be entered in column 55 for free air mount, while a "B" must be entered for chassis mount.

4. For Types RA, RJ, RK, RR, RP, and RV, the number of taps, if greater than 3, must be entered in field Q3. (entered information is right justified)

Figure A-4. Input format for resistors.

**INDUCTORS**

| MODULE NUMBER | MODULE PART NUMBER | COMPONENT TYPE | MANUFACTURER | PART NUMBER (15 cols.) | STRESS NOTE 1 | OPERATING TEMPERATURE | OPERATING ENVIRONMENT | SCREENING LEVEL | | DUTY CYCLE OR USAGE | |
|---|---|---|---|---|---|---|---|---|---|---|---|

Note: The applicable screening levels are: UPPER, MILSPC, and LOWER. These are right justified.

Figure A-5. Input format for inductors.

# APPENDIX II

A failure rate will be calculated for the following component types.

| Code | Component |
| --- | --- |
| IC- | Integrated Circuit |
| XR- | Transistor |
| D-- | Diode, General Purpose |
| ZD- | Diode, Zener |
| RD- | Diode, Voltage Reference |
| VD- | Diode, Varactor |
| DCR | Thyristor |
| RES | Resistor |
| CAP | Capacitor |
| IND | Inductor |
| PCB | Printed Circuit Board |

The following components are acceptable by ORACLE but at this time the determination of the failure rate has not been provided for.

| Code | Component |
| --- | --- |
| ROT | Rotating Devices |
| RY- | Relay |
| SW- | Switch |
| CON | Connectors |
| TUB | Tube |
| LSR | Laser |
| XTL | Quartz Crystal |
| FUS | Fuse |
| NL- | Neon Lamp |
| INC | Incondescent Lamp |
| MTR | Meter |
| WW- | Wire Wrap Connection |
| HSC | Hand Soldered Connection |

# APPENDIX III

The following list is a list of manufacturer codes listed in alphabetical order:

| Code | Manufacturer |
|---|---|
| AMI | American Micro-Systems, Inc. |
| APX | Amperx Electronic Corp. |
| AMC | Ampower Semiconductor Corp. |
| AVA | Avantek, Inc. |
| CEI | Calvert Electronics International, Inc. |
| CSI | Carter Semiconductor, Inc. |
| CLA | Clirex Electronics |
| CTR | Communications Transistor Corp. |
| CRI | Crimson Semiconductor, Inc. |
| CSR | CSR Industries, Inc. |
| DEL | Delco Electronic Div. |
| ESI | Electro-State Industries, Inc. |
| ETC | Electronic Transistors, Corp. |
| FSC | Fairchild Semiconductor Corp. |
| GES | General Electric Co. |
| GIC | General Instrument Corp. |
| GSE | General Semiconductor Industries, Inc. |
| GSI | General Sensors, Inc. |
| GPD | Germanium Power Devices Corp. |
| HSC | Helios Semiconductor |
| HPA | Hewlett Packard |
| HZN | Horizon Semiconductor Corp. |
| INT | Intel |
| IDI | International Devices, Inc. |
| IDC | International Diode Corp. |
| INL | Intersil, Inc. |
| ITT | ITT Semiconductors |
| KER | Kertron, Inc. |
| KMC | KMC Semiconductor |
| MWS | Microwave Semiconductor Corp. |
| MOT | Motorola |

| Code | Manufacturer |
| --- | --- |
| NAT | National Semiconductor Corp. |
| NTR | National Transistor Corp. |
| NJS | New Jersey Semiconductor Products Co. |
| NPC | Nucleonic Products Co., Inc. |
| PPC | Power Physics Corp. |
| PTI | Power Tech, Inc. |
| PRE | Precision Semiconductors, Inc. |
| RTN | Raytheon |
| RCA | RCA Corp. |
| SCA | Semicoa |
| SDE | Semiconductor Devices |
| STI | Semiconductor Technology, Inc. |
| SEI | Semiconductors, Inc. |
| SES | Semitronics Corp. |
| SEN | Sensitron Semiconductors |
| SIG | Signetics |
| STC | Silicon Transistor Corp. |
| SIX | Siliconix, Inc. |
| SPC | Solid Power Corp. |
| SST | Solid State, Inc. |
| SSI | Solid State Devices, Inc. |
| SSE | Solid State Electronics Co. |
| SLD | Solid State Industries, Inc. |
| SSS | Solid State Scientific, Inc. |
| SOD | Solitron Devices, Inc. |
| SPR | Sprague Electric Co. |
| STL | Stow Laboratories, Inc. |
| SWT | Swampscott Electronics Co. |
| TCY | Teledyne Crystalonics, Inc. |
| TSC | Teledyne Semiconductor |
| TI- | Texas Instrument, Inc. |
| TEC | Transitron Electronic Corp. |
| TRW | TRW Semiconductors, Inc. |
| UTS | Uni-Tran Semiconductor Corp. |
| UNI | Unitrode Corp. |
| UPI | UPI Semiconductor |
| WAB | Walbern Devices, Inc. |
| WES | Westinghouse Electric Corp. |

# APPENDIX IV

The following is a list of Environmental Classification Codes:

| Code | Application Environment |
|---|---|
| AB-I | Airborne, Inhabited |
| AB-U | Airborne, Uninhabited |
| GD-B | Ground, Benign |
| GD-F | Ground, Fixed |
| GD-M | Ground, Mobile |
| NV-S | Naval, Sheltered |
| NV-U | Naval, Unsheltered |
| MS-L | Missile or Satellite Launch |
| SPFL | Space Flight |

# APPENDIX V

## HOW TO ENTER A PART INTO THE DATABASE

This Appendix contains guidelines for entering data into the abstracted and the regular data base. Although the format is the same for both, for some column segments, that which is entered in one is slightly different from that which is entered in the other. The information given here is directed toward the entry of data into the abstracted data base.

Part Number: The part number is entered left justified in the field provided, all other data is right justified in the field.

The units to be used are given below:

| Quantity | Unit |
|---|---|
| Voltage | Volts |
| Current | Amperes |
| Power | Watts |
| Temperature | Degrees Centigrade |

Use scientific notation for fields between columns 52 and 77.

The following format is used to read a line of data from the database:

| Column | Format | Column | Format |
|---|---|---|---|
| 1 | 1X | 49-51 | F3.1 |
| 2-4 | A3 | 52-60 | E9.3 |
| 5-7 | A3 | 61-69 | E9.3 |
| 8-14 | A7 | 70-77 | E8.3 |
| 15-17 | A3 | 78-101 | 3A8 |
| 18-21 | A4 | 102-103 | I2 |
| 22-25 | A4 | 104-105 | I2 |
| 26 | A1 | 106-108 | A3 |
| 27 | A1 | 109-111 | I3 |
| 28-31 | A4 | 112-114 | I3 |
| 32-36 | I5 | 115 | I1 |
| 37-40 | F4.2 | 116-121 | F6.2 |
| 41-44 | F4.2 | 122-127 | F6.2 |
| 45-48 | F4.2 | 128 | I1 |

Integrated Circuits

| Column | Use |
|---|---|
| 1 | Blank |
| 2-4 | Device type: IC- |
| 5-7 | Manufacturer Code (See Appendix III) |
| 8-17 | Part number and package<br>Left justify part number (columns 8-14)<br>Right justify package type (columns 15, 16, 17)<br>Dash "-" fill between part number and package |
| 18-21 | Function code, all ICs are 0000 series function codes (this is a program definition, not a manufacturer definition) |
| 22-26 | Type of technology (BIPOL, RAM--) |
| 27 | Level of integration (L, M, S) |
| 28-31 | Logic type, left justify, dash fill<br>(LIN-, TTL-, DTL-, MEMR, MOS) |
| 32-36 | Date part is entered (YMMDD)<br>Y = last digit of year<br>MM = two digit month, 01 = January<br>DD = day of month, 01 = first |
| 37-40 | Package length, right justify - in cm.<br>(decimal pt. col. 38) |
| 41-44 | Package width, right justify - in cm.<br>(decimal pt. col. 42) |
| 45-48 | Package height, right justify - in cm.<br>(decimal pt. col. 46) |
| 49-51 | Package weight, right justify - in grams<br>(decimal pt. col. 50) |
| 52-60 | Supply voltage (if more than one line use a continuation line)<br>5. volts entered as 0.500E+01<br>-25. volts enterex as -.250E+02 |
| 61-69 | Nominal current (if more than one line use a continuation line)<br>5. amps entered as 0.500E+01<br>2.5 amps entered as 0.250E+01 |

| Column | Use |
|---|---|
| 70-77 | Maximum current (if more than one line use a continuation line)<br>5. amps entered as .500E+01<br>2.5 amps entered as .250E+01 |
| 78-101 | Blank |
| 102-105 | Complexity, number of gates, assume 4 transistors per gate, right justify. For example, 400 transistors means that 100 is entered as a complexity factor |
| 106-108 | Leave blank |
| 109-111 | Number of leads, right justify |
| 112-114 | Number of wires, right justify |
| 115 | Number of metalization layers |
| 116-121 | Cost in single quantity XXX.XX, right justify |
| 122-127 | Cost in 1000 quantity XXX.XX, right justify |
| 128 | Continuation digit<br>0 if next line does not apply to this part also<br>1 if next line does apply to this part also |

The first 21 columns must be repeated on subsequent continuation lines

## Discrete Semiconductors

| Column | Use |
|---|---|
| 1 | Blank |
| 2-4 | Device type:<br>XR- Transistor<br>D-- Diode, general purpose<br>RD- Reference diode<br>ZD- Zener diode<br>VD- Varactor diode<br>THY Thyristor |
| 5-7 | Manufacturer code (See Appendix III) |
| 8-17 | Part number, left justify |
| 18 | Derating knee temperature code:<br>A Ambient<br>C Case |
| 19-25 | Blank |
| 26-27 | Material (SI, GE):<br>SI Silicon<br>GE Germanium |
| 28-31 | Device reference field, left justify entry<br>NPN<br>PNP<br>COM Complementary pair<br>UJT Unijunction<br>SCR Silicon controlled rectifier<br>NFT N channel field effect transistor<br>PFT P channel field effect transistor<br>DGP Diode, general purpose<br>DMM Diode, microwave mixer<br>DVM Diode, microwave varactor<br>DTU Diode, tunnel<br>VSD Diode, varactor and step recovery<br>DUD Diode, UHF detector<br>DUM Diode, UHF mixer |
| 32-36 | Date part is entered (YMMDD)<br>Y = last digit of year<br>MM = two digit month<br>DD = day of month |

| Column | Use |
|---|---|
| 37-40 | Package length, right justify - in cm. (decimal pt. col. 38) |
| 41-44 | Package width, right justify - in cm. (decimal pt. col. 42) |
| 45-48 | Package height, right justify - in cm. (decimal pt. col. 46) |
| 49-51 | Package weight, right justify - in grams (decimal pt. col.50) |
| 52-60 | Enter the appropriate quantity according to the following table: (use scientific notation) |

| Cols. 2-4 incl. of part | Description of quantity |
|---|---|
| XR- | Maximum rated voltage |
| D-- | Maximum rated voltage |
| ZD- | Rated Zener voltage |
| RD- | Rated Zener voltage |
| VD- | Maximum rated voltage |
| THY | Maximum rated voltage |

| Column | Use |
|---|---|
| 61-69 | Enter the appropriate quantity according to the following table: (use scientific notation) |

| Cols. 2-4 incl. of part | Description of quantity |
|---|---|
| XR- or D-- or THY | Maximum rated current |
| ZD- or RD- or VD | Zero |

| Column | Use |
|---|---|
| 70-77 | Enter the appropriate quantity according to the following table: (use scientific notation) |

| Cols. 2-4 incl. of part | Description of quantity |
|---|---|
| XR- or ZD- or RD- or VD- | Maximum rated power |
| D-- | Zero, unless it is a microwave mixer or microwave detector, then enter the maximum spike leakage in ergs. |

| Column | Use |
|---|---|
| 78-106 | Blank |

| Columns | Use |
|---|---|
| 107-108 | Complexity code such as follows:<br>SD Single device<br>DM Dual matched<br>DU Dual unmatched<br>DT Darlington<br>DE Dual emitter<br>ME Multiple emitter<br>CT Dual complementary<br>DG Tetrode |
| 109-111 | Maximum rated temperature |
| 112-114 | Knee of derating cure temperature |
| 115 | Number of devices in package. Example: Dual transistor means a 2 is entered. |
| 116-121 | Cost in single quantity XXX.XX |
| 122-127 | Cost in 1000 quantitites XXX.XX |
| 128 | Continuation character, if needed<br>0 = no continuation<br>1 = next line is a continuation<br><br>On a continuation, the first 17 columns must be repeated |

## Capacitors

The database for capacitors is not a full database. The majority of capacitor part numbers can be decoded by the software; however, part numbers starting with "M" must be entered in the database in the following manner:

| Column | Description |
|---|---|
| 1 | Blank |
| 2-4 | Device code: CAP |
| 5-7 | Manufacturer code (See Appendix III for codes) |
| 8-17 | Part number; enter the first ten characters of the part number in this field. Example: if a part number is M39022/07-1022, you enter M39022/07- in this field. |
| 18-36 | Blank |
| 37-40 | Component length, right justified - in cm.(decimal pt.col.38) |
| 41-44 | Component width, right justified - in cm.(decimal pt. col.42) |
| 45-48 | Component height, right justified - in cm.(decimal pt. col.46) |
| 49-51 | Component weight, right justified - in grams(decimal pt. col. 50 |
| 52-60 | Rated voltage - use scientific notation e.g. 5.0 volts is entered as 0.500E+01 |
| 61-77 | Blank |
| 78-81 | Quality level "L" last four digits of part number or -001 if none |
| 82-85 | Quality level "M" last four digits of part number or -001 if none |
| 86-89 | Quality level "P" last four digits of part number or -001 if none |
| 90-93 | Quality level "R" last four digits of part number or -001 if none |
| 94-97 | Quality level "S" last four digits of part number or -001 if none |
| 98-101 | Quality level "T" last four digits of part number or -001 if none |

| Column | Description |
|---|---|
| 102-105 | Non-established quality level last four digits of part number or -001 if none |
| 106-109 | Knee of derating curve temperature |
| 109-111 | Maximum rated temperature |
| 112-114 | Quantity, the number of continuous part numbers beginning with the last four digits of a part number in all of the quality level fields and ending with that number plus this quantity minus one. The voltage entered on this line must be for all the parts represented on the line. If a change in rated voltage occurs within a continuous group of part numbers, you must use a new line. |
| 115 | Blank |
| 116-121 | Cost of single quantity XXX.XX |
| 122-127 | Cost of 1000 quantity XXX.XX |
| 128 | Continuation characters, 1 means the next line is a continuation of information for the ten-digit part number entered in columns 8-17. 0 means the next line is not a continuation of information for the ten-digit part number entered in columns 8-17 of this line. |

On a continuation, the first 17 columns must be repeated.

## nductors

| Column | Description |
|---|---|
| 1 | Blank |
| 2-4 | Device code: IND |
| 5-7 | Manufacturer code (See Appendix III) |
| 8-21 | Part number, left justified |
| 22-27 | Blank |
| 28-31 | Temperature rise, which can be calculated from the following formula:<br><br>TRISE = (PLOSS X 125.)/AREA<br><br>where<br><br>TRISE = the temperature rise in degrees C<br>PLOSS = the power loss in watts at 100% load<br>AREA = the radiating area of the device in square inches. |
| 32-36 | Blank |
| 37-40 | Component length, right justified-in cm.(decimal pt. col. 38) |
| 41-44 | Component width, right justified-in cm.(decimal pt. col. 42) |
| 45-48 | Component height, right justified-in cm.(decimal pt. col. 46) |
| 49-51 | Component weight, right justified-in grams(decimal pt. col.50) |
| 52-127 | Blank |
| 128 | Continuation character, 1 means the next line is a non-unique part number within the first ten digits; 0 means the next part number of unique - i.e. no continuation.<br><br>On a continuation, the first 21 columns must be repeated. |