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FLEET RELIABILITY ASSESSMENT PROGRAM. VOLUME 5. AN/URC-62 VLF F--ETC(U)
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# LEVEL III

(12)

## VOLUME 5

# FINAL REPORT

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# FLEET RELIABILITY ASSESSMENT PROGRAM

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# AN/URC-62 VLF FLEET BROADCAST SYSTEM

## NAVAL WEAPONS SUPPORT CENTER CRANE, INDIANA

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(9) FINAL REPORT.

(6) FLEET RELIABILITY ASSESSMENT PROGRAM.

Volume 5.

AN/URC-62
VLF FLEET BROADCAST SYSTEM. Volume 3.

NAVAL WEAPONS SUPPORT CENTER
CRANE, INDIANA

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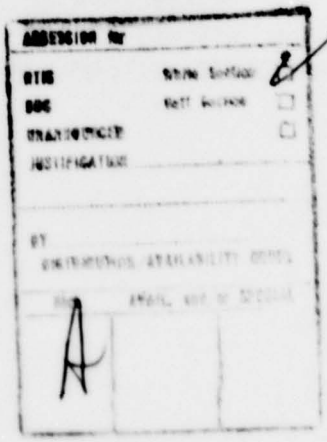
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FLEET RELIABILITY ASSESSMENT PROGRAM

DEPARTMENT OF THE NAVY

NAVAL ELECTRONIC SYSTEMS COMMAND

PREPARED UNDER THE DIRECTION OF

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| B | SAMPLING MATRIX |
| C | DATA CODING |
| D | DATA ANALYSIS |
| E | LOGISTICS MODEL |
| F | GLOSSARY OF TERMS |

VOLUME 5 AN/URC-62 EQUIPMENT REPORT

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## SECTION I - INTRODUCTION

### 1-1 CLARINET VERDIN, AN/URC-62.

1-1.1 Verdin is a Very Low Frequency (VLF) Fleet broadcast system intended primarily for transmission to submerged submarines. Four separate equipments make up the Verdin System. Of these, only two were operationally deployed during the FRAP study, the AN/ART-50 airborne transmitter and the AN/WRR-7 shipboard receiver.

## SECTION II - RESULTS.

### 2-1 AIRBORNE AN/ART-50 VLF TRANSMITTER.

2-1.1 FRAP SAMPLE RESULTS. The estimated mean time between operational failures is 150 hours. The estimated mean time between equipment failures is 169 hours. The AN/ART-50 is considered to be meeting the piece-parts predicted (MIL-HDB-217) MTBF of 169 hours but not the specified MTBF of 750 hours. Seventy per cent (70%) of the observed failures were in the Frequency Time Standard. Although the ART-50 has an estimated mean time between repair of 4 hours and does not meet the specified MTTR of .36 hours, this is not considered serious as this includes other times besides actual repair time with most of it being on the ground.

2-1.2 REPAIR DEPOT DATA. Fifty-seven percent (57%) of the significant problem areas at the repair depot were done to FTS modules.

2-1.3 CORRECTIVE ACTION. The most cost-effective corrective action to improve the ART-50 performance is to provide a hot spare (discussed in paragraph 6-1.1 below).

### 2-2 SHIPBOARD AN/WRR-7 VLF RECEIVER.

2-2.1 FRAP SAMPLE RESULTS. The estimated mean time between operational failures is 2432 hours and is improving as the WRR-7 failure times follow Weibull distribution with $\beta = .416$. The estimated mean time between equipment failures is 2350 hours assuming an exponential distribution. The WRR-7 is considered to be meeting its specified MTBF of 1000 hours. The estimated mean time to repair and mean down time are 2.3 and 336 hours, respectively. Although the estimate MTTR does not meet the specified .62 hours, the MDT of 336 hours has a much greater effect on operational availability.

2-2.2 REPAIR DEPOT DATA. The R-1738/WR radio set is the largest current problem area.

2-2.3 CORRECTIVE ACTION. The most cost-effective action to improve the operational availability of the WRR-7 is to increase sparing levels to reduce the down-time since only modest gains in Ao can be achieved through the MTBF inprovements that are likely (See Figure 5-7.1 and Table 5-10.2). However, effective fixes for the receiver power supply P/N 616-1789 and the SMO P/N 792-6701 would significantly reduce the WRR-7 cost-to-repair.

SECTION III - SYSTEM DESCRIPTION

## 3-1 AN/URC-62, CLARINET VERDIN SYSTEM

3-1.1 FUNCTIONAL DESCRIPTION. Clarinet Verdin, AN/URC-62, is a Fleet broadcast system operating in the VLF range (3KHz - 30KHz). The VLF range is noted for long distance groundwave propagation, relative immunity from ionospheric disturbances and sunspots, and significant wave penetration into salt water. The later effect allows submarines to receive VLF signals without surfacing. The VLF range has severe natural interference from thunderstorms and narrow bandwidths, an effect which arises from the basic nature of tuned resonant circuits and the reactive nature of VLF antennas Verdin provides multiple channel capability, noise tolerant encoding/decoding techniques, and encryption capability through the use of computerized message processing and phase-shift keying using a concept called "minimum shift keying". The AN/URC-62 system is broken into transmit only and receive only sections, each with its own nomenclature. Previous to Verdin, VLF systems were low speed, single channel systems.

3-1.2 EQUIPMENT DESCRIPTION. The AN/URC-62 addresses the problems of the VLF band with a family of sophisticated transmitters and receivers. All members of the Verdin family contain an electronic digital computer, called a "processor", and ultra-stable Frequency Time Standard (FTS) units. A large number of modules are common throughout the family and a single depot level repair facility serves them all. Each family member has its own nomenclature. The two Verdin family equipments studied by FRAP are tne AN/ART-50 transmitter and the AN/WRR-7 receiver.

## 3-2 AN/ART-50 VLF TRANSMITTER

3-2.1 DESCRIPTION. The AN/ART-50 is the flying transmitter for the verdin system. It consists of five major sections (WRA's) mounted in an equipment rack. (See Figure 5-3.1) A typical installation is in the cargo hold of a converted turboprop cargo aircraft. Rather than function as a stand-alone transmitter, current installations use the AN/ART-50 as an exciter for a power amplifier which drives an extendable antenna. The antenna, when deployed, trails out behind the aircraft for a distance of up to five miles. A second antenna is played out above the main antenna to serve as a tuning stub. This smaller antenna may be up to one mile in length. These large physical dimensions are necessitated by the low frequencies used. While the techniques used in the power amplifier and antenna systems are revivals of those used in the earliest days of radio, the AN/ART-50 is the embodiment of the latest developments in computerized signal processing, information theory, and encoding algorithms. The transmitter is in an area pressurized and air conditioned for the benefit of the operating crew. In-flight repair is possible by module level replacement from a stock of ready spares. The system is fully powered throughout the flight and is thoroughly tested during a two-hour preflight shakedown. The majority of the O-level maintenance performed on the system is accomplished by the ground crew.

3-2.2 FRAP SAMPLE. Data was taken from nine aircrafts of VQ-4 TACAMO Squadron based at the Naval Air Training Center, Patuxent River, Maryland.

## 3-3 AN/WRR-7 VLF RECEIVER

3-3.1 DESCRIPTION. The AN/WRR-7 (See Figure 5-3.2) is the shipboard receiver for the AN/ART-50. It consists of five major assemblies (WRA's). Only the FTS is directly

interchangeable with that used in the transmitter, but card and module level interchangeability with other AN/URC-62 equipment has been carried as far as practical. The AN/WRR-7 can receive standard digital modulations such as Frequency Shift Keying (FSK), but is intended primarily as an Minimum Shift Keying (MSK) receiver. When working with MSK, coherent detection, a technique using the FTS's super stable time signals, gives the system enough noise tolerance to allow reception of encrypted (COMSEC) traffic. The system is intended primarily for installation aboard submarines using external loop or floating wire antennas. The receiver is typically mounted in an equipment rack in the radio room of a submarine. Personnel work in this area, but radio rooms are typically crowded with equipment and ventilation is at a premium. Repair is by module replacement from a stock of ready spares. Radio room personnel normally perform all O-level maintenance on the system. A typical mission may be 60 days in duration. FRAP shows a duty cycle of 0.443.

3-3.2 FRAP SAMPLE. A total of 14 sample WRR-7's were monitored on a 8 sample platforms, Eleven sample equipments were in the Atlantic Fleet aboard 4 submarines and 2 tenders and 3 sample equipments were in the Pacific Fleet aboard 2 submarines.

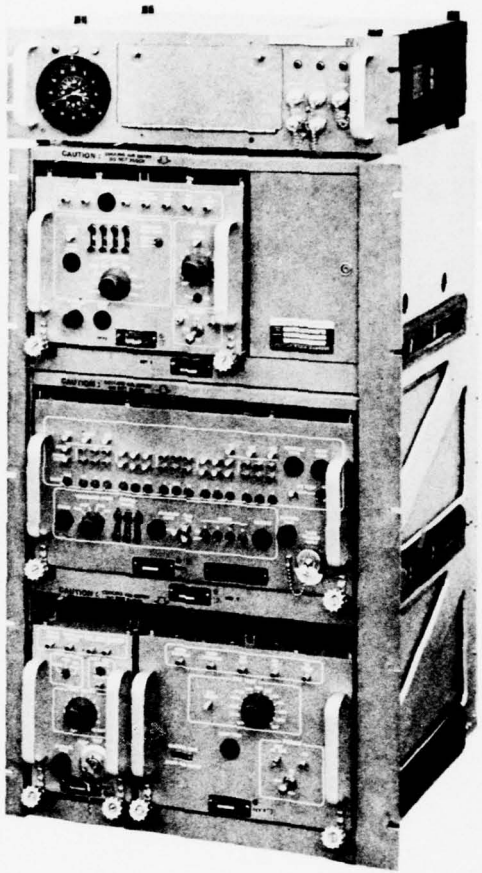


Figure 5-3.1

DIGITAL DATA TRANSMITTING SET AN/ART-50

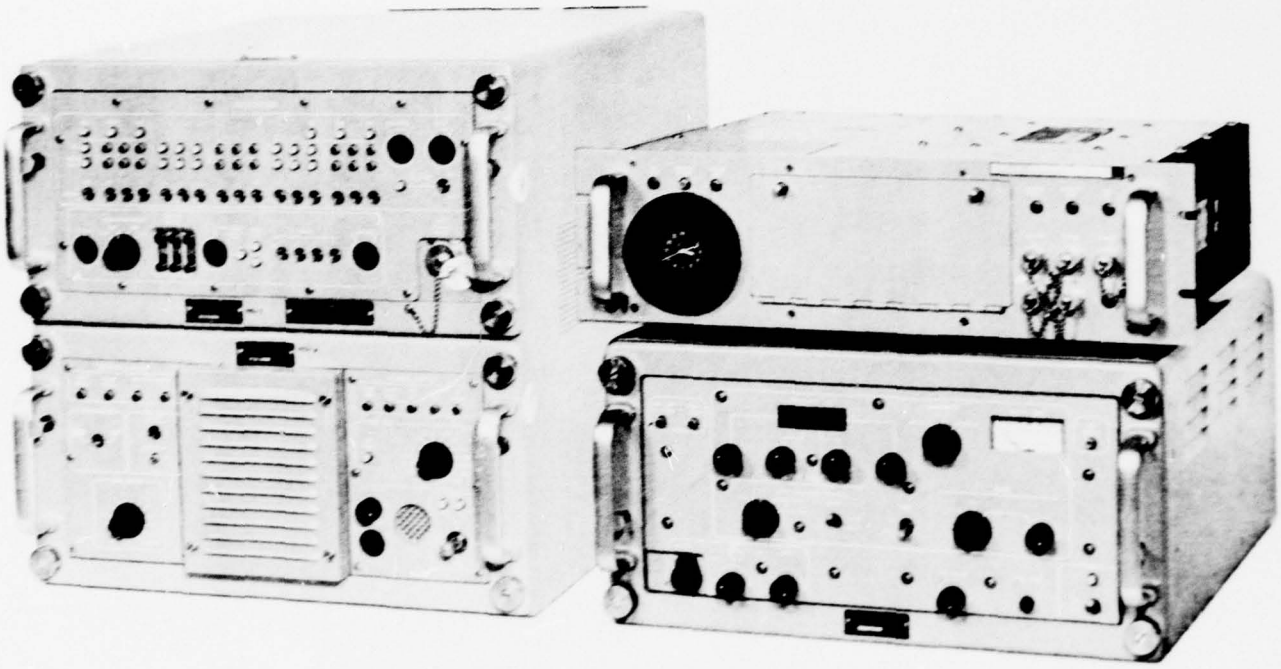


Figure 5-3.2

DIGITAL DATA RECEIVING SET AN/WRR-7

SECTION IV - RELIABILITY MODELS

## 4-1 AN/ART-50, VLF TRANSMITTER

4-1.1 MISSION DESCRIPTION. As currently used, the AN/ART-50 is powered up approximately two hours before take-off during preflight testing of on-board equipment. It remains fully powered during the mission, typically ten hours in duration, and is not powered down until post flight equipment shutdown. Although emergency bypass and patch-through operating modes are technically possible, flight crews advise that such operation is rare. In-flight repair is accomplished by substitution of modules and circuit boards from a stock of ready spares. Although box level (WRA level) substitutions in flight are possible, box level spares are not carried on board except for the Frequency/Time Standard (FTS), which has proved to be troublesome. Even in this case, box level substitution is considered to be a last resort.

4-1.2 RELIABILITY BLOCK DIAGRAM (WRA LEVEL). Figure 5-4.1 shows the five WRA sections of the AN/ART-50 in a series arrangement to indicate that all five sections must fully function for a successful mission. The AN/ART-50 modulator section, which performs the same function as a radio transmitter, resembles an audio system. Because of the low frequencies used by Verdin and the relatively low output power of the AN/ART-50, the large stress level shifts that usually are observed during transmitter ON-OFF cycling do not occur.

4-1.3 RELIABILITY BLOCK DIAGRAM (O-LEVEL). Instead of presenting a diagram down to the O-Level unit, the O-Level units within each WRA are listed in Figure 5-4.2 along with a reliability key (block) number, their failure rate, the number used, and O-Level nomenclature. All of the O-Level units within the Power Supply, the Control Unit, and the Modulator (WRA 2, 3, and 5, respectively) are serially connected as a failure of one O-Level unit would result in a system failure. However, the processor (WRA 4) a special purpose computer, is a large and multi-mode assembly. Normally, each operating mode of this WRA would be represented by a diagram for that mode only. However, as several of the modes were classified, all O-Level units of the processor are considered to be in series in order to eliminate possible classification problems. Thus, the entire AN/ART-50 reliability block diagram would be a series connection of the O-Level units given in Figure 5-4.2.

4-1.4 MATHEMATICAL MODEL. The relaibility of each O-Level unit (reliability key number in Figure 5-4.2) is expressed as

$$R_i = R_i^{n_i} \qquad (1)$$

where i is the ith O-Level and $n_i$ the number of ith units used. Thus, the reliability of a WRA is the product of the reliabilities of the O-Level units within the WRA. For example, the reliability of WRA 1 is

$$R_{WRA\,1} = \prod_{i=28}^{45} R_i^{n_i} \qquad (2)$$

The reliability of the overall system may be expressed as a product of WRA reliability or as a product of O-Level unit reliabilities, i.e.

$$R_{SYS} = \prod_{i=1}^{5} R_{WRA_i} = \prod_{i=1}^{105} R_i^{n_i} \qquad (3)$$

If the exponential distribution of failure rates is assumed (constant failure rate), then

$$R_i = EXP(-\lambda_i t) \qquad (4)$$

where $\lambda_i$ is failure rate of the ith O-Level unit and t is the mission time. Of course, as R, the reliability, is probability of no failures at or prior to time t, 1-R is the probability of one or more failures at or prior to time t.

4-1.5 COMPUTER PROGRAM. A program to determine the reliability of the AN/ART-50 using equations (3) and (4) is listed in Figure 5-A.1 in Appendix 5A. The program is written in BASIC computer language and can be used on any system accepting this language. Figure shows the results of running this program with the information given in Figure 5-4.3. The failure rates are MIL-HDB-127 predictions obtained from Reliability analysis and MTBF prediction for Verdin Digital Data Communications System, AN/URC-62 - Volume I, dated 9 July 1976.

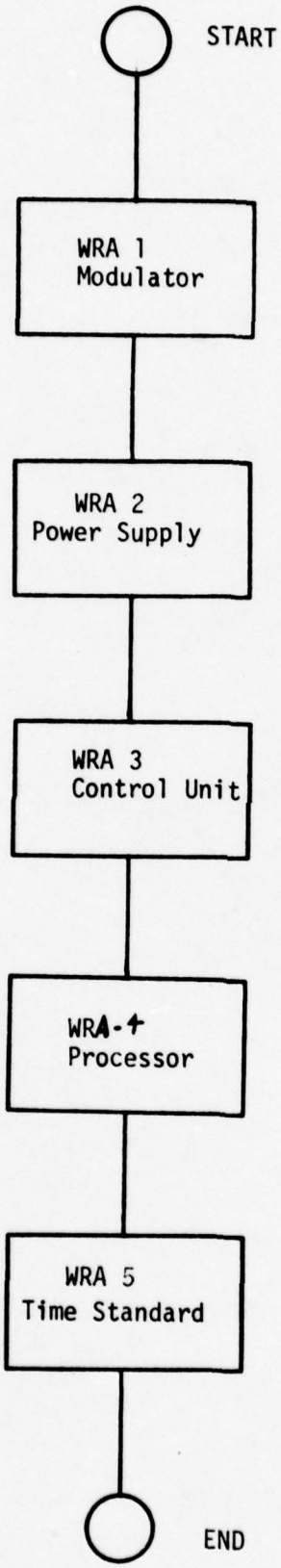
4-2 AN/WRR-7, VLF RECEIVER

4-2.1 MISSION DESCRIPTION. The AN/WRR-7 is designed to be fully powered throughout the entire mission of a patrol submarine (typically up to 90 days). In actual practice, only the FTS requires continuous power. The remainder of the receiver can be powered down when not in use. Patrol submarines usually carry dual AN/WRR-7 installations and probably do power down the standby system to reduce heat and noise in the radio room. FRAP data shows a duty cycle of .443. Repair is by card level substitution from a stock of ready spares carried on board. No box level (WRA) spares are carried.

4-2.2 RELIABILITY BLOCK DIAGRAM (WRA LEVEL). Figure 5-4.4 shows the WRA level reliability diagram for the AN/WRR-7. Each block is a box level replaceable unit. The serial chain arrangement indicates that all five boxes must function for a successful mission. Since operating personnel do not normally substitute at the WRA level, each box must be represented by a submodel which represents the performance of the WRA's component modules from a reliability view point.

4-2.3 RELIABILITY BLOCK DIAGRAM (O-LEVEL). As with the AN/ART-50, the Power Supply and FTS reliability diagrams serial chains of replaceable modules or cards. The Demodulator, likewise, must fully function for a mission success; it also is represented by a serial chain diagram. For reasons explained in Section 4-1.3, the processor model is assumed to be a serial chain. The receiver (WRA#1) model is clearly a serial chain except for the BFO/audio card, which is strictly a manual tuning aid. However, this card is tested during automated diagnostics and, if found defective, a shutdown for replacement would probably follow. For this reason, the BFO/audio card is included in the serial chain. Thus, all WRA's have serial chain reliability diagrams and are themselves connected in a serial chain. Therefore, the entire AN/WRR-7 reliability block diagram would be a series connection after O-level units given in Figure 5-4.5.

4-2.5 COMPUTER PROGRAM. A program, written in BASIC language, to determine the reliability of the AN/WRR-7 is listed in Figure 5-A.2 in Appendix 5A. Figure 5-4.5 shows the results of running this program with the information given in Figure 5-4.5 with a full duty cycle. The failure rates and MIL-HDB-217 predictions obtained in paragraph 4-1.5 as described.






AN/ART-50
WRA Model
**Figure 5-4.1**

| MODEL | KEY | NUMBER | O-LEVEL | FRAME | NUMBER | USED | WRA # | DESIG. | PART NAME | PART # |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2.642 | | 1 | 2 | RA5 | | | POWER SUPPLY -25V | 784-3655 |
| | 2 | 2.208 | | 3 | 2 | RA7 | | | POWER SUPPLY +15V | 784-3656 |
| | 3 | 2.052 | | 2 | 2 | RA8 | | | 15 VOLTS FILTERS | 784-3657 |
| | 4 | 4.491 | | 3 | 2 | RA9 | | | LAMP DRIVERS | 784-3658 |
| | 5 | 5.611 | | 1 | 2 | RB2 | | | POWER SUPPLY -5.2V | 784-3659 |
| | 6 | 2.411 | | 1 | 2 | RB4 | | | POWER SUPPLY +25V | 784-3661 |
| | 7 | 2.060 | | 1 | 2 | PV2 | | | POWER SUPPLY MONITOR | 784-4166 |
| | 8 | 11.787 | | 1 | 2 | | | | CHASSIS | 784-5800 |
| | 9 | 3.471 | | 1 | 2 | RB3 | | | BATTERY CONVERTER | 619-0996 |
| | 10 | 6.486 | | 1 | 2 | RC3 | | | BATTERY MODULE | 609-4511 |
| | 11 | 3.095 | | 1 | 3 | PF5 | | | PROCESSOR INPUT | 784-4004 |
| | 12 | 4.053 | | 1 | 3 | PF8 | | | PROCESSOR OUTPUT | 784-4008 |
| | 13 | 4.490 | | 1 | 3 | PF9 | | | TIME BASE I | 784-4010 |
| | 14 | 3.394 | | 1 | 3 | PG2 | | | TIME BASE II | 784-4012 |
| | 15 | 3.390 | | 1 | 3 | PG3 | | | TIME BASE III | 784-4014 |
| | 16 | 5.533 | | 2 | 3 | PG4 | | | CONTROL COUNTER | 784-4016 |
| | 17 | 6.463 | | 1 | 3 | PG5 | | | PHASE 2 INTERFACE | 784-4018 |
| | 18 | 7.146 | | 1 | 3 | PG7 | | | DEMULTIPLEXER | 784-4020 |
| | 19 | 2.889 | | 1 | 3 | PG8 | | | FILTER | 784-4022 |
| | 20 | 3.799 | | 1 | 3 | PG9 | | | ALARM | 784-4024 |
| | 21 | 7.261 | | 1 | 3 | | | | CHASSIS | 784-5750 |
| | 22 | 3.428 | | 1 | 3 | TTY | | | TELETYPE INTERFACE | 784-5336 |
| | 23 | 3.498 | | 1 | 3 | | | | | 784-5244 |
| | 24 | 5.284 | | 1 | 3 | KG | | | KEY GENERATOR INTERFACE | 784-5340 |
| | 25 | 5.574 | | 1 | 3 | BDTL | | | BLACK DIGITAL | 784-6444 |
| | 26 | 6.382 | | 1 | 3 | | | | WIRED BACKCAP | 784-7611 |
| | 27 | 17.202 | | 1 | 3 | | | | WIRED PANEL | 784-7745 |
| | 28 | 3.735 | | 1 | 1 | PD9 | | | | 784-3982 |
| | 29 | 4.259 | | 1 | 1 | PE4 | | | I/O FAULT | 784-3988 |
| | 30 | 3.853 | | 1 | 1 | PE5 | | | SELF TEST | 784-3990 |
| | 31 | 3.788 | | 1 | 1 | PE9 | | | MULTIPLEXER | 784-3996 |
| | 32 | 4.153 | | 1 | 1 | PF2 | | | TIME BASE III | 784-3998 |
| | 33 | 4.318 | | 1 | 1 | PF3 | | | TIME BASE I | 784-4000 |
| | 34 | 1.756 | | 1 | 1 | PF4 | | | WAVEFORM GENERATOR | 784-4002 |
| | 35 | 1.838 | | 1 | 1 | PH2 | | | MODULATOR V/Z | 784-4026 |
| | 36 | 2.881 | | 1 | 1 | PH3 | | | MODULATOR CONTROL | 784-4028 |
| | 37 | 25.498 | | 1 | 1 | SMO | | | STABILIZED MASTER OSC. | 792-6701 |
| | 38 | 11.786 | | 1 | 1 | | | | CHASSIS | 784-7700 |
| | 39 | 2.552 | | 1 | 1 | | | | SHELF/BACKCAP | 792-6366 |
| | 40 | 3.297 | | 1 | 1 | PE3 | | | HET 2 | 620-7111 |
| | 41 | 2.834 | | 1 | 1 | HET1 | | | POWER AMPLIFIER | 620-7115 |
| | 42 | 2.411 | | 1 | 1 | RB | | | POWER SUPPLY +25V | 784-3661 |
| | 43 | 2.052 | | 1 | 1 | RA8 | | | POWER SUPPLY 15V | 784-3657 |
| | 44 | 3.471 | | 1 | 1 | RB3 | | | BATTERY MODULE | 619-0996 |

Figure 5-4.2 AN/ART-50 O-Levels

| MK DEV MEL | NUMBER | OFF-LEVEL | RAIL ELEVER | RAIL UNIT | NUMBER | USED | WIRE # | DESIG. | PART NAME | PART # |
|---|---|---|---|---|---|---|---|---|---|---|
| 45 | | 6.518 | | | 1 | 1 | RC3 | | BATTERY CONVERTER | 609-4511 |
| 46 | | 4.491 | | | 4 | 1 | RA9 | | POWER SUPPLY 5.2V | 784-3658 |
| 57 | | 2.298 | | | 4 | 4 | PJ7 | | READ/WRITE SWITCH | 784-4048 |
| 58 | | 5.657 | | | 4 | 4 | PE7 | | READ/WRITE DRIVER | 784-3992 |
| 59 | | 2.468 | | | 8 | 4 | PJ8 | | INHIBIT DRIVER | 784-4050 |
| 60 | | 3.154 | | | 1 | 4 | PN7 | | WRITE DRIVER | 784-4104 |
| 61 | | 3.159 | | | 1 | 4 | PD8 | | READ DRIVER | 784-3980 |
| 62 | | 1.008 | | | 1 | 4 | PD7 | | STROBE | 784-3978 |
| 63 | | 1.515 | | | 1 | 4 | PF7 | | MEMORY TIMING | 784-4006 |
| 64 | | 2.657 | | | 3 | 4 | PE8 | | DIODE BOARD | 784-3994 |
| 65 | | 2.000 | | | 1 | 4 | CORE | | ARRAY, MAGNETIC | 784-5626 |
| 66 | | 1.886 | | | 2 | 4 | PD5 | | SENSE AMPLIFIER | 784-3976 |
| 67 | | 3.509 | | | 1 | 4 | PX2 | | CYCLE CONTROL I | 784-4194 |
| 68 | | 3.099 | | | 1 | 4 | PX5 | | CYCLE CONTROL II | 784-4200 |
| 69 | | 3.758 | | | 1 | 4 | PX4 | | R/S CYCLE CONTROL | 784-4198 |
| 70 | | 2.887 | | | 1 | 4 | PW7 | | I/O CONTROL | 784-4188 |
| 71 | | 1.711 | | | 1 | 4 | PW9 | | I/O SELECTOR | 784-4192 |
| 72 | | 3.656 | | | 1 | 4 | PV7 | | PT ADAPTER I | 784-4174 |
| 73 | | 3.789 | | | 1 | 4 | PV5 | | PT ADAPTER II | 784-4172 |
| 74 | | 1.985 | | | 1 | 4 | MTU | | MAGNETIC TAPE UNIT | 771-4616 |
| 76 | | 3.828 | | | 16 | 4 | PY5 | | BIT MEMORY | 784-4214 |
| 78 | | 3.190 | | | 1 | 4 | PW8 | | I/O FAN-IN | 784-4190 |
| 79 | | 3.735 | | | 1 | 4 | PY3 | | PANEL INTERFACE | 784-4210 |
| 80 | | 2.435 | | | 1 | 4 | PY2 | | INSTRUCTION DECODER | 784-4208 |
| 81 | | 3.806 | | | 1 | 4 | PX9 | | TRANSFER CONTROL A | 784-4206 |
| 82 | | 3.799 | | | 1 | 4 | PX8 | | TRANSFER CONTROL Z | 784-4204 |
| 83 | | 3.586 | | | 1 | 4 | PX7 | | TRANSFER CONTROL B | 784-4202 |
| 84 | | 3.616 | | | 1 | 4 | PX3 | | C. TEST | 784-4196 |
| 85 | | 3.968 | | | 2 | 4 | PY4 | | COMPARATOR ACCUMULATOR | 784-4212 |
| 86 | | 2.592 | | | 1 | 4 | PV9 | | MTA SHIFT | 784-4178 |
| 87 | | 1.887 | | | 1 | 4 | PV8 | | MTA REGISTER | 784-4176 |
| 88 | | 3.990 | | | 1 | 4 | PW2 | | MTA TIMING | 784-4180 |
| 89 | | 4.900 | | | 1 | 4 | PW4 | | | 784-4184 |
| 90 | | 4.993 | | | 1 | 4 | PW5 | | | 784-4186 |
| 91 | | 3.219 | | | 1 | 4 | PV4 | | MODE INDICATOR | 784-4170 |
| 92 | | 5.033 | | | 1 | 4 | LDR | | LAMP DRIVERS | 784-4222 |
| 93 | | 26.645 | | | 1 | 4 | | | CHASSIS | |
| 94 | | 8.000 | | | 1 | 5 | RVFR | | RB VAPOR FREQ. REF. | 617-6876 |
| 95 | | 7.484 | | | 1 | 5 | VR | | VOLTAGE REGULATOR | 797-3632 |
| 96 | | 7.235 | | | 1 | 5 | | | SERVO AMPLIFIER | 797-3627 |
| 97 | | 1.182 | | | 1 | 5 | | | SYNTHESIZER | 606-9515 |
| 98 | | 6.395 | | | 1 | 5 | | | R.F. AMPLIFIER | 797-3628 |
| 99 | | 1.136 | | | 1 | 5 | | | R.F. GENERATOR | 606-9520 |
| 100 | | 6.675 | | | 1 | 5 | | | THERMO CONTROL | 606-9527 |

Figure 5-4.2 AN/ART-50 O-Level (Continued)

| MODEL | KEY NUMBER | D-LEVEL | FAILURE | RATE | NUMBER | USED | WR # | DESIG. | PART NAME | PART # |
|---|---|---|---|---|---|---|---|---|---|---|
| 101 | | 3.926 | | | 1 | | 5 | | AUXILIARY R.F. AMPLIFIER | 609-1376 |
| 102 | | 8.106 | | | 1 | | 5 | | CLOCK DIVIDER | 606-9521 |
| 103 | | .400 | | | 1 | | 5 | | BATTERY MODULE | 606-9524 |
| 104 | | 4.238 | | | 1 | | 5 | | BATTERY CHARGER | 606-9523 |
| 105 | | 11.197 | | | 1 | | 5 | | POWER SUPPLY MODULE | 606-9525 |
| 106 | | 3.311 | | | 1 | | 5 | | CLOCK | 617-6154 |
| 107 | | 3.981 | | | 1 | | 5 | | THERMO-ELEC. COOLER | 606-9526 |
| 108 | | 7.383 | | | 1 | | 5 | | CHASSIS | 606-9513 |

**Figure 5-4.2 AN/ART-50 O-Level (Continued)**

```
RUN

 77/03/08. 16.18.44.
PROGRAM   ART50


INPUT MISSION LENGTH (IN HOURS) = ? 12

MEAN TIME BETWEEN FAILURES BY WRA (IN HOURS)
MODULATOR       POWER SUPPLY    CONTROL BOX     PROCESSOR       TIME STD.
939             1637            1016            407             1239

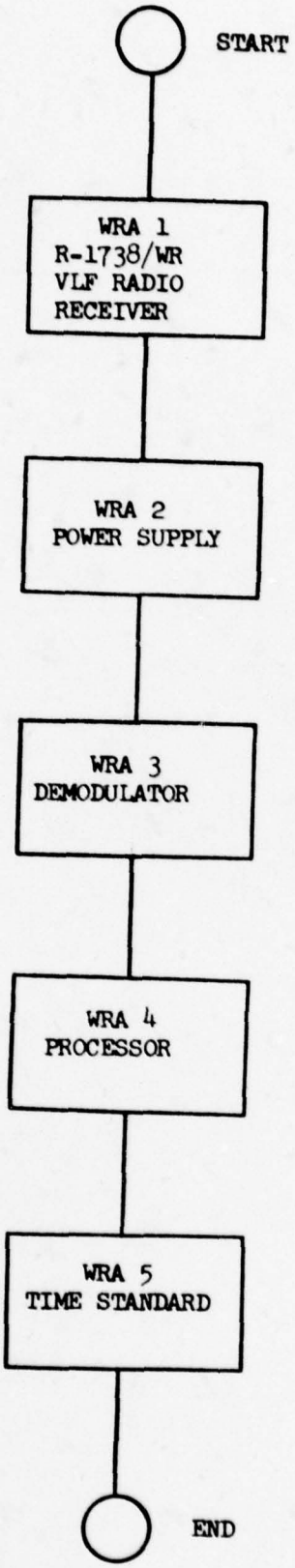
OVERALL SYSTEM MTBF =  169

OVERALL SYSTEM RELIABILITY FOR  12  HOUR MISSION =  .931


SBU      0.628 UNTS.

RUN COMPLETE.
```

Figure 5-4.3




AN/WRR-7
WRA Model
Figure 5-4.4

| MODEL | KEY NUMBER | NEXT-LEVEL REF | AAA LETTER | NUMBER USED | WRA | DESIG. # | PART NAME | PART # |
|---|---|---|---|---|---|---|---|---|
| 1 | | 5.571 | | 1 | 1 | A2 | R.F. AMPLIFIER | 616-1629 |
| 2 | | 1.180 | | 1 | 1 | A3 | FIRST MIXER | 616-1669 |
| 3 | | .990 | | 1 | 1 | A4 | FIRST I.F. AMPLIFIER | 616-1689 |
| 4 | | .724 | | 1 | 1 | A11 | SECOND MIXER | 616-1710 |
| 5 | | 1.323 | | 1 | 1 | A9 | FSK DETECTOR | 616-1730 |
| 6 | | .405 | | 1 | 1 | A19 | 7.5 KHZ AMPLIFIER | 616-1740 |
| 7 | | .376 | | 1 | 1 | A7 | 5 MHZ SWITCH/AMPLIFIER | 616-1749 |
| 8 | | .101 | | 1 | 1 | A12 | BFO/AUDIO | 616-1760 |
| 9 | | .718 | | 1 | 1 | A10 | AGC DETECTOR/AMPLIFIER | 616-1770 |
| 10 | | 3.706 | | 1 | 1 | A8 | RECEIVER POWER SUPPLY | 616-1789 |
| 11 | | 1.618 | | 1 | 1 | A1 | FRONT PANEL | 616-1651 |
| 12 | | 3.345 | | 1 | 1 | | CHASSIS COMPONENTS | 792-6377 |
| 13 | | .593 | | 1 | 1 | A13 | SELF CHECK MULTIPLEXER | 616-1810 |
| 14 | | .937 | | 1 | 1 | A14 | SELF CHECK | 616-1820 |
| 15 | | 1.813 | | 1 | 1 | A5 | SECOND I.F. AMPLIFIER | 616-1829 |
| 16 | | 1.520 | | 1 | 1 | | BCD FREQUENCY CONTROL | 616-1780 |
| 17 | | .490 | | 1 | 1 | | RFI ASSEMBLY | 616-1624 |
| 18 | | 8.625 | | 1 | 1 | A6 | STABILIZED MASTER OSC. | 792-6701 |
| 19 | | 1.573 | | 1 | 3 | TTY | TELETYPE INTERFACE | 784-5336 |
| 20 | | 1.682 | | 1 | 3 | BANL | BLACK ANALOG INTERFACE | 784-5338 |
| 21 | | 2.532 | | 1 | 3 | KGEN | KEY GENERATOR INTERFAC | 784-5340 |
| 22 | | 2.075 | | 1 | 3 | BDIG | BLACK DIGITAL INTERFAC | 784-6444 |
| 23 | | 1.291 | | 1 | 3 | | WIRED BACKCAP ASSEMBLY | 784-7611 |
| 24 | | .331 | | 1 | 3 | | BACKPLANE | 784-5244 |
| 25 | | 2.209 | | 2 | 3 | PD9 | WEIGHTING FUNCTION GEN | 784-3982 |
| 26 | | 1.686 | | 1 | 3 | PF9 | TIME BASE I | 784-4010 |
| 27 | | 1.763 | | 1 | 3 | PG2 | TIME BASE II | 784-4012 |
| 28 | | 1.698 | | 1 | 3 | PG3 | TIME BASE III | 784-4014 |
| 29 | | 1.592 | | 1 | 3 | PJ9 | ADC CONTROL | 784-4052 |
| 30 | | 1.665 | | 1 | 3 | PK2 | ADC DETECTOR | 784-4054 |
| 31 | | 2.127 | | 1 | 3 | PK3 | ADC MULTIPLEXER | 784-4056 |
| 32 | | 1.120 | | 1 | 3 | PK4 | DIGITAL-ANALOG CONVERT | 784-4058 |
| 33 | | 2.743 | | 1 | 3 | PK5 | BINARY AND TIMING | 784-4060 |
| 34 | | 1.969 | | 2 | 3 | PK7 | DETECTOR B | 784-4062 |
| 35 | | 1.314 | | 1 | 3 | PK8 | SYNCHRONIZING | 784-4064 |
| 36 | | .940 | | 1 | 3 | PK9 | AMPLITUDE MULTIPLIER | 784-4066 |
| 37 | | 1.969 | | 1 | 3 | PL2 | DETECTOR A | 784-4068 |
| 38 | | 2.209 | | 2 | 3 | PL3 | RESOLVER | 784-4070 |
| 40 | | 2.112 | | 1 | 3 | PL7 | REGISTER TWO | 784-4076 |
| 41 | | 2.030 | | 1 | 3 | PL8 | REGISTER THREE | 784-4078 |
| 42 | | 1.909 | | 1 | 3 | PL9 | REGISTER FOUR | 784-4080 |
| 43 | | 1.904 | | 1 | 3 | PM2 | REGISTER FIVE | 784-4082 |
| 44 | | 2.043 | | 1 | 3 | PM3 | REGISTER SIX | 784-4084 |
| 45 | | 2.772 | | 1 | 3 | PM4 | REGISTER SEVEN | 784-4086 |

AN/WRR-7
O-Levels
Figure 5-4.5

| MODEL | MKR NUMBER | OFR - ALEVEL | AAR ILUE | NTE | NUMBER | USED | WAR # | DESIG. | PART NAME | PART # |
|---|---|---|---|---|---|---|---|---|---|---|
| 46 | | 2.267 | | 1 | | 3 | | PM5 | ALARM PHASE TWO | 784-4088 |
| 47 | | 1.833 | | 1 | | 3 | | RB7 | CONTROL PHASE TWO | 784-5334 |
| 48 | | 2.234 | | 1 | | 2 | | RA5 | POWER SUPPLY, -25V | 784-3655 |
| 49 | | 1.593 | | 3 | | 2 | | RA7 | POWER SUPPLY, +15V | 784-3656 |
| 50 | | 1.751 | | 2 | | 2 | | RA8 | 15 V FILTER | 784-3657 |
| 51 | | 3.141 | | 4 | | 2 | | RA9 | LAMP DRIVER | 784-3658 |
| 52 | | 3.454 | | 1 | | 2 | | RB2 | POWER SUPPLY, -5.2V | 784-3659 |
| 53 | | 1.947 | | 1 | | 2 | | RB4 | POWER SUPPLY, +25V | 784-3661 |
| 54 | | 1.255 | | 1 | | 2 | | PV2 | POWER SUPPLY MONITOR | 784-4166 |
| 55 | | 5.391 | | 1 | | 2 | | PB3 | BATTERY SOURCE | 619-0996 |
| 56 | | 2.732 | | 1 | | 2 | | RC3 | BATTERY CONVERTER | 609-4511 |
| 57 | | 1.277 | | 4 | | 4 | | PJ7 | READ/WRITE SWITCH | 784-4048 |
| 58 | | 1.623 | | 4 | | 4 | | PE7 | READ/WRITE DRIVER | 784-3992 |
| 59 | | .973 | | 8 | | 4 | | PJ8 | INHIBIT DRIVER | 784-4050 |
| 60 | | 1.106 | | 1 | | 4 | | PN7 | WRITE DRIVER | 784-4104 |
| 61 | | 1.129 | | 1 | | 4 | | PD8 | READ DRIVER | 784-3980 |
| 62 | | .303 | | 1 | | 4 | | PD7 | STROBE | 784-3978 |
| 63 | | .808 | | 1 | | 4 | | PF7 | MEMORY TIMING | 784-4006 |
| 64 | | 2.992 | | 3 | | 4 | | PE8 | DIODE BOARD | 784-3994 |
| 65 | | 2.000 | | 1 | | 4 | | CORE | MAGNETIC CORE MEMORY | 784-5626 |
| 66 | | 1.097 | | 2 | | 4 | | PD5 | SENSE AMPLIFIER | 784-3976 |
| 67 | | 1.727 | | 1 | | 4 | | PX2 | MAJORITY CYCLE CONTROL | 784-4194 |
| 68 | | 1.476 | | 1 | | 4 | | PX5 | MINORITY CYCLE CONTROL | 784-4200 |
| 69 | | 1.869 | | 1 | | 4 | | PX4 | READ/SENSE CYCLE CONTR | 784-4198 |
| 70 | | 1.399 | | 1 | | 4 | | PW7 | INPUT/OUTPUT CONTROL | 784-4188 |
| 71 | | .841 | | 1 | | 4 | | PW9 | INPUT/OUTPUT SELECTOR | 784-4192 |
| 72 | | 2.002 | | 1 | | 4 | | PV7 | PAPER TAPE ADAPTER I | 784-4174 |
| 73 | | 1.892 | | 1 | | 4 | | PV5 | PAPER TAPE ADAPTER II | 784-4172 |
| 74 | | 14.390 | | 1 | | 4 | | MTU | MAGNETIC TAPE UNIT | 771-4616 |
| 76 | | 1.838 | | 16 | | 4 | | PY5 | BIT MEMORY | 784-4214 |
| 78 | | 1.599 | | 1 | | 4 | | PW8 | INPUT/OUTPUT FAN-IN | 784-4190 |
| 79 | | 1.793 | | 1 | | 4 | | PY3 | PANEL INTERFACE | 784-4210 |
| 80 | | 1.173 | | 1 | | 4 | | PY2 | INSTRUCTION DECODER | 784-4208 |
| 81 | | 1.861 | | 1 | | 4 | | PX9 | TRANSFER CONTROL A | 784-4206 |
| 82 | | 1.833 | | 1 | | 4 | | PX8 | TRANSFER CONTROL Z | 784-4204 |
| 83 | | 1.734 | | 1 | | 4 | | PX7 | TRANSFER CONTROL B | 784-4202 |
| 84 | | 1.744 | | 1 | | 4 | | PX3 | TEST | 784-4196 |
| 85 | | 1.899 | | 2 | | 4 | | PY4 | COMPARATOR ACCUMULATOR | 784-4212 |
| 86 | | 1.266 | | 1 | | 4 | | PV9 | MTA SHIFT | 784-4178 |
| 87 | | .919 | | 1 | | 4 | | PV8 | MTA REGISTER | 784-4176 |
| 88 | | 1.970 | | 1 | | 4 | | PW2 | MTA TIMING | 784-4180 |
| 89 | | 2.454 | | 1 | | 4 | | PW4 | | 784-4184 |
| 90 | | 2.592 | | 1 | | 4 | | PW5 | | 784-4186 |
| 91 | | 1.725 | | 1 | | 4 | | PV4 | MODE CONTROL | 784-4170 |

AN/WRR-7
O-Levels
Figure 5-4.5
(Continued)

| MODEL | KEY NUMBER | OFF-LINE LEVEL | AIR LINE LEVEL | NUMBER | USED | WARR | DESIG. | PART NAME | PART # |
|---|---|---|---|---|---|---|---|---|---|
| | 92 | 2.902 | | 1 | 4 | LDVR | | LAMP DRIVER | 784-4222 |
| | 93 | 9.168 | | 1 | 4 | | | CHASSIS W/ MOUNTED COM | |
| | 94 | 8.000 | | 1 | 5 | A5 | | RB VAPOR FREQ. REF. | 617-6876 |
| | 95 | 1.654 | | 1 | 5 | A1 | | VOLTAGE REGULATOR | 797-3632 |
| | 96 | 3.592 | | 1 | 5 | A2 | | SERVO AMPLIFIER | 797-3632 |
| | 97 | 4.287 | | 1 | 5 | A3 | | SYNTHESIZER | 606-9515 |
| | 98 | 1.134 | | 1 | 5 | A4 | | R.F. AMPLIFIER | 797-3628 |
| | 99 | 2.802 | | 1 | 5 | A6 | | R.F. GENERATOR | 606-9520 |
| | 100 | 2.894 | | 1 | 5 | A7 | | THERMO CONTROL | 606-9527 |
| | 101 | .806 | | 1 | 5 | A8 | | AUXILIARY R.F. AMP. | 609-1376 |
| | 102 | 3.775 | | 1 | 5 | A9 | | CLOCK DIVIDER | 606-9521 |
| | 103 | .200 | | 1 | 5 | A10 | | BATTERY | 606-9524 |
| | 104 | 1.090 | | 1 | 5 | A11 | | BATTERY CHARGER | 606-9523 |
| | 105 | 3.438 | | 1 | 5 | A12 | | FTS POWER SUPPLY | 606-9525 |

AN/WRR-7
O-Levels
Figure 5-4.5
(Continued)

```
RUN
 77/04/12. 15.58.06.
PROGRAM   WRR7


INPUT MISSION LENGTH (IN DAYS) =  ? 60

MEAN TIME BETWEEN FAILURES BY WRA (IN HOURS)
RECEIVER        POWER SUPPLY    DEMODULATOR     PROCESSOR       TIME STD.
 2938            2641            1731            772             2521

OVERALL SYSTEM MTBF =  334

OVERALL SYSTEM RELIABILITY FOR  60  DAY MISSION =  .013


SBU      0.786 UNTS.

RUN COMPLETE.
```

Figure 5-4.6

SECTION V - PROBLEMS

5-1 PROBLEM DEFINITION.

5-1.1 PROBLEM DEFINED. For the purpose of this report, a problem is defined as a module, part or assembly specified MTBF being greater the FRAP predicted mean at the 90% confidence level (the specified MTBF being below the upper 90% confidence limit). If only a single failure is observed and the specified MTBF is so large that the total accumulated sample time is not at least 20% of the specified MTBF, that single failure will not be considered a problem unless that module, part or assembly is also at least 95% significant on a structured analysis of depot data (see Section X).

5-2 AN/ART-50 PROBLEMS OBSERVED.

5-2.1 Of the 44 failures observed (37 corrective actions, some with multiple replacements), 70% involved the FTS. These 31 failures are not resolvable below WRA level because FTS repair at VQ-4 is an I-level task and the I-level facility was not included in the FRAP study. During the period of the FRAP study, the FRAP sample encompassed an estimated 80% of all operational AN/ART-50's. Therefore, depot return data for AN/ART-50 should accurately reflect FTS module level performance at VQ-4, i.e. for the FRAP sample. This data shows the Rubidium Vapor Frequency Reference (RVFR) as the highest failure module in the FTS. In the problem impact ranking (see 10-2.1 for a discussion of depot data problem ranking), five additional FTS modules (43% of those in the unit) show up as significant problems, i.e., fail significantly more often than predicted. While this might be indicative of an overly optimistic reliability prediction, it more likely indicates that the FTS design is marginal in the airborne environment.

5-2.2 The processor WRA recorded 10 failures, five of which were sent to I-level for resolution. Of these five, four are not resolvable to module level. The fifth was sent to I-level for replacement of bad switches and lights. Two non-resolvable failures listed "will not load" as the failure symptom. At the present state of resolution, no significant processor problems can be identified.

5-3 AN/WRR-7 PROBLEMS OBSERVED.

5-3.1 Of 17 failures observed (15 corrective actions with two cases of multiple replacements), four (24%) involved the FTS and seven (41%) involved the R-1738/WR radio receiver. Both WRA's met MTBF specifications. No significant problems were identified in the FTS. One significant problem, the receiver power supply module, was identified in the R-1738/WR radio. Three power supply failures plus two occasions of fuse replacement (a prelude to power supply failure) were observed. The data suggests the possibility that some of the SMO failures may be induced as secondary failures resulting from power supply degradation/failure.

SECTION VI - CORRECTIVE ACTIONS

6-1 AN/ART-50.

6-1.1 The AN/ART-50 has potential for significant reliability growth if effective corrective actions are taken. The effects of various corrective actions as illustrated in the following table.

TABLE 5-6.1

| Action Taken: | No Action | Projected Maximum | Expected Maximum | FTS Fix | RVFR Only | Hot Spare |
|---|---|---|---|---|---|---|
| IMPROVEMENT FACTOR | 1.0 | 2.79 | 1.55 | 1.39 | 1.18 | 2.79 |
| EQUIPMENT MTBF (Hours) | 168 | 469 | 260 | 234 | 199 | 417 |

In this table, status quo is taken as "No Action". The "Projected Maximum" assumes none of the modules listed on Table 5-10.1 has been subjected to past corrective action while "Expected Maximum" and those to the right reflect an estimate of the impact of past corrective actions. In all cases, it is assumed that any corrective action will merely restore the affected module to the originally predicted MTBF. For example, the "FTS Fix" is assumed to bring the FTS MTBF up to its predicted 1240 hour MTBF level. The "RVFR Only" fix is the current retrofit being installed. "Hot Spare" is a redundancy arrangement being fitted aboard certain aircraft. It nearly totally removes the FTS as a potential system problem (4328 hour effective MTBF on 12 hour missions) at the expense of doubling FTS module return rates. None of the corrective actions or combinations of corrective actions examined raise the MTBF to 750 hours, which indicates the current design will not reach the specified equipment MTBF. At the current level of performance, 92% of all 12 hour missions are flown without an AN/ART-50 failure. The hot spare FTS modification will mean 97.2% of such missions can be flown without system outage. For comparision, 98.2% of such missions would have been flown without repair if the AN/ART-50 performed up to the 750 hour MTBF specification. This would amount to seven additional no outage missions per year as compared to the hot spare arrangement.

6-2 AN/WRR-7.

6-2.1 The AN/WRR-7 is undergoing reliability growth at this time as evidenced by the observed failure distribution, a Weibull with a beta of 0.416. A system with a constant failure rate has a beta of 1.00, which is the familiar exponential or "constant hazard" situation usually associated with electronics hardware. It is too soon to assess the ultimate impact of current corrective actions, such as those involving the Magnetic Tape Unit (MTU), except to note that the observed growth trend must be attributed to these actions since the system has been deployed long enough to have passed beyond the "infant mortality" stage.

6-2.3 An air filter on the back of the R-1738/WR radio receiver is difficult to remove, clean, and replace. The current design is a polyfoam material without a rigid frame. Four self-locking nuts must be removed to free the assembly. Considering the physical location and the fact tools are required to remove/replace the filter, a very great disincentive exists to clean the filter regularly. Although FRAP was unable to positively document a cause/effect relationship, it is strongly suspected that filter blockage figures prominently in the accerated rate of Stable Master Oscillator (SMO) returns observed (see section 10-3.8 for discussion about the SMO). Collins has designed a slide-out rigid frame filter that can be easily serviced without tools. It is highly recommended that this assembly be made available to AN/WRR-7 users as a field-installable retrofit kit.

SECTION VII - COST BENEFIT

7-1 AN/ART-50

7-1.1 Considering the necessity of this equipment to be up during the complete 12 hour mission, the most realistic cost effective improvement appears to be the hot spare as discussed in paragraph 6-1.1 above. As the ART-50 is presently meeting its MIL-HDB-217 predicted MTBF of 169 hours (See Section 9-2), improvement of a similar magnitude by other means would be much more costly.

7-2 AN/WRR-7

7-2.1 Figure 5-7.1 shows the effort of independent improvement of maintainability, logistic and reliability on operational availability (MTBF/MTBF + MDT) of the WRR-7 This shows a similar magnitude of improvement in logistics and reliability results in the same operational availability improvement. The reliability is still improving as evidenced by failure rates following the Weibull distribution with $\beta = .416$. However, it is not expected to double the present estimated MTBF of 2432 hours. When, a pair of the WRR-7 are used, the expected system MTBF is 7296 hours, a 3-fold increase resulting in an operational availability of .956 with the present down time. Then, if the present MDT were reduced by a factor of 4, the operational availability would be .988. This reduction in down time should not be too costly as 75% of the total down time observed in the FRAP sample was due to one maintenance action (See paragraph 9-2.3).

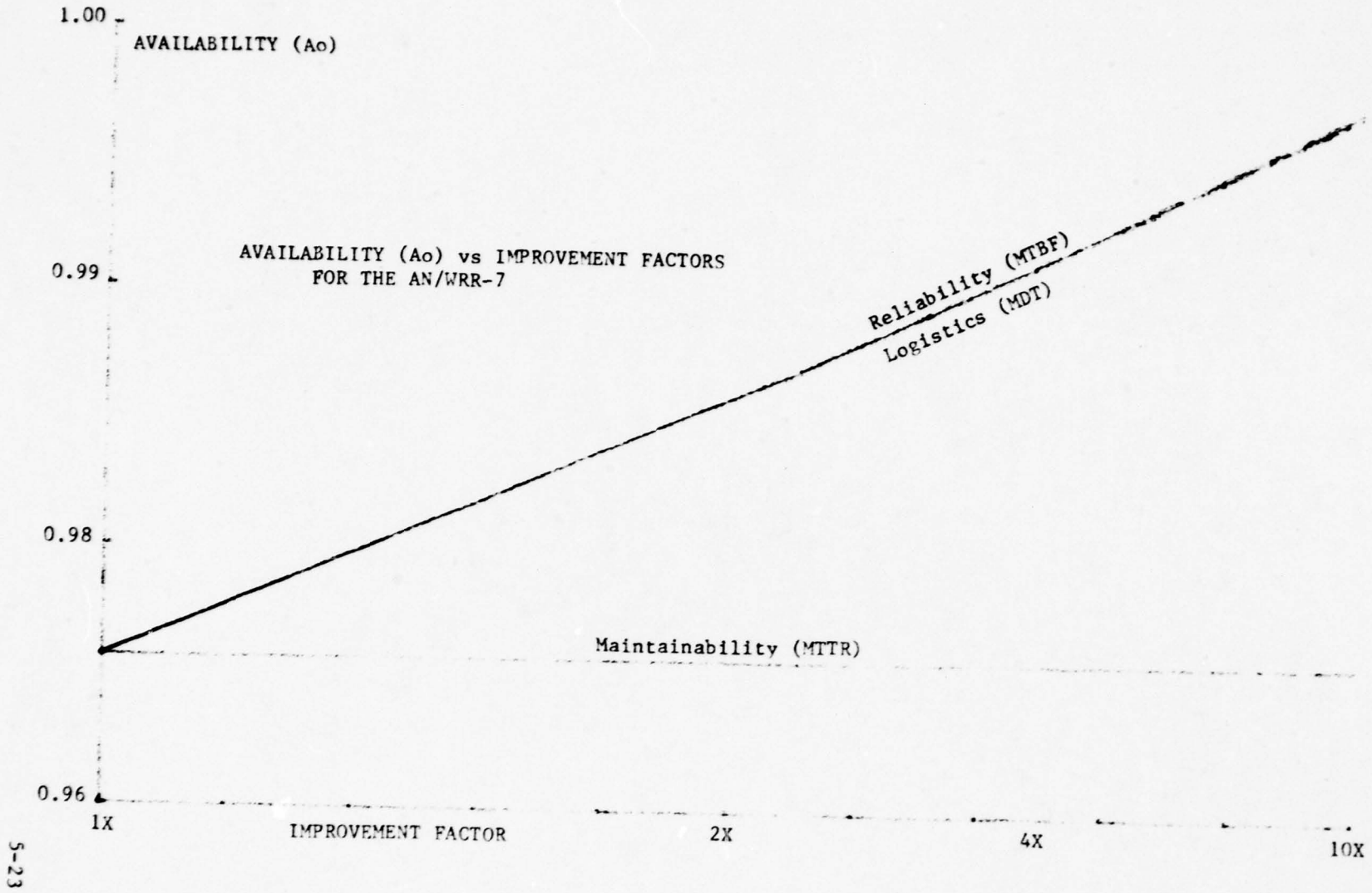

1.00
AVAILABILITY (Ao)
AVAILABILITY (Ao) vs IMPROVEMENT FACTORS
FOR THE AN/WRR-7
0.99
Reliability (MTBF)
Logistics (MDT)
0.98
Maintainability (MTTR)
0.96
1X
IMPROVEMENT FACTOR
2X
4X
10X

Figure 5-7.1

TABLE 5-7.1

AN/WRR-7 OPERATIONAL AVAILABILITY IMPROVEMENT

$A_o$ = MTBF/MTBF + MDT

MTBF - 2432 assuming Weibull
MTTR = 2.3 assuming exponential
MDT = 336 assuming Weibull

RELIABILITY IMPROVEMENT

| $F_I$ | MTBF | MDT | $A_o$ | U |
|---|---|---|---|---|
| 1 | 2432 | 336 | .879 | .121 |
| 2 | 4864 | 336 | .935 | .065 |
| 4 | 9728 | 336 | .967 | .033 |
| 10 | 24,320 | 336 | .986 | .014 |

MAINTAINABILITY IMPROVEMENT

| $F_I$ | MTBF | MTTR | MDT | $A_o$ | U |
|---|---|---|---|---|---|
| 1 | 2432 | 2.3 | 336 | .879 | .121 |
| 2 | 2432 | 1.15 | 334.85 | .879 | .121 |
| 4 | 2492 | .575 | 334.275 | .879 | .121 |
| 10 | 2432 | .23 | 334.045 | .879 | .121 |

LOGISTIC IMPROVEMENT

| $F_I$ | MTBF | MTTR | MDT | $A_o$ | U |
|---|---|---|---|---|---|
| 1 | 2432 | 2.3 | 336 | .879 | .121 |
| 2 | 2432 | 2.3 | 169.15 | .935 | .065 |
| 4 | 2432 | 2.3 | 85.725 | .966 | .034 |
| 10 | 2432 | 2.3 | 35.67 | .986 | .014 |

SECTION VIII - SPECIFICATION REQUIREMENTS.

8-1 CONTRACT SPECIFICATION.

8-1.1 AN/ART-50. Air specification AS-1238B (AV), SPECIFICATION FOR RADIO GROUP AN/ARA(#), dated 6 March 1973, states in paragraph 3.3.2.3 "... 750 hours of mean (operating) time between failures..." is required. No quantitative MTTR values are called out although maintainability enhancing design features are called out.

8-1.2 AN/WRR-7. ELEX-R-1198, CONTRACT SPECIFICATION VLF/LF RADIO RECEIVING SET, DIGITAL DATA, dated 24 September 1973, states in section 3.3.9.1 "The specified mean time between failures (MTBF) ($\theta o$ as defined by MIL-STD-781) of this equipment shall be 1,000 hours for the receive terminal equipment (see 1.2.1)". The "receive terminal equipment" is now nomenclatured AN/WRR-7. No quantitative MTTR values are stated although maintainability enhancing design features are called out and the requirement for an MTTR prediction in accordance with MIL-HDBK-472 is called out. The VERDIN SHIPBOARD MEAN TIME TO REPAIR PREDICTION, dated 10 February 1971, Contract Number N00039-70-C-1507, states that the predicted MTTR at O-level is 0.439 hours.

8-2 INTEGRATED LOGISTICS SUPPORT PLAN.

8-2.1 RELIABILITY. The Integrated Logistics Support Plan (ILSP), dated 9 August 1974, states, "The specified Mean Time Between Failures (MTBF) for the AN/WRR-7 receiver... is 1,000 hours. The MTBF for the AN/ART-50... is specified at 750 hours".

8-2.2 MAINTAINABILITY. The ILSP goes on to state, "The Mean Time to Repair (MTTR) value is .36 hours for A/B and .62 for S/B with organizational level maintenance limited to the replacement of failed printed circuit cards and modular assemblies". The AN/ART-50 is considered to be in the "A/B" class and the AN/WRR-7 is in the "S/B" class.

8-3 O-LEVEL SPECIFICATIONS

8-3.1 The values used for the specified O-Level requirements were basically obtained from Reliability Analysis and MTBF prediction for Verdin, Digital Data Communications System, AN/URC-62-Revision C, Volume 1, dated 9 July 1971. These failure rates are for a temperature of $50^{o}C$.

SECTION IX - FLEET DATA ANALYSIS

9-1 DATA COLLECTION.

9-1.1 Data in the FRAP field study was collected by interviews with operating and maintenance personnel (inclusive of OPNAV 4790/60 Forms from VQ-4 squadron) and by mail in the form of copies of 3M OPNAV 4790/2K forms returned using pre-addressed envelopes. To allow use of parametric analysis, FRAP instructed sample platforms to include Elapsed Time Meter (ETM) readings with each submission. Numerical data was encoded, keypunched, and statistically reduced using electronic digital computers. Data from interviews, narrative comments on the 3M forms, and information from failure analysis was used by FRAP reliability engineers to correlate, interpret and, sometimes, correct data submitted by the Fleet.

9-2 COMPUTER ANALYSIS.

9-2.1 RMA ANALYSES. These analyses and the computer output are described in Appendix C of Volume 7. Basically, the computer output consists of:

(1) Graphs for system and WRA failure and repair times and system down time showing:

a. The fit of the best-fitting probability distribution to FRAP observed times.

b. The fit of other distributions tried.

(2) Tabulation of observed data for time-to-failure, repair, and down times.

(3) Observed frequency distributions and associated goodness-of-fit tests and confidence intervals for the above parameters.

(4) Confidence intervals on the O-Level parts which failed and whether these O-Level parts are performing in the Fleet as good as specified (MIL-HDB-217 predictions).

(5) Summaries of 2K forms where problems were detected in either failure or repair times.

(6) Values for inherent and observed (predicted operational) availability.

9-2.2 SUMMARY. Table 5-9.1 summarizes the output of the computer runs for the AN/ART-50 and the AN/WRR-7 contained in Appendix 5B.

9-2.3 PARAMETER ASSESSMENT. Reliability and maintainability estimated parameters as discussed below:

(1) Reliability. From Table 5-9.1 it can be seen that the WRR-7 estimated operational MTBF exceeds the specified value of 1000 hours whereas the ART-50 estimated operational MTBF meets the predicted but does not meet the specified MTBF at the 80% confidence level. (Meeting is defined as being within the given confidence interval). However, as specifications are generally given in equipment reliability assuming the exponential distribution the effect of these two factors must be considered.

The AN/ART-50 estimated operational MTBF in the above table is for an exponential distribution. It is estimated that 89% of the failures are equipment failures (See paragraph 10-1.4) thus the estimated equipment reliability is 169 hours (150 - .89), which is still much less than the specified 750 hours. Problem areas of the ART-50 are discussed in paragraph 9-2.4 below.

The AN/WRR-7 estimated operational MTBF in the above table is for an Weibull distribution with a decreasing failure rate ($\beta$ = .416). Thus the mean is changing with time and is quite variable resulting in a wide confidence interval. If the exponential is assumed, the estimated mean in 1892 hours. Then, it is estimated that 79% of the failures are equipment failures, thus the estimated equipment MTBF assuming an exponential distribution would be 2350 hours which is still much above the specified 1000 hours.

(2) Maintainability (Repair Time). The ART-50 repair time follows the Weibull distribution with a $\beta$ = .707 and the WRR-7 repair time follows the exponential distribution. It can be seen in Table 5-9.1 that the lower confidence limit is much larger than the specified MTTR for the ART-50 and WRR-7, thus indicating a problem with repair time. However, all 3-M repair times are recorded to the nearest hour, including time for fault isolation, and obtaining on-board repair parts. Also, considering the medians, 50% or more of the repair times are estimated to be below two hours. The improvement of these repair times will not affect the operational availability significantly, as is shown in Section VII.

(3) Maintainability (Down Time). Down time is defined as equipment being in an inoperable or reduced capability state. By definition and mission, the AN/ART-50 is always up during its mission use. However, the down time of the AN/WRR-7 follows the Weibull distribution ($\beta$ = .2364) with an estimated mean of 336 hours. However, 75% of the total down time was due to a maintenance action on one submarine. The effect of this large down time shows up in the gross difference between the median, 2.2 hours, and the mean. Nevertheless, considering the length of mission of submarines (60 days) and the effect on operational availability, it is desired to eliminate all down times of such magnitude. The effect of improvement in down time upon availability is described in Section VII.

9-2.4 PROBLEM AREAS. Problem areas will be addressed by WRA first. Module level problems will be addressed in the order of appearance in the O-level summary.

(1) AN/ART-50. At the 90% confidence level, the MTBF of WRA-5, the FTS, is not greater than 294 hours. This is nearly 1,000 hours less than the predicted 1240 hour MTBF, indicating a severe problem exists. Of the observed 44 failures, 31 involved the FTS (one of the six WRA-4 999 failures refers to an FTS replacement). This is 70% of all observed AN/ART-50 failures. Resolution of problems below WRA level is not possible because AN/ART-50 users in the FRAP sample considered FTS repair to be an I-level task. No other significant problems were identified.

(2) AN/WRR-7. All WRA's meet or exceed predictions. The only significant O-level problem is the receiver power supply module, WRA-1 10. Three failures were observed with two additional failures (fuses) being related. The power supply is known to blow fuses with increasing frequency before total failure. This problem is known to have surfaced during the FRAP study period. See Section 10-3.6 for further discussion.

TABLE 5-9.1

| | ART-50 | WRR-7 |
|---|---|---|
| Total Equipment Calendar Time | 5,541 | 64,008 |
| Total Equipment Operating Time | 25,344 | 28,373 |
| Duty Cycle | .219 | .443 |
| No. of Operational Failures | 37 | 15 |
| Estimated Operational MTBF | 150 | 2432 |
| 80% Confidence Interval | 120-188 | 0-4838 |
| Estimated Median TBF | 104 | 351 |
| Specified MTBF | 750 | 1000 |
| Predicted (MIL-HDB-217) MTBF | 169 | 334 |
| Estimated Operational MTTR | 4.0 | 2.3 |
| 80% Confidence Interval | 2.9-5.2 | 1.7-3.2 |
| Estimated Median TTR | 2.0 | 1.6 |
| Specified MTTR | .36 | .62 |
| Estimated Operational MDT | - | 336 |
| 80% Confidence Interval | - | 0.1387 |
| Estimated Median DT | - | 2.2 |
| Estimated Mean Operational Availability | - | .809 |
| Estimated Inherent Availability | .974 | .982 |
| Specified Inhterent Availability | .9995 | .9994 |

SECTION X - DEPOT DATA ANALYSIS

10-1 BACKGROUND.

10-1.1 DATA SOURCE. The AN/URC-62 family of VLF communications equipment is manufactured by Collins Radio Group, a division of Rockwell International. Depot level repair for Verdin modules and mainframes has been established at the Collins facility located in Newport Beach, California. NAVELEX has contracted with Collins Newport to provide engineering support services, one of which is a monthly report by a reliability engineer that contains, among other things, a computer data bank printout of repair actions sorted by module part number.* This report and especially the data listing is absolutely invaluable for reliability analysis. The data is timely, complete and of superior quality. Data from the March 1977 report was partitioned into AN/ART-50 and AN/WRR-7 returns. Non-flying AN/ART-50 users and non-shipboard AN/WRR-7 users were removed from the data base. AN/URT-30 returns were likewise screened out. The partitioned repair actions were then tabulated by part number in preparation for statistical analysis.

10-1.2 STRUCTURED ANALYSIS. FRAP has developed a failure ranking technique useful for locating field problems as evidenced by their module return rates. This method takes into account both the numbers of each module used in a system and the complexity of each module. A problem is evidenced by an observed return rate which is significantly larger than the expected return rate. To measure this significance, a Poisson Test of Means is used. The results of this test are expressed in percent and represent the probability that the observed return rates are greater than the expected return rates. In FRAP, 95% or greater probability (significance) was used as the trigger point for follow-up study.

10-1.3 Additional calculations were performed for those modules identified as having 95% + significance from structured anlaysis. Using the projected expected return rate, a calculation was performed as to the percentage of reduction in the overall return rate that would have resulted had the module demonstrated the predicted MTBF. This reduction is the maximum that can reasonably be expected of this design.

10-1.4 VERIFICATION RATIO. To assist in problem isolation, a verification factor for each 95% + significant module was calculated using:

$$V = (N_1 + N_2/2)/N$$

where $N_1$ = Number of failures confirmed at depot
$N_2$ = Number of non-confirmed failures
$N^2 = N_1 + N_2$ = Total number of failures reported by fleet

This equation states that there is an even chance that a non-confirmed failure did malfunction in the Fleet but the cause was not discovered at depot level repair.

* "Monthly Report for Verdin Field Failure Monitoring Program", data item C00J on contract N00039-75-0082.

This is perhaps somewhat harsh on the depot test facility, but depot tests are in open air at room temperature with no vibration and usually on simulation jigs. Even if the trouble report specifically calls out a temperature problem, as did the SMO module serial number 360 which returned to depot on 25 May 1976 with this trouble report, "SMO OUT OF LOCK LITE WAS ON AT 50 DEG C AND GREATER THAN 90 PERCENT RH. AFTER COOLING DOWN, LITE WENT OFF", the trouble often (as in this case) is not confirmed. A verification ratio of 0.85-0.90 (20-30% unconfirmed) is considered average. The possible values range from 0.50 for no confirmations to 1.00 for all returns confirmed as failures. Some types of possible problems that will result in low verification ratios are: Errors in tech manuals, BITE design faults, misapplications, thermal or vibration problems, and correlation problems between module test jigs and actual system operating conditions.

10-2 FINDINGS FOR AN/ART-50.

10-2.1 AN/ART-50. A total of 158 modules from AN/ART-50 users were tabulated and statistically analyzed. Seven modules indicated a 95% + significance. They will be reviewed in the order of projected maximum improvement, i.e., the ranking order of Table 5-10.1. This ranking indicates the areas of greatest potential system improvement. It does not address cost effectiveness nor technical feasibility.

10-2.2 MAGNETIC TAPE UNIT (MTU). The MTU, part number 771-4616-001, was a severe early problem in the Verdin Processor. The module is a reel-to-reel digital tape recorder using two servoed motors to maintain constant tape speed and tension without using a capstan. These motors drive the takeup reels via flat belts. The entire assembly is enclosed such that no access to the mechanics or electronics of the unit is possible without tools. The MTU shows 100% significance on 42 returns with a verification ratio of 0.88. Early units suffered from two problems that were related. At humidities of 40% or more, the tape became sticky and adhered to the tape guides and record/playback head. This added load plus a small slipping problem overloaded the drive motor shaft/belt interface resulting in rapid wear of the motor shaft friction coating. Once the coating was gone, the motors could not start the tape fast enough to allow data transfer. A change in the tape, a different shaft coating, and changes in the tape guides have removed those problems. The effect of these severe problems remain in the depot data and will continue to remain for some time. This is further accented by a much smaller problem concerning the unexpectly high incidence of connector damage. MTU's must be removed from non-ready status aircraft because the tape contains classified data. This results in more handling damage than was projected. Changes in installation procedures have reduced the rate of connector breakage. It is not yet possible to assess the effect of these changes on the depot return rate.

10-2.3 RUBIDIUM VAPOR FREQUENCY REFERENCE (RVFR). The RVFR, part number 617-6876-001, is the heart module of the FTS. It contains a lamp/filter arrangement which shines light through a gas cell of rubidium vapor. This gas cell is contained in a

microwave cavity. When microwave energy of a precise frequency (6.834833 GHz) is present, electrons in the upper ground state are induced to drop into the lower ground state, a transition that emits a photon of microwave energy. Filtered light optically pumps the lower ground state to the high energy state, from which electrons fall with equal probability into the two ground states. The pumping process absorbs light in proportion to the number of electrons pumped. With microwave energy of the correct frequency present, the number of pumped electrons roughly doubles. A photocell detects the resulting drop in light transmission as the microwave energy hits the precisely correct pumping frequency. From this effect an error voltage is created that controls the FTS. The RVFR module shows 100% significance on 25 returns with a verficiation ratio of 0.98. The FTS was designed with the intent that it be fully powered at all times. In aircraft operation, the FTS is powered down after each flight. The RVFR stripline microcircuit is being literally torn apart by thermal stress during ON-OFF cycling. ECP's to address this problem have been developed and are being implemented. No reworked RVFR modules were in service during the FRAP study.

10-2.4 MAGNETIC CORE MEMORY. The core module, part number 784-5626-001, is a part of the processor and, like the MTU, is removed from non-ready status aircraft for security reasons. Like the MTU, the core module is suffering primarily from handling damage. The core module contains an array of tiny wires strung with doughnuts (cores) of ferrite material such that a non-volatile computer memory is formed. The core stack shows 100% significance on 11 returns with a verification ratio of 0.88, which is average. This indicates that the BITE testing of this complex module is effective. Like the MTU, new handling/installation procedures have been implemented to reduce physical damage. It is not yet possible to assess the effect of these procedures on depot return rates.

10-2.5 R.F. GENERATOR. The radio frequency generator, part number 606-9520-001, is part of the FTS. The generator is a 10 MHz crystal controlled oscillator. The error signal mentioned in the RVFR discussion is applied to this assembly. A varactor diode, which is a voltage controlled capacitor, slightly alters the output frequency in response to the error signal to hold the generator precisely on 10 MHz. The generator module shows 100% significance on 9 returns with a 0.91 verification ratio. No pattern of failure is apparent. From the verification ratio, it appears that the module is not being returned by mistake, but is actually failing to perform in the field.

10-2.6 FTS POWER SUPPLY. The FTS power supply module, part number 606-9525-001, was an early problem. An electrolytic filter capacitor materials problem was identified and corrected. Modules in the field with the problem capacitor are handled on a replace-while-repaired basis. This module shows 99.96% significance on 9 returns with a verification ratio of 1.00.

10-2.7 SYNTHESIZER. The synthesizer module, part number 606-9515-001, is part of the FTS. It receives the 10 MHz generated by the R.F. generator and creates the various output frequencies of the FTS. It also creates the mixing frequency which forms the basis for the microwave excitation energy applied to the RVFR gas cell. Synthesizer modules show 100% significance on 6 returns with a verification ratio of 1.00. No pattern of failure is apparent.

10-2.8 RB2 MODULE. The RB2 module, part number 784-3659-001, is a -5.2V power supply. It shows 99.92% significance on 7 returns with a verification ratio of 0.93. The RB2 module was an early problem corrected by parts changes, specifically

Q1 through Q5. Modules in the field are handled on a replace-while-repaired basis. Usually the reason for return of the RB2 module is the failure of the parts which are to be retrofitted.

10-3 FINDINGS FOR AN/WRR-7.

10-3.1 AN/WRR-7. A total of 561 modules from AN/WRR-7 users were tabulated and statistically analyzed. Fifteen modules indicated a 95% + significance. They will be reivewed in the order of projected maximum improvement, i.e. the ranking order of Table 5-10.2. This ranking indicates the areas of greatest potential improvement and does not address cost effectiveness or technical feasibility. Since many Verdin modules are used throughout the family, certain modules are used in the AN/ART-50 and are discussed in detail there. Such modules will include a reference to the appropriate section of the AN/ART-50 analysis as part of their discussion.

10-3.2 RB2 MODULE. The RB2 module, part number 784-3659-001, is a part of the Verdin power supply. It shows 100% significance on 50 returns with a verfiication ratio of 1.00. See Section 10-2.8 for discussion.

10-3.3 BFO/AUDIO MODULE. The Beat Frequency Oscillator/audio module, part number 616-1760-001, is a part of the R-1738/WR radio receiver. This module is a tuning aid for the operator. It contains an oscillator which may be manually adjusted to produce an audio tone by heterodyning (beating) against the received signal as output from the I.F. amplifier. Such an arrangement can also be used to receive continuous wave (C.W.) hand-keyed Morse Code transmissions. The module is tested during system self test, but the BFO adjustment knob must be set at a rotational extreme or invalid indications will result. The BFO/audio module shows 100% significance on 38 returns with a verification of 0.70, which indicates a factor other than component failure is operating. It is concluded that the Fleet users believe significant ECP action has been enacted on the BFO/audio module and that they should return their modules for rework and updating. Once the module supply turns over so that all are updated, this "problem" is expected to go away.

10-3.4 RUBIDIUM VAPOR FREQUENCY REFERENCE. The RVFR module, part number 617-6870-001, is a part of the FTS. This module shows 100% significance on 50 returns with a verification ratio of 0.98. Refer to section 10-2.3 for discussion.

10-3.5 FTS POWER SUPPLY. The FTS power supply module, part number 6-6-9525-001, shows 100% significance on 23 returns with a verification ratio of 0.98. See Section 10-2.6 for discussion.

10-3.6 R-1738/WR RECEIVER POWER SUPPLY. The power supply module, part number 616-1789-001, is a part of the R-1738/WR radio set. This module shows a 100% significance on 23 returns with a verification ratio of 0.96. The return rate, triple the 7 returns expected, and the high verification ratio indicate an equipment problem exists in the module. This problem developed during the FRAP study period and first became significant on depot data with the January 1977 report when it showed 97.18% significance. The trend indicates the problem is still developing and no estimate of its severity is possible from depot data. Collins has identified two failure patterns which are likely to be interrelated. The power transformer, T1, is failing, probably

due to overload from failing electrolytic filter capacitors. These capacitors have been identified as being overloaded with regard to AC ripple current. At the time this module was designed, no ripple current specifications had been developed for the capacitor used. An ECP is being prepared at this time.

10-3.7 PW5 MODULE. The PW5 module, part number 784-4186-001, is the magnetic tape interface for the processor. Class 1 ECP No. 282R2 recalled this module for a retrofit to avoid MTU lockup when a power drop occurs during rewinding of the MTU's tape. The verification ratio of 0.52, nearly the lowest possible, shows that most of the 23 returns were sent back for modification rather than repair.

10-3.8 STABLE MASTER OSCILLATOR. The SMO module, part number 792-6701-001, is part of the R-1738/WR radio receiver. This large, complex module contains 28% of the total circuitry in the R-1738/WR radio set. In the SMO, a 5 MHz reference signal is used to control the generation of the various heterodyne frequencies needed by the radio for its operation. The SMO can either accept an external 5 MHz signal from a source such as the FTS or create its own 5 MHz reference from a stabilized internal crystal oscillator. The SMO is 99.86% significant on 30 returns (17 were expected) with a verification ratio of 0.93, which indicates that the reason for return is actual part failure.

10-3.9 MAGNETIC CORE MEMORY. The core module, part number 784-5626-001, is a part of the processor. This module contains an array of fine wires with tiny ferrite doughnuts (cores) strung on them like beads. This array is a non-volatile computer memory for the processor. The core module shows 100% significance on 15 returns with a verification ratio of 0.86. Further, 6 of the 13 returns are for mechanical damage to covers and connectors, clearly a handling related problem. The returns situation resembles the experience of the AN/ART-50 users except that their verification ratio (0.88) is higher. AN/WRR-7 users have their systems in a secure area and have no need to pull and replace MTU's and core stacks as do airborne Verdin users. The reason for the similarity between the shipboard and airborne user's experience with regard to handling damage is unknown.

10-3.10 SECOND INTERMEDIATE FREQUENCY AMPLIFIER. The 2nd I.F. amp module, part number 616-1829-001, is a part of the R1738/WR radio set. The 2nd I.F. amplifier module contains Noise Reduction Circuits (NRC) and crystal bandwidth filters in addition to fixed gain amplifier stages. This module shows 100% significance on 12 returns with a verification ratio of 0.86. The verification ratio is in the expected range of 0.85-0.90, which indicates that these modules are being returned for cause. No failure pattern is apparent.

10-3.11 PW9 MODULE. The PW9 module, part number 784-4196-001, is a part of processor. It is also called a "fan-in selector", which means it serves to select which of several inputs will pass into the processor. This module is 100% significant on 9 returns with a verification ratio of 0.63. The very low verification ratio and the fact that all reasons for return as listed by the users were "repair" indicates that a problem exists in the system test procedure. The users had no symptoms to report which means either that the auto diagnotics called the module out as faulty or, more likely, the user suspected the module and could not prove it to be definitely good or definitely defective.

10-3.12 FREQUENCY SHIFT KEY DETECTOR. The FSK detector module, part number 616-1730-001, is part of the R-1738/WR radio set. This module receives the output of the 2nd I.F. amp and converts it into a single channel 6V polar keyed data stream suitable for teletype use. The FSK detector module shows a significance of 99.59% on 8 returns with a verification ratio of 0.75. Three of the returns showed mechanical damage; none of the returns required electronic parts replacement. Confirmed failures appear to be of the type expected under normal wear and tear.

10-3.13 R.F. AMPLIFIER. The radio frequency amplifier, part number 797-3628-001, is part of the FTS. This module amplifies and filters the outputs of the synthesizer module, and originates the TIMING FAULT lamp signal. The R.F. amplifier module shows a 99.81% significance on 8 returns with a verification ratio of 0.94, which indicates that the unit is being returned for cause. No failure pattern is apparent.

10-3.14 RADIO FREQUENCY GENERATOR. The R.F. generator is part of the FTS. It is 98.09% significant on 11 returns with a verification factor of 0.80. See Section 10-2.5 for discussion.

10-3.15 PK9 MODULE. The PK9 module, part number 784-4066-001, is part of the demodulator. Also known as the amplitude multiplier, the PK9 module is part of the analog signal processing circuitry. This module shows 99.05% significance on 6 returns with a verification ratio of 0.80. No failure pattern is apparent. No descriptive symptoms were reported.

10-3.16 PF7 MODULE. The PF7 module, part number 784-4006-001, is part of the processor. Also known as the memory timing module, PF7 works with the core stack to provide the processor a non-volite memory. This module shows 98.06% significance on 5 returns with a verification ratio of 0.80. In 3 cases delay line, designator DL1, was replaced. There were no descriptive symptoms accompanying the returns.

10-4 CONCLUSIONS FROM DEPOT DATA.

10-4.1 AN/ART-50. The single largest problem area is the FTS with 57% of the significant problems listed in Table 5-10.1. It is estimated that the operational MTBF of the system could be raised 29% to 194 hours by bringing the FTS into line with its predicted reliability performance. The number of FTS modules with significant problems probably indicates that the current FTS design is marginal in the airborne environment.

10-4.2 AN/WRR-7. The R-1738/WR radio set is the largest current system problem area. The presence of 5 modules on the significant problem listing might be taken as an indication that the R-1738/WR is being operated independently of the remainder of the system and is accumulating a disproportionate number of hours. The SMO and 2nd I.F. amp modules show good verification ratios with no pattern of failures. The power supply and FSK detector modules show patterns which account for their accelerated return rates. The BFO/audio module appears to be a special case not related to operating time. This is not to rule out the possiblity that the radio set is run while the processor and so forth are shut down. The support for such a theory, however, is not present in this depot data.

10-4.3 VERIFICATION RATIOS. Verification ratios (V) and number (N) on which it is based by system are as follows:

TABLE 5-10.3

| SORT: | AN/ART-50 | AN/WRR-7 | All Verdin |
|---|---|---|---|
| N | 147 | 341 | 743 |
| V | 0.80 | 0.79 | 0.83 |

To determine the impact of the lack of Fleet user input on the effectiveness of depot repairs, the following tabulation was made:

TABLE 5-10.4

| SORT: | Returns w/o Symptoms | Returns w/Symptoms |
|---|---|---|
| N | 534 | 209 |
| V | 0.80 | 0.88 |

It appears that depot repair effectiveness can be increased by including a description of trouble symptoms with the returned module.

RESULTS OF AN/ART-50 DEPOT ANALYSIS

| | NAME | PART NO. | FAILURES Observed | FAILURES Expected | % Improvement Possible | % Significant | Action Status | Verification Factor |
|---|---|---|---|---|---|---|---|---|
| 1 | MTU | 771-4616 | 42 | 6 | 23 | 100.00 | Yes | .88 |
| 2 | RVFR | 617-6876 | 25 | 2 | 15 | 100.00 | Yes | 0.98 |
| 3 | Mag. Core | 784-5626 | 11 | 1 | 6 | 100.00 | No | 0.91 |
| 4 | RF Gen | 606-9520 | 9 | 1 | 6 | 100.00 | No | 0.88 |
| 5 | FTS P.S. | 606-9525 | 9 | 3 | 4 | 99.96 | Yes | 1.00 |
| 6 | Synthesizer | 606-9515 | 6 | 1 | 4 | 100.00 | No | 1.00 |
| 7 | RB2 | 784-3659 | 7 | 2 | 4 | 99.92 | Yes | 0.93 |

TOTAL 58%

TABLE 5-10.1

RESULTS OF AN/WRR-7 DEPOT ANALYSIS

| NAME | | PART NO. | FAILURES Observed | FAILURES Expected | % Improvement Possible | % Significant | Action Status | Verification Factor |
|---|---|---|---|---|---|---|---|---|
| 1 | RB2 | 784-3659 | 50 | 7 | 8 | 100.00 | Yes | 1.00 |
| 2 | BFO/Audio | 616-1760 | 38 | 1 | 7 | 100.00 | No | 0.70 |
| 3 | RVFR | 617-6876 | 50 | 15 | 6 | 100.00 | Yes | 0.98 |
| 4 | FTS P.S. | 6-6-9525 | 23 | 7 | 3 | 100.00 | Yes | 0.98 |
| 5 | RCVR P.S. | 616-1789 | 23 | 7 | 3 | 100.00 | Yes | 0.96 |
| 6 | PW5 | 784-4186 | 23 | 5 | 3 | 100.00 | Yes | 0.52 |
| 7 | SMO | 792-6701 | 30 | 17 | 2 | 99.86 | No | 0.93 |
| 8 | Magnetic Core | 784-5626 | 15 | 4 | 2 | 100.00 | No | 0.86 |
| 9 | 2nd IF | 616-1829 | 12 | 2 | 2 | 100.00 | No | 0.83 |
| 10 | PW9 | 784-4196 | 9 | 2 | 1 | 100.00 | No | 0.63 |
| 11 | FSK Det. | 616-1730 | 8 | 3 | 1 | 99.59 | No | 0.75 |
| 12 | RF Amp | 797-3628 | 8 | 3 | 1 | 99.84 | No | 0.94 |
| 13 | RF Gen | 606-9520 | 11 | 6 | 1 | 98.09 | No | 0.80 |
| 14 | PK9 | 784-4066 | 6 | 1 | 1 | 99.05 | No | 0.80 |
| 15 | PF7 | 784-4006 | 5 | 2 | 1 | 98.06 | No | 0.80 |

TOTAL 42%

TABLE 5-10.2

# APPENDIX 5A

# RELIABILITY MODEL COMPUTER PROGRAMS

```
 77/03/14. 09.16.21.
PROGRAM   ART50

100 REM MODEL FOR AN/ART-50
00105 PRINT
00110 PRINT"INPUT MISSION LENGTH (IN HOURS) = ";
00120 INPUT T
00125 PRINT
00130 DIM R(108,2),W(5)                          'SETUP ARRAYS
00140 FOR I=1 TO 5
00150 W(5)=0                                     'ZERO WRA ARRAY
00155 R=1
00160 NEXT I
00170 F0=0                                       'ZERO TOTALIZER VARIABLE
00180 RESTORE
00190 FOR I=1 TO 108
00200 READ A,B,C,D                               'READ FAILURE RATE DATA
00210 R(I,1)=B*C*1E-5                            'CONVERT TO DECIMAL
00220 R(I,2)=D
00230 IF D=0 THEN 250
00240 W(D)=W(D)+R(I,1)                           'SUM BY WRA
00250 F0=F0+R(I,1)                               'SUM FOR SYSTEM
00251 REM PLACE DISTRIBUTION BELOW
00252 R1=EXP(-(R(I,1)*T))                        'CALC SYSTEM REL.
00255 R=R*R1
00260 NEXT I
00270 REM EXPONENTIAL DISTRIBUTION IS ASSUMED
00280 FOR I=1 TO 5
00290 W(I)=1/W(I)                                'CALC. WRA MTBF
00300 W(I)=INT(W(I))                             'CROP FOR PRINTOUT
00310 NEXT I
00320 M=INT(1/F0)                                'CALC. SYSTEM MTBF
00330 PRINT"MEAN TIME BETWEEN FAILURES BY WRA (IN HOURS)"
00340 PRINT"MODULATOR","POWER SUPPLY","CONTROL BOX","PROCESSOR";
00350 PRINT,"TIME STD."
00360 PRINT W(1),W(2),W(3),W(4),W(5)
00370 PRINT
00380 PRINT"OVERALL SYSTEM MTBF = ";M
00390 REM OVERAL SYSTEM RELIABILITY IS IN R
00400 PRINT
00410 PRINT"OVERALL SYSTEM RELIABILITY FOR ";T;" HOUR MISSION = ";
00420 R=INT(1000*R)/1000                         'CROP FOR PRINTOUT
00430 PRINT R
00440 PRINT
00450 STOP
00460 REM O-LEVEL FAILURE RATES (IN %/1000 HOURS)
00470 REM R#, FAILURE RATE, NUMBER USED, WRA KEY NUMBER
00480 DATA     1,  2.642, 1, 2
00490 DATA     2,  2.208, 3, 2
00500 DATA     3,  2.052, 2, 2
00510 DATA     4,  4.491, 3, 2
00520 DATA     5,  5.611, 1, 2
00530 DATA     6,  2.411, 1, 2
00540 DATA     7,  2.060, 1, 2
```

Figure 5-A.1

```
00550 DATA     8, 11.787, 1, 2
00560 DATA     9,  3.471, 1, 2
00570 DATA    10,  6.486, 1, 2
00580 DATA    11,  3.095, 1, 3
00590 DATA    12,  4.053, 1, 3
00600 DATA    13,  4.490, 1, 3
00610 DATA    14,  3.394, 1, 3
00620 DATA    15,  3.390, 1, 3
00630 DATA    16,  5.533, 2, 3
00640 DATA    17,  6.463, 1, 3
00650 DATA    18,  7.146, 1, 3
00660 DATA    19,  2.889, 1, 3
00670 DATA    20,  3.799, 1, 3
00680 DATA    21,  7.261, 1, 3
00690 DATA    22,  3.428, 1, 3
00700 DATA    23,  3.498, 1, 3
00710 DATA    24,  5.284, 1, 3
00720 DATA    25,  5.574, 1, 3
00730 DATA    26,  6.382, 1, 3
00740 DATA    27, 17.202, 1, 3
00750 DATA    28,  3.735, 1, 1
00760 DATA    29,  4.259, 1, 1
00770 DATA    30,  3.853, 1, 1
00780 DATA    31,  3.788, 1, 1
00790 DATA    32,  4.153, 1, 1
00800 DATA    33,  4.318, 1, 1
00810 DATA    34,  1.756, 1, 1
00820 DATA    35,  1.838, 1, 1
00830 DATA    36,  2.881, 1, 1
00840 DATA    37, 25.498, 1, 1
00850 DATA    38, 11.786, 1, 1
00860 DATA    42,  2.411, 1, 1
00870 DATA    40,  3.297, 1, 1
00880 DATA    41,  2.834, 1, 1
00890 DATA    42,  2.411, 1, 2
00900 DATA    43,  2.052, 1, 1
00910 DATA    44,  3.471, 1, 1
00920 DATA    45,  6.518, 1, 1
00930 DATA    46,  4.491, 4, 1
00940 DATA    47,  0    , 0, 0
00950 DATA    48,  0    , 0, 0
00960 DATA    49,  0    , 0, 0
00970 DATA    50,  0    , 0, 0
00980 DATA    51,  0    , 0, 0
00990 DATA    52,  0    , 0, 0
01000 DATA    53,  0    , 0, 0
01010 DATA    54,  0    , 0, 0
01020 DATA    55,  0    , 0, 0
01030 DATA    56,  0    , 0, 0
01040 DATA    57,  2.298, 4, 4
01050 DATA    58,  5.657, 4, 4
01060 DATA    59,  2.468, 8, 4
01070 DATA    60,  3.154, 1, 4
01080 DATA    61,  3.159, 1, 4
01090 DATA    62,  1.008, 1, 4
01100 DATA    63,  1.515, 1, 4
01110 DATA    64,  2.657, 3, 4
01120 DATA    65,  2.000, 1, 4
01130 DATA    66,  1.886, 2, 4
01140 DATA    67,  3.509, 1, 4
01150 DATA    68,  3.099, 1, 4
01160 DATA    69,  3.758, 1, 4
01170 DATA    70,  2.887, 1, 4
01180 DATA    71,  1.711, 1, 4
01190 DATA    72,  3.656, 1, 4
01200 DATA    73,  3.789, 1, 4
01210 DATA    74,  1.985, 1, 4
01220 DATA    75,  0    , 0, 0
01230 DATA    76,  3.828,16, 4
01240 DATA    77,  0    , 0, 0
01250 DATA    78,  3.190, 1, 4
01260 DATA    79,  3.735, 1, 4
01270 DATA    80,  2.435, 1, 4
01280 DATA    81,  3.806, 1, 4
01290 DATA    82,  3.799, 1, 4
01300 DATA    83,  3.586, 1, 4
01310 DATA    84,  3.616, 1, 4
01320 DATA    85,  3.968, 2, 4
01330 DATA    86,  2.592, 1, 4
01340 DATA    87,  1.887, 1, 4
01350 DATA    88,  3.990, 1, 4
01360 DATA    89,  4.900, 1, 4
01370 DATA    90,  4.993, 1, 4
01380 DATA    91,  3.219, 1, 4
01390 DATA    92,  5.033, 1, 4
01400 DATA    93, 26.645, 1, 4
01410 DATA    94,  8.000, 1, 5
01420 DATA    95,  7.484, 1, 5
01430 DATA    96,  7.235, 1, 5
01440 DATA    97,  1.182, 1, 5
01450 DATA    98,  6.395, 1, 5
01460 DATA    99,  1.136, 1, 5
01470 DATA   100,  6.675, 1, 5
01480 DATA   101,  3.926, 1, 5
01490 DATA   102,  8.106, 1, 5
01500 DATA   103,  0.400, 1, 5
01510 DATA   104,  4.238, 1, 5
01520 DATA   105, 11.197, 1, 5
01530 DATA   106,  3.311, 1, 5
01540 DATA   107,  3.981, 1, 5
01550 DATA   108,  7.383, 1, 5
READY.
```

Figure 5-A.1 (Continued)

```
LIST
 77/04/12. 15.58.51.
PROGRAM   WRR7

100 REM MODEL FOR AN/WRR-7
00105 PRINT
00110 PRINT"INPUT MISSION LENGTH (IN DAYS) = ";
00115 INPUT T
00120 T=T*24
00125 PRINT
00130 DIM R(108,2),W(5)                    'SETUP ARRAYS
00140 FOR I=1 TO 5
00150 W(5)=0                               'ZERO WRA ARRAY
00155 R=1
00160 NEXT I
00170 F0=0                                 'ZERO TOTALIZER VARIABLE
00180 RESTORE
00190 FOR I=1 TO 108
00200 READ A$,B$,C$,B,C,D
00210 R(I,1)=B*C*1E-5                      'CONVERT TO DECIMAL
00220 R(I,2)=D
00230 IF D=0 THEN 250
00240 W(D)=W(D)+R(I,1)                     'SUM BY WRA
00250 F0=F0+R(I,1)                         'SUM FOR SYSTEM
00251 REM PLACE DISTRIBUTION BELOW
00252 R1=EXP(-(R(I,1)*T))                  'CALC SYSTEM REL.
00253 REM EXPONENTIAL DISTRIBUTION IS ASSUMED
00255 R=R*R1
00260 NEXT I
00280 FOR I=1 TO 5
00290 W(I)=1/W(I)                          'CALC. WRA MTBF
00300 W(I)=INT(W(I))                       'CROP FOR PRINTOUT
00310 NEXT I
00320 M=INT(1/F0)                          'CALC. SYSTEM MTBF
00330 PRINT"MEAN TIME BETWEEN FAILURES BY WRA (IN HOURS)"
00340 PRINT"RECEIVER","POWER SUPPLY","DEMODULATOR","PROCESSOR";
00350 PRINT,"TIME STD."
00360 PRINT W(1),W(2),W(3),W(4),W(5)
00370 PRINT
00380 PRINT"OVERALL SYSTEM MTBF = ";M
00390 REM OVERAL SYSTEM RELIABILITY IS IN R
00400 PRINT
00410 PRINT"OVERALL SYSTEM RELIABILITY FOR ";T/24;" DAY MISSION = ";
00420 R=INT(1000*R)/1000                   'CROP FOR PRINTOUT
00430 PRINT R
00440 PRINT
00450 STOP
```

Figure 5-A.2

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

```
05000 REM D-LEVEL FAILURE RATES (IN %/1000 HOURS)
05010 REM DESIG., NAME, P/N, # USED, FAILURE RATE, WRA KEY #
05000 DATA "A2","R.F.  AMPLIFIER","616-1629",1,5.571,1
05001 DATA "A3","FIRST MIXER","616-1669",1,1.180,1
05002 DATA "A4","FIRST I.F. AMPLIFIER","616-1689",1,0.990,1
05003 DATA "A11","SECOND MIXER","616-1710",1,0.724,1
05004 DATA "A9","FSK DETECTOR","616-1730",1,1.323,1
05005 DATA "A19","7.5 KHZ AMPLIFIER","616-1740",1,0.405,1
05006 DATA "A7","5 MHZ SWITCH/AMPLIFIER","616-1749",1,0.376,1
05007 DATA "A12","BFO/AUDIO","616-1760",1,0.101,1
05008 DATA "A10","AGC DETECTOR/AMPLIFIER","616-1770",1,0.718,1
05009 DATA "A8","RECEIVER POWER SUPPLY","616-1789",1,3.706,1
05010 DATA "A1","FRONT PANEL","616-1651",1,1.618,1
05011 DATA "","CHASSIS COMPONENTS","792-6377",1,3.345,1
05012 DATA "A13","SELF CHECK MULTIPLEXER","616-1810",1,0.593,1
05013 DATA "A14","SELF CHECK","616-1820",1,0.937,1
05014 DATA "A5","SECOND I.F. AMPLIFIER","616-1829",1,1.813,1
05015 DATA "","BCD FREQUENCY CONTROL","616-1780",1,1.520,1
05016 DATA "","RFI ASSEMBLY","616-1624",1,0.490,1
05017 DATA "A6","STABILIZED MASTER OSC.","792-6701",1,8.625,1
05018 DATA "TTY","TELETYPE INTERFACE","784-5336",1,1.573,3
05019 DATA "BANL","BLACK ANALOG INTERFACE","784-5338",1,1.682,3
05020 DATA "KGEN","KEY GENERATOR INTERFACE","784-5340",1,2.532,3
05021 DATA "BDIG","BLACK DIGITAL INTERFACE","784-6444",1,2.075,3
05022 DATA "","WIRED BACKCAP ASSEMBLY","784-7611",1,1.291,3
05023 DATA "","BACKPLANE","784-5244",1,0.331,3
05024 DATA "PD9","WEIGHTING FUNCTION GENERATOR","784-3982",2,2.209,3
05025 DATA "PF9","TIME BASE I","784-4010",1,1.686,3
05026 DATA "PG2","TIME BASE II","784-4012",1,1.763,3
05027 DATA "PG3","TIME BASE III","784-4014",1,1.698,3
05028 DATA "PJ9","ADC CONTROL","784-4052",1,1.592,3
05029 DATA "PK2","ADC DETECTOR","784-4054",1,1.665,3
05030 DATA "PK3","ADC MULTIPLEXER","784-4056",1,2.127,3
05031 DATA "PK4","DIGITAL-ANALOG CONVERTER","784-4058",1,1.120,3
05032 DATA "PK5","BINARY AND TIMING","784-4060",1,2.743,3
05033 DATA "PK7","DETECTOR B","784-4062",2,1.969,3
05034 DATA "PK8","SYNCHRONIZING","784-4064",1,1.314,3
05035 DATA "PK9","AMPLITUDE MULTIPLIER","784-4066",1,0.940,3
05036 DATA "PL2","DETECTOR A","784-4068",1,1.969,3
05037 DATA "PL3","RESOLVER","784-4070",2,2.209,3
05038 DATA "","","",0,0,0
05039 DATA "PL7","REGISTER TWO","784-4076",1,2.112,3
05040 DATA "PL8","REGISTER THREE","784-4078",1,2.030,3
05041 DATA "PL9","REGISTER FOUR","784-4080",1,1.909,3
05042 DATA "PM2","REGISTER FIVE","784-4082",1,1.904,3
05043 DATA "PM3","REGISTER SIX","784-4084",1,2.043,3
```

Figure 5-A.2 (Continued)

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

```
05044 DATA "PM4","REGISTER SEVEN","784-4086",1,2.772,3
05045 DATA "PM5","ALARM PHASE TWO","784-4088",1,2.267,3
05046 DATA "RB7","CONTROL PHASE TWO","784-5334",1,1.833,3
05047 DATA "RA5","POWER SUPPLY, -25V","784-3655",1,2.234,2
05048 DATA "RA7","POWER SUPPLY, +15V","784-3656",3,1.593,2
05049 DATA "RA8","15 V FILTER","784-3657",2,1.751,2
05050 DATA "RA9","LAMP DRIVER","784-3658",4,3.141,2
05051 DATA "RB2","POWER SUPPLY, -5.2V","784-3659",1,3.454,2
05052 DATA "RB4","POWER SUPPLY, +25V","784-3661",1,1.947,2
05053 DATA "PV2","POWER SUPPLY MONITOR","784-4166",1,1.255,2
05054 DATA "PB3","BATTERY SOURCE","619-0996",1,5.391,2
05055 DATA "RC3","BATTERY CONVERTER","609-4511",1,2.732,2
05056 DATA "PJ7","READ/WRITE SWITCH","784-4048",4,1.277,4
05057 DATA "PE7","READ/WRITE DRIVER","784-3992",4,1.623,4
05058 DATA "PJ8","INHIBIT DRIVER","784-4050",8,0.973,4
05059 DATA "PN7","WRITE DRIVER","784-4104",1,1.106,4
05060 DATA "PD8","READ DRIVER","784-3980",1,1.129,4
05061 DATA "PD7","STROBE","784-3978",1,0.303,4
05062 DATA "PF7","MEMORY TIMING","784-4006",1,0.808,4
05063 DATA "PE8","DIODE BOARD","784-3994",3,2.992,4
05064 DATA "CORE","MAGNETIC CORE MEMORY","784-5626",1,2.0,4
05065 DATA "PD5","SENSE AMPLIFIER","784-3976",2,1.097,4
05066 DATA "PX2","MAJORITY CYCLE CONTROL","784-4194",1,1.727,4
05067 DATA "PX5","MINORITY CYCLE CONTROL","784-4200",1,1.476,4
05068 DATA "PX4","READ/SENSE CYCLE CONTROL","784-4198",1,1.869,4
05069 DATA "PW7","INPUT/OUTPUT CONTROL","784-4188",1,1.399,4
05070 DATA "PW9","INPUT/OUTPUT SELECTOR","784-4192",1,0.841,4
05071 DATA "PV7","PAPER TAPE ADAPTER I","784-4174",1,2.002,4
05072 DATA "PV5","PAPER TAPE ADAPTER II","784-4172",1,1.892,4
05073 DATA "MTU","MAGNETIC TAPE UNIT","771-4616",1,14.390,4
05074 DATA "","","",0,0,0
05075 DATA "PY5","BIT MEMORY","784-4214",16,1.838,4
05076 DATA "","","",0,0,0
05077 DATA "PW8","INPUT/OUTPUT FAN-IN","784-4190",1,1.599,4
05078 DATA "PY3","PANEL INTERFACE","784-4210",1,1.793,4
05079 DATA "PY2","INSTRUCTION DECODER","784-4208",1,1.173,4
05080 DATA "PX9","TRANSFER CONTROL A","784-4206",1,1.861,4
05081 DATA "PX8","TRANSFER CONTROL Z","784-4204",1,1.833,4
05082 DATA "PX7","TRANSFER CONTROL B","784-4202",1,1.734,4
05083 DATA "PX3","TEST","784-4196",1,1.744,4
05084 DATA "PY4","COMPARATOR ACCUMULATOR","784-4212",2,1.899,4
05085 DATA "PV9","MTA SHIFT","784-4178",1,1.266,4
05086 DATA "PV8","MTA REGISTER","784-4176",1,0.919,4
05087 DATA "PW2","MTA TIMING","784-4180",1,1.970,4
05088 DATA "PW4","","784-4184",1,2.454,4
```

Figure 5-A.2 (Continued)

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

```
05089 DATA "PW5","","784-4186",1,2.592,4
05090 DATA "PV4","MODE CONTROL","784-4170",1,1.725,4
05091 DATA "LDVR","LAMP DRIVER","784-4222",1,2.902,4
05092 DATA "","CHASSIS W/ MOUNTED COMPONENTS","",1,9.168,4
05093 DATA "A5","RB VAPOR FREQ. REF. (RVFR)","617-6876",1,8.0,5
05094 DATA "A1","VOLTAGE REGULATOR","797-3632",1,1.654,5
05095 DATA "A2","SERVO AMPLIFIER","797-3632",1,3.592,5
05096 DATA "A3","SYNTHESIZER","606-9515",1,4.287,5
05097 DATA "A4","R.F. AMPLIFIER","797-3628",1,1.134,5
05098 DATA "A6","R.F. GENERATOR","606-9520",1,2.802,5
05099 DATA "A7","THERMO CONTROL","606-9527",1,2.894,5
05100 DATA "A8","AUXILIARY R.F. AMPLIFIER","609-1376",1,0.806,5
05101 DATA "A9","CLOCK DIVIDER","606-9521",1,3.775,5
05102 DATA "A10","BATTERY","606-9524",1,0.2,5
05103 DATA "A11","BATTERY CHARGER","606-9523",1,1.090,5
05104 DATA "A12","FTS POWER SUPPLY","606-9525",1,3.438,5
05105 DATA "","CLOCK","617-6154",1,1.407,5
05106 DATA "A5A2","THERMO-ELEC. COOLER","606-9526",1,1.927,5
05107 DATA "","CHASSIS W/ MOUNTED COMPONENTS","606-9513",1,2.646,5
05108 END
```

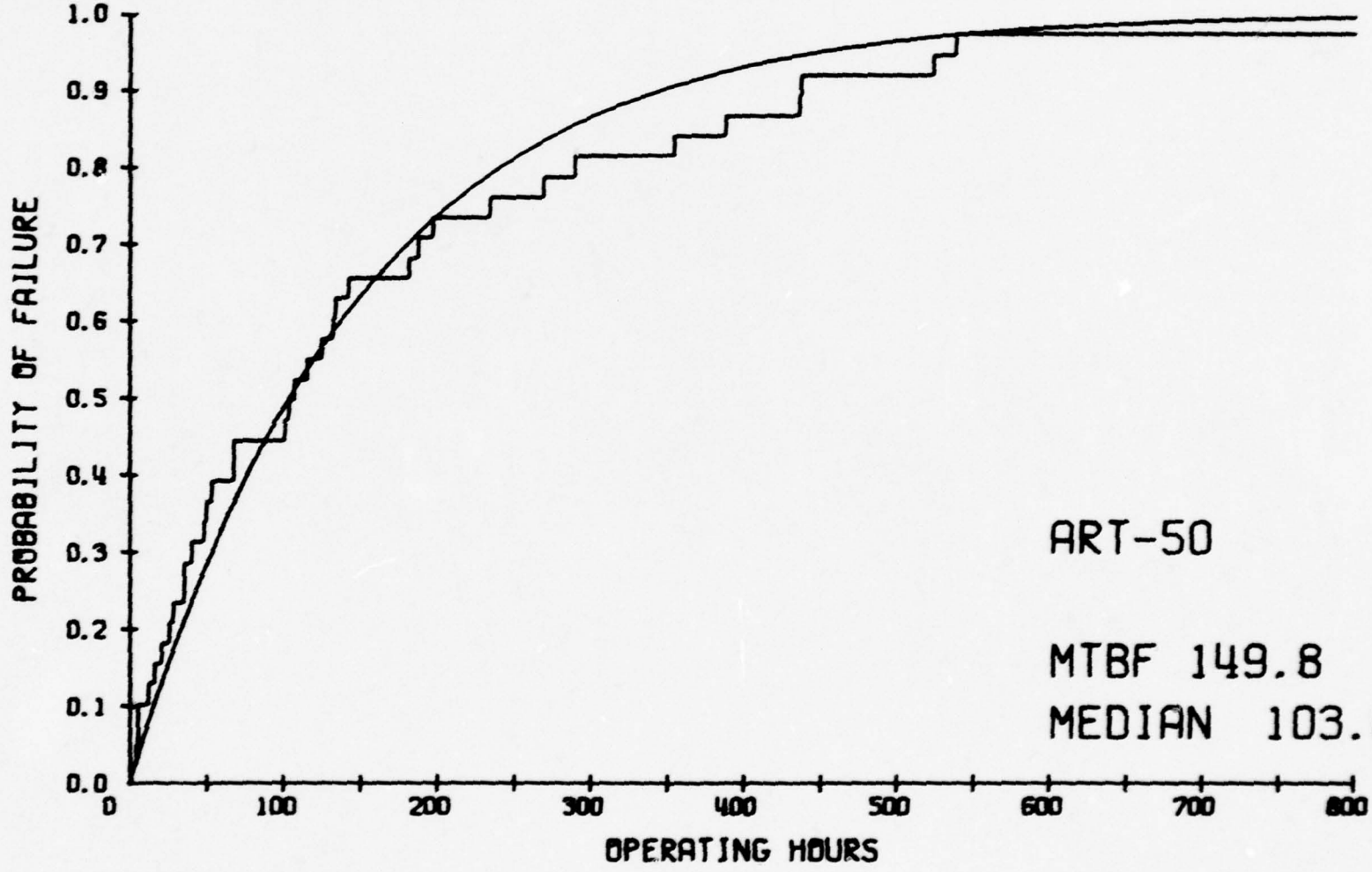
Figure 5-A.2 (Continued)

# APPENDIX 5B

## COMPUTER OUTPUT FOR ANALYSIS OF FRAP FLEET DATA

OUTPUT FOR AN/ART-50

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



FLEET RELIABILITY ASSESSMENT DATA

| MTYP | DATE | WRA | OL1 | OL2 | OL3 | ETM | ETM1 | ETM2 | OPERATE | DUTY | TTF | SYS | UIC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 6076 6092 | 4 | 65 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 5 | 0 |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | |
| 3 | 6030 6030 | 5 | 999 | 0 | 0 | 1766.0 | 1766.0 | 1766.0 | 0.0 | 0.000 | 0.0 | 5 | 151888 |
| 3 | 6052 6052 | 5 | 999 | 0 | 0 | 1878.0 | 1878.0 | 1878.0 | 112.0 | .212 | 112.0 | 5 | 151888 |
| 3 | 6089 6090 | 1 | 999 | 0 | 0 | 2120.0 | 2120.0 | 2120.0 | 354.0 | .246 | 242.0 | 5 | 151888 |
| 0 | 6258 6258 | 5 | 999 | 0 | 0 | 3004.0 | 3004.0 | 3004.0 | 0.0 | 0.000 | 0.0 | 5 | 151888 |
| 3 | 6310 6314 | 5 | 103 | 999 | 0 | 3109.0 | 3109.0 | 3109.0 | 105.0 | .078 | 105.0 | 5 | 151888 |
| 3 | 6315 6321 | 4 | 999 | 0 | 0 | 3131.0 | 3131.0 | 3131.0 | 127.0 | .084 | 22.0 | 5 | 151888 |
| 3 | 6324 6324 | 4 | 999 | 0 | 0 | 3172.0 | 3172.0 | 3172.0 | 168.0 | .106 | 41.0 | 5 | 151888 |
| 3 | 7030 7030 | 4 | 999 | 0 | 0 | 3496.0 | 3496.0 | 3496.0 | 492.0 | .150 | 324.0 | 5 | 151888 |
| 3 | 7031 7031 | 4 | 999 | 0 | 0 | 3501.0 | 3501.0 | 3501.0 | 497.0 | .150 | 5.0 | 5 | 151888 |
| 3 | 7044 7046 | 5 | 999 | 0 | 0 | 3558.0 | 3558.0 | 3558.0 | 554.0 | .151 | 57.0 | 5 | 151888 |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | |
| 3 | 6005 6008 | 5 | 999 | 0 | 0 | 9834.0 | 9834.0 | 9834.0 | 0.0 | 0.000 | 0.0 | 5 | 151889 |
| 3 | 6028 6034 | 5 | 999 | 0 | 0 | 9839.0 | 9839.0 | 9839.0 | 5.0 | .007 | 5.0 | 5 | 151889 |
| 0 | 6275 6275 | 4 | 74 | 0 | 0 | 212.0 | 212.0 | 212.0 | 0.0 | 0.000 | 0.0 | 5 | 151889 |
| 3 | 6299 6300 | 5 | 999 | 0 | 0 | 246.0 | 246.0 | 246.0 | 34.0 | .057 | 34.0 | 5 | 151889 |
| 3 | 6316 6317 | 5 | 999 | 0 | 0 | 331.0 | 331.0 | 331.0 | 119.0 | .118 | 85.0 | 5 | 151889 |
| 3 | 6334 6336 | 4 | 65 | 0 | 0 | 421.0 | 421.0 | 421.0 | 209.0 | .143 | 90.0 | 5 | 151889 |
| 3 | 7013 7018 | 5 | 999 | 0 | 0 | 646.0 | 646.0 | 646.0 | 434.0 | .167 | 225.0 | 5 | 151889 |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | |
| 3 | 6060 6089 | 5 | 94 | 106 | 0 | 9922.0 | 9922.0 | 9922.0 | 0.0 | 0.000 | 0.0 | 5 | 156170 |
| 0 | 7008 7008 | 5 | 105 | 999 | 0 | 840.0 | 840.0 | 840.0 | 0.0 | 0.000 | 0.0 | 5 | 156170 |
| 3 | 7015 7015 | 5 | 999 | 0 | 0 | 870.0 | 870.0 | 870.0 | 30.0 | .179 | 30.0 | 5 | 156170 |
| 3 | 7023 7025 | 5 | 999 | 0 | 0 | 900.0 | 900.0 | 900.0 | 60.0 | .147 | 30.0 | 5 | 156170 |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | |
| 3 | 6012 6015 | 5 | 999 | 0 | 0 | 9176.0 | 9176.0 | 9176.0 | 0.0 | 0.000 | 0.0 | 5 | 156173 |
| 3 | 6077 6077 | 1 | 38 | 0 | 0 | 9341.0 | 9341.0 | 9341.0 | 165.0 | .106 | 165.0 | 5 | 156173 |
| 3 | 6080 6080 | 5 | 94 | 0 | 0 | 9359.0 | 9359.0 | 9359.0 | 183.0 | .112 | 18.0 | 5 | 156173 |
| 3 | 6115 6115 | 5 | 999 | 0 | 0 | 9516.0 | 9516.0 | 9516.0 | 340.0 | .138 | 157.0 | 5 | 156173 |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | |
| 3 | 6144 6144 | 4 | 67 | 0 | 0 | 9016.0 | 9016.0 | 9016.0 | 0.0 | 0.000 | 0.0 | 5 | 156174 |
| 0 | 6299 6299 | 5 | 999 | 0 | 0 | 9744.0 | 9744.0 | 9744.0 | 0.0 | 0.000 | 0.0 | 5 | 156174 |
| 3 | 6331 6334 | 5 | 999 | 0 | 0 | 9896.0 | 9896.0 | 9896.0 | 152.0 | .181 | 152.0 | 5 | 156174 |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | |
| 3 | 6006 6006 | 4 | 88 | 0 | 0 | 9219.0 | 9219.0 | 9219.0 | 0.0 | 0.000 | 0.0 | 5 | 156175 |
| 3 | 6039 6039 | 5 | 999 | 0 | 0 | 9330.0 | 9330.0 | 9330.0 | 111.0 | .140 | 111.0 | 5 | 156175 |
| 3 | 6039 6040 | 5 | 999 | 0 | 0 | 9331.0 | 9331.0 | 9331.0 | 112.0 | .137 | 1.0 | 5 | 156175 |
| 3 | 6071 6074 | 5 | 999 | 0 | 0 | 9527.0 | 9527.0 | 9527.0 | 308.0 | .189 | 196.0 | 5 | 156175 |
| 3 | 6089 6089 | 4 | 74 | 0 | 0 | 9538.0 | 9538.0 | 9538.0 | 319.0 | .160 | 11.0 | 5 | 156175 |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | |
| 3 | 6054 6054 | 2 | 999 | 0 | 0 | 8598.0 | 8598.0 | 8598.0 | 0.0 | 0.000 | 0.0 | 5 | 156177 |
| 3 | 6068 6068 | 1 | 38 | 0 | 0 | 8695.0 | 8695.0 | 8695.0 | 97.0 | .289 | 97.0 | 5 | 156177 |
| 3 | 6150 6150 | 5 | 999 | 0 | 0 | 9060.0 | 9060.0 | 9060.0 | 462.0 | .201 | 365.0 | 5 | 156177 |

FLEET RELIABILITY ASSESSMENT DATA

| MTYP | DATE | | WRA | OL1 | OL2 | OL3 | ETM | ETM1 | ETM2 | OPERATE | DUTY | TTF | SYS | UIC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NO | INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | |
| 3 | 6058 | 6058 | 5 | 999 | 0 | 0 | 103.0 | 103.0 | 103.0 | 0.0 | 0.000 | 0.0 | 5 | 159348 |
| 0 | 6301 | 6301 | 4 | 65 | 0 | 0 | 1048.0 | 1048.0 | 1048.0 | 0.0 | 0.000 | 0.0 | 5 | 159348 |
| 3 | 6324 | 6324 | 4 | 999 | 0 | 0 | 1485.0 | 1485.0 | 1485.0 | 437.0 | .792 | 437.0 | 5 | 159348 |
| 3 | 6330 | 6331 | 5 | 999 | 0 | 0 | 1509.0 | 1509.0 | 1509.0 | 461.0 | .640 | 24.0 | 5 | 159348 |
| 3 | 6340 | 6342 | 5 | 999 | 0 | 0 | 1554.0 | 1554.0 | 1554.0 | 506.0 | .514 | 45.0 | 5 | 159348 |
| 3 | 7043 | 7050 | 5 | 999 | 999 | 999 | 1918.0 | 1918.0 | 1918.0 | 870.0 | .318 | 364.0 | 5 | 159348 |
| NO | INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | |
| 3 | 6033 | 6033 | 5 | 999 | 0 | 0 | 109.0 | 109.0 | 109.0 | 0.0 | 0.000 | 0.0 | 5 | 159469 |
| 3 | 6122 | 6122 | 5 | 999 | 0 | 0 | 558.0 | 558.0 | 558.0 | 449.0 | .210 | 449.0 | 5 | 159469 |
| 3 | 6149 | 6149 | 5 | 999 | 0 | 0 | 615.0 | 615.0 | 615.0 | 506.0 | .182 | 57.0 | 5 | 159469 |
| 0 | 6224 | 6224 | 5 | 999 | 0 | 0 | 1038.0 | 1038.0 | 1038.0 | 0.0 | 0.000 | 0.0 | 5 | 159469 |
| 3 | 6259 | 6265 | 5 | 999 | 999 | 999 | 1125.0 | 1125.0 | 1125.0 | 87.0 | .088 | 87.0 | 5 | 159469 |
| 3 | 6281 | 6282 | 4 | 71 | 74 | 0 | 1244.0 | 1244.0 | 1244.0 | 206.0 | .148 | 119.0 | 5 | 159469 |
| 3 | 6344 | 6346 | 5 | 108 | 0 | 0 | 1540.0 | 1540.0 | 1540.0 | 502.0 | .171 | 296.0 | 5 | 159469 |
| 3 | 6353 | 6353 | 4 | 59 | 999 | 0 | 1582.0 | 1582.0 | 1582.0 | 544.0 | .176 | 42.0 | 5 | 159469 |
| 3 | 6355 | 6356 | 5 | 999 | 0 | 0 | 1586.0 | 1586.0 | 1586.0 | 548.0 | .173 | 4.0 | 5 | 159469 |
| 3 | 6363 | 7001 | 5 | 999 | 0 | 0 | 1600.0 | 1600.0 | 1600.0 | 562.0 | .165 | 14.0 | 5 | 159469 |

R E L I A B I L I T Y

ART-50 SYSTEM LEVEL

| TIME TO FAIL | NO. FAILURES | NO. CENSURED | SURVIVORS | CPDF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|---|
| 1.2 | 1. | | 37. | .026 | .008 | .018 |
| 4.8 | 1. | | 36. | .053 | .032 | .021 |
| 6.0 | 2. | | 35. | .105 | .039 | .066 |
| 13.2 | 1. | | 33. | .132 | .084 | .047 |
| 16.8 | 1. | | 32. | .158 | .106 | .052 |
| 21.6 | 1. | | 31. | .184 | .134 | .050 |
| 26.4 | 1. | | 30. | .211 | .162 | .049 |
| 28.8 | 1. | | 29. | .237 | .175 | .062 |
| 36.0 | 2. | | 28. | .289 | .214 | .076 |
| 40.8 | 1. | | 26. | .316 | .238 | .077 |
| 49.2 | 1. | | 25. | .342 | .280 | .062 |
| 50.4 | 1. | | 24. | .368 | .286 | .083 |
| 54.0 | 1. | | 23. | .395 | .303 | .092 |
| 68.4 | 2. | | 22. | .447 | .367 | .081 |
| 102.0 | 1. | | 20. | .474 | .494 | .047 |
| 104.4 | 1. | | 19. | .500 | .502 | .028 |
| 108.0 | 1. | | 18. | .526 | .514 | .014 |
| 116.4 | 1. | | 17. | .553 | .540 | .014 |
| 126.0 | 1. | | 16. | .579 | .569 | .016 |
| 133.2 | 1. | | 15. | .605 | .589 | .016 |
| 134.4 | 1. | | 14. | .632 | .592 | .039 |
| 142.8 | 1. | | 13. | .658 | .615 | .043 |
| 182.4 | 1. | | 12. | .684 | .704 | .046 |
| 188.4 | 1. | | 11. | .711 | .716 | .032 |
| 198.0 | 1. | | 10. | .737 | .733 | .023 |
| 235.2 | 1. | | 9. | .763 | .792 | .055 |
| 270.0 | 1. | | 8. | .789 | .835 | .072 |
| 290.4 | 1. | | 7. | .816 | .856 | .067 |
| 355.2 | 1. | | 6. | .842 | .907 | .091 |
| 388.8 | 1. | | 5. | .868 | .925 | .083 |
| 436.8 | 1. | | 4. | .895 | .946 | .077 |
| 438.0 | 1. | | 3. | .921 | .946 | .052 |
| 524.4 | 1. | | 2. | .947 | .970 | .049 |
| 538.8 | 1. | | 1. | .974 | .973 | .025 |

R E L I A B I L I T Y

ART-50 SYSTEM LEVEL

EQUIPMENT OPERATING HOURS (O,H,) = 5541.6 CALENDAR HOURS(C,H,) =, 25344.0 DUTY CYCLE (O,H,/C,H,) = .219

NUMBER OF FAILURES = 37, OBSERVED FAILURE RATE/O,H, = .66768E-02

DISTRIBUTION DETERMINATION,

K-S CRITICAL VALUE ( .10,37,) = .158

MAX DIFF CALC = .092, IS LESS THAN CRITICAL VALUE THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 149,773, EST. MEDIAN = 103,815, 90 PER CENT LCL FOR MEAN = 120.3, 90 PER CENT UCL FOR MEAN = 188,1

90 PERCENT UCL 188,14 IS GREATER THAN 160,00 HOURS, THEREFORE THE EQUIPMENT MEETS THE SPECIFICATIONS

R E L I A B I L I T Y

ART-50 WRA 1 LEVEL

| TIME TO FAIL | NO. FAILURES | NO. CENSORED |
|---|---|---|
| 6.0 | | 1. |
| 72.0 | | 1. |
| 116.4 | 1. | |
| 182.4 | | 1. |
| 198.0 | 1. | |
| 210.0 | | 1. |
| 382.8 | | 1. |
| 424.8 | 1. | |
| 438.0 | | 1. |
| 520.8 | | 1. |
| 607.2 | | 1. |
| 664.8 | | 1. |
| 674.4 | | 1. |
| 1044.0 | | 1. |

EQUIPMENT OPERATING HOURS (O.H.) = 5541.6 CALENDAR HOURS(C.H.) =, 25344.0 DUTY CYCLE (O.H./C.H.) = .219

NUMBER OF FAILURES = 3. OBSERVED FAILURE RATE/O.H. = .54136E-03

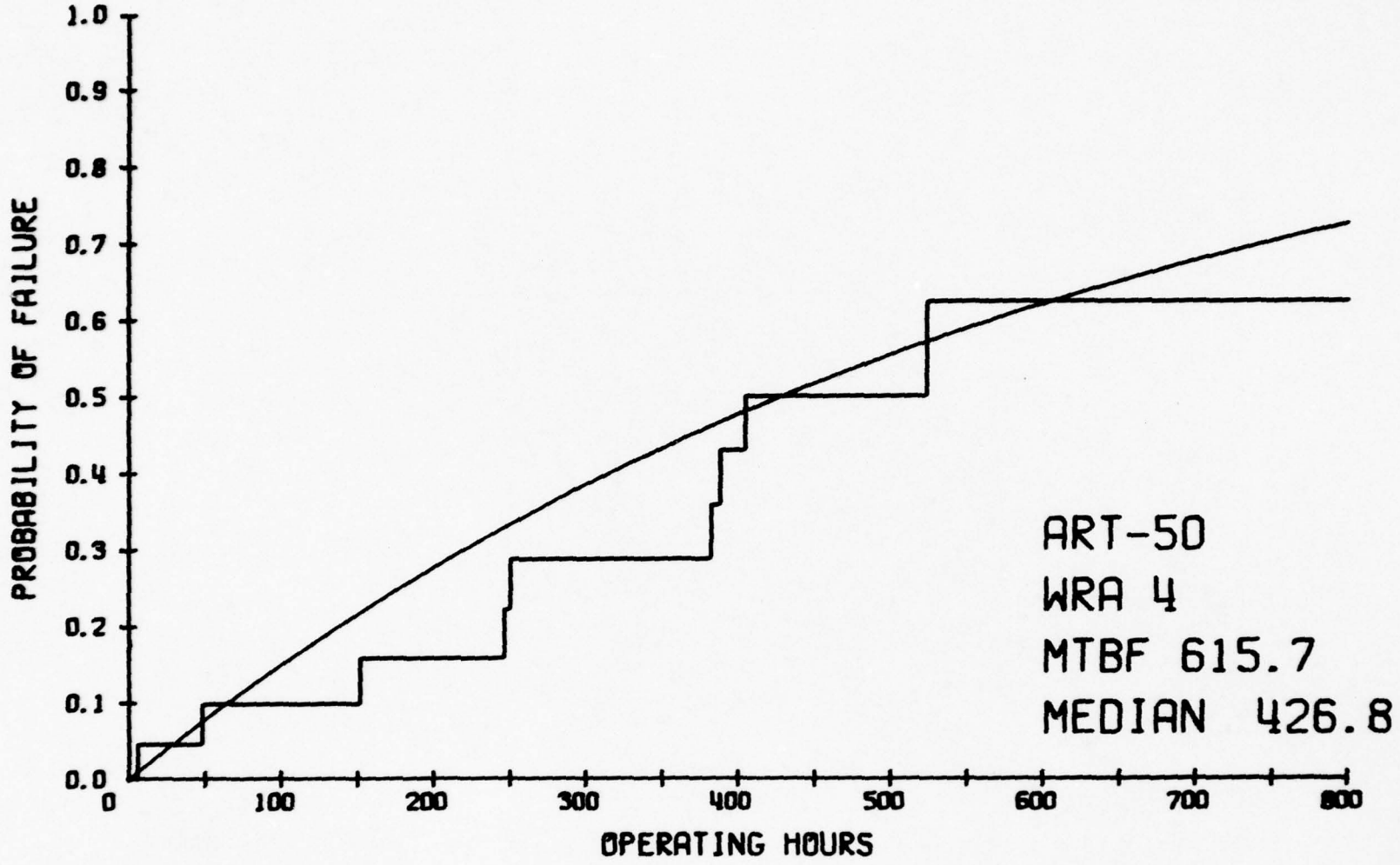
LESS THAN FOUR FAILURES THE EXPONENTIAL DISTRIBUTION IS ASSUMED

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 1847.200, EST. MEDIAN = 1280.381, 90 PER CENT LCL FOR MEAN = 829.5, 90 PER CENT UCL FOR MEAN = 5028.4

90 PERCENT UCL 5028.38 IS GREATER THAN 1306.00 HOURS, THEREFORE THE EQUIPMENT MEETS THE SPECIFICATIONS

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



R E L I A B I L I T Y

ART-50 WRA 4 LEVEL

| TIME TO FAIL | NO. FAILURES | NO. CENSORED | SURVIVORS | CPDF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|---|
| 6.0 | 1. | | 20. | .048 | .010 | .038 |
| 6.0 | | 1. | | | | |
| 21.6 | | 1. | | | | |
| 49.2 | 1. | | 17. | .101 | .077 | .029 |
| 68.4 | | 1. | | | | |
| 72.0 | | 1. | | | | |
| 152.4 | 1. | | 14. | .160 | .219 | .119 |
| 182.4 | | 1. | | | | |
| 247.2 | 1. | | 12. | .225 | .331 | .170 |
| 250.8 | 1. | | 11. | .290 | .335 | .109 |
| 270.0 | | 1. | | | | |
| 382.8 | 1. | | 9. | .361 | .463 | .173 |
| 388.8 | 1. | | 8. | .432 | .468 | .107 |
| 405.6 | 1. | | 7. | .503 | .482 | .051 |
| 408.0 | | 1. | | | | |
| 424.8 | | 1. | | | | |
| 519.6 | | 1. | | | | |
| 524.4 | 1. | | 3. | .627 | .573 | .071 |
| 554.4 | | 1. | | | | |
| 607.2 | | 1. | | | | |

EQUIPMENT OPERATING HOURS (O.H.) = 5541.6 CALENDAR HOURS(C.H.) = 25344.0 DUTY CYCLE (O.H./C.H.) = .219

NUMBER OF FAILURES = 9. OBSERVED FAILURE RATE/O.H. = .16241E-02

DISTRIBUTION DETERMINATION,

K-S CRITICAL VALUE ( .10, 9.) = .311

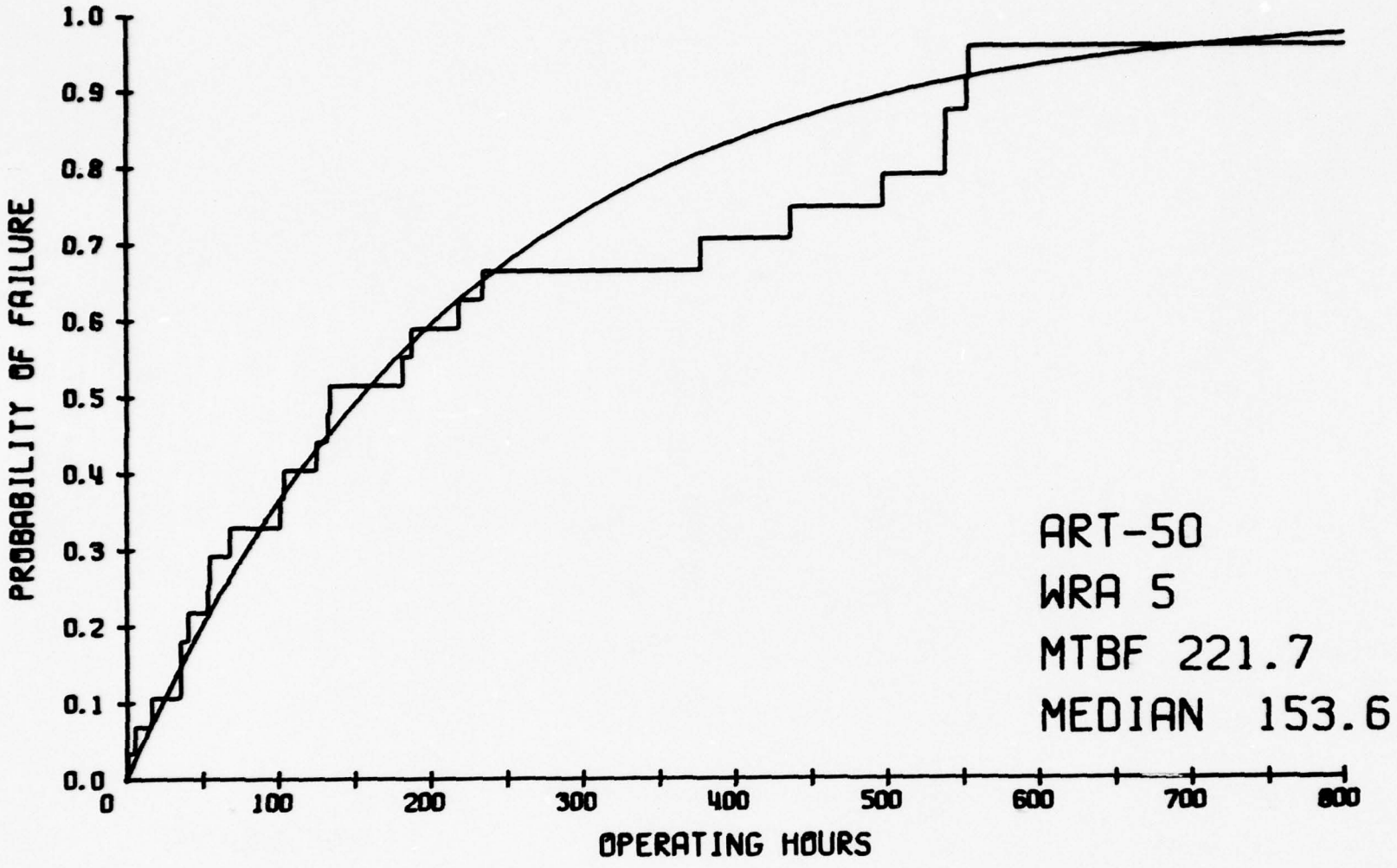
MAX DIFF CALC = .173, IS LESS THAN CRITICAL VALUE THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 615.733, EST. MEDIAN = 426.794, 90 PER CENT LCL FOR MEAN = 390.1, 90 PER CENT UCL FOR MEAN = 1020.1

90 PERCENT UCL 1020.09 IS GREATER THAN 407.00 HOURS, THEREFORE THE EQUIPMENT MEETS THE SPECIFICATIONS

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



RELIABILITY

ART-50 WRA 5 LEVEL

| TIME TO FAIL | NO. FAILURES | NO. CENSORED | SURVIVORS | CPDF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|---|
| 1.2 | 1. | | 27. | .036 | .005 | .030 |
| 6.0 | 1. | | 26. | .071 | .027 | .045 |
| 13.2 | | 1. | | | | |
| 16.8 | 1. | | 24. | .109 | .073 | .036 |
| 36.0 | 2. | | 23. | .183 | .150 | .041 |
| 40.8 | 1. | | 21. | .220 | .168 | .052 |
| 54.0 | 1. | | 20. | .257 | .216 | .041 |
| 55.2 | 1. | | 19. | .294 | .220 | .074 |
| 68.4 | 1. | | 18. | .331 | .266 | .066 |
| 102.0 | 1. | | 17. | .369 | .369 | .037 |
| 104.4 | 1. | | 16. | .406 | .376 | .030 |
| 126.0 | 1. | | 15. | .443 | .434 | .028 |
| 133.2 | 1. | | 14. | .480 | .452 | .028 |
| 134.4 | 1. | | 13. | .517 | .455 | .062 |
| 182.4 | 1. | | 12. | .554 | .561 | .044 |
| 188.4 | 1. | | 11. | .591 | .573 | .019 |
| 219.6 | 1. | | 10. | .629 | .629 | .037 |
| 235.2 | 1. | | 9. | .666 | .654 | .025 |
| 290.4 | | 1. | | | | |
| 378.0 | 1. | | 7. | .708 | .818 | .153 |
| 436.8 | 1. | | 6. | .749 | .861 | .153 |
| 498.0 | 1. | | 5. | .791 | .894 | .145 |
| 538.8 | 2. | | 4. | .875 | .912 | .121 |
| 553.2 | 1. | | 2. | .916 | .918 | .043 |
| 554.4 | 1. | | 1. | .958 | .918 | .040 |

R E L I A B I L I T Y

ART-50 WRA 5 LEVEL

EQUIPMENT OPERATING HOURS (O.H.) = 5541.6 CALENDAR HOURS(C.H.) = 25344.0 DUTY CYCLE (O.H./C.H.) = .219

NUMBER OF FAILURES = 25. OBSERVED FAILURE RATE/O.H. = .45113E-02

DISTRIBUTION DETERMINATION,

K-S CRITICAL VALUE ( .10,25.) = .191

MAX DIFF CALC = .153, IS LESS THAN CRITICAL VALUE THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 221.664, EST. MEDIAN = 153.646, 90 PER CENT LCL FOR MEAN = 169.4, 90 PER CENT UCL FOR MEAN = 294.1

90 PERCENT UCL 294.07 IS LESS THAN 1240.00 HOURS, THUS A RELIABILITY PROBLEM EXISTS

# RELIABILITY

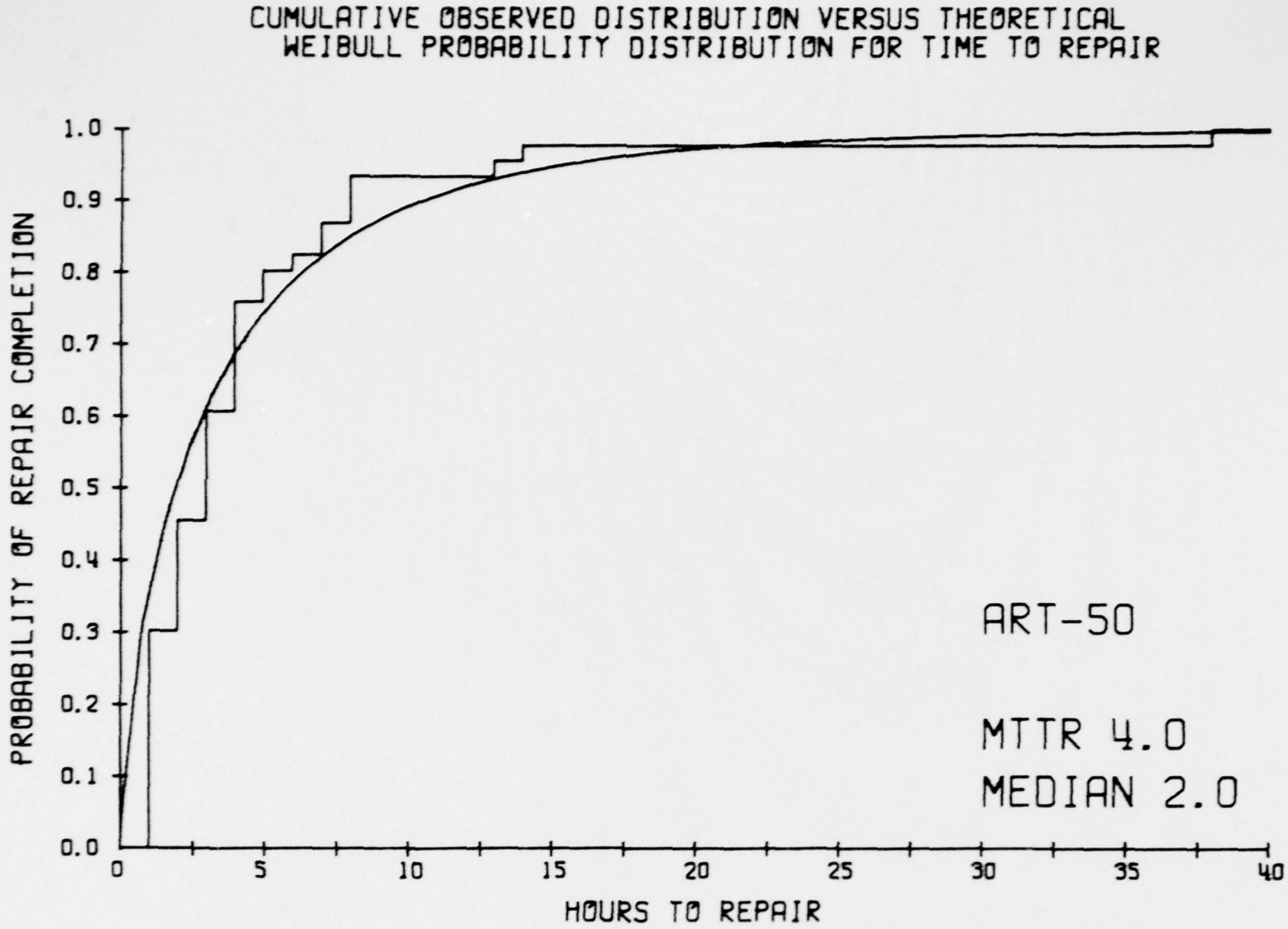
ART-50 O-LEVEL SUMMARY

| WRA | O-LEVEL BLOCK | NO. | O-LEVEL NOMENCLATURE | | NUMBER FAILURES | LOWER 90 CONF LIM | MEAN | UPPER 90 CONF LIM | SPEC MTBF | OBSERVED FAILURE TIMES LOW | OBSERVED FAILURE TIMES HIGH | RELIAB PROBLEM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 38 | | CHASSIS | 784-7700 | 2. | 1041,20 | 2770,80 | 10420,23 | 8485,00 | 116,40 | 198,00 | NO |
| 1 | 999 | | | | 1. | 1424,68 | 5541,60 | 52596,81 | 1000000,00 | 424,80 | 424,80 | YES |
| 4 | 59 | PJ8 | INHBT DVR | 784-4050 | 1. | 1424,68 | 5541,60 | 52596,81 | 5065,00 | 652,80 | 652,80 | NO |
| 4 | 65 | | CORE MAG MEM | 784-5626 | 1. | 1424,68 | 5541,60 | 52596,81 | 50000,00 | 250,80 | 250,80 | NO |
| 4 | 71 | PW9 | I/O SEL | 784-4192 | 1. | 1424,68 | 5541,60 | 52596,81 | 58445,00 | 247,20 | 247,20 | YES |
| 4 | 74 | MTU | MAG TAPE | 771-4616 | 2. | 1041,20 | 2770,80 | 10420,23 | 5038,00 | 247,20 | 382,80 | NO |
| 4 | 999 | | | | 6. | 526,16 | 923,60 | 1758,18 | 1000000,00 | 6,00 | 652,80 | YES |
| 5 | 94 | RVFR | FREQ REF | 617-6876 | 1. | 1424,68 | 5541,60 | 52596,81 | 12500,00 | 219,60 | 219,60 | NO |
| 5 | 103 | | BATTERY MODULE | | 1. | 1424,68 | 5541,60 | 52596,81 | 250000,00 | 126,00 | 126,00 | YES |
| 5 | 108 | | CHASSIS | | 1. | 1424,68 | 5541,60 | 52596,81 | 13545,00 | 602,40 | 602,40 | NO |
| 5 | 999 | | | | 27. | 158,55 | 205,24 | 269,03 | 1000000,00 | 1,20 | 664,80 | YES |

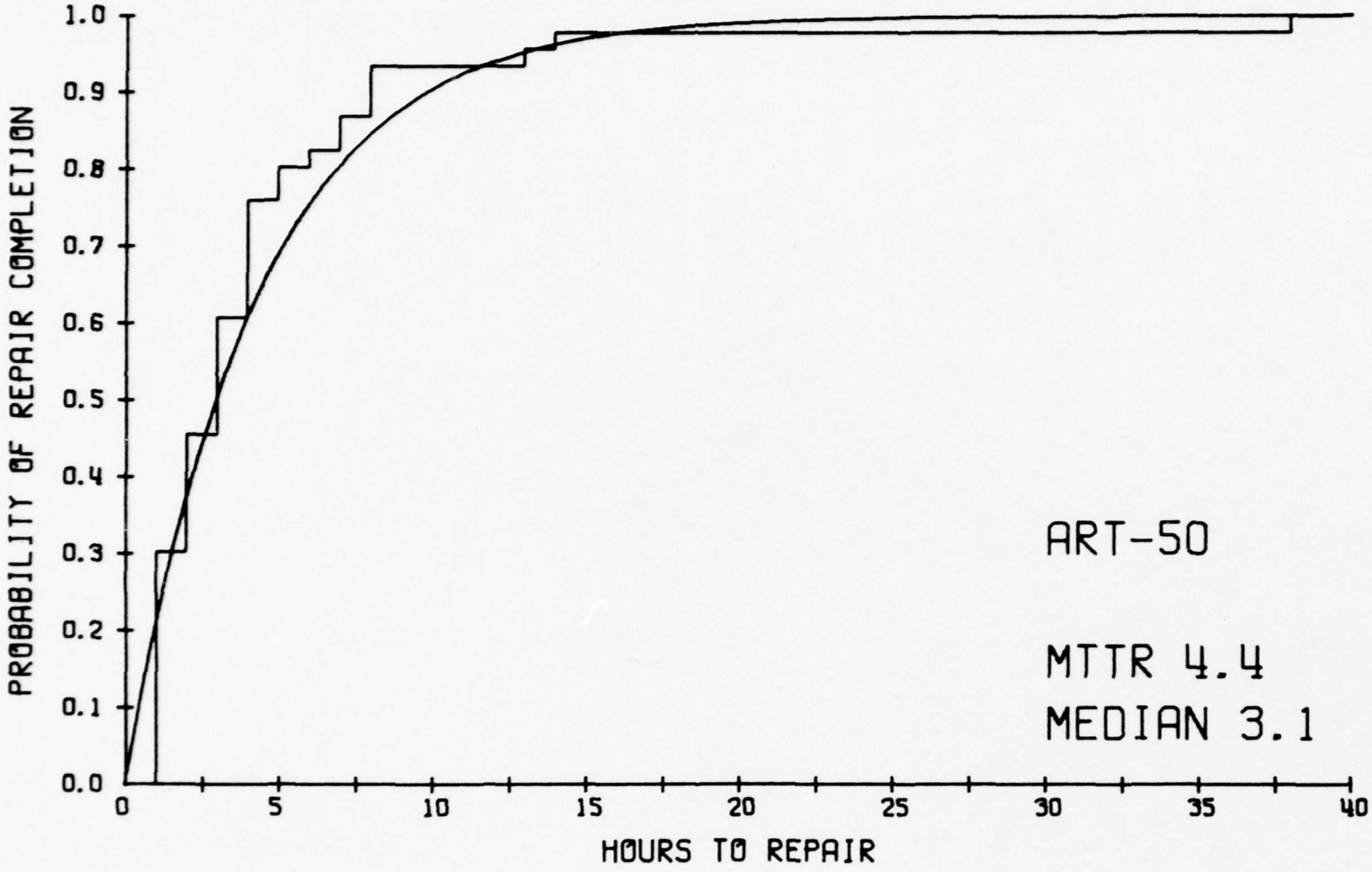
# R E L I A B I L I T Y

## 2K SUMMARY FOR ART-50 PROBLEM AREAS

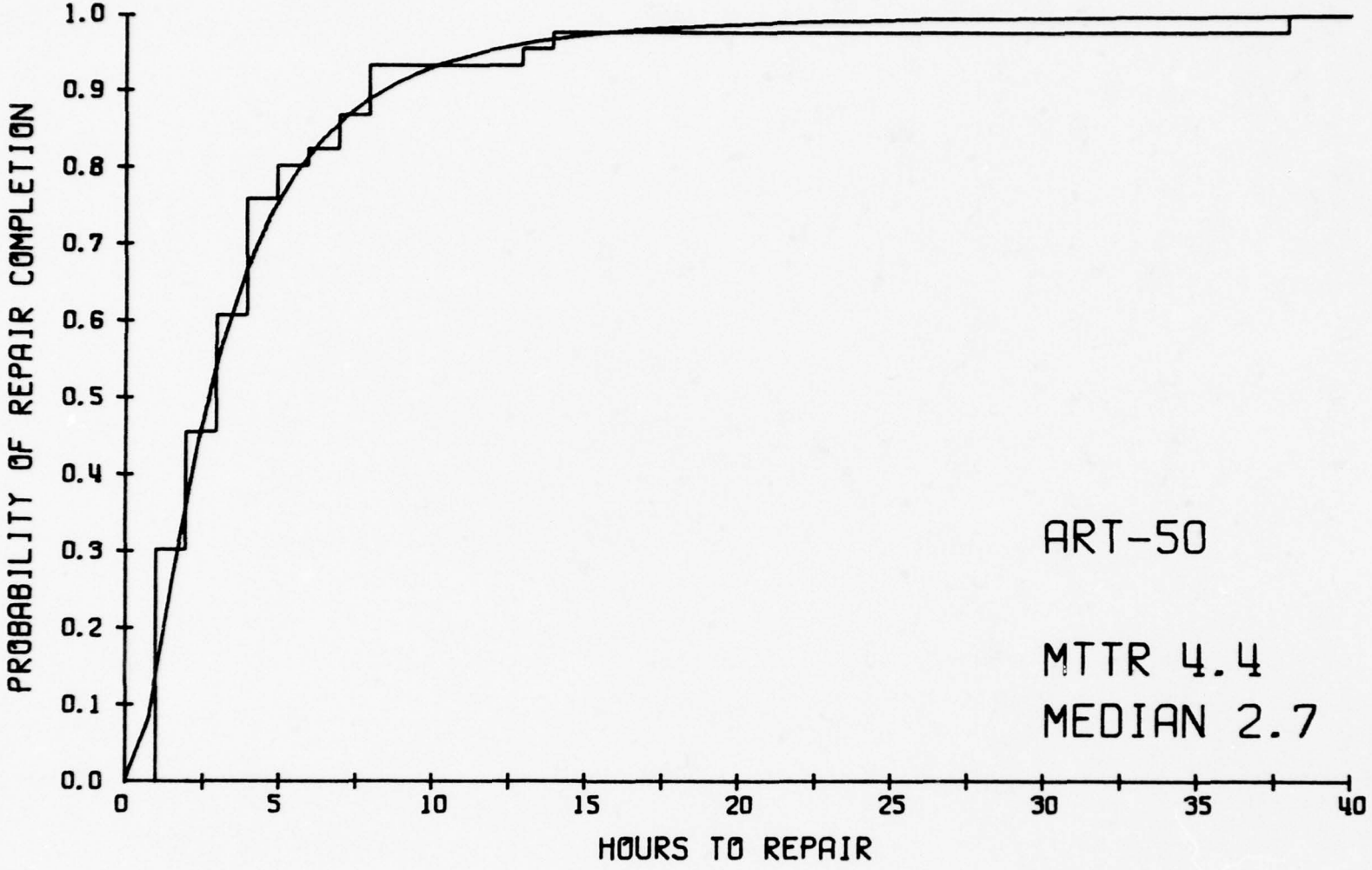
| JCN | SYSTEM | WRA | D-L | D-L | D-L | SYSTEM SYMPTON | DIAGNOSTIC | RESULTS |
|---|---|---|---|---|---|---|---|---|
| A460060308760 | 5 | 5 | 999 | 0 | 0 | NO 2ND HARM | | R+R FTS A14 W/ A21 |
| A460060528320 | 5 | 5 | 999 | 0 | 0 | NO TIME ON | O-SCOPE | R+R FTS A21 W/ A20 |
| A460060808390 | 5 | 1 | 999 | 0 | 0 | NO LITE ON1 | OVISUAL | R+R BUSTED PINS |
| A460062588900 | 5 | 5 | 999 | 0 | 0 | GAINS 2M/HR | | R+R FTS A14 W/ A7 |
| A460063108730 | 5 | 5 | 103 | 999 | 0 | NO BAT OPS | | R+R BAT MODULE+MOD |
| A460063154220 | 5 | 4 | 999 | 0 | 0 | SWS+LITE BA | D | R+R PROCESSOR |
| A460063248460 | 5 | 4 | 999 | 0 | 0 | NO PASS DIA | GMICRO | R+R PROC A2 W/ A21 |
| A460070308730 | 5 | 4 | 999 | 0 | 0 | NO LOAD | | R+R PROC-NO FIX |
| A460070318740 | 5 | 4 | 999 | 0 | 0 | NO LOAD | | R+R PROC. |
| A460070448070 | 5 | 5 | 999 | 0 | 0 | MISSN KNOB | | R+R FTS A20 W/ A3 |
| A460060059840 | 5 | 5 | 999 | 0 | 0 | NO 5MHZ | | R+R FTS A19 W/ A12 |
| A460060289690 | 5 | 5 | 999 | 0 | 0 | LOW 2ND HAR | M | R+R FTS A12 W/ A6 |
| A460062999540 | 5 | 5 | 999 | 0 | 0 | NO 2ND HARM | LITE | R+R FTS A11 W/ A7 |
| A460063169440 | 5 | 5 | 999 | 0 | 0 | BUSTED WIRE | | FIX PLUG J6 |
| A460070189210 | 5 | 5 | 999 | 0 | 0 | TMG FAULT | LITE | R+R FTS A36 W/ A18 |
| A460060600260 | 5 | 5 | 94 | 106 | 0 | CAN T ALIGN | CK ND. | 7R+R RVFR + CLOCK |
| A460070080310 | 5 | 5 | 105 | 999 | 0 | TMG FAULT | LITE | R+R FTS A36W/ A9 |
| A460070150660 | 5 | 5 | 999 | 0 | 0 | TMG FAULT | LITE | ADJ + ALIGNED FTS |
| A460070250480 | 5 | 5 | 999 | 0 | 0 | TMG FAULT | LITE | R+R FTS A36 W/ A9 |
| A460060123060 | 5 | 5 | 999 | 0 | 0 | -1MIN/2 HR | CLOCK | R+R FTS |
| A460060803800 | 5 | 5 | 94 | 0 | 0 | NO TEST LIT | E | FTS TO DEPOT REPAR |
| A460061153600 | 5 | 5 | 999 | 0 | 0 | NO 2ND HARM | | R+R FTS A15 W/ A9 |
| A460062994110 | 5 | 5 | 999 | 0 | 0 | HAND STKS | | R+R FTS A36 W/ A14 |
| A460063314330 | 5 | 5 | 999 | 0 | 0 | BUSTED CK W | R | R+R FTS A6 W/ A7 |
| A460060395440 | 5 | 5 | 999 | 0 | 0 | MIN HAND FZ | N | R+R FTS A7 W/ A16 |
| A460060395470 | 5 | 5 | 999 | 0 | 0 | NO SWX BATT | . | R+R FTS A7 W/ A16 |
| A460060715190 | 5 | 5 | 999 | 0 | 0 | NO 2ND HARM | TF LITE | R+R FTS A21 W/ A55 |
| A460061507710 | 5 | 5 | 999 | 0 | 0 | CLOCK INOP | PDS = 3 | R+R FTS |
| A460060586570 | 5 | 5 | 999 | 0 | 0 | FAULT LITE | PDS7- . | 6R+R FTS A7 W/ A20 |
| A460063246720 | 5 | 4 | 999 | 0 | 0 | BAD MS6 PRT | 29J-BUS | TR+R PROC A12/A13 |
| A460063306950 | 5 | 5 | 999 | 0 | 0 | NO SW TO DC | | NOT CONFIRMED |
| A460063404080 | 5 | 5 | 999 | 0 | 0 | FAULT LITE | | R+R FTS A3 W/ A3 |
| A460070436430 | 5 | 5 | 999 | 999 | 999 | TMG FLT LIT | EP=7 0. | 6R+R FTS A3 W/ A3 |
| A460060331100 | 5 | 5 | 999 | 0 | 0 | NO 5 MHZ SI | G | R+R FTS A19 W/ B6 |
| A460061221330 | 5 | 5 | 999 | 0 | 0 | LOW 5MHZ | PDS =9 | R+R FTS A36 W/ A3 |
| A460061491250 | 5 | 5 | 999 | 0 | 0 | SEC HND IND | PVISUAL | R+R FTS A3 W/ A9 |
| A460062241320 | 5 | 5 | 999 | 0 | 0 | LST 2ND HAR | M | R+R FTS A7 W/ A9 |
| A460062581530 | 5 | 5 | 999 | 999 | 999 | FLT LITE | | R+R FTS "3 TIMES? |
| A460062811200 | 5 | 4 | 71 | 74 | 0 | MTU BUST PI | N | R+R PW9 CARD MTU |
| A460063441500 | 5 | 5 | 108 | 0 | 0 | BSTD PWR SW | X | R+R FTS A16 / A16 |
| A460063531090 | 5 | 4 | 59 | 999 | 0 | NO LOAD PGM | LITE | R+R PJ8 PCB FTS |
| A460063551320 | 5 | 5 | 999 | 0 | 0 | TMG FALT LI | TLITE | ADJ 2ND HARM |
| A460063131550 | 5 | 5 | 999 | 0 | 0 | TMG FAULT | LITE | R+R FTS A36W/A6 |


CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
WEIBULL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR
PROBABILITY OF REPAIR COMPLETION
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
HOURS TO REPAIR
ART-50
MTTR 4.0
MEDIAN 2.0

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
LOGNORMAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



FLEET MAINTAINABILITY ASSESSMENT DATA

| WRA | DL1 | DL2 | DL3 | DISCOVERY DATE | COMPLETION DATE | REPAIR TIME (HRS) | SYS | UIC |
|---|---|---|---|---|---|---|---|---|
| 4 | 65 | 0 | 0 | 6076 | 6092 | 8.0 | 5 | 000000 |
| 5 | 999 | 0 | 0 | 6030 | 6030 | 8.0 | 5 | 151888 |
| 5 | 999 | 0 | 0 | 6052 | 6052 | 4.0 | 5 | 151888 |
| 1 | 999 | 0 | 0 | 6089 | 6090 | 4.0 | 5 | 151888 |
| 5 | 103 | 999 | 0 | 6310 | 6314 | 4.0 | 5 | 151888 |
| 4 | 990 | 0 | 0 | 6315 | 6321 | 4.0 | 5 | 151888 |
| 4 | 999 | 0 | 0 | 6324 | 6324 | 3.0 | 5 | 151888 |
| 4 | 999 | 0 | 0 | 7030 | 7030 | 13.0 | 5 | 151888 |
| 4 | 999 | 0 | 0 | 7031 | 7031 | 5.0 | 5 | 151888 |
| 5 | 999 | 0 | 0 | 7044 | 7046 | 2.0 | 5 | 151888 |
| 5 | 999 | 0 | 0 | 6005 | 6008 | 14.0 | 5 | 151889 |
| 5 | 999 | 0 | 0 | 6028 | 6034 | 2.0 | 5 | 151889 |
| 5 | 999 | 0 | 0 | 6299 | 6300 | 2.0 | 5 | 151889 |
| 5 | 999 | 0 | 0 | 6316 | 6317 | 3.0 | 5 | 151889 |
| 4 | 65 | 0 | 0 | 6334 | 6336 | 7.0 | 5 | 151889 |
| 5 | 999 | 0 | 0 | 7013 | 7018 | 3.0 | 5 | 151889 |
| 5 | 94 | 106 | 0 | 6060 | 6089 | 38.0 | 5 | 156170 |
| 5 | 999 | 0 | 0 | 7015 | 7015 | 1.0 | 5 | 156170 |
| 5 | 999 | 0 | 0 | 7023 | 7025 | 3.0 | 5 | 156170 |
| 5 | 999 | 0 | 0 | 6012 | 6015 | 7.0 | 5 | 156173 |
| 1 | 38 | 0 | 0 | 6077 | 6077 | 3.0 | 5 | 156173 |
| 3 | 94 | 0 | 0 | 6080 | 6080 | 4.0 | 5 | 156173 |
| 5 | 999 | 0 | 0 | 6115 | 6115 | 1.0 | 5 | 156173 |
| 4 | 67 | 0 | 0 | 6144 | 6144 | 8.0 | 5 | 156174 |
| 5 | 999 | 0 | 0 | 6331 | 6334 | 3.0 | 5 | 156174 |
| 4 | 88 | 0 | 0 | 6006 | 6006 | 6.0 | 5 | 156175 |
| 5 | 999 | 0 | 0 | 6039 | 6039 | 1.0 | 5 | 156175 |
| 5 | 999 | 0 | 0 | 6039 | 6040 | 1.0 | 5 | 156175 |
| 5 | 999 | 0 | 0 | 6071 | 6074 | 2.0 | 5 | 156175 |
| 4 | 74 | 0 | 0 | 6089 | 6089 | 4.0 | 5 | 156175 |
| 2 | 999 | 0 | 0 | 6054 | 6054 | 1.0 | 5 | 156177 |
| 1 | 38 | 0 | 0 | 6068 | 6068 | 1.0 | 5 | 156177 |
| 5 | 999 | 0 | 0 | 6150 | 6150 | 1.0 | 5 | 156177 |
| 5 | 999 | 0 | 0 | 6058 | 6058 | 1.0 | 5 | 159348 |
| 4 | 999 | 0 | 0 | 6324 | 6324 | 5.0 | 5 | 159348 |
| 5 | 999 | 0 | 0 | 6330 | 6331 | 1.0 | 5 | 159348 |
| 5 | 999 | 0 | 0 | 6340 | 6342 | 2.0 | 5 | 159348 |
| 5 | 999 | 999 | 999 | 7043 | 7050 | 3.0 | 5 | 159348 |
| 5 | 999 | 0 | 0 | 6033 | 6033 | 1.0 | 5 | 159469 |
| 5 | 999 | 0 | 0 | 6122 | 6122 | 2.0 | 5 | 159469 |
| 5 | 999 | 0 | 0 | 6149 | 6149 | 1.0 | 5 | 159469 |
| 5 | 999 | 999 | 999 | 6259 | 6265 | 4.0 | 5 | 159469 |
| 4 | 71 | 74 | 0 | 6281 | 6282 | 1.0 | 5 | 159469 |
| 5 | 108 | 0 | 0 | 6344 | 6346 | 1.0 | 5 | 159469 |
| 4 | 59 | 999 | 0 | 6353 | 6353 | 8.0 | 5 | 159469 |
| 5 | 999 | 0 | 0 | 6355 | 6356 | 2.0 | 5 | 159469 |
| 5 | 999 | 0 | 0 | 6363 | 7001 | 1.0 | 5 | 159469 |

MAINTAINABILITY (REPAIR TIME)

ART=50 SYSTEM LEVEL

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | LOGNORMAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 14. | 14.0 | .298 | .126 | .172 |
| 2.0 | 7. | 21.0 | .447 | .361 | .086 |
| 3.0 | 7. | 28.0 | .596 | .543 | .096 |
| 4.0 | 7. | 35.0 | .745 | .668 | .076 |
| 5.0 | 2. | 37.0 | .787 | .755 | .032 |
| 6.0 | 1. | 38.0 | .809 | .815 | .028 |
| 7.0 | 2. | 40.0 | .851 | .859 | .050 |
| 8.0 | 3. | 43.0 | .915 | .890 | .039 |
| 13.0 | 1. | 44.0 | .936 | .963 | .048 |
| 14.0 | 1. | 45.0 | .957 | .969 | .033 |
| 38.0 | 1. | 46.0 | .979 | .999 | .041 |

TOTAL REPAIR HOURS = 204.0 NUMBER OF REPAIRS = 46. OBSERVED REPAIR RATE/HR = .2255E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = 1.00 STD DEV OF LN'S = .88

K-S CRITICAL VALUE ( .10, 46, ) = .119 MAX DIFF CALC = .172 IS GREATER THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION CANNOT BE ASSUMED

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 14. | 14. | .298 | .202 | .096 |
| 2.0 | 7. | 21. | .447 | .363 | .084 |
| 3.0 | 7. | 28. | .596 | .492 | .104 |
| 4.0 | 7. | 35. | .745 | .596 | .150 |
| 5.0 | 2. | 37. | .787 | .676 | .111 |
| 6.0 | 1. | 38. | .809 | .742 | .067 |
| 7.0 | 2. | 40. | .851 | .794 | .057 |
| 8.0 | 3. | 43. | .915 | .835 | .080 |
| 13.0 | 1. | 44. | .936 | .947 | .032 |
| 14.0 | 1. | 45. | .957 | .957 | .021 |
| 38.0 | 1. | 46. | .979 | 1.000 | .042 |

TOTAL REPAIR HOURS = 204.0 NUMBER OF REPAIRS = 46. OBSERVED REPAIR RATE/HR = .2255E+00

DISTRIBUTION DETERMINATION

K-S CRITICAL VALUE ( .10, 46, ) = .142 MAX DIFF CALC = .150 IS GREATER THAN THE CRITICAL VALUE

THEREFORE THE EXPONENTIAL DISTRIBUTION CANNOT BE ASSUMED

WEIBULL DISTRIBUTION ASSUMED, ESTIMATED PARAMETERS ARE ALPHA = .43677E+00 BETA = .70796E+00

EST MEDIAN = 1.968 EST MEAN = 4.043 90 PER CENT LCL ON MEAN = 2.923 90 PER CENT UCL ON MEAN = 5.163

SPECIFIED MTTR = .75 HOURS LOWER CONF LIM 2.92 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

MAINTAINABILITY (REPAIR TIME)

ART-50 WRA 1 LEVEL

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | LOGNORMAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 1. | 1.0 | .250 | .129 | .121 |
| 3.0 | 1. | 2.0 | .500 | .644 | .394 |
| 4.0 | 1. | 3.0 | .750 | .777 | .277 |

TOTAL REPAIR HOURS = 8.0 NUMBER OF REPAIRS = 3. OBSERVED REPAIR RATE/HR = .3750E+00

DISTRIBUTION DETERMINATION

MEAN OF LNTS = .83 STD DEV OF LNTS = .73

LESS THAN FOUR DISTINCT REPAIR TIMES

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

EST MEAN = 2.67 EST MEDIAN = 2.29 90 PER CENT LCL ON MEDIAN = 1.03 90 PER CENT UCL ON MEDIAN = 5.08

SPECIFIED MTTR = .75 HOURS LOWER CONF LIM 1.03 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

MAINTAINABILITY (REPAIR TIME)

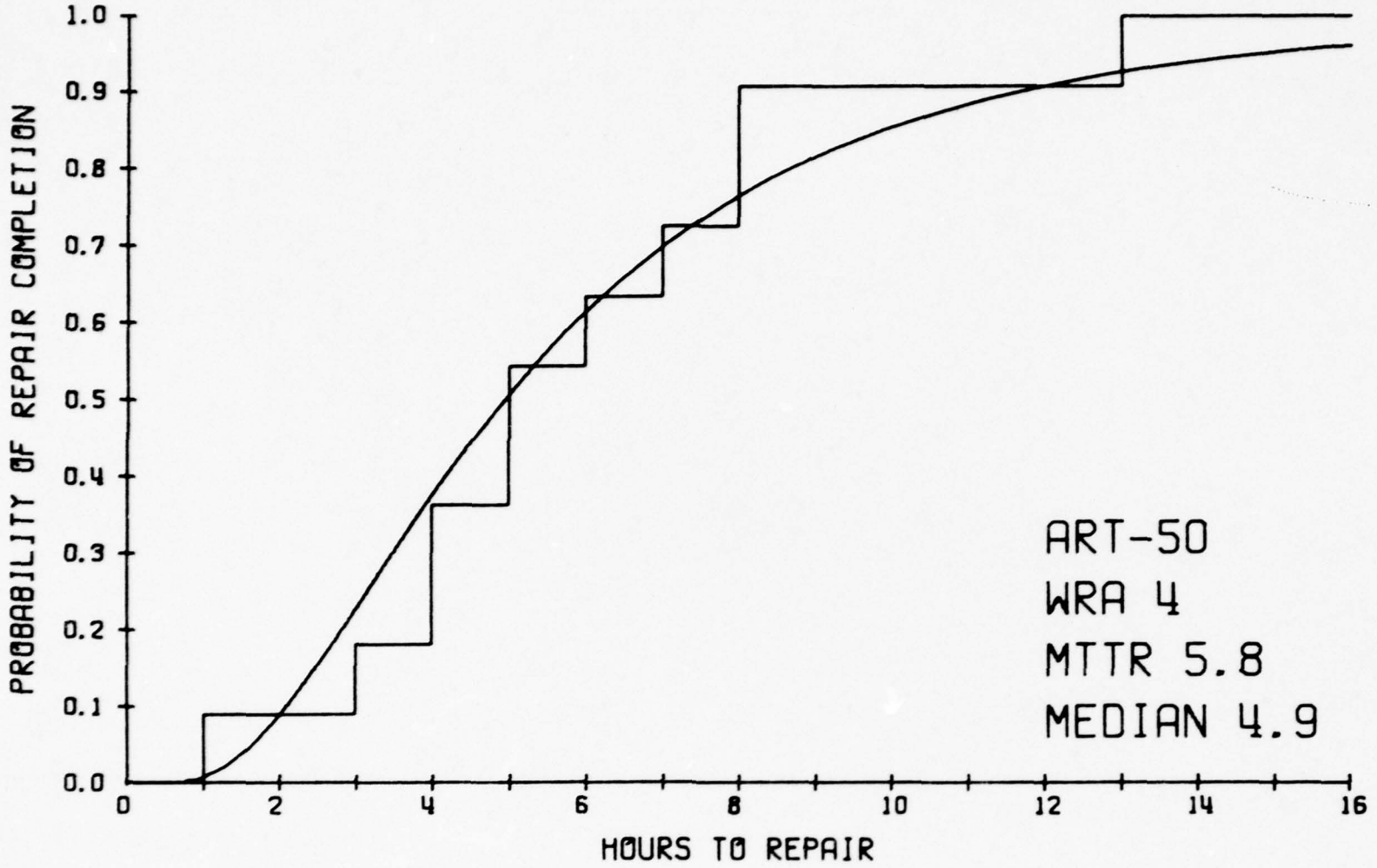
ART-50 WRA 2 LEVEL

LESS THAN FOUR DISTINCT REPAIR TIMES

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

ONLY ONE DISTINCT REPAIR TIME -- NO CONFIDENCE LIMITS

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
LOGNORMAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



MAINTAINABILITY (REPAIR TIME)

ART-50 WRA 4 LEVEL

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | LOGNORMAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 1. | 1.0 | .083 | .008 | .075 |
| 3.0 | 1. | 2.0 | .167 | .228 | .145 |
| 4.0 | 2. | 4.0 | .333 | .377 | .210 |
| 5.0 | 2. | 6.0 | .500 | .508 | .175 |
| 6.0 | 1. | 7.0 | .583 | .616 | .116 |
| 7.0 | 1. | 8.0 | .667 | .700 | .117 |
| 8.0 | 2. | 10.0 | .833 | .766 | .099 |
| 13.0 | 1. | 11.0 | .917 | .927 | .094 |

TOTAL REPAIR HOURS = 64.0 NUMBER OF REPAIRS = 11. OBSERVED REPAIR RATE/HR = .1719E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = 1.60 STD DEV OF LN'S = .67

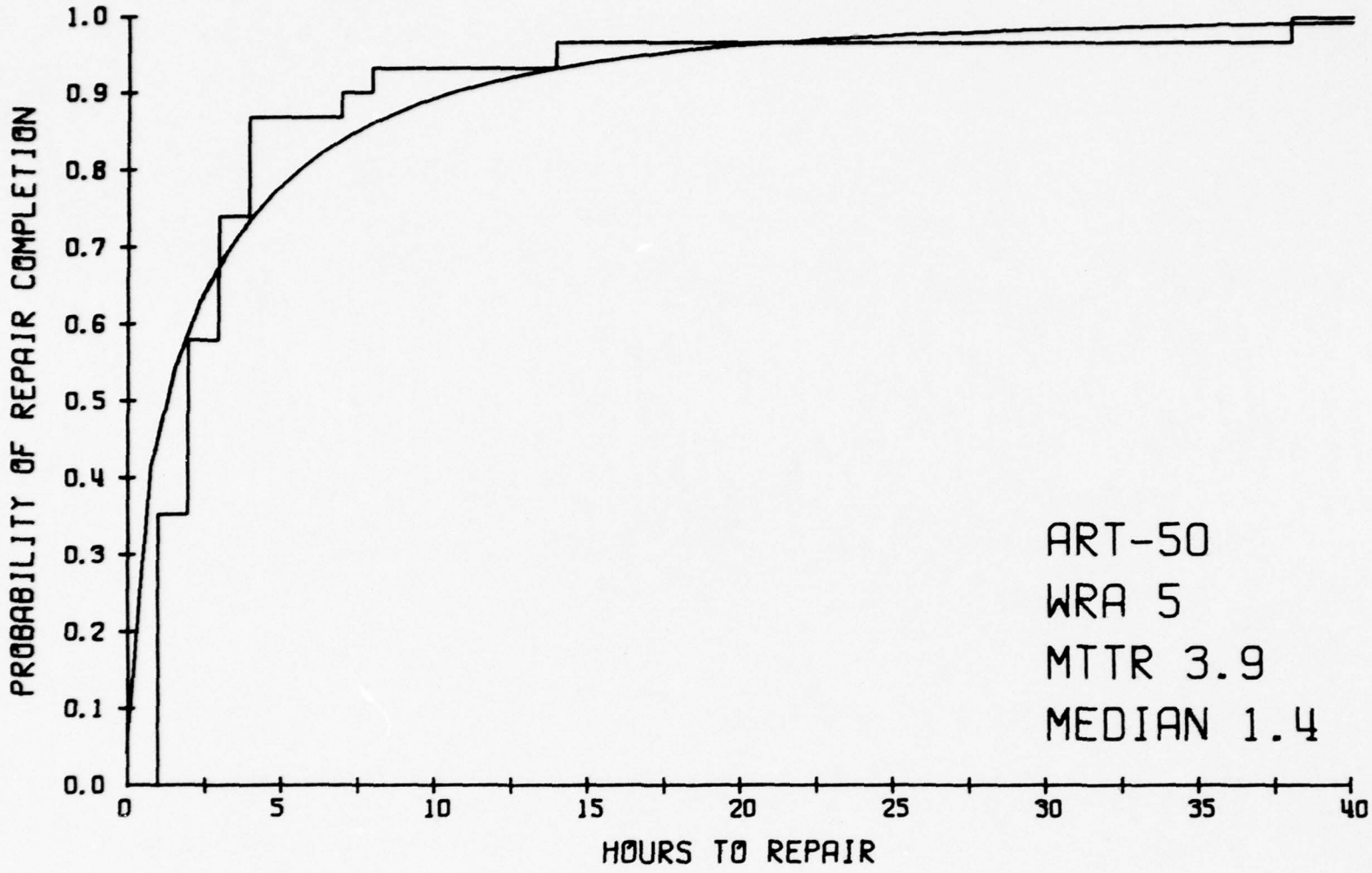
K-S CRITICAL VALUE ( .10, 11. ) = .230 MAX DIFF CALC = .210 IS LESS THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

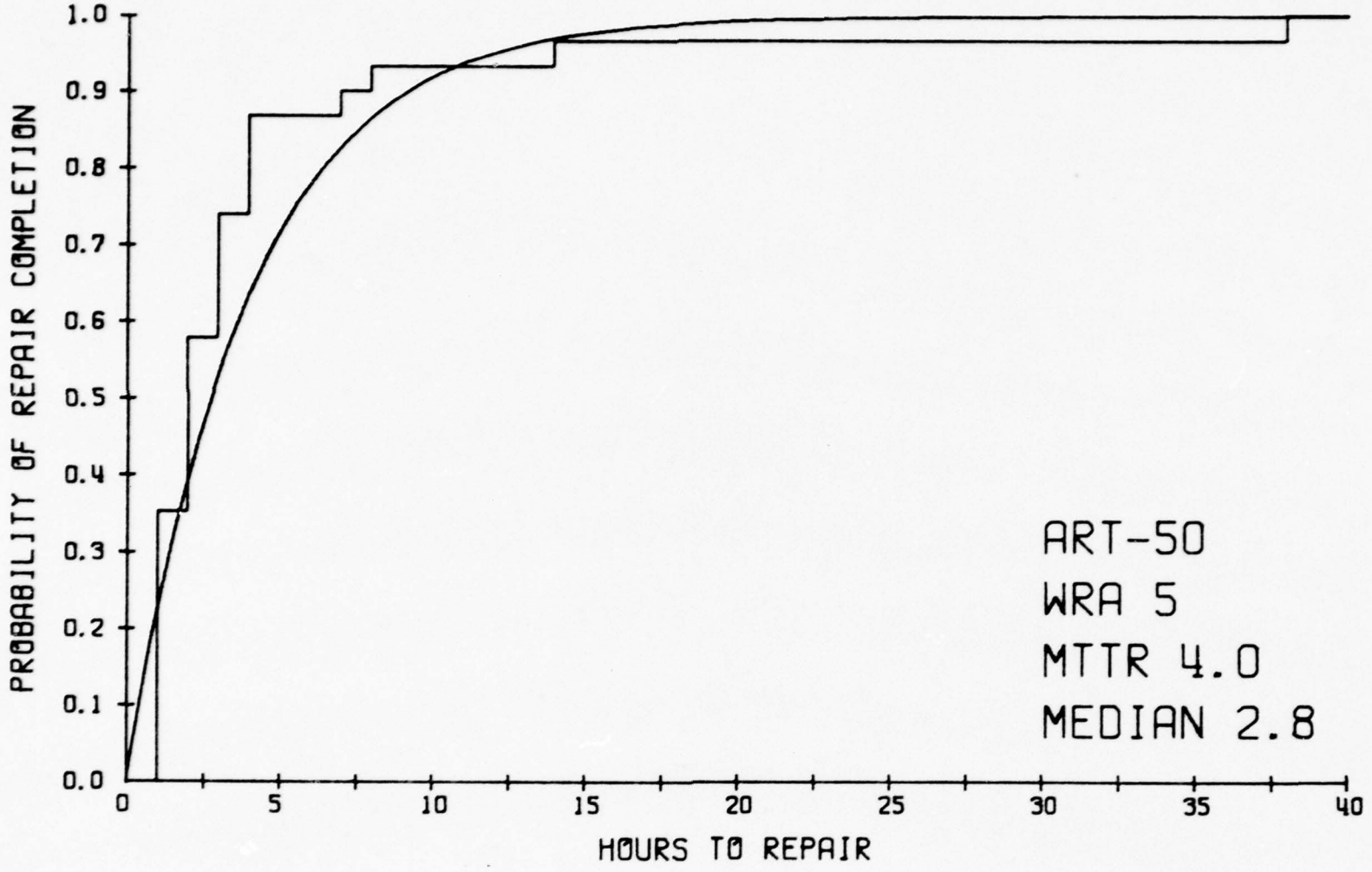
EST MEAN = 5.82 EST MEDIAN = 4.93 90 PER CENT LCL ON MEDIAN = 3.74 90 PER CENT UCL ON MEDIAN = 6.50

SPECIFIED MTTR = .75 HOURS LOWER CONF LIM 3.74 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

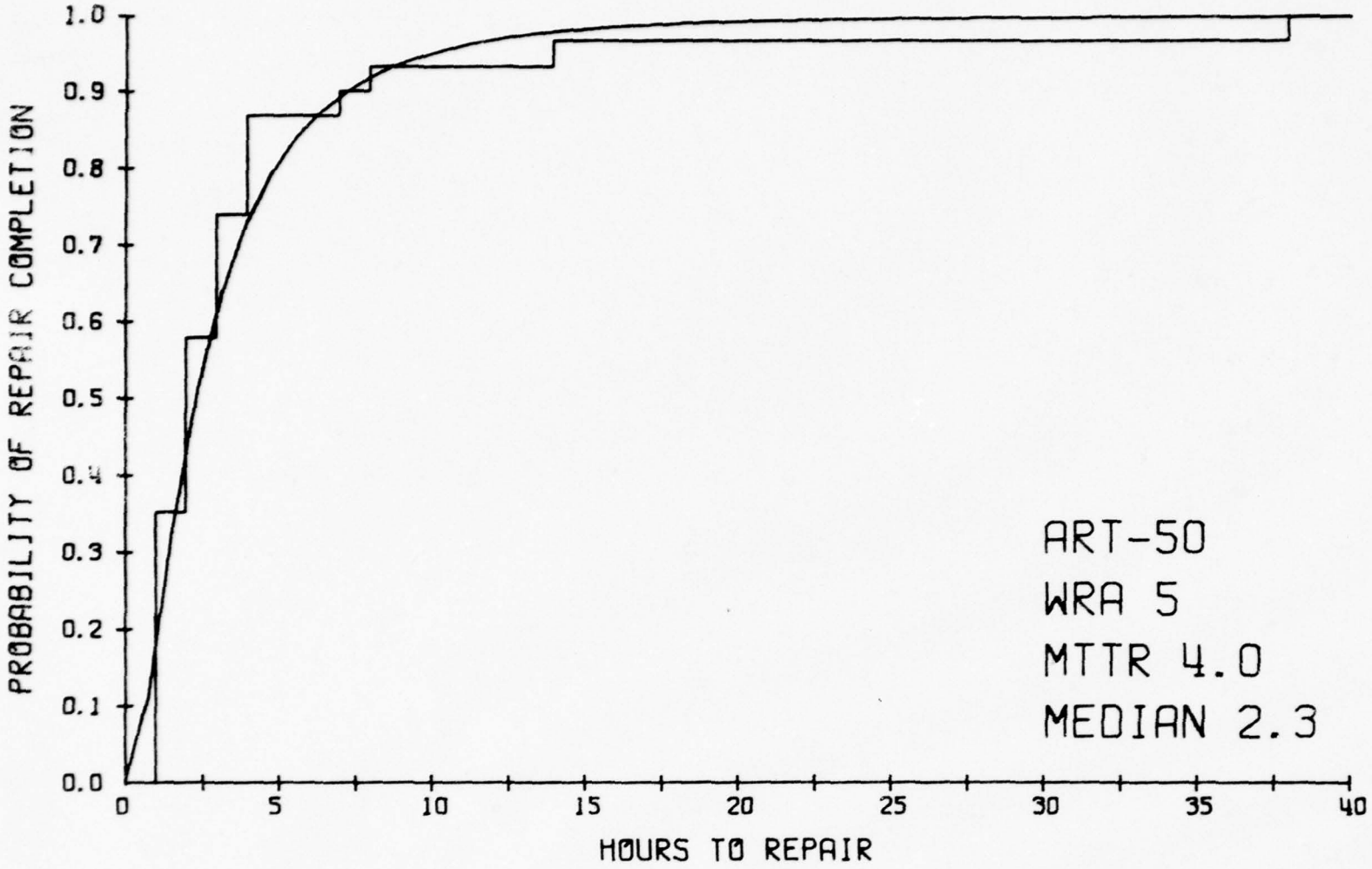
CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
WEIBULL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
LOGNORMAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



MAINTAINABILITY (REPAIR TIME)

ART-30 WRA 5 LEVEL

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | LOGNORMAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 11. | 11.0 | .344 | .169 | .175 |
| 2.0 | 7. | 18.0 | .563 | .432 | .131 |
| 3.0 | 5. | 23.0 | .719 | .613 | .105 |
| 4.0 | 4. | 27.0 | .844 | .731 | .113 |
| 7.0 | 1. | 28.0 | .875 | .894 | .051 |
| 8.0 | 1. | 29.0 | .906 | .919 | .044 |
| 14.0 | 1. | 30.0 | .936 | .979 | .073 |
| 38.0 | 1. | 31.0 | .969 | .999 | .061 |

TOTAL REPAIR HOURS = 123.0 NUMBER OF REPAIRS = 31. OBSERVED REPAIR RATE/HR = .2520E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = .84 STD DEV OF LN'S = .88

K-S CRITICAL VALUE ( .10, 31. ) = .145 MAX DIFF CALC = .175 IS GREATER THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION CANNOT BE ASSUMED

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 11. | 11. | .344 | .223 | .121 |
| 2.0 | 7. | 18. | .563 | .396 | .167 |
| 3.0 | 5. | 23. | .719 | .531 | .188 |
| 4.0 | 4. | 27. | .844 | .635 | .209 |
| 7.0 | 1. | 28. | .875 | .829 | .046 |
| 8.0 | 1. | 29. | .906 | .867 | .039 |
| 14.0 | 1. | 30. | .938 | .971 | .064 |
| 38.0 | 1. | 31. | .969 | 1.000 | .062 |

575

TOTAL REPAIR HOURS = 123.0 NUMBER OF REPAIRS = 31. OBSERVED REPAIR RATE/HR = .2520E+00

DISTRIBUTION DETERMINATION

K-S CRITICAL VALUE ( .10, 31. ) = .172 MAX DIFF CALC = .209 IS GREATER THAN THE CRITICAL VALUE

THEREFORE THE EXPONENTIAL DISTRIBUTION CANNOT BE ASSUMED

WEIBULL DISTRIBUTION ASSUMED, ESTIMATED PARAMETERS ARE ALPHA = .60385E+00 BETA = .57073E+00

EST MEDIAN = 1.374 EST MEAN = 3.899 90 PER CENT LCL ON MEAN = 2.181 90 PER CENT UCL ON MEAN = 5.618

SPECIFIED MTTR = .75 HOURS LOWER CONF LIM 2.18 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

MAINTAINABILITY (REPAIR TIME)

ART-50 O-LEVEL SUMMARY

| WRA | O-LEVEL BLOCK | NO. | O-LEVEL NOMENCLATURE | | NUMBER REPAIRS | LOWER 90 CONF LIM | UPPER 90 CONF LIM | SPEC MTTR | OBSERVED REPAIR TIMES LOW | MEAN | HIGH | MAINT PROBLEM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 38 | | CHASSIS | 784-7900 | 2. | .32 | 9.39 | .8 | 1.0 | 2.00 | 3.0 | NO |
| 1 | 999 | | | | 2. | .24 | 16.89 | .8 | 1.0 | 2.50 | 4.0 | NO |
| 4 | 59 | PJ8 | INHBT DVR | 784-4050 | 1. | NO CONF LIMITS | | .8 | 8.0 | 8.00 | 8.0 | |
| 4 | 65 | | CORE MAG MEM | 784-5626 | 1. | NO CONF LIMITS | | .8 | 7.0 | 7.00 | 7.0 | |
| 4 | 67 | PX2 | CYCLE CTL I | 784-4194 | 1. | NO CONF LIMITS | | .8 | 8.0 | 8.00 | 8.0 | |
| 4 | 71 | PW9 | I/O SEL | 784-4192 | 1. | NO CONF LIMITS | | .8 | 1.0 | 1.00 | 1.0 | |
| 4 | 74 | MTU | MAG TAPE | 771-4616 | 2. | .24 | 16.89 | .8 | 1.0 | 2.50 | 4.0 | NO |
| 4 | 88 | PW2 | MTA TMG | 784-4180 | 1. | NO CONF LIMITS | | .8 | 6.0 | 6.00 | 6.0 | |
| 4 | 999 | | | | 6. | 4.10 | 7.69 | .8 | 3.0 | 6.33 | 13.0 | YES |
| 5 | 94 | RVFR | FREQ REF | 617-6876 | 2. | .39 | 394.13 | .8 | 4.0 | 21.00 | 38.0 | NO |
| 5 | 103 | | BATTERY MODULE | | 1. | NO CONF LIMITS | | .8 | 4.0 | 4.00 | 4.0 | |
| 5 | 106 | | CLOCK | | 1. | NO CONF LIMITS | | .8 | 38.0 | 38.00 | 38.0 | |
| 5 | 108 | | CHASSIS | | 1. | NO CONF LIMITS | | .8 | 1.0 | 1.00 | 1.0 | |
| 5 | 999 | | | | 32. | 1.93 | 2.66 | .8 | 1.0 | 2.94 | 14.0 | YES |

# MAINTAINABILITY (REPAIR TIME)

## 2K SUMMARY FOR ART=50 PROBLEM AREAS

| JCN | SYSTEM | WRA | D=L | D=L | D=L | SYSTEM SYMPTON | DIAGNOSTIC | RESULTS |
|---|---|---|---|---|---|---|---|---|
| A46006076X620 | 5 | 4 | 65 | 0 | 0 | NO LOAD | | OPEN RUNS/PINS |
| A4600608O760 | 5 | 5 | 999 | 0 | 0 | NO 2ND HARM | | R&R FTS A14 W/ A21 |
| A4600608O528320 | 5 | 5 | 999 | 0 | 0 | NO TIME ON | O=SCOPE | R&R FTS A21 W/ A20 |
| A4600608O8390 | 5 | 1 | 999 | 0 | 0 | NO LITE ON1 | OVISUAL | R&R BUSTED PINS |
| A4600625889OO | 5 | 5 | 999 | 0 | 0 | 6A1NS 2M/HR | | R&R FTS A14 W/ A7 |
| A4600631087З0 | 5 | 5 | 103 | 999 | 0 | NO BAT OPS | | R&R BAT MODULE+MOD |
| A46006315A220 | 5 | 4 | 999 | 0 | 0 | SWS+LITE BA | D | R&R PROCESSOR |
| A4600632484б0 | 5 | 4 | 999 | 0 | 0 | NO PASS DIA | GMICRO | R&R PROC A2 W/ A21 |
| A4600703087З0 | 5 | 4 | 999 | 0 | 0 | NO LOAD | | R&R PROC=NO FIX |
| A4600703187Ч0 | 5 | 4 | 999 | 0 | 0 | NO LOAD | | R&R PROC, |
| A4600704480Ч0 | 5 | 5 | 999 | 0 | 0 | MISSN KNOB | | R&R FTS A20 W/ A3 |
| A4600600598Ч0 | 5 | 5 | 999 | 0 | 0 | NO 5MHZ | | R&R FTS A19 W/ A12 |
| A4600602896Ч0 | 5 | 5 | 999 | 0 | 0 | LOW 2ND HAR | M | R&R FTS A12 W/ A6 |
| A4600627598Ю | 5 | 4 | 74 | 0 | 0 | STUCK | | R&R MTU B45 W/A140 |
| A4600629995Ч0 | 5 | 5 | 999 | 0 | 0 | NO 2ND HARM | LITE | R&R FTS A11 W/ A7 |
| A4600631694Ч0 | 5 | 5 | 999 | 0 | 0 | BUSTED WIRE | | FIX PLUG J8 |
| A46006334A140 | 5 | 4 | 65 | 0 | 0 | NO LOAD | 06 ERRO | RR&R PROC A14/ A12 |
| A4600701892Ю | 5 | 5 | 999 | 0 | 0 | TMG FAULT | LITE | R&R FTS A36 W/ A18 |
| A4600700803Ю | 5 | 5 | 105 | 999 | 0 | TMG FAULT | LITE | R&R FTS A36W/ A9 |
| A4600701506б0 | 5 | 5 | 999 | 0 | 0 | TMG FAULT | LITE | ADJ + ALIGNED FTS |
| A4600702504Ю0 | 5 | 5 | 999 | 0 | 0 | TMG FAULT | LITE | R&R FTS A36 W/ A9 |
| A4600601230б0 | 5 | 5 | 999 | 0 | 0 | =1MIN/2 HR | CLOCK | R&R FTS |
| A4600607735Ю0 | 5 | 1 | 38 | 0 | 0 | ROTRY SW ST | KSTUCK | R&R MOD A22 W/ A18 |
| A4600611536Ю0 | 5 | 5 | 999 | 0 | 0 | NO 2ND HARM | | R&R FTS A15 W/ A9 |
| A4600614442Ю | 5 | 6 | 67 | 0 | 0 | BAD CHECKSU | MSELF | R&R PX=2 CARD |
| A4600629941Ю | 5 | 5 | 999 | 0 | 0 | HAND STKS | | R&R FTS A36 W/ A14 |
| A4500633143З0 | 5 | 5 | 999 | 0 | 0 | BUSTED CK W | R | R&R FTS A6 W/ A7 |
| A4600600654Ю | 5 | 4 | 88 | 0 | 0 | NOT PASS DI | AAUTOMAT | IR&R PW=2 CARD |
| A4600603954Ю | 5 | 5 | 999 | 0 | 0 | MIN HAND FZ | N | R&R FTS A7 W/ A16 |
| A4600603954Ю | 5 | 5 | 999 | 0 | 0 | NO SWX BATT | , | R&R FTS A7 W/ A16 |
| A4600607151Ю | 5 | 5 | 999 | 0 | 0 | NO 2ND HARM | TF LITE | R&R FTS A21 W/ A55 |
| A4600608951З0 | 5 | 6 | 74 | 0 | 0 | PROC, FAILS | M20=120 | R&R MTU A122 W/A17 |
| A4600606871Ю | 5 | 1 | 38 | 0 | 0 | BUSTED SW | VISUAL | R&R MOD A21 W/ A16 |
| A4600615077Ю | 5 | 5 | 999 | 0 | 0 | CLOCK INOP | POS = 3 | R&R FTS |
| A4600605865Ю | 5 | 5 | 999 | 0 | 0 | FAULT LITE | POS7= , | 6R&R FTS A7 W/ A20 |
| A4600603016Ю4 | 5 | 4 | 65 | 0 | 0 | NO PGM LD | LITE | R&R CORE STACK |
| A4600632467Ю | 5 | 6 | 999 | 0 | 0 | BAD M96 PRT | 29J=BUS | TR&R PROC A12/A13 |
| A4600633069Ю | 5 | 5 | 999 | 0 | 0 | NO SW TO DC | | NOT CONFIRMED |
| A46006340A080 | 5 | 5 | 999 | 0 | 0 | FAULT LITE | | R&R FTS A3 W/ A3 |
| A4600704364Ю | 5 | 5 | 999 | 999 | 999 | TMG FLT LIT | EP=7 0, | 6R&R FTS A3 W/ A3 |
| A4600603311Ю0 | 5 | 5 | 999 | 0 | 0 | NO 5 MHZ SI | G | R&R FTS A19 W/ B6 |
| A4600612213З0 | 5 | 5 | 999 | 0 | 0 | LOW 5MHZ | POS =9 | R&R FTS A36 W/ A3 |
| A4600614912Ю | 5 | 5 | 999 | 0 | 0 | SEC HND IND | PVISUAL | R&R FTS A3 W/ A9 |
| A4600622413Ю | 5 | 5 | 999 | 0 | 0 | LST 2ND HAR | M | R&R FTS A7 W/ A9 |
| A4600625815З0 | 5 | 5 | 999 | 999 | 999 | FLT LITE | | R&R FTS "3 TIMES? |
| A4600628112Ю0 | 5 | 6 | 71 | 74 | 0 | MTU BUST PI | N | R&R PW9 CARD MTU |
| A4600633531Ю9 | 5 | 4 | 59 | 999 | 0 | NO LOAD PGM | LITE | R&R PJ8 PCB FTS |
| A4600633513Ю | 5 | 5 | 999 | 0 | 0 | TMG FALT LI | TLITE | ADJ 2ND HARM |
| A4600631315Ю | 5 | 5 | 999 | 0 | 0 | TMG FAULT | LITE | R&R FTS A36W/A6 |

RMA SUMMARY ART-50 SYSTEM LEVEL

TTF DISTRIBUTION IS EXPONENTIAL WITH MEAN = 149.80

RT DISTRIBUTION IS WEIBULL WITH ALPHA = .43680 AND BETA = .70740 MEAN = 4.04

INHERENT AVAILABILITY = MTBF/(MTBF+MTTR)

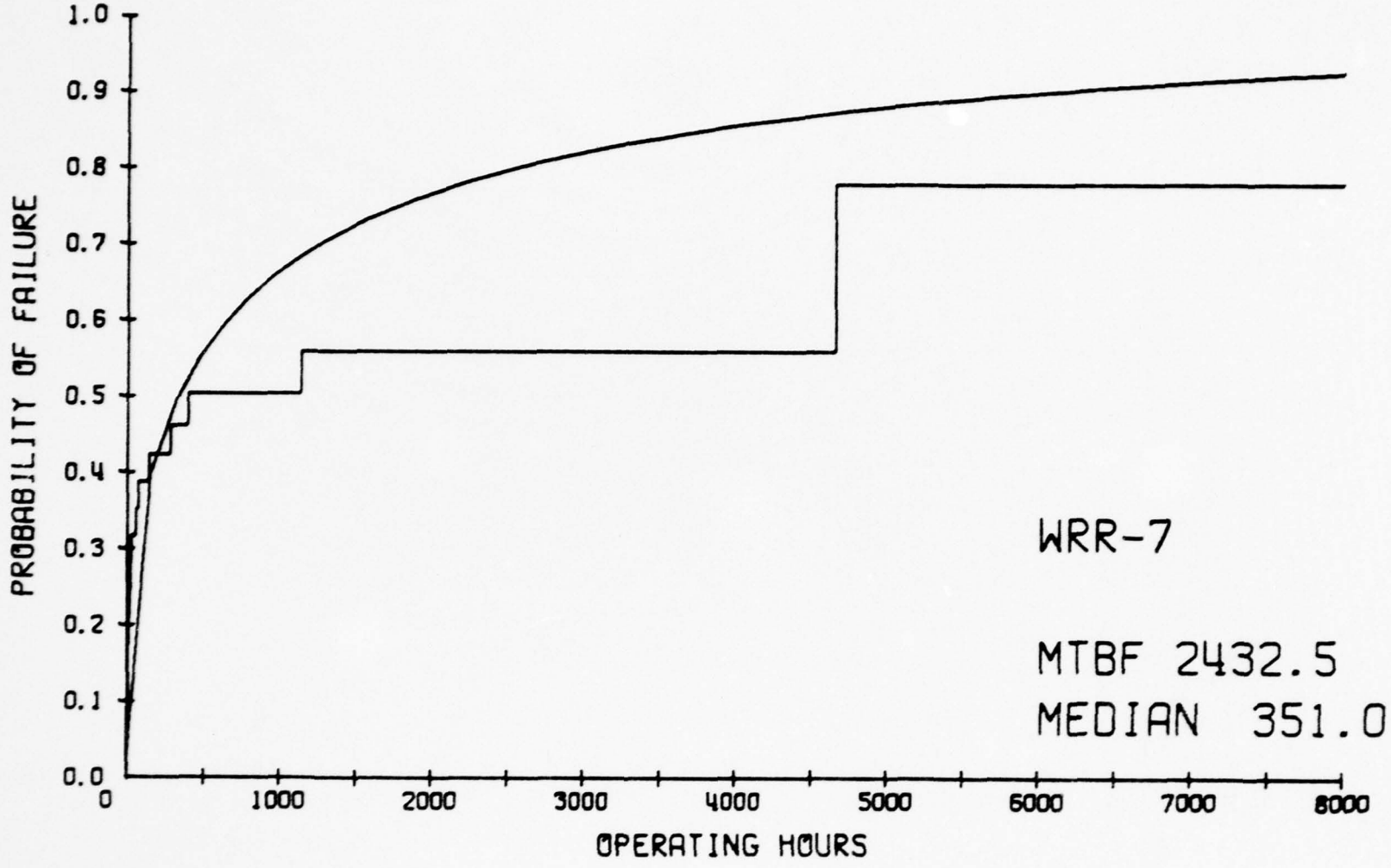
MEAN TIME TO FAILURE = 149.80

MEAN REPAIR TIME = 4.04

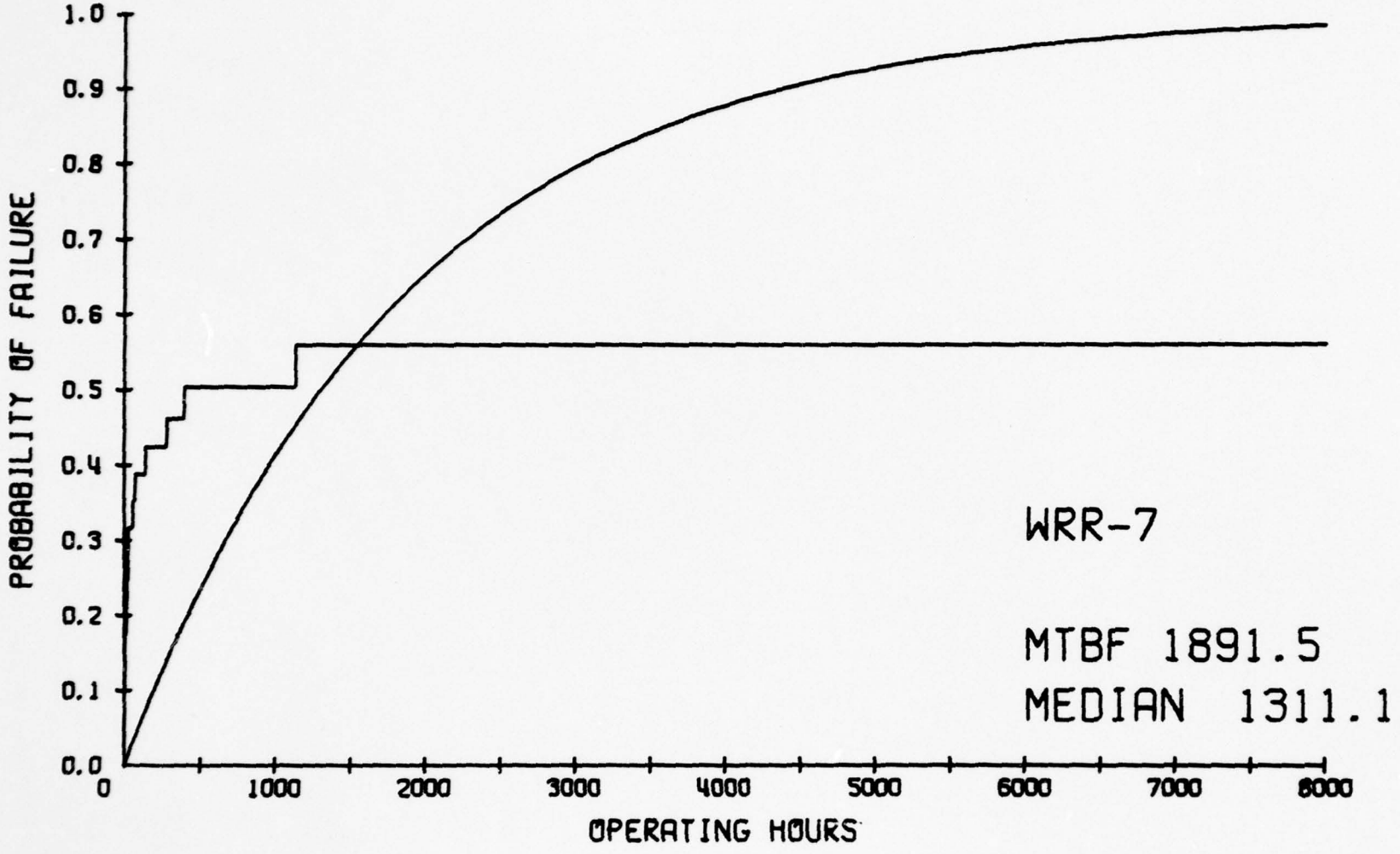
INHERENT AVAILABILITY = .9737

OUTPUT FOR AN/WRR-7

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
WEIBULL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



# FLEET RELIABILITY ASSESSMENT DATA

| MTYP | DATE | | WRA | OL1 | OL2 | OL3 | ETM | ETM1 | ETM2 | OPERATE | DUTY | TTF | SYS | UIC | SHIP NAME | HULL | NO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 6162 | 0 | 0 | 0 | 0 | 0 | 6163.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 46290 | PROTEUS | AS | 19 |
| 0 | 7040 | 0 | 0 | 0 | 0 | 0 | 1879.1 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 46290 | PROTEUS | AS | 19 |
| 0 | 7057 | 0 | 0 | 0 | 0 | 0 | 2659.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 46290 | PROTEUS | AS | 19 |
| 0 | 6159 | 0 | 0 | 0 | 0 | 0 | 3325.1 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 46890 | HUNLEY | AS | 31 |
| 3 | 6163 | 6163 | 1 | 999 | 0 | 0 | 0.0 | 3327.2 | 3327.2 | 2.1 | .022 | 2.1 | 4 | 46890 | | | |
| 6 | 6166 | 6166 | 9 | 108 | 0 | 0 | 0.0 | 3332.2 | 3332.2 | 7.1 | .042 | 5.0 | 4 | 46890 | | | |
| 3 | 6183 | 6183 | 1 | 10 | 18 | 0 | 0.0 | 3343.8 | 3343.8 | 18.7 | .032 | 11.6 | 4 | 46890 | | | |
| 8 | 6286 | 6286 | 0 | 0 | 0 | 0 | 0.0 | 3543.6 | 3543.6 | 218.5 | .072 | 199.8 | 4 | 46890 | | | |
| 0 | 7003 | 7005 | 1 | 10 | 2 | 0 | 1979.7 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 46890 | HUNLEY | AS | 31 |
| 3 | 7017 | 7018 | 5 | 999 | 0 | 0 | 0.0 | 2267.7 | 2267.7 | 288.0 | .800 | 288.0 | 4 | 46890 | | | |
| 3 | 7063 | 7063 | 1 | 10 | 0 | 0 | 0.0 | 3420.0 | 3420.0 | 1440.3 | 1.000 | 1152.3 | 4 | 46890 | | | |
| 4 | 7082 | 7082 | 0 | 0 | 0 | 0 | 0.0 | 3808.7 | 3808.7 | 1829.0 | .965 | 388.7 | 4 | 46890 | | | |
| 0 | 6201 | 0 | 0 | 0 | 0 | 0 | 884.3 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 46970 | LAKE, SIMON | AS | 33 |
| 3 | 6250 | 6250 | 4 | 85 | 0 | 0 | 0.0 | 950.2 | 950.8 | 65.9 | .056 | 65.9 | 4 | 46970 | | | |
| 3 | 6282 | 6282 | 4 | 58 | 0 | 0 | 0.0 | 1355.2 | 1359.2 | 470.3 | .242 | 404.4 | 4 | 46970 | | | |
| 4 | 7082 | 7082 | 0 | 0 | 0 | 0 | 0.0 | 2086.7 | 2086.7 | 1197.8 | .203 | 727.5 | 4 | 46970 | | | |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | | | | | |
| 3 | 6287 | 6288 | 1 | 4 | 0 | 0 | 1724.0 | 1720.0 | 1724.0 | 0.0 | 0.000 | 0.0 | 4 | 51100 | ABRAHAM LINCOL | SSBN602 | |
| 4 | 7057 | 7057 | 0 | 0 | 0 | 0 | 0.0 | 3909.0 | 3909.0 | 2185.0 | .674 | 2185.0 | 4 | 51100 | | | |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | | | | | |
| 4 | 7057 | 7057 | 0 | 0 | 0 | 0 | 3117.0 | 3117.0 | 3117.0 | 0.0 | 0.000 | 0.0 | 4 | 51102 | ABRAHAM LINCOL | SSBN602 | |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | | | | | |
| 3 | 6357 | 6358 | 4 | 74 | 0 | 0 | 340.1 | 337.2 | 340.1 | 0.0 | 0.000 | 0.0 | 4 | 51160 | ETHAN ALLEN | SSBN608 | |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | | | | | |
| 3 | 6167 | 6167 | 2 | 52 | 0 | 0 | 757.2 | 757.2 | 757.2 | 0.0 | 0.000 | 0.0 | 4 | 51170 | SAM HOUSTON | SSBN609 | |
| 3 | 6268 | 6268 | 5 | 94 | 0 | 0 | 0.0 | 768.0 | 772.0 | 10.8 | .004 | 10.8 | 4 | 51170 | | | |
| 1 | 6306 | 0 | 0 | 0 | 0 | 0 | 809.0 | 809.0 | 0.0 | 47.8 | .004 | 37.0 | 4 | 51170 | | | |
| 2 | 6306 | 6316 | 5 | 103 | 0 | 0 | 809.0 | 809.0 | 809.0 | 47.8 | .013 | 37.0 | 4 | 51170 | | | |
| 1 | 6316 | 0 | 0 | 0 | 0 | 0 | 0.0 | 839.0 | 0.0 | 77.8 | .013 | 30.0 | 4 | 51170 | | | |
| 2 | 6316 | 6322 | 2 | 48 | 0 | 0 | 839.0 | 839.0 | 839.0 | 77.8 | .021 | 30.0 | 4 | 51170 | | | |
| 0 | 7006 | 7006 | 1 | 10 | 0 | 0 | 1312.0 | 1312.0 | 1312.0 | 0.0 | 0.000 | 0.0 | 4 | 51170 | SAM HOUSTON | SSBN609 | |
| 4 | 7057 | 7057 | 0 | 0 | 0 | 0 | 0.0 | 2029.0 | 2029.0 | 717.0 | .586 | 717.0 | 4 | 51170 | | | |
| 0 | 6309 | 0 | 0 | 0 | 0 | 0 | 2610.4 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 51231 | LAFAYETTE | SSBN616 | |
| 4 | 7176 | 7176 | 0 | 0 | 0 | 0 | 0.0 | 5844.5 | 5844.5 | 3234.1 | .581 | 3234.1 | 4 | 51231 | | | |
| 0 | 6309 | 0 | 0 | 0 | 0 | 0 | 2279.3 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 51232 | LAFAYETTE | SSBN616 | |
| 3 | 6311 | 6311 | 5 | 999 | 0 | 0 | 2279.5 | 2279.5 | 2279.5 | .2 | .004 | .2 | 4 | 51232 | | | |
| 3 | 6325 | 6325 | 1 | 999 | 0 | 0 | 2302.1 | 2302.1 | 2302.1 | 22.8 | .059 | 22.6 | 4 | 51232 | | | |
| 3 | 6337 | 6337 | 4 | 93 | 0 | 0 | 2280.2 | 2380.2 | 2380.2 | 100.9 | .150 | 78.1 | 4 | 51232 | | | |
| 4 | 7176 | 7176 | 0 | 0 | 0 | 0 | 0.0 | 5126.1 | 5126.1 | 2846.8 | .511 | 2745.9 | 4 | 51232 | | | |
| 0 | 6210 | 0 | 0 | 0 | 0 | 0 | 170.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 57011 | MADISON, JAMES | SSBN627 | |
| 8 | 6244 | 6244 | 0 | 0 | 0 | 0 | 0.0 | 178.0 | 178.0 | 8.0 | .010 | 8.0 | 4 | 57011 | | | |
| 3 | 6252 | 6252 | 4 | 65 | 0 | 0 | 0.0 | 319.0 | 319.0 | 149.0 | .148 | 149.0 | 4 | 57011 | | | |
| 4 | 7172 | 7172 | 0 | 0 | 0 | 0 | 0.0 | 3588.6 | 3588.6 | 3418.6 | .436 | 3269.6 | 4 | 57011 | | | |
| 0 | 6210 | 0 | 0 | 0 | 0 | 0 | 172.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 57012 | MADISON, JAMES | SSBN627 | |
| 8 | 6232 | 6232 | 0 | 0 | 0 | 0 | 0.0 | 176.0 | 176.0 | 4.0 | .008 | 4.0 | 4 | 57012 | | | |
| 8 | 6241 | 6241 | 0 | 0 | 0 | 0 | 0.0 | 177.0 | 177.0 | 5.0 | .007 | 5.0 | 4 | 57012 | | | |
| NO INITIAL RECORD-FIRST RECORD USED | | | | | | | | | | | | | | | | | |
| 4 | 7172 | 7172 | 0 | 0 | 0 | 0 | 1141.9 | 1141.9 | 1141.9 | 0.0 | 0.000 | 0.0 | 4 | 57013 | MADISON, JAMES | SSBN627 | |
| 0 | 6219 | 0 | 0 | 0 | 0 | 0 | 3032.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 57131 | KAMEHAMEHA | SSBN642 | |
| 4 | 7117 | 7117 | 0 | 0 | 0 | 0 | 0.0 | 6900.5 | 6900.5 | 3868.5 | .613 | 3868.5 | 4 | 57131 | | | |
| 0 | 6219 | 0 | 0 | 0 | 0 | 0 | 817.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 57132 | KAMEHAMEHA | SSBN642 | |
| 4 | 7117 | 7117 | 0 | 0 | 0 | 0 | 0.0 | 5484.3 | 5484.3 | 4667.3 | .739 | 4667.3 | 4 | 57132 | | | |

FLEET RELIABILITY ASSESSMENT DATA

| MTYP | DATE | | WRA | OL1 | OL2 | OL3 | ETM | ETM1 | ETM2 | OPERATE | DUTY | TTF | SYS | UIC | SHIP NAME | HULL NO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 6207 | 0 | 0 | 0 | 0 | 0 | 459.7 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 57201 | KEY,FRANCIS SC | SSBN657 |
| 6 | 6257 | 6310 | 1 | 18 | 10 | 0 | 297.5 | 477.5 | 477.5 | 17.8 | .007 | 17.8 | 4 | 57201 | | |
| 4 | 7105 | 7105 | 0 | 0 | 0 | 0 | 0.0 | 1413.9 | 1413.9 | 954.2 | .151 | 936.4 | 4 | 57201 | | |
| 0 | 6207 | 0 | 0 | 0 | 0 | 0 | 144.3 | 0.0 | 0.0 | 0.0 | 0.000 | 0.0 | 4 | 57202 | KEY,FRANCIS SC | SSBN657 |
| 4 | 7105 | 7105 | 0 | 0 | 0 | 0 | 0.0 | 3297.8 | 3297.8 | 3153.5 | .500 | 3153.5 | 4 | 57202 | | |

R E L I A B I L I T Y

XRR-7 SYSTEM LEVEL

| TIME TO FAIL | NO. FAILURES | NO. CENSURED | SURVIVORS | CPDF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|---|
| .2 | 1. | | 28. | .034 | .000 | .034 |
| 2.1 | 1. | | 27. | .069 | .001 | .068 |
| 5.0 | 1. | | 26. | .103 | .003 | .101 |
| 5.0 | | 1. | | | | |
| 10.8 | 1. | | 24. | .139 | .006 | .134 |
| 11.6 | 1. | | 23. | .175 | .006 | .169 |
| 17.8 | 1. | | 22. | .211 | .009 | .202 |
| 22.6 | 1. | | 21. | .247 | .012 | .235 |
| 30.0 | 1. | | 20. | .283 | .016 | .267 |
| 37.0 | 1. | | 19. | .319 | .019 | .299 |
| 65.9 | 1. | | 18. | .354 | .034 | .320 |
| 78.1 | 1. | | 17. | .390 | .040 | .350 |
| 149.0 | 1. | | 16. | .426 | .076 | .350 |
| 199.8 | | 1. | | | | |
| 288.0 | 1. | | 14. | .464 | .141 | .323 |
| 388.7 | | 1. | | | | |
| 404.4 | 1. | | 12. | .506 | .192 | .313 |
| 717.0 | | 1. | | | | |
| 727.5 | | 1. | | | | |
| 936.4 | | 1. | | | | |
| 1152.3 | 1. | | 8. | .561 | .456 | .104 |
| 2185.0 | | 1. | | | | |
| 2745.9 | | 1. | | | | |
| 3153.5 | | 1. | | | | |
| 3234.1 | | 1. | | | | |
| 3269.6 | | 1. | | | | |
| 3868.5 | | 1. | | | | |
| 4667.3 | | 1. | | | | |

R E L I A B I L I T Y

*RR-7 SYSTEM LEVEL

EQUIPMENT OPERATING HOURS (O.H.) = 28373.1 CALENDAR HOURS(C.H.) = 64008.0 DUTY CYCLE (O.H./C.H.) = .443

NUMBER OF FAILURES = 15. OBSERVED FAILURE RATE/O.H. = .52867E-03

DISTRIBUTION DETERMINATION,

K-S CRITICAL VALUE ( .10,15.) = .244

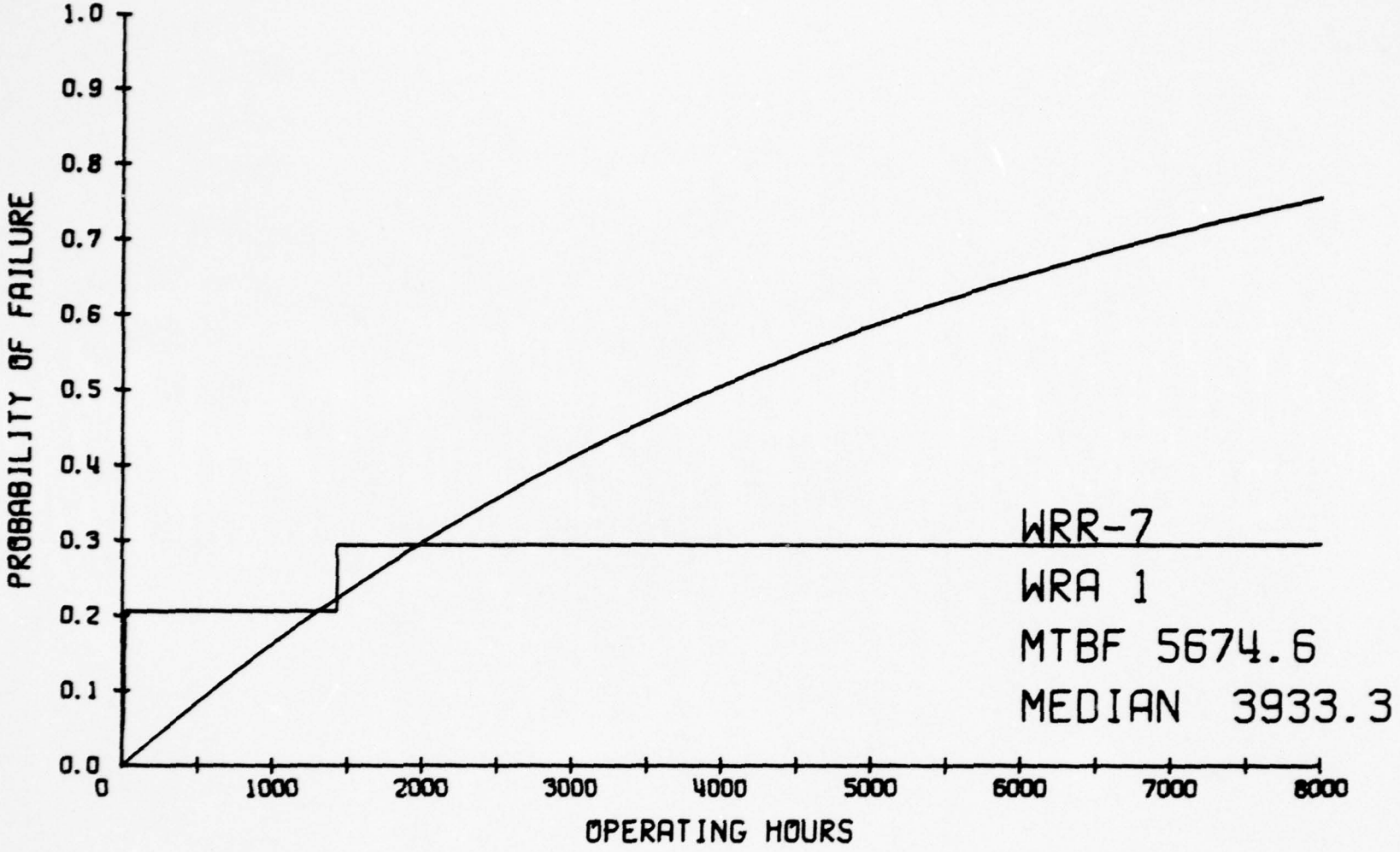
MAX DIFF CALC = .350, IS GREATER THAN CRITICAL VALUE THEREFORE THE WEIBULL DISTRIBUTION IS ASSUMED

THE WEIBULL PARAMETERS ARE ALPHA = .618166E-01 BETA = .415601E+00

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 2432.450, EST. MEDIAN = 351.020, 90 PER CENT LCL FOR MEAN = 0.000, 90 PER CENT UCL FOR MEAN = 4838.493

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



R E L I A B I L I T Y

ARR-7 WRA 1 LEVEL

| TIME TO FAIL | NO. FAILURES | NO. CENSORED | SURVIVORS | CPDF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|---|
| 2.1 | 1. | | 19. | .050 | .000 | .050 |
| 5.0 | | 1. | | | | |
| 16.6 | 1. | | 17. | .103 | .003 | .100 |
| 17.8 | 1. | | 16. | .156 | .003 | .152 |
| 22.8 | 1. | | 15. | .208 | .004 | .204 |
| 77.8 | | 1. | | | | |
| 199.8 | | 1. | | | | |
| 388.7 | | 1. | | | | |
| 717.0 | | 1. | | | | |
| 936.4 | | 1. | | | | |
| 1197.8 | | 1. | | | | |
| 1440.3 | 1. | | 8. | .296 | .224 | .072 |
| 2185.0 | | 1. | | | | |
| 2824.0 | | 1. | | | | |
| 3153.5 | | 1. | | | | |
| 3234.1 | | 1. | | | | |
| 3418.6 | | 1. | | | | |
| 3868.5 | | 1. | | | | |
| 4667.3 | | 1. | | | | |

EQUIPMENT OPERATING HOURS (O.H.) = 28373.1 CALENDAR HOURS(C.H.) = 64008.0 DUTY CYCLE (O.H./C.H.) = .443

NUMBER OF FAILURES = 5. OBSERVED FAILURE RATE/O.H. = .17622E-03

DISTRIBUTION DETERMINATION,

K-S CRITICAL VALUE ( .10, 5.) = .406

MAX DIFF CALC = .204, IS LESS THAN CRITICAL VALUE THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 5674.620, EST. MEDIAN = 3933.347, 90 PER CENT LCL FOR MEAN = 3059.2, 90 PER CENT UCL FOR MEAN = 11663.741

90 PERCENT UCL 11663.74 IS GREATER THAN 2900.00 HOURS, THEREFORE THE EQUIPMENT MEETS THE SPECIFICATIONS

R E L I A B I L I T Y

APR-7 ARA 2 LEVEL

| TIME TO FAIL | NO. FAILURES | NO. CENSORED |
|---|---|---|
| 5.0 | | 1. |
| 77.8 | 1. | |
| 218.5 | | 1. |
| 717.0 | | 1. |
| 954.2 | | 1. |
| 1197.8 | | 1. |
| 1829.0 | | 1. |
| 2185.0 | | 1. |
| 2846.8 | | 1. |
| 3153.5 | | 1. |
| 3234.1 | | 1. |
| 3418.6 | | 1. |
| 3868.5 | | 1. |
| 4667.3 | | 1. |

EQUIPMENT OPERATING HOURS (O,H,) = 28373.1 CALENDAR HOURS(C,H,) =, 64008.0 DUTY CYCLE (O,H,/C,H,) = .443

NUMBER OF FAILURES = 1. OBSERVED FAILURE RATE/O,H, = .35245E-04

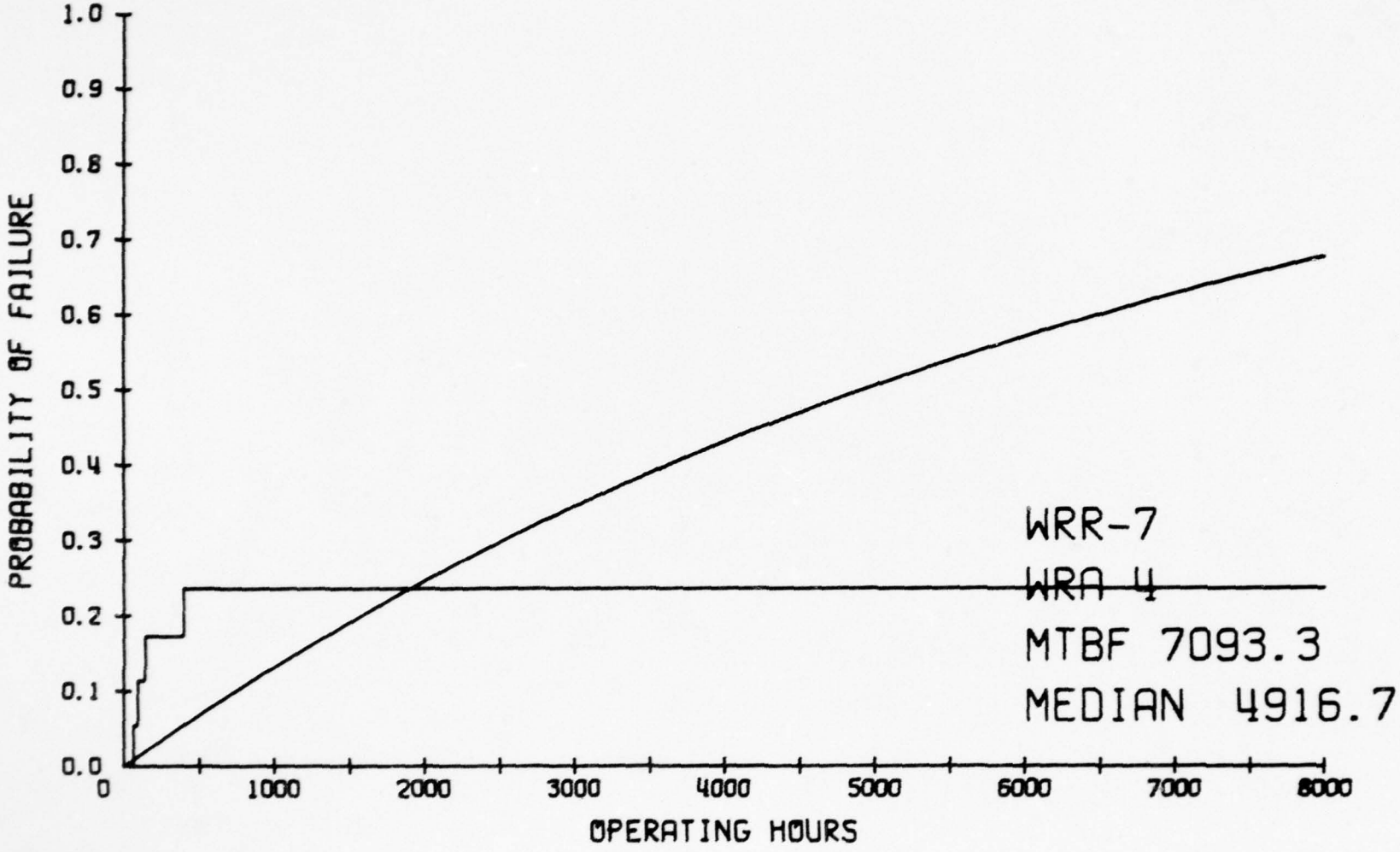
LESS THAN FOUR FAILURES THE EXPONENTIAL DISTRIBUTION IS ASSUMED

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 28373,100, EST. MEDIAN = 19666,734, 90 PER CENT LCL FOR MEAN = 7294,4, 90 PER CENT UCL FOR MEAN = 269296,697

90 PERCENT UCL 269296.70 IS GREATER THAN 10500.00 HOURS, THEREFORE THE EQUIPMENT MEETS THE SPECIFICATIONS

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



R E L I A B I L I T Y

ARR-7 ORA 4 LEVEL

| TIME TO FAIL | NO. FAILURES | NO. CENSORED | SURVIVORS | CPDF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|---|
| 5.0 | | 1. | | | | |
| 65.9 | 1. | | 17. | .056 | .009 | .046 |
| 77.8 | | 1. | | | | |
| 100.9 | 1. | | 15. | .115 | .014 | .100 |
| 149.0 | 1. | | 14. | .174 | .021 | .153 |
| 218.5 | | 1. | | | | |
| 404.4 | 1. | | 12. | .237 | .055 | .182 |
| 717.0 | | 1. | | | | |
| 727.5 | | 1. | | | | |
| 954.2 | | 1. | | | | |
| 1829.0 | | 1. | | | | |
| 2185.0 | | 1. | | | | |
| 2745.9 | | 1. | | | | |
| 3153.5 | | 1. | | | | |
| 3234.1 | | 1. | | | | |
| 3269.6 | | 1. | | | | |
| 3868.5 | | 1. | | | | |
| 4667.3 | | 1. | | | | |

EQUIPMENT OPERATING HOURS (D,H,) = 28373.1 CALENDAR HOURS(C,H,) =, 64008.0 DUTY CYCLE (D,H,/C,H,) = .443

NUMBER OF FAILURES = 4, OBSERVED FAILURE RATE/D,H, = .14098E-03

DISTRIBUTION DETERMINATION,

K-S CRITICAL VALUE ( .10, 4,) = .449

MAX DIFF CALC = .182, IS LESS THAN CRITICAL VALUE THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED

FOR THE ASSUMED DISTRIBUTION

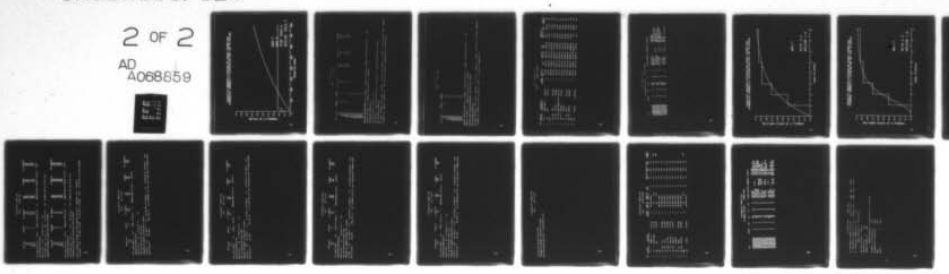
EST, MEAN = 7093.275, EST, MEDIAN = 4916.684, 90 PER CENT LCL FOR MEAN = 3549.5, 90 PER CENT UCL FOR MEAN = 16261.800

90 PERCENT UCL 16261.80 IS GREATER THAN 800.00 HOURS, THEREFORE THE EQUIPMENT MEETS THE SPECIFICATIONS

AD-A068 859 NAVAL WEAPONS SUPPORT CENTER CRANE IN F/G 5/2
FLEET RELIABILITY ASSESSMENT PROGRAM. VOLUME 5. AN/URC-62 VLF F--ETC(U)
SEP 77

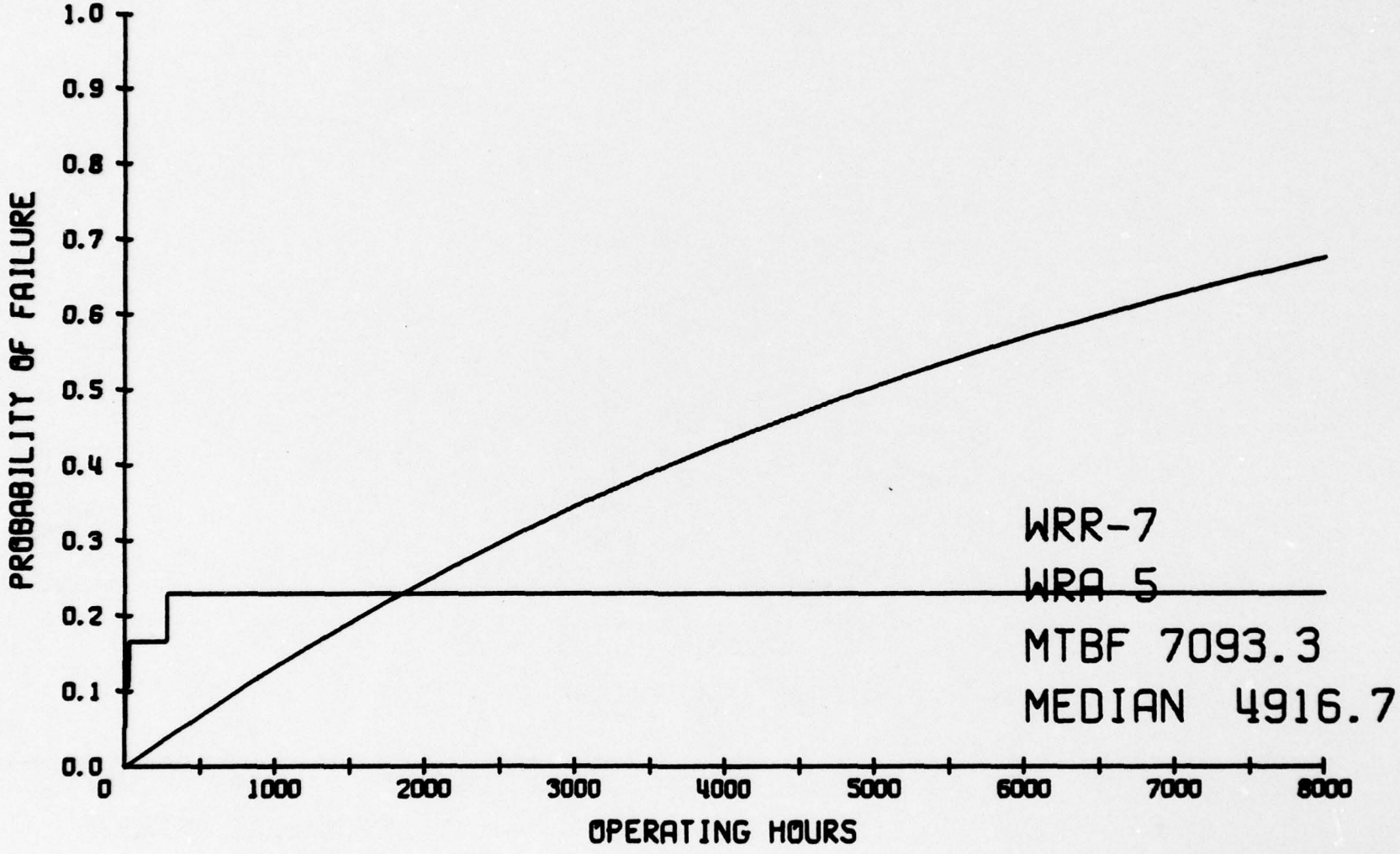
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CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



R E L I A B I L I T Y

VRR-7 ..RA 5 LEVEL

| TIME TO FAIL | NO. FAILURES | NO. CENSORED | SURVIVORS | CPDF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|---|
| .2 | 1. | | 18. | .053 | .000 | .053 |
| 5.0 | | 1. | | | | |
| 10.8 | 1. | | 16. | .108 | .002 | .107 |
| 30.0 | | 1. | | | | |
| 37.0 | 1. | | 14. | .168 | .005 | .163 |
| 218.5 | | 1. | | | | |
| 288.0 | 1. | | 12. | .232 | .040 | .192 |
| 717.0 | | 1. | | | | |
| 954.2 | | 1. | | | | |
| 1197.8 | | 1. | | | | |
| 1541.0 | | 1. | | | | |
| 2185.0 | | 1. | | | | |
| 2846.6 | | 1. | | | | |
| 3153.5 | | 1. | | | | |
| 3234.1 | | 1. | | | | |
| 3418.6 | | 1. | | | | |
| 3868.5 | | 1. | | | | |
| 4667.3 | | 1. | | | | |

EQUIPMENT OPERATING HOURS (O.H.) = 26373.1 CALENDAR HOURS(C.H.) =, 64008.0 DUTY CYCLE (O.H./C.H.) = .443

NUMBER OF FAILURES = 4. OBSERVED FAILURE RATE/O.H. = .14098E-03

DISTRIBUTION DETERMINATION,

K-S CRITICAL VALUE ( .10, 4.) = .449

MAX DIFF CALC = .192, IS LESS THAN CRITICAL VALUE THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 7093.275, EST. MEDIAN = 4916.684, 90 PER CENT LCL FOR MEAN = 3549.5, 90 PER CENT UCL FOR MEAN = 16261.800

90 PERCENT UCL 16261.80 IS GREATER THAN 2900.00 HOURS, THEREFORE THE EQUIPMENT MEETS THE SPECIFICATIONS

R E L I A B I L I T Y

WRR-7 ..RA 9 LEVEL

| TIME TO FAIL | NO. FAILURES | NO. CENSORED |
|---|---|---|
| 5.0 | | 1. |
| 7.1 | 1. | |
| 77.8 | | 1. |
| 211.4 | | 1. |
| 717.0 | | 1. |
| 954.2 | | 1. |
| 1197.8 | | 1. |
| 1829.0 | | 1. |
| 2185.0 | | 1. |
| 2846.8 | | 1. |
| 3153.5 | | 1. |
| 3234.1 | | 1. |
| 3418.6 | | 1. |
| 3868.5 | | 1. |
| 4667.3 | | 1. |

EQUIPMENT OPERATING HOURS (O.H.) = 28373.1 CALENDAR HOURS(C.H.) =, 64008.0 DUTY CYCLE (O.H./C.H.) = .443

NUMBER OF FAILURES = 1. OBSERVED FAILURE RATE/O.H. = .35245E-04

LESS THAN FOUR FAILURES THE EXPONENTIAL DISTRIBUTION IS ASSUMED

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 28373.100, EST. MEDIAN = 19666.734, 90 PER CENT LCL FOR MEAN = 7294.4, 90 PER CENT UCL FOR MEAN = 269296.697

90 PERCENT UCL 269296.70 IS LESS THAN 2000000.00 HOURS, THUS A RELIABILITY PROBLEM EXISTS

# R E L I A B I L I T Y

## WRR-7 O-LEVEL SUMMARY

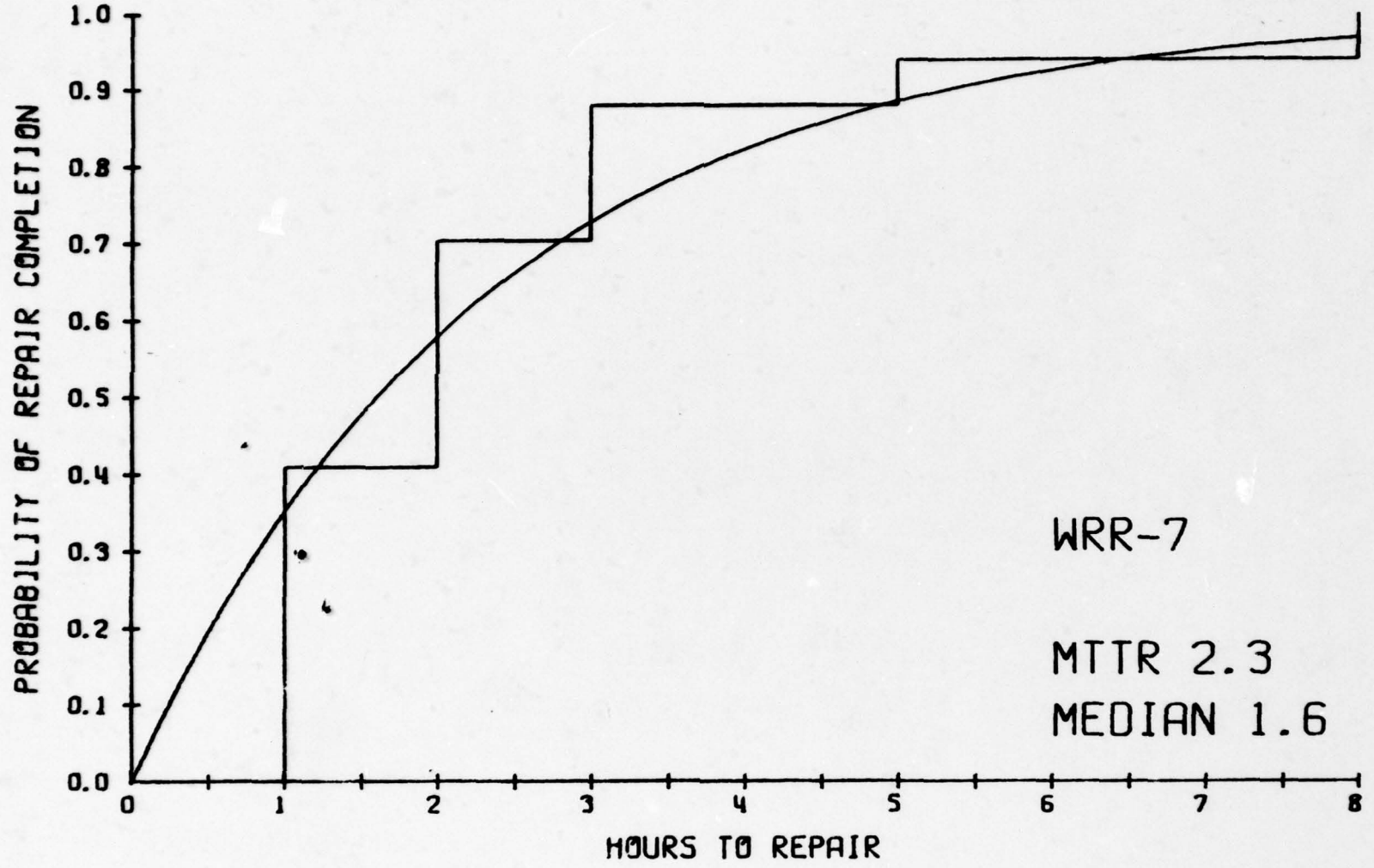
| WRA | O-LEVEL BLOCK NO. | | O-LEVEL NOMENCLATURE | | NUMBER FAILURES | LOWER 90 CONF LIM | MEAN | UPPER 90 CONF LIM | SPEC MTBF | OBSERVED FAILURE TIMES LOW | OBSERVED FAILURE TIMES HIGH | RELIAB PROBLEM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10 | | POWER SUPPLY | 616-1789 | 3. | 4246.96 | 9457.70 | 25745.40 | 26900.00 | 17.80 | 1440.30 | YES |
| 1 | 18 | | SMO | 792-6701 | 2. | 5330.98 | 14186.55 | 53351.80 | 11600.00 | 17.90 | 18.70 | NO |
| 1 | 999 | | | | 2. | 5330.98 | 14186.55 | 53351.80 | 2000000.00 | 2.10 | 22.80 | YES |
| 2 | 48 | RA5 | -25V | 784-3655 | 1. | 7294.38 | 28373.10 | 269296.70 | 44843.00 | 77.80 | 77.80 | NO |
| 4 | 58 | PE7 | P/W DVR | 784-3992 | 1. | 7294.38 | 28373.10 | 269296.70 | 61633.00 | 470.30 | 470.30 | NO |
| 4 | 65 | CORE | CORE MAGNETIC MEM | 784-5626 | 1. | 7294.38 | 28373.10 | 269296.70 | 50000.00 | 149.00 | 149.00 | NO |
| 4 | 85 | PY4 | CMPR ACC | 784-4212 | 1. | 7294.38 | 28373.10 | 269296.70 | 52654.00 | 65.90 | 65.90 | NO |
| 4 | 93 | | CHASSIS | | 1. | 7294.38 | 28373.10 | 269296.70 | 10907.00 | 100.90 | 100.90 | NO |
| 5 | 94 | A5 | RVFR | 617-6876 | 1. | 7294.38 | 28373.10 | 269296.70 | 12500.00 | 10.80 | 10.80 | NO |
| 5 | 103 | A10 | BATTERY | 606-9524 | 1. | 7294.38 | 28373.10 | 269296.70 | 500000.00 | 47.80 | 47.80 | YES |
| 5 | 999 | | | | 2. | 5330.98 | 14186.55 | 53351.80 | 2000000.00 | .20 | 288.00 | YES |
| 9 | 108 | | CHASSIS | 606-9513 | 1. | 7294.38 | 28373.10 | 269296.70 | 37800.00 | 7.10 | 7.10 | NO |

# RELIABILITY

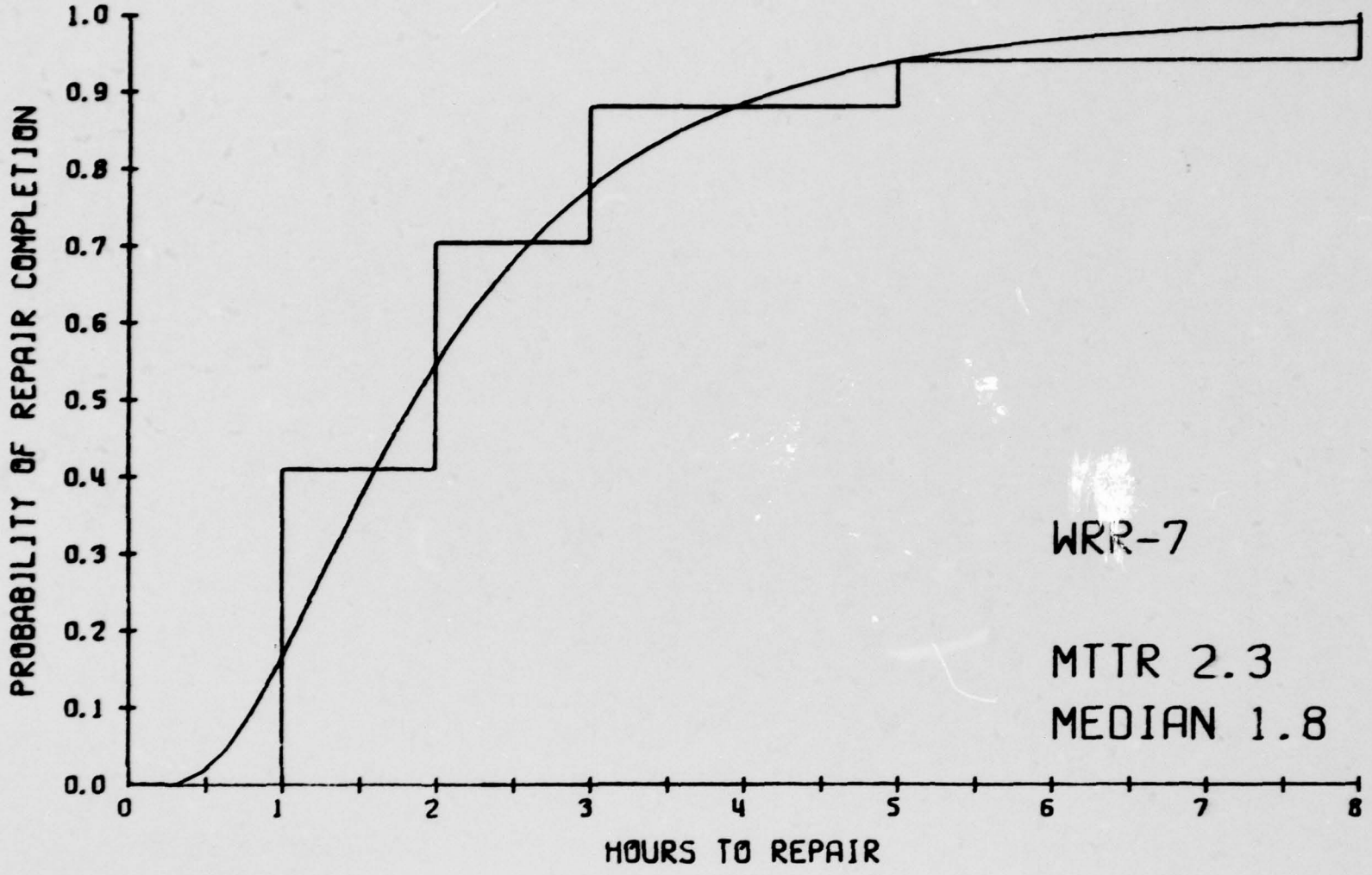
## 2K SUMMARY FOR WRR-7 PROBLEM AREAS

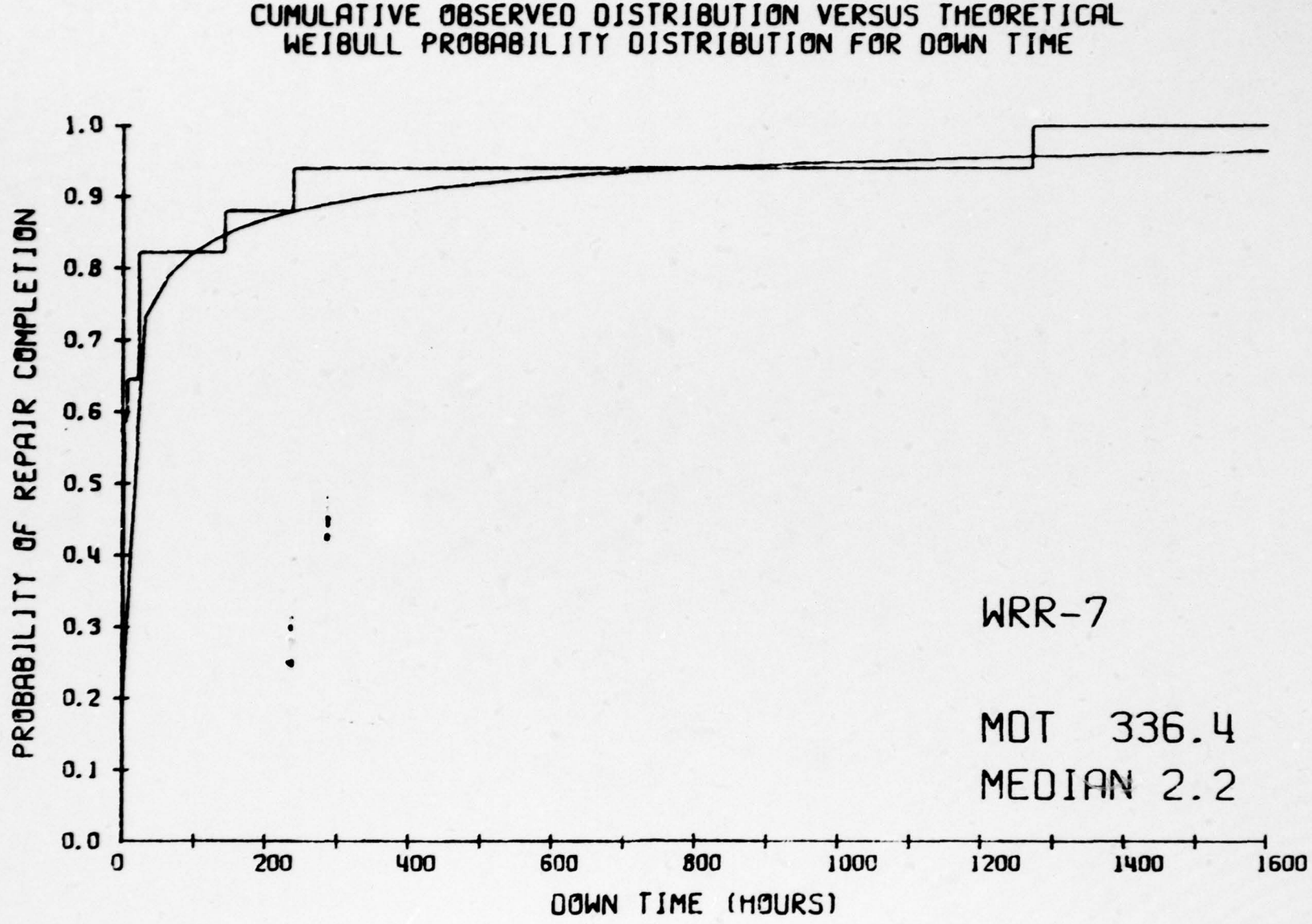
| JCN | SYSTEM | WRA | O-L | O-L | O-L | SYSTEM SYMPTON | DIAGNOSTIC | RESULTS |
|---|---|---|---|---|---|---|---|---|
| 04689CE010856 | 4 | 1 | 999 | 0 | 0 | BLWN FUSE | | R+R FUSE |
| 04689CE010853 | 4 | 9 | 108 | 0 | 0 | SMASHED SWS | | PERSONNEL |
| 04689CE010858 | 4 | 1 | 10 | 18 | 0 | BLO FUSE | | R+R A6A8 IN R1738 |
| 04689CE010971 | 4 | 1 | 10 | 2 | 0 | SMO OUTA LC | KLITE | R+R PWR SUPT 1MIX |
| 04689CE010985 | 4 | 5 | 999 | 0 | 0 | LO 2ND HARM | | ADJ+CHNG MTR R |
| 04689CE011018 | 4 | 1 | 10 | 0 | 0 | BLUE FUSES | | R+R RCVR PS MODULE |
| 05117DC010460 | 4 | 5 | 103 | 0 | 0 | TIME LOSS | NO DC L | TR+R BATTERY MODULE |
| 05117DC010483 | 4 | 1 | 10 | 0 | 0 | | | R+R PWR SUPPLY |
| 05123DC010605 | 4 | 5 | 999 | 0 | 0 | TM6 FAULT | LITE | R+R FTS |
| 05123D6010608 | 4 | 1 | 999 | 0 | 0 | BLUE FUSE | | R+R F3 |
| 05720DC010423 | 4 | 1 | 18 | 10 | 0 | LOCK, FUZE | LIT, BL | NR+R SMO + RC PR SP |

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR

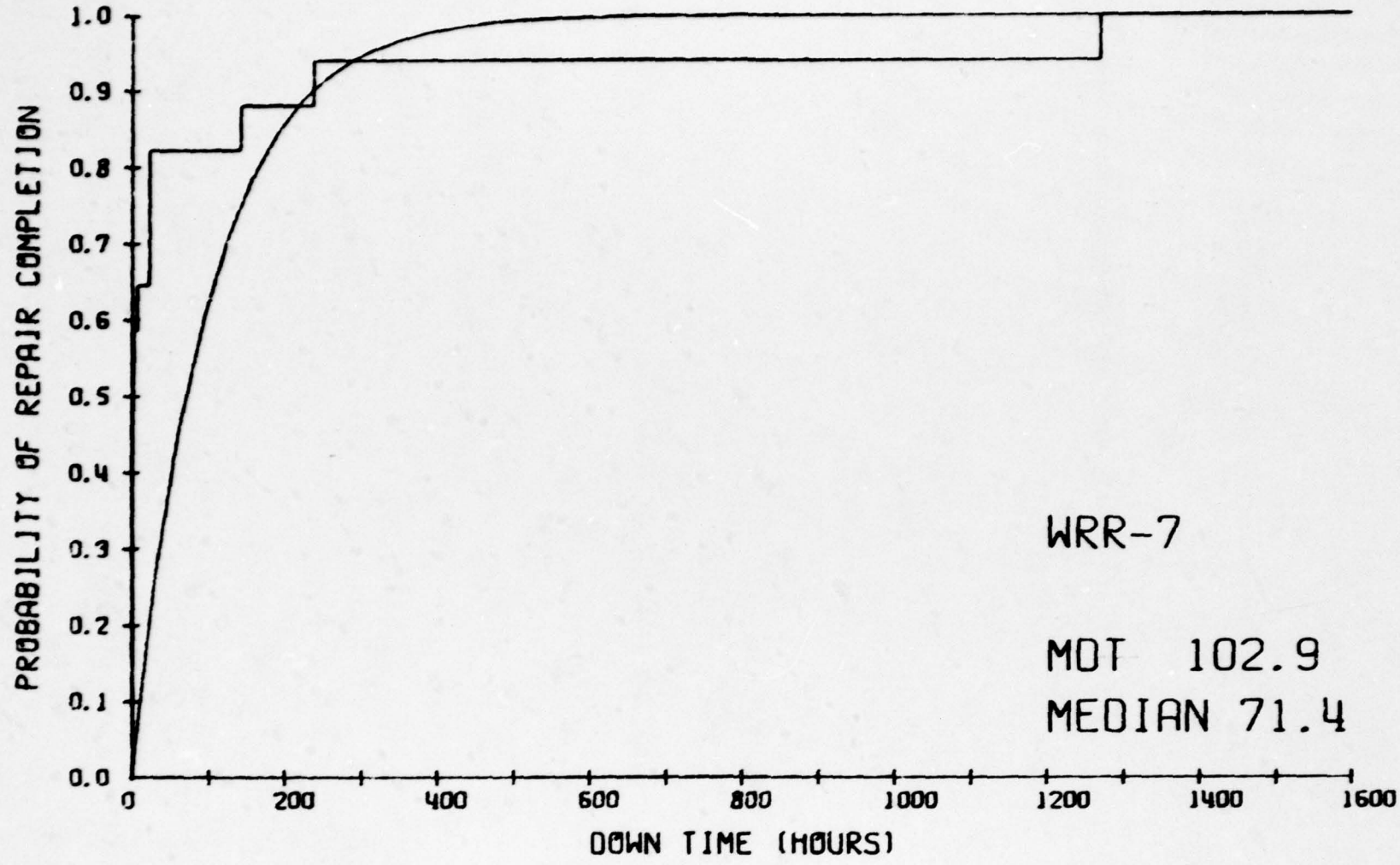


CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
LOGNORMAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



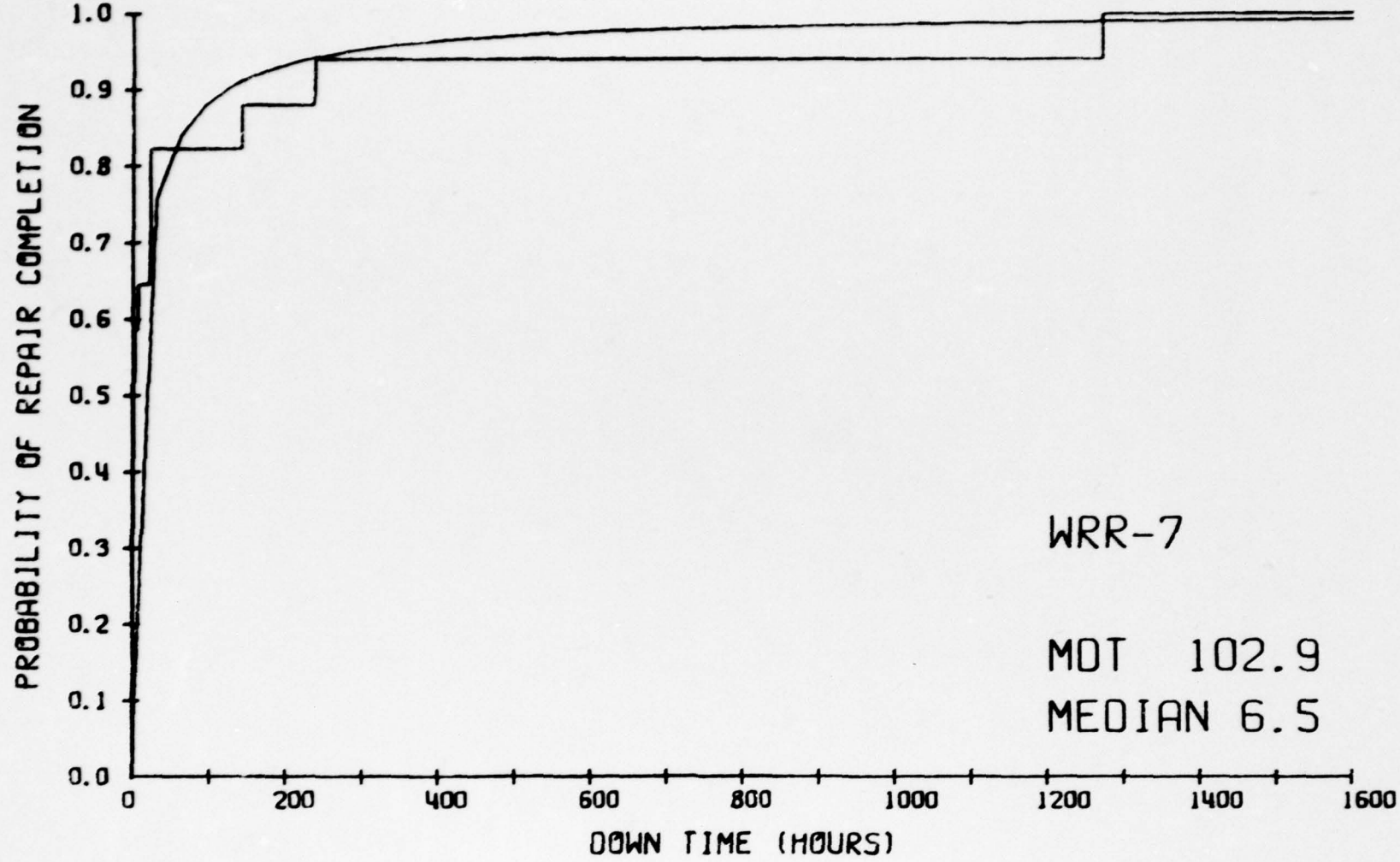

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
WEIBULL PROBABILITY DISTRIBUTION FOR DOWN TIME
PROBABILITY OF REPAIR COMPLETION
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
200
400
600
800
1000
1200
1400
1600
DOWN TIME (HOURS)
WRR-7
MDT 336.4
MEDIAN 2.2

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR DOWN TIME




96-5

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
LOGNORMAL PROBABILITY DISTRIBUTION FOR DOWN TIME



FLEET MAINTAINABILITY ASSESSMENT DATA

| WRA | OL1 | OL2 | OL3 | DISCOVERY DATE | COMPLETION DATE | DOWN TIME (HRS) | REPAIR TIME (HRS) | SYS | UIC |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 999 | 0 | 0 | 6163 | 6163 | 1.0 | 1.0 | 4 | 04689 |
| 9 | 108 | 0 | 0 | 6166 | 6166 | 1.0 | 1.0 | 4 | 04689 |
| 1 | 10 | 18 | 0 | 6183 | 6183 | 2.0 | 2.0 | 4 | 04689 |
| 5 | 999 | 0 | 0 | 7017 | 7018 | 24.0 | 2.0 | 4 | 04689 |
| 1 | 10 | 0 | 0 | 7063 | 7063 | 1.0 | 1.0 | 4 | 04689 |
| 4 | 85 | 0 | 0 | 6250 | 6250 | 1.0 | 1.0 | 4 | 04697 |
| 4 | 58 | 0 | 0 | 6282 | 6282 | 8.0 | 8.0 | 4 | 04697 |
| 1 | 4 | 0 | 0 | 6267 | 6288 | 24.0 | 2.0 | 4 | 05110 |
| 4 | 74 | 0 | 0 | 6357 | 6358 | 24.0 | 5.0 | 4 | 05116 |
| 2 | 52 | 0 | 0 | 6167 | 6167 | 1.0 | 1.0 | 4 | 05117 |
| 5 | 94 | 0 | 0 | 6268 | 6268 | 2.0 | 2.0 | 4 | 05117 |
| 5 | 103 | 0 | 0 | 6306 | 6316 | 240.0 | 3.0 | 4 | 05117 |
| 2 | 48 | 0 | 0 | 6316 | 6322 | 144.0 | 2.0 | 4 | 05117 |
| 5 | 999 | 0 | 0 | 6311 | 6311 | 3.0 | 3.0 | 4 | 05123 |
| 1 | 999 | 0 | 0 | 6325 | 6325 | 1.0 | 1.0 | 4 | 05123 |
| 4 | 93 | 0 | 0 | 6337 | 6337 | 1.0 | 1.0 | 4 | 05123 |
| 4 | 65 | 0 | 0 | 6252 | 6252 | 0.0 | 0.0 | 4 | 05701 |
| NO REPAIR TIME FOR THE ABOVE RECORD | | | | | | | | | |
| 1 | 18 | 10 | 0 | 6257 | 6310 | 1272.0 | 3.0 | 4 | 05720 |

MAINTAINABILITY (REPAIR TIME)

WRR-7 SYSTEM LEVEL

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | LOGNORMAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 7. | 7.0 | .389 | .168 | .221 |
| 2.0 | 5. | 12.0 | .667 | .569 | .100 |
| 3.0 | 3. | 15.0 | .833 | .776 | .109 |
| 5.0 | 1. | 16.0 | .889 | .960 | .107 |
| 8.0 | 1. | 17.0 | .944 | .989 | .100 |

TOTAL REPAIR HOURS = 39.0 NUMBER OF REPAIRS = 17. OBSERVED REPAIR RATE/HR = .4359E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = .61 STD DEV OF LN'S = .64

K-S CRITICAL VALUE ( .10, 17. ) = .189 MAX DIFF CALC = .221 IS GREATER THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION CANNOT BE ASSUMED

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 7. | 7. | .389 | .333 | .036 |
| 2.0 | 5. | 12. | .667 | .582 | .193 |
| 3.0 | 3. | 15. | .833 | .730 | .104 |
| 5.0 | 1. | 16. | .889 | .887 | .054 |
| 8.0 | 1. | 17. | .944 | .969 | .081 |

TOTAL REPAIR HOURS = 39.0 NUMBER OF REPAIRS = 17. OBSERVED REPAIR RATE/HR = .4359E+00

DISTRIBUTION DETERMINATION

K-S CRITICAL VALUE ( .10, 17. ) = .229 MAX DIFF CALC = .193 IS LESS THAN THE CRITICAL VALUE

THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED

EST MEAN = 2.29 EST MEDIAN = 1.59 90 PER CENT LCL ON MEAN = 1.74 90 PER CENT UCL ON MEAN = 3.25

SPECIFIED MTTR = .62 HOURS LOWER CONF LIM 1.74 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

MAINTAINABILITY (DOWN TIME)

WRR-7 SYSTEM LEVEL

| DOWN TIME | FREQUENCY | CUM FREQUENCY | NPF | LOGNORMAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 7. | 7.0 | .389 | .207 | .182 |
| 2.0 | 2. | 9.0 | .500 | .304 | .196 |
| 3.0 | 1. | 10.0 | .556 | .369 | .187 |
| 8.0 | 1. | 11.0 | .611 | .537 | .074 |
| 24.0 | 3. | 14.0 | .778 | .717 | .106 |
| 144.0 | 1. | 15.0 | .833 | .913 | .135 |
| 240.0 | 1. | 16.0 | .889 | .943 | .110 |
| 1272.0 | 1. | 17.0 | .944 | .990 | .101 |

TOTAL DOWN TIME (TDT) = 1750.0 NUMBER OF REPAIRS (NR) = 17. OBSERVED DOWN TIME/REPAIR (TDT/NR) = 102.94

DISTRIBUTION DETERMINATION

MEAN OF LN'S = 1.86 STD DEV OF LN'S = 2.28

K-S CRITICAL VALUE ( .10, 17. ) = .189 MAX DIFF CALC = .196 IS GREATER THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION CANNOT BE ASSUMED

| DOWN TIME | FREQUENCY | CUM FREQUENCY | NPF | EXPONENTIAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 7. | 7. | .389 | .010 | .379 |
| 2.0 | 2. | 9. | .500 | .019 | .481 |
| 3.0 | 1. | 10. | .556 | .029 | .527 |
| 8.0 | 1. | 11. | .611 | .075 | .536 |
| 24.0 | 3. | 14. | .778 | .208 | .570 |
| 144.0 | 1. | 15. | .833 | .753 | .080 |
| 240.0 | 1. | 16. | .889 | .903 | .070 |
| 1272.0 | 1. | 17. | .944 | 1.000 | .111 |

TOTAL DOWN TIME (TDT) = 1750.0 NUMBER OF REPAIRS (NR) = 17. OBSERVED DOWN TIME/REPAIR (TDT/NR) = 102.94

DISTRIBUTION DETERMINATION

K-S CRITICAL VALUE ( .10, 17. ) = .229 MAX DIFF CALC = .570 IS GREATER THAN THE CRITICAL VALUE

THEREFORE THE EXPONENTIAL DISTRIBUTION CANNOT BE ASSUMED

WEIBULL DISTRIBUTION ASSUMED, ESTIMATED PARAMETERS ARE ALPHA = .58208E+00 BETA = .23643E+00

EST MEDIAN = 2.217 EST MEAN = 336.398 90 PER CENT LCL ON MEAN = 0.000 90 PER CENT UCL ON MEAN =1386.865

MAINTAINABILITY (REPAIR TIME)

WRR-7 WRA 1 LEVEL

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | LOGNORMAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 3. | 3.0 | .429 | .193 | .236 |
| 2.0 | 2. | 5.0 | .714 | .721 | .292 |
| 3.0 | 1. | 6.0 | .857 | .984 | .210 |

TOTAL REPAIR HOURS = 10.0 NUMBER OF REPAIRS = 6. OBSERVED REPAIR RATE/HR = .6000E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = .41 STD DEV OF LN'S = .48

LESS THAN FOUR DISTINCT REPAIR TIMES

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

EST MEAN = 1.67 EST MEDIAN = 1.51 90 PER CENT LCL ON MEDIAN = 1.13 90 PER CENT UCL ON MEDIAN = 2.02

SPECIFIED MTTR = .62 HOURS LOWER CONF LIM 1.13 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

MAINTAINABILITY (REPAIR TIME)

WRR-7 WRA 2 LEVEL

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | LOGNORMAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 1. | 1.0 | .333 | .260 | .094 |
| 2.0 | 1. | 2.0 | .667 | .760 | .427 |

TOTAL REPAIR HOURS = 3.0 NUMBER OF REPAIRS = 2. OBSERVED REPAIR RATE/HR = .6667E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = .35 STD DEV OF LN'S = .49

LESS THAN FOUR DISTINCT REPAIR TIMES

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

EST MEAN = 1.50 EST MEDIAN = 1.41 90 PER CENT LCL ON MEDIAN = .49 90 PER CENT UCL ON MEDIAN = 4.11

SPECIFIED MTTR = .62 HOURS LOWER CONF LIM .49 IS LESS THAN MTTR, THUS THE EQUIPMENT MEETS THE SPECIFICATIONS

MAINTAINABILITY (REPAIR TIME)

WRR-7 WRA 4 LEVEL

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | LOGNORMAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 1.0 | 2. | 2.0 | .400 | .197 | .203 |
| 5.0 | 1. | 3.0 | .600 | .737 | .337 |
| 8.0 | 1. | 4.0 | .800 | .858 | .258 |

TOTAL REPAIR HOURS = 15.0 NUMBER OF REPAIRS = 4. OBSERVED REPAIR RATE/HR = .2667E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = .92 STD DEV OF LN'S = 1.08

LESS THAN FOUR DISTINCT REPAIR TIMES

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

EST MEAN = 3.75 EST MEDIAN = 2.51 90 PER CENT LCL ON MEDIAN = 1.04 90 PER CENT UCL ON MEDIAN = 6.10

SPECIFIED MTTR = .62 HOURS LOWER CONF LIM 1.04 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

MAINTAINABILITY (REPAIR TIME)

WRR-7 WRA 5 LEVEL

| REPAIR TIME | FREQUENCY | CUM FREQUENCY | NPF | LOGNORMAL | MAX DIFFERENCE |
|---|---|---|---|---|---|
| 2.0 | 2. | 2.0 | .400 | .193 | .207 |
| 3.0 | 2. | 4.0 | .800 | .807 | .407 |

TOTAL REPAIR HOURS = 10.0 NUMBER OF REPAIRS = 4. OBSERVED REPAIR RATE/HR = .4000E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = .90 STD DEV OF LN'S = .23

LESS THAN FOUR DISTINCT REPAIR TIMES

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

EST MEAN = 2.50 EST MEDIAN = 2.45 90 PER CENT LCL ON MEDIAN = 2.02 90 PER CENT UCL ON MEDIAN = 2.97

SPECIFIED MTTR = .62 HOURS LOWER CONF LIM 2.02 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

MAINTAINABILITY (REPAIR TIME)

WRR-7 WRA 9 LEVEL

LESS THAN FOUR DISTINCT REPAIR TIMES

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

ONLY ONE DISTINCT REPAIR TIME -- NO CONFIDENCE LIMITS

MAINTAINABILITY (REPAIR TIME)

WRR-7 O-LEVEL SUMMARY

| WRA | O-LEVEL BLOCK NO. | | O-LEVEL NOMENCLATURE | | NUMBER REPAIRS | LOWER 90 CONF LIM | UPPER 90 CONF LIM | SPEC MTTR | OBSERVED REPAIR TIMES LOW | MEAN | HIGH | MAINT PROBLEM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4 | | SECOND I F | 616-1710 | 1. | NO CONF LIMITS | | .6 | 2.0 | 2.00 | 2.0 | |
| 1 | 10 | | POWER SUPPLY | 616-1789 | 3. | .99 | 3.33 | .6 | 1.0 | 2.00 | 3.0 | YES |
| 1 | 18 | | SMD | 792-6701 | 2. | 1.31 | 4.57 | .6 | 2.0 | 2.50 | 3.0 | YES |
| 1 | 999 | | | | 2. | NO CONF LIMITS | | .6 | 1.0 | 1.00 | 1.0 | |
| 2 | 48 | RA5 | -25V | 784-3655 | 1. | NO CONF LIMITS | | .6 | 2.0 | 2.00 | 2.0 | |
| 2 | 52 | RB2 | -5.2V | 784-3659 | 1. | NO CONF LIMITS | | .6 | 1.0 | 1.00 | 1.0 | |
| 4 | 58 | PE7 | P/W DVR | 784-3992 | 1. | NO CONF LIMITS | | .6 | 8.0 | 8.00 | 8.0 | |
| 4 | 74 | MTU | TAPE UNIT | 777-4616 | 1. | NO CONF LIMITS | | .6 | 5.0 | 5.00 | 5.0 | |
| 4 | 85 | PY6 | CMPR ACC | 784-4212 | 1. | NO CONF LIMITS | | .6 | 1.0 | 1.00 | 1.0 | |
| 4 | 93 | | CHASSIS | | 1. | NO CONF LIMITS | | .6 | 1.0 | 1.00 | 1.0 | |
| 5 | 94 | A5 | RVPR | 617-6876 | 1. | NO CONF LIMITS | | .6 | 2.0 | 2.00 | 2.0 | |
| 5 | 103 | A10 | BATTERY | 606-9524 | 1. | NO CONF LIMITS | | .6 | 3.0 | 3.00 | 3.0 | |
| 5 | 999 | | | | 2. | 1.31 | 4.57 | .6 | 2.0 | 2.50 | 3.0 | YES |
| 9 | 108 | | CHASSIS | 606-9513 | 1. | NO CONF LIMITS | | .6 | 1.0 | 1.00 | 1.0 | |

## MAINTAINABILITY (REPAIR TIME)

### 2K SUMMARY FOR WAR-7 PROBLEM AREAS

| JCN | SYSTEM | WRA | D-L | D-L | D-L | SYSTEM SYMPTOM | DIAGNOSTIC | RESULTS |
|---|---|---|---|---|---|---|---|---|
| 04689CE010856 | 4 | 1 | 999 | 0 | 0 | BLWN FUSE | | R+R FUSE |
| 04689CE010858 | 4 | 1 | 10 | 18 | 0 | BLO FUSE | | R+R A6A8 IN A1738 |
| 04689CE010971 | 4 | 1 | 10 | 2 | 0 | SMO OUTA LC | KLITE | R+R PWR SUPT 1MIX |
| 04689CE010985 | 4 | 5 | 999 | 0 | 0 | LO 2ND HARM | | ADJ+CHNG MTR A |
| 04689CE011018 | 4 | 1 | 10 | 0 | 0 | BLUE FUSES | | R+R RCVR PS MODULE |
| 04697CE018469 | 4 | 4 | 85 | 0 | 0 | HV LITE -5. | 2STEP 26 | R R PY-4 SEE PIX5 |
| 04697CE018480 | 4 | 4 | 58 | 0 | 0 | NO PTR | 39 *857 | R+R PE-7 CARD |
| 051100C010554 | 4 | 1 | 4 | 0 | 0 | FAILS DIAG | STEP 27 | R R MODULE A5 |
| 051160C010614 | 4 | 4 | 74 | 0 | 0 | NO LOAD | | R+R MTU S/N A65 |
| 051170C010447 | 4 | 5 | 94 | 0 | 0 | TMG FAULT | LITE | R+R RVFR |
| 051170C010460 | 4 | 5 | 103 | 0 | 0 | TIME LOSS | NO DC L | TR+R BATTERY MODULE |
| 051170C010483 | 4 | 1 | 10 | 0 | 0 | | | R+R PWR SUPPLY |
| 051230C010605 | 4 | 5 | 999 | 0 | 0 | TM6 FAULT | LITE | R+R FTS |
| 051230C010608 | 4 | 1 | 999 | 0 | 0 | BLUE FUSE | | R+R F3 |
| 051230C010612 | 4 | 4 | 93 | 0 | 0 | BAD LITE TS | T | R+R LAMP MRC W-2 |
| 057010C010652 | 4 | 4 | 65 | 0 | 0 | BLN CORE | -25V BK | RR+R CPU W/B43 CPU |
| 057200C010423 | 4 | 1 | 18 | 10 | 0 | LOCK, FUZE | LIT, BL | MR+R SMO + RC PR SP |

RMA SUMMARY ARR-7 SYSTEM LEVEL

TTF DISTRIBUTION IS WEIBULL WITH ALPHA = .06182 AND BETA = .41560 MEAN = 2432.50

DT DISTRIBUTION IS WEIBULL WITH ALPHA = .58200 AND BETA = .23640 MEAN = 336.40

RT DISTRIBUTION IS EXPONENTIAL WITH MEAN = 2.29

INHERENT AVAILABILITY = MTBF/(MTBF+MTTR)

MEAN TIME TO FAILURE = 2432.50

MEAN REPAIR TIME = 2.29

INHERENT AVAILABILITY = .9991

OBSERVED AVAILABILITY (SIMULATION OF RATIOS TTF/(TTF+DT))

90 PERCENT LCL ON INDIVIDUALS = .1575

90 PERCENT UCL ON INDIVIDUALS = .9964

MEAN = .8094

MEDIAN = .9818