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# FAILURE MODES, EFFECTS AND CRITICALITY ANALYSIS (FMECA) OF CATEGORY III INSTRUMENT LANDING SYSTEM

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#### 16. Abstract

\*A Failure Modes, Effects and Criticality Analysis (FMECA) is used to optimize system performance by identification (and subsequent elimination) of all potentially hazardous failure modes affecting either personnel safety or operational mission success. The in-depth systematic approach of such an analysis provides the quantitative assurance that the system design has achieved the highest standards of system reliability and integrity.

The FMECA performed under contract number DOT-FA71WA-2635 for the FAA on the Texas Instruments Incorporated FAA Mark III ILS identified changes/modifications which were required in order for the system to comply with the quantitative requirements imposed upon the reliability of the system. These changes/modifications have been incorporated into the design and, as a result, the design meets and exceeds the required reliability criteria set for the system. Another major valuable output of the FMECA deals with performance assurance measures (preventive maintenance). All relevant hidden equipment failure modes are identified within the analysis and, based upon allowable probabilities of occurence, their respective preventive maintenance frequencies are specified.

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# 1,0 INTRODUCTION

The increase of aircraft transportation during the last ten years has been nothing less than phenomenal. To accommodate this increase greater demands must be imposed upon aircraft and their associated ground support equipments. Higher equipment reliabilities and extremely low probabilities of mission failure are natural requirements which must be fulfilled in this area with the afg of modern technologies.

An instrument landing system (ILS) is one such ground support equipment which embodies these requirements. The ILS, providing guidance to approaching or landing aircraft under adverse weather conditions, must employ "optimum" design and reliability to ensure personnel safety. This is especially true in the Category III ILS which provides guidance information from the coverage limit of the facility at which it is installed to, and along the surface of the runway. To ensure that the "optimum" in equipment performance is achieved, a qualitative system analysis which stratifies all possible modes of failure, their criticality and effect on mission success must be accomplished. Such an analysis, called a Failure Modes, Effects and Criticality Analysis (FMECA), has been performed by Dexas Instruments Incorporated on its Category III ILS (FAA Mark III ILS) and is the subject of this report.

#### 1.1 Safety Requirement

It is impossible to achieve the implementation of a system with infinite reliability and safety; therefore, it becomes necessary that some safety/reliability goal be established to enable the relative safety of the ILS to be determined. For Category III operations, there is a brief time period during which the safety of the aircraft becomes completely dependent upon the integrity of the electronic system. Failure of certain critical ground based components during this time period could possibly result in a catastrophic event. In an attempt to quantify the safety of the equipment, the figure specified is a probability of 1 failure in ten million landings. This figure was derived by the British Air Registration Board from human mortality data and safety records of aircraft. This requirement indicates that the landing operation under Category III conditions would be safer than a person can predictably expect to be in his normal day-to-day activities. The value, if anything, is on the stringent side, in that it is not possible to categorically state that a given failure will be catastrophic, but only that it will produce a potentially hazardous situation that may be catastrophic if the proper corrective action on the part of the aircraft crew is not taken.

The relationship of mean-time-between-failures (MTBF) to the overall system reliability requirement is as follows:

The predicted localizer hardware MTBF is approximately 1200 hours and that of the glide slope is 1800 hours. Any given failure in the equipment will contribute to a lower MTBF but will not necessarily interrupt the operation or even degrade the operational category status (Category III or II). This is possible through appropriate equipment redundancy so that when individual component failures occur, Continued operation may still be possible. Consequently, it is possible for the probability of operational failure to be far less than a component failure. Given that the ground system is fully operational at the inception of a Category III ILS approach, the probability of malfunction of the radiated signal (both localizer or glide slope) during the critical part of the approach (defined as ten seconds for the localizer and five seconds for the glide slope) should be less than one in ten million which corresponds to an equivalent MTBF of operation in the order of 27,000 hours.

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# 2.0 PURPOSE

The primary purpose of performing an FMECA upon the Category III ILS is to insure that the equipment design is such that the probability of a potentially hazardous failure (loss of signal or radiation of an erroneous signal) during the cruical phase of Category III landing is less than  $1 \times 10^{-4}$ . In addition, a number of secondary objectives exist: (1) to reveal hazardous failure modes jeopardizing personnel safety and/or system performance status; (2) to enumerate all relevant functional failure modes along with their effect and failure rate; (3) to serve as a docuimented aid in the troubleshooting process of field failures in the future; (4) to serve as an objective evaluation of both the equipment specification and its design; and (5) to determine the freguency of preventive maintenance in checking for hidden failures.

# 3.0 SYSTEM DESCRIPTION

A Category III ILS provides aircraft with guidance information from the coverage limit of the facility to, and along, the surface of the runway. The system under analysis has operational performance of Category III, that is, operation with no decision height limitation. Initially the system will be used in Category IIIA operations in which the pilot will make use of external visual references during the final phase of landing and with a runway visual range (RVR) of not less than 700 feet. The ILS must be suitable for eventual use by automatic control system for rollout; which will be used in Category IIIB operations with runway visual ranges down to 150 feet.

The ILS system basically consists of two separate stations - the localizer and the glides lope; depicted in simplified block diagram form by figures 3-4 and 3-2 respectively. In addition to these stations, a central point for station control and the display of station status exists at the control tower. Up to three marker becomes are also utilized in a typical ILS installation. However, my description of the marker beacons will be provided since they will not be considered in this analysis.

### 3.1 General Descriptions

The localizer provides guidance in the horizontal plane to aircraft engaging in approaches to; and landing at, airfields. The localizer antenna group radiates two VHF carriers, each amplitude modulated by 90 and 150 Hz and both carrier frequencies within a particular VHF channel. The radiation field pattern produces a course sector with one tone predominating on one side of the course line (runway center line) and with the other tone predominating on the opposite side. Along the course line, the 90Hz and 150Hz modulations have the same levels. Being a two-frequency, capture effect system, one of the carriers (course) provides a radiation field pattern coverage in the front course sector; the other carrier (clearance) provides a radiation field pattern coverage outside that sector to ±60 degrees from the course line.

The glideslope station provides guidance in the vertical plane. It produces a UHF composite field radiation pattern which is amplitude modulated by 90 and 150 Hz. The pattern provides a straight line descent path in the vertical plane containing the runway center line, with the 150 Hz tone predominating below the path angle and the 90 Hz tone predominating above the path angle. In addition to this course coverage, a clearance UHF carrier is modulated by 150 Hz to provide low angle coverage. Both carriers (course and clearance) are within a particular glideslope UHF channel.

# 3.2 Localizer

Réferring to figure 3-1, there are two transmitter soctions incorporated into the localizer station. One transmitter is designated as the main transmitter and the other, the standby transmitter. Automatic changeover capabilities are provided. While the main transmitter radiates into the antenna system, the standby transmitter will be operating into dummy loads. Whenever the main transmitter shuts down due to some equipment failure, the standby transmitter is transferred immediately to the antenna system.

A brief explanation of each transmitting unit is in order. The course transmitter delivers a VHF carrier (108-112MHz) frequency to the solid state modulator where it is modulated by 90 and 150 Hz tones. Two signals (figure 3-2) are generated by the modulator: carrier plus sidebands (C+SB) and sidebands only (SBO). The modulator also delivers t the clearance transmitter a composite of low frequency 90 and 150 Hz tones to modulate the clearance carrier, génerating the clearance C+SB. In addition, low frequency 90 and 150 Hz tones and clearance carrier are supplied to the sideband generator where the clearance SBO is generated. The identification unit, which provides the pilot identification of the runway and the appror ch direction, generates a 1020 Hz identification signal which modulates both the course and clearance carriers.

The output signals from the main and standby transmitting units are routed to the changeover and test unit where transmitter transfer capabilities are accomplished. Signals received from the control unit determine which transmitter operates into the antennas - main or standby. When the main transmitter is connected to the antenna system, the standby transmitter operates into dummy loads. When the standby unit is connected to the antenna system, the standby unit is connected to the antenna system, the main unit is turned off. Within the changeover and test unit there exists circuitry for use in monitoring standby transmitter parameters.

From the changeover and test unit, the course and clearance transmitter signals (C+SB and SBO) are fed to the course and clearance distribution circuits respectively. Each of the distribution circuits merely distributes the C+SB and SBO signals to the localizer antennas. Phasing relationships and signal combinations are accomplished within the distribution circuits so that the proper field radiation pattern is established via the antennas. The antenna assembly consists of a parabolic reflector with directional exciters and a clearance array. The parabolic reflector with directional exciters (three directional antennas) is used in es-



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Category III Two-Frequency Localizer Wide Aperture Configuration Block Diagram Figure 3-1.

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tablishing the course field radiation pattern; however, to establish the clearance field radiation pattern both the clearance array (consisting of 4 antenna elements) and the course antenna system are required.

To provide integral monitoring ability of the radiated signal parameters, proximity detectors are utilized. Each transmitting source is sampled by a proximity probe. The captured signals are then combined (in the distribution circuit cabinets) to provide the proper signals with which system parameters are monitored. The system parameters which are monitored are: course position, displacement sensitivity, carrier power level, percentage modulation, identification signal, and clearance monitoring.

Triplicate monitoring of each of these parameters is incorporated as shown in figure 3-1. When the tolerance limit of any parameter is exceeded, an alarm signal from each of the respective monitor channels is fed to the control unit, from which a transfer to the standby transmitting unit is initiated. The control unit acts upon a 2 of 3 vote to initiate the transfer.

In addition to the integral monitoring of system parameters, near field and far field course position monitoring is also incorporated. The near field monitoring utilizes a single yagi antenna to provide dual monitoring ability. The far field monitoring utilizes three Yagi antennas feeding triplicate VHF receivers and triplicate monitor channels with a 2 of 3 vote. Both near field and far field alarm signals are delayed to prevent disturbances created by aircraft overflights and landings from causing equipment alarm and shutdown.

The same system parameters are monitored for the standby transmitting unit as for the main transmitting unit. However, only single monitoring is incorporated. Upon an alarm from any standby monitor, the standby transmitting unit will be shut down after a nominal 5 second time delay.

The far field monitor has its own alarm processing circuitry to minimize the quantity of telephone lines needed for remote transmission. Each far field monitor channel provides two alarm outputs - a Category III alarm and a Category II alarm. The difference between these two alarm outputs is merely in tolerance limits. A two of three vote is utilized for both the Category II and Category III alarms. Time delays are associated with the final alarm outputs for both categories; however, the Category III alarm time delay is accomplished at the remote control unit in the control tower (the Category III alarm signal is conveyed directly to the tower where performance downgrade is accomplished). Besides a general power/temperature alarm and a far field monitor bypass signal, three signals are sent to the localizer control unit - a monitor mismatch, a shutdown alert, and a shutdown. A monitor mismatch signal indicates that one of the three Category II monitor channel alarms has existed over a definite time period (nominal 120 seconds). A shutdown signal indicates that 2 of 3 Category II monitor channel alarms have existed over a set time period (nominal 70 seconds). When received at the localizer control unit, this shutdown signal will immediately shut down the entire localizer station. The shutdown alert signal precedes the shutdown signal by a nominal 5 seconds. The shutdown alert signal initiates a shutdown warning signal (within the control unit) which is transmitted to the pilot to give him an advance warning of the forthcoming shutdown.

The localizer control unit processes alarm signals received from the monitor channels. If only one alarm is received from any monitor channel set, a MONITOR MISMATCH lamp located on the control unit front panel will illuminate. All integral monitor alarms require a two of three voting to initiate a transfer command. An actual transfer will be accomplished only if the standby transmitting unit is available while the main is operative. If either the standby transmitter is operative (on the air) or if it is shut down, a transfer command leads to a localizer shutdown. If both near field monitors alarm, a direct localizer shutdown will result after the nominal 5 second time delay. A shutdown alert is also initiated prior to the shutdown command of the near field alarms.

In addition to the alarm processing already described, the control unit:

- 1. Provides signals to the remote control unit showing the status of the main and standby transmitting equipment.
- 2. Provides signals to the remote control unit downgrading the facility performance Category III status to Category II if the standby equipment is either not available or is on the air.
- 3. Processes transmitter "cycle" commands received from the remote control unit.
- 4. Visually displays all alarm conditions and transmitter status.
- 5. Provides for the selection of the main transmitting unit.
- 6. Provides for the bypassing of all monitor channels.
- 7. Provides for the memorization or non-memorization of monitor alarms.

- 8. Providés for the selection of command control from either the remote control unit or the localizer control unit.
- 9. Inhibits restoration of radiation for at least 20 seconds after localizer radiation has been shut down.
- 10. Provides for testing the integrity of both abnormal indication and monitor alarm lamps with a bulb test switch.
- Provides signals to the remote control unit showing either
  (1) monitor alarm abnormals or (2) power/environmental abnormals. (Note: power/environmental abnormals downgrade system performance status from Category III to Category II after a preset time delay.)

With regards to system power supplies, redundancy is highly incorporated. The two main battery chargers are connected in parallel, each possessing the capability of independently supplying. the load-current and voltage. Each battery charger has its own respective battery which it keeps fully charged. Two DC/DC converters, receiving their input from the common charger output voltage (+28 volts), produce the remaining system dc voltages. Each converter voltage is virtually in parallel with the other respective converter voltage, thus providing a dual redundancy of all system dc supply-voltages.

## 3.3 Glideslope

The simplified block diagram of the glideslope station is presented in figure 3-1. As is evident the configuration of the station is very similar to that of the localizer. Some of the major differences are: (1) the glideslope does not possess either a far field monitor or an identification unit/monitors (2) the glideslope has an antenna tower misalignment detector (3) triplicate near field monitors are utilized for the glideslope (4) no shutdown alert warning signal is provided.

The transmitter section is also slightly different. The course transmitter delivers a UHF carrier (328.6 - 335.4 MHz) frequency which is amplified by the 10 watt amplifier. This amplified carrier is then delivered to the solid state modulator where, as for the localizer, it is modulated by 90 and 150 Hz tones. The two signals, C+SB and SBO are generated by the modulator. In addition the modulator also provides a low frequency 150Hz signal used for modulating the clearance carrier within the clearance transmitter. The clearance signal is only C+SB 150 Hz. The changeover and test unit provides the same function as that of the localizer - transfer transmitter signals of the main and standby unit either into the antenna system (including distribution circuits) or into dummy loads. Also within the changeover and test unit there exists circuitry for monitoring of the standby transmitter parameters.

From the changeover and test unit, the three signals (course C+SB, course SBO, and clearance C+SB 150) are routed to the distribution circuits where these signals are combined and distributed to the three 2-lambda glideslope antennas. Correct phase relationships are established within the distribution circuits. The three 2-lambda antennas (M-array) are identical and are mounted on the tower at 3 different heights (H, 2H, 3H). H is dependent both upon the radiating frequency and the glide path angle.

Proximity field detectors are employed to provide integral monitoring ability of the radiated signal parameters. The UHF combining-circuits combine the signals provided by the probes so that parameter monitoring can be accomplished. The parameters to be monitored are: path alignment (course position), carrier power level, percentage modulation, path width (displacement sensitivity) and the clearance signal. As in the localizer, triplicate monitoring of all parameters is incorporated.

In addition to integral monitoring, near field monitors are provided to monitor the path angle (course position). The near field monitor antenna couples the appropriate signal to three parallel monitor channels. A two of three vote for monitor channel alarms is utilized. Since aircraft overflights may cauge field disturbances which will create near field alarms, the alarms are delayed a nominal 2 seconds at the control unit. "True" near field alarms lead directly to station shutdown.

As in the case of the localizer, the same standby parameters are monitored for the standby transmitting unit as for the main transmitting unit. Again, only single parameter monitoring is incorporated.

A glide slope antenna tower deformation monitor is employed to verify the integrity of the tower. If misalignment or deformation of the antenna tower persists for a nominal 135 seconds, an alarm is provided to the control unit which will shut down the entire glideslope station. The misalignment detector is mounted at the top of the antenna tower and is nominally set to detect a five inch deflection at the top of the tower.

The glideslope control unit utilizes the same printed wiring boards as the localizer. (Actually there is one less board used in the glideslope). Hence all functional operations and displays of status are identical. For minor differences (such as a misalignment detector alarm versus the far field monitor alarms) strap options are employed.

# 3.4 Remote Control Unit

The remote control unit, figure 3-3, receives inputs from the localizer station, the glideslope station, and each of the marker beacons. It is used for the display of all status information from these stations. It also provides for remote cycling capability of transmitting units for each station (cycle sequence: MAIN-OFF-STANBY-OFF).



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Figure 3-3. Remote Control Unit

Two ABNORMAL indications are provided for each station -MONITOR ABNORMAL and POWER/ENVIRONMENTAL ABNOR-MAL. The MONITOR ABNORMAL lamp is illuminated whenever:

- The main transmitter is not operational.
- A mismatch exists on one of the monitor channel sets (i.e. one monitor channel out of three is in alarm).
- A main inhibit is generated (note: a main inhibit inhibits the main monitor channels).

- An alarm has occurréd on the standby monitor channels.
  (the alarm may be due to either a failure in the standby transmitter or in one of the standby monitor channels).
- For the localizer, a far field shutdown alarm has occurred; for the glideslope, a misalignment detector alarm has occurred.

The POWER/ENVIRONMENTAL ABNORMAL is illuminated when ever:

- One of the DC/DC converter voltages fails,
- The temperature limits are exceeded.
- The primary power to either of the two battery chargers fails.
- Either of the battery chargers fail.
- The terminal battery voltages drop below a preset level.
- For the localizer, a power/temperature alarm occurs at the far field monitor.

When either of these abnormals are generated an audible alarm is sounded. By depressing the SILENCE switch, the audible alarm is turned off.

An ILS performance category status is also provided for visual display at the remote control unit. The Category III lamp is illuminated only if all of the conditions listed below are satisfied.

- 1. Localizer main transmitter is on the air.
- 2. Localizer standby transmitter is available.
- 3. Localizer far field course monitors see the course position parameter within Category III tolerance limits (adjustable 20 second time delay available).
- 4. Localizer monitor channel inhibit is not present.
- 5. Localizer terminal battery voltage is above a preset level.
- 6. Glideslope main transmitter is on the air.
- 7. Glideslope standby transmitter is available.
- 8. Glideslope monitor channel inhibit is not present.

Glideslope terminal battery voltage is above preset

10. Outer marker beacon is on with no rf level or identifi-

- 11. Middle marker beacon is on with no rf level or identification alarm.
- 2. Inner marker beacon is on with no rf level or identification alarm.
- 13. Distance measuring equipment (DME) is within tolerance (if applicable).
- 14. The "absence" of localizer POWER/ENVIRONMENTAL ABNORMAL condition. (A time delay of up to 3 hours is used for this condition).
- 15. The absence of glideslope POWER/ENVIRONMENTAL ABNORMÁL condition. (A time delay of up to 3 hours is used for this condition).

The Category II lamp is illuminated only if all of the conditions listed below are satisfied.

- 1. Either the localizer main or standby transmitter is on the air, provided that no monitor channel inhibit exists.
- 2. Either the glideslope main or standby transmitter is on the air, provided that no monitor channel inhibit exists.
- 3. The Category III indicator lamp is off.

- 4. Outer marker beacon is on with no rf level or identification alarm.
- 5. Middle marker beacon is on with no rf level or identification alarm.
- 6. Inner marker beacon is on with no rf.level or identification alarm.

Whenever a change in performance category occurs, a momentary buzzer is triggered.

### 4.0 PROCEDURE

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The following steps briefly summarize the general approach taken in this analysis:

- 1. The functional block diagram of the system is drawn, exhibiting all relevant signal flow paths between the various functional assemblies. In addition to the system block diagram, detailed functional descriptions (such as Boolean algebraic expressions and simplified assembly block diagrams) are provided when signal flow charace terization is not readily attained at the system block diagram level.
- 2. Each functional entity in the system block diagram is then analyzed for all possible failure modes which have a direct effect on the system operational status. It should be noted that each failure mode listed reflects actual piecepart failure effects at the functional block output. The various failure mode effects and system failure indications are then tabulated.
- 3. Upon completion of the tabulation of the failure modes and effects, the failure rate of each failure mode will be calculated. That failure rate is the total failure rate of all the piecepart components which, upon failure, produce that functional failure mode.
- 4. The final step of the FMECA is the verification that system design and reliability such that the probability of a potentially hazardous failure during the critical landing phase of a Category III landing is less than 1 x 10<sup>-7</sup>. This is accomplished by developing mathematical models which entail all conceivable events (or sequence of events) that lead to one of two probabilities of system failure: (1) the loss of signal (station shutdown) or (2) the radiation of a hazardous signal (out of Category III tolerance). The probability math models for each of these conditions are determined by utilizing the failure modes and effects data. The final calculation of the probability of the Category III SSILS mission failure is then performed.

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#### 5.0 ASSUMPTIONS/CONSIDERATIONS

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The EMECA was not performed at piecepart level but rather at the functional level, i. e., the level at which one or more distinct circuits serve a separate system operational function. In most cases this functional level neatly coincides with the assembly level of the system. To perform a piecepart analysis on a system as extensive as the SSILS was judged neither necessary nor desirable.

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Prior to any failure both the localizer and glideslope are operating on main transmitting units in Category III performance status as indicated by the remote control unit CAT III status indicator. On a per station basis, Category III performance status simply implies that (1) the main transmitter is on the air, operating within Category III tolerance limits; (2) the standby transmitter is available (3) a power or environmental alarm has not existed over some preset interval of time (3 hours maximum). For descriptive purposes within this analysis, transmitting unit number 1 will be considered as main and transmitting unit number 2 as standby.

When the monitoring system of the SSILS is functioning properly (no monitor malfunctions present), radiation pattern degradations beyond the Gategory III tolerance limits are detected. Hence, the criteria for establishing a "true functional (or catastrophic) failure" is that it degrades the radiated signal beyond the alarm limits of the monitors.

Only single piecepart failures (open/short component failures) are considered in the determination of functional failure modes. However, multiple functional failure modes will be considered for the determination of hazardous failure conditions.

The following are excluded from the analysis:

- a. Monitor indicator circulory not affecting operational status (such as alarm memory latches, lamp drivers, bulbs, metering circuitry).
- b. Intercom c/rcuitry not vital for system operation.
- c. Marker beacons not vital for Category III operation.
- d. Heater resistors within the cabinets of the distribution circuits. Since distribution circuitry failures are considered in the analysis, the cause of failure, temperature or otherwise, is immaterial to this analysis.

The analysis of the remote control/status display is given in paragraph 10. With regards to this analysis, it will be assumed

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that the operator will check the transmitter status of each stat. on and determine that the CAT III status indicator lamp is lit prior to a Category III landing.

The following failure modes are considered not hazardous:

- a. Loss or degradation of the identification signal.
- b. Loss or degradation of the shutdown alert signal.
- c. Generation of an erroneous shutdown alert signal.
- d. Loss of Category II near field monitoring ability.
- e. Generation of erroneous power/temperature alarms.

The critical landing phase period for the localizer is 10 seconds; for the glideslope 5 seconds.

The probability of failure P(F) is equal to  $\lambda t$ .

Note: The probability of success is given by the expression  $P(S) = e^{-\lambda t}$ 

Utilizing the exponential expansion,

 $P(S) = e^{-\lambda t} = 1 - \lambda t + \left(\frac{\lambda t}{2}\right)^2 - \left(\frac{\lambda t}{6}\right)^3 + \dots$ 

For values of  $\lambda t << 1$ ,

$$P(S) = 1 - \lambda t$$

Therefore the probability of failure is:

 $\mathcal{P}(\mathbf{F}) = 1 - \mathcal{P}(\mathbf{S}) = 1 - (1 - \lambda t) = \lambda t$ 

External runway disturbances such as aircraft overflights and runway activity have an adverse effect on the radiated localizer signal at the far field. The parameter of interest at the far field is the difference in depth of modulation (DDM). This parameter is affected by such disturbances and, hence, is monitored at the far field. The loss of this monitoring can lead to potentially hazardous conditions. An obstruction could exist between the localizer antenna and the far field monitor which would not be detected by the integral monitors or the near field monitors. Hence, to accomplish the primary purpose of the FMECA, the probability of external runway disturbances during the critical landing phase of a Category III landing must be known. However, the calculation of this probability requires a statistical analysis utilizing empirical data. Since such data is presently unavailable, a maximum allowable probability of occurance is established within the analysis of the FMECA and is listed as an assumption. The assumed value of this probability is  $1 \times 10^{-5}$ .

The proper alignment of the glideslope antenna tower is vital for the radiation of correct signals. The alignment is monitored for permanent deformations due to such natural forces as earth demors, strong winds, tower settling, etc. This probability of permanent misalignment (within the preventive maintenance cycle of a one week period) must be known for the accomplishment of the FMECA. Since such a probability is unavailable for this analysis, a maximum allowable value is again assumed. A maximum number for this occurrence is  $1 \times 10^{-5}$ .

Coaxial cables, connectors, antennas and probes will not be treated independently for failure modes and effects, but rather are considered in the analysis as part of the functional block to which they are associated since the analysis is performed at the functional level.

The assignment of a criticality number to each failure mode is the conventional means of performing a criticality analysis. Such an approach, however; tends to be partially subjective due to weighing factors by which the criticality number is established. A more objective approach is: (1) to provide merely the failure rate as a representation of the criticality of each failure mode; and (2) to identify each failure mode as being either hazardous or not hazardous. These two items, moreover, are necessary inputs toward accomplishing the primary purpose of the FMECA as outlined in the procedure. For these reasons this approach will be utilized for the criticality analysis of the FMECA.

The failure rates used in this analysis were derived using the following considerations:

- a, Source of base failure rates was RADC Reliability Notebook, Volume II, dated September 1967. (RADC-TR-67-108)
- b. Equipment ambient temperatures was 25°C. Appropriate temperature rises were used for the part ambients depending upon their location in the equipment.
- c. Environmental factor was 'ground fixed' as defined in the RADC notebook.

### 6.0 FUNCTIONAL BLOCK DIAGRAMS

Appendices A and B contain detailed functional block diagrams of the localizer and glideslope respectively. It is at that functional level the FMECA will be performed. Also contained in the appendices are all the functional block diagrams of each inajor assembly. All the various functional block diagrams may be utilized to obtain a rather detailed understanding of system operation.

Two observations should be made concerning the general station block diagrams. First, all signals which can affect station operational performance are provided in the diagrams. Hence, only the outputs from each functional block need to be considered for analysis. Secondly, each functional block has an identification number by which the results of the tabulated analysis may be brought into system perspective. Additional clarification of the tabulated results of the FMECA can be attained when the functional block is viewed at the system level.

The detailed diagrams of the control unit for each station should be particularly useful for a thorough understanding of control unit operation. The Boolean expressions provided completely characterize all major logic signals and commands. Hence, these diagrams should be a tremendous aid in troubleshooting control unit failures.

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## 7.0 FAILURE ANÁLYSIS

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The heart of the FMECA is the failure analysis. This analysis identifies each failure mode, describes the corresponding failure effects, and lists the failure rate by which its criticality is measured. This failure analysis is performed in the form given in figure 7-1. The following clarification of terms should be made concerning this form.

1. Failure Mode: This is the item (functional block) failure mode. Each failure mode reflects the piecepart failures within the block that can affect the output signals in the prescribed failure mode. Such terms as "loss of signal" are normally applied to any failure condition that totally destroys the characteristics of a "good" signal. Also any radiated signal that is not degraded beyond the Category III alarm limits is not considered to constitute a functional failure.

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- 2. <u>Failure Effect</u>: Normally listed under this term are the immediate failure effects upon the system (or station) from an operational standpoint. Effects on radiated signals may also be listed here. Occasionally incorporated within this column are some conditional failure effect comments - the effects upon the system operation if another failure were to occur.
- 3. <u>System Operation After Failure</u>: The system performance category immediately after the failure is revealed in these columns. These indications correspond to the performance indicator lamps at the Remote Control Tower. An "OFF" condition exists if the system is neither in Category II or Category III performance.
- 4. Failure Indications: The abnormal indication lights which should be lighted at the different locations after the failure occurs are presented in these columns. The Remote Control column lists the abnormal indications present at the Remote Control Tower. The Control Unit column is normally used to give the abnormal indications that are displayed on the respective station control unit front panel. The "other" column is normally utilized for any other display of abnormal indications such as the monitor channel alarm lights or the remote far field monitor indications. True monitor channel alarm light indications are revealed only in the monitors locally bypassed (MLB) mode of operation; hence, the monitor alarm light indications presented here are those that will be displayed in the MLB mode of operation. It should be

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SYSTEM.

PAGE OF

2	REMARKS	
FAILURE	(\X 10~6)	
ATIONS	OTHER	
URE INDIC	CONTROL	
, FAIL	REMOTE	
ATION	URE I OFF	
EMCOPER	LK FAIL	
LSYS'	CAT II	
	FAILURE EFFECT	
FAILURE	MODE	
	FUNCTION	
ATION	0.0 - V	
IDENTIFIC	I TEM NAME	

Figure 7-1. Failure Analysis Form

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realized that the MLB mode is utilized during any failure troubleshooting.

Failure Rate: This column lists the total failure rate of 5 the piecepart failures that can produce the respective functional failure mode. The failure rate given in this column is worst case since all component failure rates that can cause the particular failure mode are included regardless of the piecepart failure modes. In essence this number is a representation of the criticality of each failure mode - the larger the failure rate the greater the criticality of the failure mode. The failure rate number given in this column is in terms of failures per million hours. Failure rate identification is accomplished by alpha-numeric-subscripts of  $\lambda_{i}$ . The numeric portion of the subscript applies to the identification of the functional block; the alphabetic portion identifies the specific failure mode. For example,  $\lambda$  1B implies the failure rate of the second (B) failure mode of the control unit (01).

The results of the failure analysis are provided in appendices C and D for localizer and glideslope respectively. The failure rates were determined on separate work sheets which will not be provided within this report. Table 7-1 provides an example of these work sheets, showing the failure rate calculations for two failure modes of the localizer control unit. All failure modes listed in the analysis are considered to be hazardous unless specifically identified to be "not hazardous" in the "remarks" column. Table 7-1. Failure Mode Failure Rats Calculations

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System SSILS Subcret

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		Failure Rate ( <sup>A</sup> m x 10 <sup>6</sup> )	1 827	1.202.1	-													-					-	-	
	<b>T</b>	Failure Rate $(\lambda_i \ge 10^6)$		+0, 140	+0.140	+0.140	+0.140	+0,140	+0.140	+0.041	+0.04]	+0.041	+0.041	+1.144	$\div 0.140$	+0.140	+0.140	+0.140	+0.041	+0.041	+0.041	+0.683	4	-	
		Part/ Component	U2 537051-1	U4 537051-1	U6 537051-1	U8 537051-1	U13 537051-1	U11 537051-1	Uj6 537051-1 <sup>°</sup>	CR2 JANTXIN 4148	CR4 JANTXIN 4148	CR6 JANTXIN 4148	CR8 JANTXIN 4148	Subtotal	U12 537051-1	U4 537051-1	U6 537051-1	U8 537051-1	CR 9 JANTXIN 4148	CR11 JANTXIN 4148	CR13 JANTXIN 4148	Subtotal	~		
		Assy/PWB	Alarm PWB			<u> </u>						,		,	Alarm and	time delay	PWB.				1		ζ.		
LIZER STATION		Failure Möde	Generation of an	erronéous trans-	fer signal, due to	alarm processing	cırcuitry.																	`·	
TOCA	ion	I. D. No.	01		· · ·								1 11		<u> </u>			,							
Subsystem	Identificat	Item Name	Control	Unit				, 1 k					- 4		<b>-</b> 1										

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Table 7-1. Fäilure Mode Failure Rate Calculations (Continued)

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System SSILS

STATION	
LOCALIZER	
Subsystem	

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Identificat	ioń			<	Failure	Failure
tem Name	I. D. No.	Failure Mode	Assy/PWB	.Part/ Component	Rate $(\lambda_{i \times 106})$	Ráté (Àm × 106)
Control	01	Generation of an	Alarm and	ŪZ 537051≃J	+0.140	3.507
Jnit		erroneous shut-	time delay	U13 53705121	+0.140	-
Continued)	-	down signal due	PWB.	R25 2K	+0.006	
``		to alarm proces-		B264.7K	+0.006	
		sing circuitry.		R27.0K	+0. 006	
				R28 4.7K	+0.006	
				R29 2K	+0.006	
				Q9 JANTX2N2907	+0.102	n
				Q10 JANTX2N2222A	+0,:058	
				CR3 JANTXIN 4148	+0.041	
				<b>CR4 JANTXIN 4148</b>	+0.041	-
				R32 10K	+0,006	
				R33 12K	+0.006	-
	•			R35 4. 75t	+0,006	
				R36 10K	+0.006	
				Q11 JANTX2N 4858	+0.475	
				Q12 JANTX2N 2222A	+0.058	
			- - - -	Subtotal	: +1. I09	
			Far field/	6. 8K	+0.006	
	) <del>(1111) (1111)</del>		shutdown	680 C	+0.006	
_			alert PWB.	. 22µf	+0.038	
				JANTX2N 2222A	. <b>∔0. 058</b>	
				10K	+0.006	
				537051-1	+0.140	-
				Subtotal	+0.254	
					¢	

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Table 7-1. Failure Mode Failure Rate Calculations (Continued)

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System SSILS Subsystem LOCALIZE

Subsystem	LOCA	LIZER STATION	- ()	< 2 7		, ,
Identifica	tion	y	;	1	Failure	Failüre
Item Name	No.	Faïlure Mode	A'ssy/\PWB	Paurt/ Component	Rafe $(\lambda_{11} \times 10^{6})$	Rate ( <sup>Å</sup> m x 10 <sup>6</sup> )
Control	01	Generation of an	Pwr/ënvir.	U5 537051-1	+0.140	***
Unit		erroneous shút-	PWB.	U3 537051-1	+0.140	<i>v</i>
(Continued)		down signal due		Subtotal	+0.280	
		sing circuitry.	Alarm PWB	U11 537051-J	+0.140	
		(Continued)		U16 537051-1	+0.140	
		5		U15 537051-1	+0.140	2
	<u>.</u>			U17 537051-1	+0.140	
	-			Subtotal	+0.560	1
			Control/inhi-	U8 537051-1	+0.140	7.4
			bition PWB.	UŞ 537051-A	+0.140	
	<b>L</b>		1	R6 IK	+0,006	
¢.				UIZ 537051-Î	+0.140	
ł	L	,		UI3 537051-1	+0,140	14
	<b>a</b> -			U2 537051-1	+0,140	
				Ù1 537050-1	+0.140	
				U4 537051-1	+0.140	
				<b>R7 10K</b>	+0.006	
				R5 10K	+0.006	
				QI JANTX2N 2222A	+0.058	
				R39 IK	+0. 006	
				Q11 JANTX2N 2222A	+0.058	2.4
				U11 537051-1	+0,140	
				C11 22µf	+0.038	
				R38 4.7K	+0.006	20 M
			ć	Subtotal	+1.304	
			3			

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#### 8.0 MATH MODELS

To fulfill the primary objective of this analysis, it must be verified that the probability of a potentially hazardous failure (a loss of signal or the radiation of a hazardous signal) during the critical landing phase be less than  $1 \times 10^{-7}$ . To achieve this verification, probability math models are utilized.

Figure 8-1 provides an illustration of a typical probability math model. As can be seen, three distinct paths lead to a failure. If the event whose probability is given by  $P_1$  occurs, a failure will result. For a failure to result due to path B events, all three events must occur, the probability of which is given by  $(P_2 \cdot P_3 \cdot P_4)$ . Path C is slightly more complicated. Either event 5 or event 6 must occur, event 7 must occur, and either event 8, 9, or 10 must occur to lead to a failure. Its probability of occurrance is given by  $[(P_5 + P_6) \cdot P_7 \cdot (P_8 + P_9 + P_{10})]$ . The overall total probability of a failure (P(F)) due to all three paths is simply the algebraic sum.

Rather than provide a graphical representation of the probability math models on the ILS system, it is decided to present only the probability equations of the math models. The graphical approach





would be less than meaningful since adequate description of events could not be provided. The equations, of course, provide all the same information as the graphical representation. In addition, each path of failure can be treated independently by a separate probability equation and full description of probability, events can be provided.

All the math model equations for the localizer and glideslope are tabulated in appendices E and F respectively. Each contains two different sections - the "loss of signal" probabilities and the "hazardous signal radiation" probabilities. The probability expressions were formulated by considering each and every hazardous failure mode listed in the failure analysis. Like events (failure mode failure rates of similar failure effects) were grouped together whenever possible. For each separate probability expression listed, all failure modes in the failure analysis can be identified by failure rate subscripts. For some probability calculations, préventive maintenance cycles, which are listed in the "remarks" column, must be assumed. The reason for this is that a failure which does not cause a monitor alarm (a "hidden" failure) can only be located by periodic preventive maintenance procedures. Worst case probabilities are often given whenever the numerical result proves to be negligible. This is done solely for simplification purposes.

#### 9.0 PREVENTIVE MAINTENANCE

One of the secondary objectives of this analysis is to provide a , ecommendation of how often preventive maintenance checks for hidden equipment failures should be performed to ensure a high degree of system integrity. This is a natural output for the FMECA because preventive maintenance frequencies must be utilized in the math models.

To determine the frequency of preventive maintenance checks, two factors (or requirements) must be considered: (1) an allowable probability of failure occurrence; and (2) an allowable frequency of preventive maintenance so that total mean preventive maintenance time (MPMT) does not exceed equipment specification requirements. The recommended frequency then will be a suitable compromise between these two requirements. Whenever such a compromise between these two requirements. Whenever such a compromise cannot be attained (either or both requirements cannot be fulfilled), equipment design changes must be accomplished to reduce the probability of failure.

In practice, a reasonable frequency is actimed in the math models and then the total MPMT is calculated to verify that the requirement is not exceeded. In assuming a preventive maintenance frequency, the time to perform the hidden failure check must also be considered. The charts showing the recommended preventive maintenance task frequencies for the localizer and glideslope are respectively given in appendices G and H. These charts incorporate the assumed frequencies utilized in the math model calculations. In addition to the hazardous failure modes considered in the math models; non-hazardous hidden failures identified in the failure analyses are also presented in the tables so that the overall MPMT can be calculated. A brief description of the preventive maintenance task is also provided in the charts in order to estimate the time required to perform the hidden failure check. Whenever one check can be performed simultaneously with another, its estimated task time is omitted from the table.

The sole purpose of these charts is to provide a listing of the recommended frequencies of preventive maintenance checks for hidden failures and to show that these are consistent with preventive maintenance requirements. They are not intended to be used per se by field technicians. Preventive maintenance procedures that are to be used in the field should be much more detailed. However, the frequencies provided by these charts should be an input for writing the actual field procedures.

# 10.0 REMOTE CONTROL/STATUS DISPLAY

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The status display unit is similar to the remote control unit except that it does not possess transmitter cycle capabilities and does not have a telephone. Hence, any analysis of the remote control unit services equally well for the status display unit. A simplified functional block diagram of the remote control unit is given in figure 10-1. As seen in the diagram, only one control signal for each station is an output from the unit. All other signals pertain to status only and as such cannot affect the actual radiated signal. The cycle control line failure mode is treated



Figure 10-1. Remote Control Unit

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within the framework of control unit failure modes for each station; hence, only an analysis of statissignals is necessary.

A détailed analysis of this unit is not necessary since the FMECA pertains only to a Category III performance status analysis. From an intuitive standpoint, only two revelant failure modes exist for the unit: (1), circuit failures causing the Category III performance lamp to be extinguished; and (2) circuit failures causing the Category III performance lamp to remain "on" continuously, regardless of station performance. The first of these failure modes is not hazardous. If an aircraft is just beginning (or already in) the critical landing phase, a safe Category III landing may be accomplished since the radiated signal is unaffected. Although station failures could conceiveably occur within that same 10 second critical landing phase period, the probability is totally negligible. The maximum probability of this event is given by the expression:

 $P_{MAX} = P_{REQUIREMENT} \cdot (\lambda_{RC1} \cdot 10 \text{ sec})$ 

where  $P_{REQUIREMENT} = 1 \times 10^{-7}$  (specified)

and  $\lambda_{RCI}$  is the failure rate of the remote control unit

circuitry that can cause the lamp to be extinguished.

To simplify matters, let  $\lambda_{RC1} = 100 \times 10^{-6}$  failures per hour as worst case. Then,

 $P_{MAX} = (T \bar{x} 10^{-7}) (100 \times 10^{-6}) (10/3600)$ = 2.777 x 10<sup>-14</sup>

The second failure mode, circuit failures causing the Category III performance lamp to remain lit, is potentially hazardous since the "true" status of the radiated signal is not recognizable. However, if it is assumed that the operator check the transmitter status of each station prior to a Category III landing, the severity of the hazardous condition is greatly reduced. In face, the only potentially hazardous condition that then can exist is that the localizer signal be out of Category III tolerance at the far field. All other potentially hazardous conditions are recognizable through other status indications on the remote control unit. The reason for this is that the far field Category III disable signal affects only category performance status. It is not processed by the localizer station and, hence, there is no redundant status display associated with it. The out-of-Category Ill-tolerance condition at the far field is due screey to external runway and overflight disturbances.

Since an initial evaluation of this potentially hazardous failure mode revealed its probability was too high, design changes were incorporated to provide redundancy and, thus, lower considerably the probability of this potentially hazardous occurrence. The new probability expression is given by:

$$P_{RC2} = (\lambda_{RC2} + 168) (P_{FF}) + (\lambda_{REDUND_{RC}} + 168)$$

where  $\lambda_{RC2} =$  the failure rate of the remote control far field alarm processing circuitry which can cause the Category III performance lamp to remain illuminated, without redundancy.

REDUND RC = the failure rate of the redundancy circuitry that can cause the Category III performance lamp to remain illuminated.

The calculated failure rate figures are given below:

 $\lambda_{RC2} = 1.141 \times 10^{-6}$  failures per hour

<sup>$$\lambda$$</sup>REDUND<sub>BC</sub> = 0.268 x 10<sup>-6</sup> failures per hour

Hence, the new probability is:

$$P_{RC2} = (1.141 \times 10^{-6} \cdot 168) (10^{-3}) (0.268 \times 10^{-6} \cdot 168)$$
  
= 8.636 × 10<sup>-12</sup>

With the redundancy in the design incorporated, the probability of this potentially hazardous failure mode becomes negligible.

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### 11.0 RESULTS/CONCLUSIONS

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Overall failure probabilities are readily calculated from the math model tables by simple addition. Tables 11-1 and 11-2 enumerate the failure probabilities for the localizer and glideslope respectively. Table 11-3 provides a resultant failure probability summary. As can be seen, the overall probability of mission failure is 0.89345 x  $10^{-7}$  which is less than 1 x 10-7, the specified requirement. Hence, the primary purpose of this analysis has been accomplished.

			docarrindt frankrig		-Bunt
<u>A.</u>	Loca	lizer Shutdown	Probabilities		
	1.	P <sub>s</sub> :	$3.912 \times 10^{-8}$	=	39.120 x $10^{-9}$
	2.	P <sub>AB</sub> ;	3.516 s 10 $-14$	=	$0.000 \times 10^{-9}$
	3.	P <sub>AC</sub> ;	1.227 x 10 - 11	Ξ	$0.012 \times 10^{-9}$
	4.	P <sub>AD</sub> :	9.226 x 10 <sup>-13</sup>	=	$0.001 \times 10^{-9}$
	5.	PSTBY CSE	1.722 x $10^{-14}$	=	$0.000 \times 10^{-9}$
	6.	PSTBY SEN	2.982 x $10^{-15}$	=	$0.000 \times 10^{-9}$
	7.	PSTBY CL	$1.802 \times 10^{-14}$	=	$0.000 \times 10^{-9}$
	8.	PSTBY ID	1.665 $\times 10^{-16}$	*	$0.000 \times 10^{-9}$
	9.	P <sub>STBY</sub> :	9.837 x $10^{-15}$	=	$0.000 \times 10^{-9}$
	10.	PPS/CONV	9.906 x 10 <sup>-11</sup>	÷.	$0.099 \times 10^{-9}$
	11.	PCSE/ID	5.106 x 10 <sup>-10</sup>	=	$0.511 \times 10^{-9}$
	12.	P <sub>SEN</sub> :	$2.090 \times 10^{-10}$	=	$0.209 \times 10^{-9}$
	13.	P <sub>CL</sub> :	4.540 x $10^{-10}$	z	$0.454 \times 10^{-9}$
	14.	P <sub>NF</sub> :	1.422 x $10^{-10}$	=	$0.142 \times 10^{-9}$
	15.	P <sub>FF</sub> :	$6.081 \times 10^{-10}$	=	$0.608 \times 10^{-9}$
	16.	P <sub>INHIB</sub> :	6.822 x $10^{-9}$	=	<u>6.822 x 19<sup>-9</sup></u>
			P <sub>SD</sub> ≈ ≌A	=	$47.978 \times 10^{-9}$

Table 11-1. Total Localizer Hazardous Signal Probability

<u>B.</u>	Loca	lizer Hažardous S	Signal Radiation	Pro	babilities
	Ί.	P(HS) CSE DDM	$1.287 \times 10^{-15}$	=	$0.000 \times 10^{-9}$
	2,	P(HS) <sub>FF</sub> :	5.555 $\times 10^{-10}$	=	$0.556 \times 10^{-9}$
	3.	P(HS) <sub>CSE</sub> DDM	$4.971 \times 10^{-10}$	ų	$0.497 \times 10^{-9}$
	4.	P(HS) CSE BF	$1.502 \times 10^{-9}$	=	$1.502 \times 10^{-9}$
	5.	P(HS) <sub>SEN</sub> :	1. 354 x $10^{-10}$	=	0.135 x 10 <sup>-9</sup>
	6.	P(HS) <sub>CL DDM</sub> :	3. 584 x $10^{-9}$	=	3. 5.84 x 10 <sup>-9</sup>
		•	$P_{HS} = \Sigma B$	=	$6.274 \times 10^{-9}$
P	TOT	AT. =	P <sub>SD</sub> + P <sub>HS</sub>	~~~~	54. 252 x 10 <sup>-9</sup>
	- V 1	LOCALIZER		=	$0.54252 \times 10^{-7}$

Table 11-1. Total Localizer Hazardous Signal Probability (continued)

Table 11-2.	Total Glidesl	ope Hazardous	Signal	Probability
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A. Glide	eslope Shutdown	Probabilities		
1.	P <sub>S</sub> :	2.197 $\times 10^{-8}$	=	$21.970 \times 10^{-9}$
2.	P <sub>AB</sub> :	$2.691 \times 10^{-15}$	=	$0.000 \times 10^{-9}$
3.	P <sub>AC</sub> :	5.884 x $10^{-12}$	=	$0.006 \times 10^{-9}$
4.	P <sub>AD</sub> :	$1.503 \times 10^{-15}$	=	$0.000 \times 10^{-9}$
5.	PSTBY CSE	9.045 $\times 10^{-15}$	=	$0.000 \times 10^{-9}$
А,	P <sub>STBY SEN</sub> :	$1.648 \times 10^{-15}$	=	$0.000 \times 10^{-9}$
7.	PSTBY CL	$2.282 \times 10^{-15}$	=	$0.000 \times 10^{-9}$
8.	P <sub>STBY</sub> :	2.314 $\times$ 10 <sup>-15</sup>	=	$0.000 \times 10^{-9}$
9.	P <sub>CONV</sub> :	$1.814 \times 10^{-13}$	=	$0.000 \times 10^{-9}$
10.	P <sub>CSE</sub> :	$1.815 \times 10^{-10}$	=	$0.182 \times 10^{-9}$
11.	P <sub>SEN</sub> :	$1.035 \times 10^{-10}$	=	$0.104 \times 10^{-9}$
12.	P <sub>CL</sub> :	$1.908 \times 10^{-10}$	z	$0.191 \times 10^{-9}$
13.	P <sub>NF</sub> :	$1.403 \times 10^{-10}$	=	$0.140 \times 10^{-9}$
14.	P <sub>INHIB</sub> :	$3.411 \times 10^{-9}$	×	$3.411 \times 10^{-9}$
		P <sub>SD</sub> = SA	×	$26.044 \times 10^{-9}$

Probability (continued)									
ษ.	Glide	slope	İlazardous	SignaÎ	Radiation	Pr	obabilities	-	
· · ·	1.	P(HS)	CSE DDM	(8; 989 <sup>°</sup>	$\times 10^{-16}$	=	0; 000 x	10 <sup>-9</sup>	
	2.	P(HS)	CSE SDM	4.558	$\times 10^{-10}$	=	0.456 x	10-9	
	3.	P(HS)	CSE RF <sup>i</sup>	1.248	x 10 <sup>-9</sup>	=	1.248 x	.10 <sup>-9</sup>	
	4.	P(HS)	SEN	1.518	$x = 10^{-10}$	=	0.152 x	10 <sup>-9</sup>	
	5.	P(HS)		4.427	x '10 <sup>-9</sup>	Ē	1.427 x	10 <sup>-9</sup>	
	6.	P(HS)	ATM	·5. 806	x 10 <sup>-9</sup>	÷	<u>5.806 x</u>	10-9	
	-			]	P <sub>HS</sub> = ΣB	=	9.089 x	10 <sup>-9</sup>	
$P_{TOTAL} = P_{SD} + P_{HS} = 35.110 \times 10^{-9}$									
		Ć, truć	LIDESLOF	PE		=	0.35110 x	10 <sup>-7</sup>	

Table 11-2.	Total Glideslope Hazardous Signal
	Probability (continued)

	Table	11-3.	Probability	Summary
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<u>A.</u>	Local	izer:		
	(41)	Shutdown (Loss of Radiated Signal)	• 47.978 x	10 <sup>-9</sup> .
	(2)	Radiation of Hazardous Signal	6.274 x	10 <sup>-9</sup>
в.	Glide	slope:	4	
	(1)	Shutdown (Loss of Radiated Signal)	26.004 x	10 <sup>-9</sup>
	(2)	Radiation of Hazardous Signal	9.089 x	10 <sup>-9</sup>
<u>c.</u>	Total	_	89.345 x	10 <sup>-9</sup>
		0	r 0.89345 x	10 <sup>-7</sup>

To achieve this primary objective, however, circuit design changes/modifications as dictated by the FMECA had to be accomplished. The following is a listing of these changes/modifications.

1. The SDM strap option will be employed for the localizer near field and far field monitor channels. The SDM alarm limits, however, will not be to Category III limits, but rather to some less stringent value which will provide an alarm output when a total loss of input signal exists. The SDM and DDM alarms will be "or'd" internal to the monitor channel, thus providing one general alarm output for alarm processing in the control

11-3

unit. The SDM strap option will also be utilized for the glideslope near field monitor channels.

2. If a continuous main monitor inhibit is generated in the control unit, a downgrading of category status indication (neither Category III or II) will occur at the remote control unit. In this way total loss of all monitoring due to inhibit circuitry failures will be remotely recognizable.

3. Additional redundancy in the far field monitor combining logic has been employed to reduce the probability of the loss of the far field Category III monitoring capability.

4. Redundancy circuitry has been incorporated in the control unit to provide direct remote status indication (performance category downgrade) whenever a "transfer condition" exists. This redundancy significantly reduces the probability of radiating a hazardous signal due to control unit processing circuit failures.

- 5. Redundancy has been employed in the remote control/ status displays units to extinguish the Category III performance light whenever a far field Category III disable signal occurs.
- 6. An antenna misalignment detector test feature has been incorporated into the design to allow for a "quick and easy" check of its integrity. This was required to comply with preventive maintenance requirements.

'Lo confirm that the preventive maintenance frequencies assumed within this analysis are consistent with the requirements, a quick comparison of the assignments made in appendices G and H with the equipment specification is in order. The equipment specification states that a mean preventive maintenance time (MPMT) of one hour in 336 hours of equipment operation for any station is allowable. The total MPMT estimated for localizer hidden failures is 21.9 minutes in 336 hours of equipment operation; the total MPMT for the glideslope hidden failures is 14.0 minutes in 336 hours of equipment operation.

As another outgrowth of the FMECA the following general discussion on redundancy has evolved:

• In the general design of electronic equipment, standard design procedures such as use of high reliability parts and minimization of circuit components do not necessarily ensure that system design is optimum from a performance standpoint. To obtain a high degree of system perfor-

mance, redundancy of equipment hardware has often been employed in design. This is a very effective means when utilized correctly. Unfortunately the full advanages of redundancy are often overlooked.

To exhibit the optimum use of redundancy in equipment design, the examples of figures 11-1 and 11-2 are provided. Assume that each of the monitor channels. monitors the same system parameter. Triplicate redundancy has been incorporated in the monitoring circuitry, requiring a 2 of 3 vote for monitor alarm processing in the control logic, Figure 11-1 illustrates the typical approach (minimum circuit complexity) utilized in circuit design (redundant control logic excluded). However, when calculating the probability of loss of the parameter monitoring ability  $(P(F)_{NR})$ , an interesting observation results. The desirable features of triplicate monitoring are partially lost due to the control logic and "OR" gate ( $P_{CL}$  and  $P_{OR}$  respectively). It is these circuit components that limit the reduction of the probability of failure. Hence, all the additional circuitry incorporated for triplicate monitoring is rendered partially useless in minimizing the probability of failure.



Figure 11-1. Logic Illustrating 2 of 3 Vote of Monitors for Control Processing (dashed lines illustrates partial redundancy).

An improvement of the original design results with the additional redundant control logic (dashed lines): The new probability  $(P(F)_R)$  calculation shows that there is roughly an improvement by one order of magnitude, utilizing typical values. However, as the new calculation illustrates, the true advantageous features of triplicate monitoring are still not attained. A "bottleneck" limiting factor is still present - the "OR" gate  $(P_{OR})$ .



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Ligure 11-2. Logic Illustrating 2 of 3 Vote of Monitors for Control Processing with Optimum Redundancy

• Figure 11-2 is an illustration of the optimum design, utilizing redundancy. With the additional "OR" gate included, the full advantages of redundancy are attained since the limiting factor is now the monitor channels. One final observation should be pointed out concerning this matter - the addition of a single redundant gate has decreased the probability of failure two orders of magnitude, utilizing typical values. In summary then, it is vitally important to incorporate redundancy correctly if redundancy is to be incorporated at all. The following enumerates the general conclusions resulting from the FMECA:

- If the assumptions made within this analysis prove to be reasonably valid, the probability of either (1) a loss of signal or (2) the radiation of a potentially hazardous signal during the critical landing phase of a Category III landing is less than 1 x 10<sup>-7</sup> for Texas Instruments Incorporated Category III ILS system. The validity of the result of the overall hazardous failure probability is enhanced since worst case analysis were often employed.
- 2. Single equipment failures which can lead directly to station shutdown are the major contributors which limit the reduction of the probability of a hazardous failure. Hence, to achieve further improvement of equipment design and reliability, additional redundancy in major non-redundant circuits such as the control unit is required.
- 3. Due particularly to the redundancy that has been incorporated into the design as a result of the FMECA, the probability of the radiation of a potentially hazardous signal has become insignificant compared to shutdown probabilities. The design modifications have made the triplicate monitoring utilized in the Category III system optimum since the "bottleneck" factor is the monitor channels themselves.
- 4. Since all hidden failure modes are identified in the FMECA, the results of the analysis serve as an excellent input for the writing of preventive maintenance procedures. The frequencies of these preventive maintenance checks stratified within this report are based upon allowable probabilities of occurrence and, hence, should be followed very closely in field performance.
- 5. Troubleshooting system failures should be greatly facilitated by utilizing both the functional block diagrams and the failure mode and effects analysis data.

11-7/11-8

#### 12.0 REFERENCES

The references used in development of this analysis are listed below:

"Aerospace Recommended Practice 926", Society of Automotive Engineers, Inc., New York, New York, September 15, 1967.

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"RADC Reliability Notebook, Volume II", Technical Report No. RADC-TR-67-108, September 1967.

"Reliability Engineering", ARINC Research Corporation, Prentice Hall, 1964.

"Reliability Requirements for Safe All Weather Landings"; Adkins, L. A.; Thatro, M. C.; Proceedings of the 7th Reliability and Maintainability Conference, San Francisco, California, July 14-17, 1968.

## Appendix A

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## Localizer Detailed Functional Block Diagrams

#### Appendix A

#### Localizer Detailed Functional Block Diagrams

This appendix consists of detailed functional block diagrams for the localizer. Figures A-4 through A-19 cover the numbered blocks in figures A-1 and A-2 (localizer and localizer far field monitor). Figure A-3 and the accompanying table A-1 detail the localizer control unit.

Name	Definition
A <sub>BAT</sub> :	Alarm due to a drop-in the main battery voltage.
A <sub>CON</sub> V:	Alarmon one of the DC/DC converter voltages.
A <sub>FË</sub> : S	Far field shutdown alarm.
A <sub>PE</sub> :	Power/environmental alàrm sent to remote contròl.
A <sub>S</sub> :	Alarm due to standby monitors.
<sup>A</sup> S(D) <sup>:</sup>	Alarm due to standby monitors, delayed.
A <sub>SM</sub> :	Alarm due to standby monitors, memorized.
AB:	Abnormal condition signal.
AB MON:	Abnormal condition signal due to monitor channel alàrm.
AB MON RC	Monitor alarm sent to remote control.
AC:	AC power alarm from one of the two battery charg- ers.
BC:	Battery charger alarm from one of the two chargers.
BLINK:	Blinker output signal, a square wave oscillator.
C:	Cycling command signal for transmitters.
C <sub>ANT</sub> :	Command to have transmitter no: 1 connected to the antenna.
C <sub>ANT</sub> :	Command to have transmittër no. 2 connected to the antenna.
c <sub>1</sub> :	Command to turn on transmitter no. 1.
с <sub>2</sub> :	Command to turn on transmitter no. 2.
CAT II <sub>RC</sub> :	Signal to remote control used to determine Category II status.
CAT III RC:	Signal to remote control used to determine Category III status.

## Table A-1. Definițion of Signal Names (Localizer Control Unit, Figure A-3)

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Table A-1.	Definition of Signal Names (Localizer Control
	Unit, Figure A-3) (Continued)

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Name	Definition
CONTROL:	Cycle command (MAIN, STBY, or CFF).
CL <sub>11</sub> :	Category III DDM clearance alarm, monitor no. 1.
CL <sub>12</sub> :	Category III DDM clearance alarm, monitor no. 2.
CL <sub>13</sub> :	Category III DDM clearance alarm, monitor no. 3.
CL <sub>21</sub> :	Category III SDM clearance alarm, monitor no. 1.
<sup>ÇL</sup> 22:	Category III SDM clearance alarm, monitor no. 2.
CL <sub>23</sub> :	Category III SDM clearance alarm, monitor no. 3.
CL <sub>31</sub> :	Catégory III RF cléarance alarm, monitor no. 1.
CL <sub>32</sub> ;	Category III RF clearance alarm, monitor no. 2.
CL <sub>33</sub> :	Category III RF clearance alarm, monitor no. 3.
CSE <sub>11</sub> :	Category III DDM course alarm, monitor no. 1.
CSE <sub>12</sub> :	Category III DDM course alarm, monitor no. 2.
CSE <sub>13</sub> :	Câtegory III DDM course alarm, monitor no. 3.
CSE21:	Category III SDM course alarm, monitor no. 1.
CSE <sub>22</sub> :	Category III SDM course alarm, monitor no. 2.
CSE <sub>23</sub> :	Category III SDM course alarm, monitor no. 3.
CSE <sub>31</sub> :	Category III RF course alarm, monitor no. 1.
CSE <sub>32</sub> :	Category III RF course alarm, monitor no. 2.
CSE <sub>33</sub> :	Category III RF course alarm, monitor no. 3.
CSE 111:	Category II DDM course alarm, monitor no. 1.
CSE 112:	Category II DDM course alarm, monitor no. 2.
CSE 113:	Category II DDM course alarm, monitor no. 3.

Name	Definition
FF <sub>BY</sub> :	Far field bypass local.
FFBYR:	Far field bypass remote.
FF <sub>MM</sub> :	Far field mismatch.
FF <sub>PE</sub> :	Far field power/environmental alarm.
FF <sub>S</sub> :	Far field shutdown.
FF <sub>SA</sub> :	Far field shutdown alert.
<sup>4</sup> C <sup>i</sup>	Inhibit signal to inhibit transmitter cycling cap- ability.
I <sub>MAIN</sub> :	Main inhibit to main monitor channels.
<sup>I</sup> ON <sup>:</sup>	Inhibit signal due to power turn-on.
<sup>L</sup> T:	Inhibit signal due tò transfer commands, either auto or manual.
<sup>I</sup> s:	Inhibit signal due to shutdown commands, either auto or manual,
<sup>I</sup> STBY	Standby inhibit to standby monitor channels.
ID No. 1 (tone):	ID tone from ID unit no. 1.
ID No. 2 (tone):	ID tone from ID unit no. 2,
L <sub>AB</sub> :	Abnormal status lamp signal.
L'AC:	AC power alarm status lamp signal.
L <sub>BAT</sub> :	Battery alarm status lamp signal.
L <sub>BC</sub> :	Battery charger alarm status lamp signal.
L <sub>C</sub> :	DC/DC converter alarm status lamp signal.
L <sub>FFBY</sub> :	Far field bypass status lamp signal.

## Table A-1. Définition of Signal Names (Localizer ControlUnit, Figure A-3)Continued)

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Name	Definition
L <sub>FF</sub> : GO	Far field "good condition" status lamp signal.
L <sub>FFMM</sub> :	Far field monitor mismatch status lamp signal.
L <sub>FF</sub> : PE	Far field power/environmental status lamp signal.
L <sub>FF</sub> : S	Far field shutdown status lamp signal.
L <sub>N</sub> :	Normal status lamp signal.
L <sub>TEMP</sub> :	Temperature alărm status lamp signal.
L <sub>MLB</sub> :	Monitors locally bypassed status lamp signal.
Ĺ <sub>ŇM</sub> :	Monitor mismatch status lamp signal.
<sup>L</sup> s:	Shutdown status lamp signal.
<sup>L</sup> x <sub>1</sub> :	Transmitter no. 1 connected to antenna status lamp signal.
<sup>L</sup> x <sub>2</sub> :	Transmitter no. 2 connected to antenna status lamp signal.
LOC:	Local control of transmitting unit.
LT:	Transfer signal memorized.
MACL:	Clearance monitor alarm.
MACSE111	Course monitor alarm, Category II alarm limits.
MACSE	Course monitor alarm, Category III alarm limits.
MA <sub>ID</sub> :	Monitor alarm, 2 of 3 ID monitors.
MA <sub>NF(D)</sub> :	Near field monitor alarm which is delayed.
MA <sub>S</sub> :	Shutdown command from monitor alarms.

#### Table A-1, Definițion of Signal Names (Localizer Control Unit, Figure A-3) (Continued):

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Name	Definition
MA <sub>SEN</sub> :	Sensitivity monitor alarm.
MA <sub>T</sub> :	Transfer command from monitor alarms.
MAIN:	Main transmitter "on" status signal.
MAIN <sub>RC</sub> :	Signal to remote control used to determine MAIN status.
MLB:	Monitors locally bypassed.
MM <sub>CL</sub> :	Clearance monitor mismatch.
MMCL/NF:	Clearance or neär field monitor mismatch.
<sup>MM</sup> cse <sub>111</sub> :	Course monitõr mismatch, Category III alarm limits.
MM <sub>FF</sub> :	Far field monitor mismatch.
MM <sub>1D</sub> :	Monitor mismatch, 1 of 3 I D monitors.
MM <sub>NF(D)</sub> :	Near field monitor mismatch which is delayed.
MM <sub>SEN</sub> :	Sensitivity monitor mismatch, Category III alarm limits.
NF 1:	Category II DDM near field alarm, monitor no. 1.
NF 2:	Category II DDM mear field alarm, monitor no. 2.
OFF:	Both transmitters "off" status signal.
OFF <sub>RC</sub> :	Signal to remote control used to determine OFF status.
ON/OFF:	Front panel control unit power supply control.
REM:	Remote control of transmitting unit.
RESET:	Signal to reset alarm memory latches.
<sup>S</sup> cl <sup>:</sup>	Standby clearance monitor alarm - DDM, SDM or RF with Category III limits.
<sup>S</sup> cse <sup>:</sup>	Standby course monitor alarm - DDM, SDM, or RF with Category III limits.

# Table A-1.Definition of Signal Names (Localizer Control<br/>Unit, Figure A-3) (Continued)

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Name	Definition
Ś <sub>ID</sub> :	Standby identification monitor alarm - Category III limits.
s <sub>M</sub> :	Shutdown signal memorized.
S <sub>SEN</sub> :	Standby sensitivity monitor alarm - DDM with Category III limits.
s <sub>0</sub> :	Both transmitter are selected to be off.
s <sub>l</sub> :	Transmitter no. 1 is selected as main.
s <sub>2</sub> :	Transmitter no. 2 is selected as main.
<u>s</u> <sub>12</sub> :	Selection of transmitter no. 1 memorized.
s <sub>12</sub> :	Selection of transmitter no. 2 memorized.
SA <sub>NF</sub> :	Shutdown alert signal due to near field monitors.
sen <sub>li</sub> :	Category III DDM sensitivity alarm, monitor no. 1.
SEN <sub>12</sub> :	Category III DDM sensitivity alarm, monitor no. 2.
SEN <sub>13</sub> :	Category III DDM sensitivity alarm, monitor no. 3.
STBY:	Standby transmitter "on" status signal.
STBY <sub>RC</sub> :	Signal to remote control used to determine STAND- BY status.
TEMP:	Temperature alarm inside main cabinet.
XFR:	Transfer command due to XFR1 or XFR2 (redun- dant for remote recognition).
XFR1:	Transfer command due to course and sensitivity (redundant).
XFR2:	Transfer command due to clearance and near field (redundant).
XMTR <sup>I</sup> No. 1 (shutdown warn- ing/ID no. 1):	Sum of shutdown alert and 1D tone no. 1.

# Table A-1.Definition of Signal Names (Localizer Control<br/>Unit, Figure A-3) (Continued)

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## Table A-1. Definition of Signal Names (Localizer Control Unit, Figure A-3) (Continued)

Name	Definition
XMTR No. 2 (shutdown warn; ing/ID no. 2):	Sum of shutdown alert and ID tone no, 2:
+12V ĈONTRÔL:	Control signal to turn on raonitor channels.
-18V:	A common -18v from the two DC/DC converters.
-18 <sub>1</sub> :	-18 volts from converter no. 1.
- <sup>18</sup> 2:	-18 volts from converter no. 2.
+28V BATT:	The voltage of the main batteries.
+5 <sub>.1</sub> :	+5 volts from converter no. 1.
+5 <sub>2</sub> ;	+5 volts from converter no. 2.
-50 <sub>1</sub> :	-50 volts from converter no. 1.
-5 <sup>0</sup> 2:	-50 volts from converter no. 2.

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Figure A-1. Localizer Station

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Figure A-2. Far Field Monitor

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- Figure A-3. Localizer Control Unit
  - A-13/A-14





NOTE: SEE BLOCK 03 AND 08 OF LOCALIZER FUNCTIONAL BLOCK DIAGRAM. (B) 105709

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Figure A-5. VHF Modulator

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NOTE: SEE BLOCKS 05 AND 10, OF LOCALIZER' FUNCTIONAL BLOCK DIAGRAM.





Figure A-7. Identification Unit



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Figure A-11. Battery Charger

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Figure A-13. VHF Peak Detectors



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Figure A-16. Far Field Monitor Combining Circuits

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Figure A-17. Far Field Monitor Battery Charger



Figure A-18. Far Field Monitor Dc/Dc Converter

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#### Appendix B

#### Glideslope Detailed Functional Block Diagrams

This appendix consists of detailed functional block diagrams for the glideslope, Figures B-3 through B-13 cover the numbered blocks for figure B-1. Figure B-2 and the accompanying table B-1 detail the glideslope control unit.

### Table B-1. Definition of Signal Names (Glideslope Control Unit, Figure B-2)

Namè	Definition
A <sub>BAT</sub> :	Alarm due to a drop in the main battery voltage.
ACONV:	Alarm on one of the DC/DC converter voltages.
A <sub>MD</sub> :	Misalignment detector alarm with inhibit.
A <sub>PE</sub> :	Power/environmental alarm sent to remote control.
A <sub>s</sub> :	Alarm due to standby monitors.
A <sub>S(D)</sub> ;	Alarm due to standby monitors, delayed.
A <sub>SM</sub> :	Alarm due to standby monitors, memorized.
AB:	Abnormal condition signal.
AB <sub>MON</sub> :	Abnormal condition signal due to monitor channel alarm.
AB <sub>MON<sub>RC</sub>:</sub>	Monitor alarm sent to remote control.
AC:	AC power alarm from one of the two battery charg- ers.
BC:	Battery charger alarm from one of the two chargers.
BLINK:	Blinker output signal, a square wave oscillator.
<u>(</u> <b>C</b> :	Cycling command signal for transmitters.
C <sub>ANT</sub> :	Command to have transmitter no. 1 connected to the antenna.
$\overline{c}_{ANT}$ :	Command to have transmitter no. 2 connected to the antenna.
·C <sub>1</sub> :	Command to turn on transmitter no. 1.
с <sub>2</sub> :	Command to turn on transmitter no. 2.
CAT II <sub>RC</sub> :	Signal to remote control used to determine Category Il status.
CAT III <sub>RC</sub> :	Signal to remote control used to determine Category III status.

Table B-1.	Definition of Signal Names (Glideslope Control
	Unit, Figure B-2) (Continued)

Name	Definition
CONTROL:	Cycle command (MAIN, STBY, or OFF).
CL <sub>11</sub> :	Category III DDM clearance alarm, monitor no. 1.
CL <sub>12</sub> :	Category III DDM clearance alarm, monitor no. 2.
CL <sub>13</sub> :	Category III DDM clearance alarm, monitor no. 3.
CL <sub>21</sub> :	Category III SDM clearance alarm, monitor no. 1.
CL <sub>22</sub> :	Category III SDM clearance alarm, monitor no. 2.
CL <sub>23</sub> :	Category III SDM cler rance alarm, monitor no. 3.
CL <sub>31</sub> :	Category III RF clearance alarm, monitor no. 1.
CL <sub>32</sub> :	Category III RF clearance alarm, monitor no: 2.
CL <sub>33</sub> :	Category III RF clearance alarm, monitor no. 3.
CSE <sub>11</sub> :	Category III DDM course alarm, monitor no. 1.
CSE <sub>12</sub> :	Category III DDM course alarm, monitor no. 2.
CSE <sub>13</sub> :	Category III DDM course alarm, monitor no. 3.
CSE <sub>21</sub> :	Category III SDM course alarm, monitor no. 1.
CSE22:	Category III SDM course alarm, monitor no. 2.
CSE <sub>23</sub> :	Category III SDM course alarm, monitor no. 3.
CSE <sub>31</sub> :	Category III RF course alarm, monitor no. 1.
CSE <sub>32</sub> :	Category III RF course alarm, monitor no. 2.
CSE <sub>33</sub> :	Category III RF course alarm, monitor no. 3.
CSE 111:	Category III DDM course alarm, monitor no. 1.
CSE 112:	Category III DDM course alarm, monitor no. 2.
CSE 113:	Category III DDM course alarm, monitor no. 3.

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Name	Definition
<sup>I</sup> C:	Inhibit signal to inhibit transmitter cycling capabil- ity.
<sup>L</sup> MAIN <sup>:</sup>	Main inhibit to main monitor channels.
I'ON:	inhibit signal due to power turn-on.
<sup>I</sup> T:	Inhibit signal due to transfer commands either auto or manual.
<sup>I</sup> s <sup>:</sup>	Inhibit signal due to shutdown commands, either auto or manual.
ISTBY:	Standby inhibit to standby monitor channels.
L <sub>AB</sub> :	Abnormal status lamp signal.
L <sub>AC</sub> :	AC power alarm status lamp signal.
L <sub>BAT</sub> :	Battery alarm status lamp signal.
L <sub>BC</sub> :	Battery charger alarm status lamp signal.
<sup>L</sup> c <sup>:</sup>	DC/DC converter alarm status lamp signal.
<sup>L</sup> MD A:	Misalignment detector alarm lamp.
L <sub>MD BY</sub> :	Misalignment detector bypass lanıp.
L <sub>MLB</sub> :	Misalignment detector bypass lamp.
L <sub>MM</sub> :	Monitor mismatch status lamp signal.
L <sub>N</sub> :	Normal status lamp signal.
L <sub>S</sub> :	Shutdown status lamp signal.
L <sub>TEMP</sub> :	Temperature alarm status lamp signal.
L <sub>X1</sub> :	Transmitter no. 1 connected to antenna status lamp signal.
<sup>L</sup> X2 <sup>:</sup>	Transmitter no. 2 connected to antenna status lamp signal.

# Table B-1.Definition of Signal Names (Glideslope Control<br/>Unit, Figure B-2) (Continued)

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Table B-1.	Definition of Signal Names (Glideslope Control
	Unit, Figure B-2) (Continued)

Name	Definition
LOC:	Local control of transmitting unit.
LT:	Transfer signal memorized.
MA <sub>CL</sub> :	Clearance monitor alarm.
MACSE11	Course monitor alarm, Category II alarm limits.
MA <sub>CSE</sub> :	Course monitor alarm, Category III alarm limits.
MA <sub>NF(D)</sub> :	Near field monitor alarm which is delayed.
MA <sub>s</sub> :	Shutdown command from moniter alarms.
MA <sub>SEN</sub> :	Sensitivity monitor alarm.
MA <sub>T</sub> :	Transfer command from monitor alarms.
MAIN:	Main transmitter "on" status signal.
MAIN <sub>RC</sub> :	Signal to remote control used to determine MAIN status.
MDA:	Misalignment detector alarm without inhibit.
MD <sub>BYL</sub> :	Misalignment detector bypassed locally.
MLB:	Monitors .ocally bypassed.
MM <sub>CL</sub> :	Clearance monitor mismatch.
MM <sub>CL/NF</sub> :	Clearance or near field monitor mismatch.
MMCSE111	Course monitor mismatch, Category III alarm limits.
MM <sub>NF(D)</sub> :	Near field monitor mismatch which is delayed.
MM <sub>SEN</sub> :	Sensitivity monitor mismatch, Category III alaım limits.
NF 1:	Category III DDM near field alarm, monitor no. 1.
NF 2:	Category III DDM near field alarm, monitor no. 2.

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# Table B-1.Definition of Signal Names (Glideslope ControlUnit, Figure B-2) (Continued)

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Name	Definition					
NF 3:	Category III DDM near field alarm, monitor no. 3.					
OFF:	Both transmitters ''off'' status signal.					
off <sub>rc</sub> :	Signal to remote control used to determine OFF status.					
ON/OFF:	Front panel control unit power supply control.					
REM:	Remote control of transmitting unit.					
RESET:	Signal to reset alarm memory latches.					
<sup>S</sup> ÇL <sup>∶</sup>	Standby clearance monitor alarm - DDM, SDM, or RF with Category III limits.					
S <sub>CSE</sub> :	Standby course monitor alarm - DDM, SDM, or RF with Category III limits.					
s <sub>M</sub> :	Shutdown signal memorized.					
S <sub>SEN</sub> "	Standby sensitivity monitor alarm - DDM with Cat- egory III limits.					
s <sub>0</sub> :	Both transmitter are selected to be off.					
s <sub>1</sub> :	Transmitter no. 1 is selected as main.					
s <sub>2</sub> :	Transmitter no. 2 is selected as main.					
<u>s</u> <sub>12</sub> :	Selection of transmitter no. 1 memorized.					
s <sub>12</sub> :	Selection of transmitter no. 2 memorized.					
SEN <sub>11</sub> :	Category III DDM sensitivity alarm, monitor no. 1.					
SEN <sub>12</sub> :	Category III DDM sensitivity alarm, monitor no. 2.					
SEN <sub>13</sub> :	Category III DDM scnsitivity alarm, monitor no. 3.					
STBY:	Standby transmitter "on" status signal.					
STBY <sub>RC</sub> :	Signal to remote control used to determine STAND- BY status.					
TEMP:	Temperature alarm inside main cabinet.					

# Table B-1.Definition of Signal Names (Glideslope Control<br/>Unit, Figure B-2) (Continued)

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Name	Definition						
XF/Ż:	Transfer command due to XFR1 or XFR2 (redun- dant for remote recognition).						
XFR1:	Transfer command due to course and sensitivity (redundant).						
XFR2:	Transfer command due to clearance and near field (redundant).						
+12V CONTROL:	Control signal to turn on monitor channels.						
-18V:	A common-1.8v from the two DC/DC converters.						
-18 <sub>1</sub> :	-18 volts from converter no. 1.						
-18 <sub>2</sub> :	-le volts from converter no. 2.						
+28V BAIT:	The voltage of the main batteries.						
+5 <sub>1</sub> :	+5 volts from converter no. 1.						
+5 <sub>2</sub> :	+5 volts from converter no. ?.						
-50 <sub>1</sub> :	-50 volts from converter no: 1.						
-50/2:	-50 volts from converter no. 2.						

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Figure B-1. Glideslope Station





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Figure B-2. Glideslope Control Unit

#### B-11/B-12



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NOTE: SEE BLOCKS 03 AND 07 OF GLIDESLOPE FUNCTIONAL BLOCK DIAGRAM.

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Figure B-4. UHF Modulator

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Figure B-5. UHF Changeover and Test Assembly

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Figure B-9. Battery Charger

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Figure B-10. Dc/Dc Converter



Figure B-11. UHF Peak Detectors



Figure B-12. Monitor Channel

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Appendix C Localizer Failure Analysis

## Appendix C

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### Localizer Failure Analysis

This appendix, referred to in section 7.0, consists to the failure analysis for the localizer, as shown in table C-1. Table C-1. Localizer Failure Analysis

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4 of loy) 9. ostil- 21. retult- 21. retult- 21. retult- 21. retult- 20. Hz 11. 90 Hz 11. 90 Hz 11. 90 Hz 11. 91 Hz 41 atton.

			<b>،</b>	-	I		
Pare 2 of 27		الم وجود الم والم			Net hažardoos - sıgali fill within Cat. III toldeşance.	Ne hazardous - signal still within Cot. III tolerance.	-
	Failure	Pares 10'1	0.415 1NB	1.453 ÅNC	2. 426 MD	2.426, ÅNE	12. <b>832</b> . Ant
ļ		Qeher Q	Alarma on all course, senattivi- ty, and near field monitors.	Alarma on all course. sencitivi- ty, near field and clearance monitors:	2		Alarma on all course. scasitivi- ty, and near field monitors
	lure Indicati	Control I'nit	TABN'' and "TRANS- FER"	"ABN" and "TRANS- FER"	NONE	S .	NABN" And UTRANS- F. 291,
-	, Fall	Pemáte Cantral	"MON" ABN" and "STBY"	"MON ABN" and "STBY"	NON	NONE	NGN ABN" STBY"
	د ب	, ž		, i			<u> </u>
ĺ	System Opera	11 H. J.	×	×			×
•		Alter Alter			×	*	
		Fallure Effret	Loss of SB in course C-SB janal and course SBO signal.	Out of tolerance course and clear- ance C45B and SBO signals.	Silght disfortion of the course C+SB sin SBO signals.	Distortion some- what more than 1/32 of the CC.ree CoSB and SBO signals.	Out of tolerance course C+5B and SED algrada.
		Fallure Mode	Loss (of V215 carrier to Jigtal phas- Jig cuts to atther or both of the 90 and 150 90 and 150 eral?	Loss of 90 or 150 di- viders. syn- chronization circuitry or gn/153 Hz shift reg- isters.	Lose of A/32 driving oig- mal to delay line (either the 90 Hz phase shift- er).	Loss of A/15 driving eig- mal to the delay lines (either the 90He or 150 Hz phase shifter).	Lose of A/8. X/4. X/4. X/2 or X/2 v/2 or T/2 Jaby line. (sibby line. (sibby line. (sibber be 90 Hs or 150 Zis phase ebifie?).
ZER STATION		function					
SILS OCALI	ş	с. ч.	5 5 5		, managana ang pang pang pang pang pang pan		
System Subaystem L	Identificat	ltern Kanne	Modulator (Continued)	99999999999999999999999999999999999999			

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"It sinthar corrienting many thei alarm fallare occured in "and the complete two size-tions of the complete boulder" their, themselate boulder buildown will result. Pare 1 of 22 Semarks. Rate (Ax 106) Failure Alarma cn 1.552 all clear-> ANH ance mon-13.310 0. 388 ANI 5. 390 Mil 1.302 0.756 Alarma 13.31 UN X Z all course. > Alarma on all clear-ance montý, and sear field monitore. Alarma on all clear-Alárme on ance monmonitor. channel. Other tore. itore. Failure Indications TOR MIS-NATCH" "ABN" and "TRANS-FER" "ABN" abd "TRANS-FER" "ABN" and "TRANS-FER" TRANS-Control Unit "ABN" NONE ABN" ABN" ABN" And "STBY", NON" ABN" ABN" NC22' NOW" ABN" ABV" NOM" ABN" Pare NALN" Remote Control NONE Cat III Cat II OII System Operation After Failure × × × × × × Loss of 2 of 3 mon-lor voits cipabil-ity. Now dependent on 1 of 2 remaining control (resamiltor transfer exchility). Lose of modulation for clearance trans-mitter resulting in SB lose of clearance C+SB. Loss of 2 of 3 mm-ttor voting calu-bility. Now de-pendent upon 2 of 2 remaining moni-tors for system con-trol Out of tolerance clearance C+SB and SBO aignals. Out of tolerance course C+SB and SBO signals. Loss of clearance SBO eignal. Fallure-Fllect Loss of either the 90 Hz or 150 91 signal dat signal for clear-Loss of 90-150 Hz sig-nel. Logs of 490. -90. +150. or -150 Hz phase shift-er RF sig-zel. Loss of 90+ 150 Hz sig-Loss of menitoring ablity. producing alarms. Loss of mozitoring ability. producing no alarma. ance trans-Failure Mode mussion. Ъ. Providě monitoring of the providě monitor (DDM), the source position (DDM), the 5 modulation (SDM), a sud the course RF power prover. Function System SSUS Subsystem LOCALIZER STATION 30.35 . D. 5 5 8 **Edentification** CONTRE MON-ILOT CHAN-NELS (1, 2, or 3) (MAIN) ltern Name Kodulátor (Continued)

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		Fallure		oyatem Aftef	Failure	 		Tre Indicatio		Failure		
	unction	Made	Failure,Effect	Cat III	Cat II 0	SII C	ontrol	Unit	Other	(30 <sup>6</sup> )		
Same as monitor of monitors of monitors of meters of the second s	mun course hannels except rourse para- f standby unit.	Loss of mónit ving ability. producing alàrme.	Shutdown of standby transmittor		×	e < 4 e	MON Bu" MAIN"		Alarm light(s) on standby course monitor.	13.310 <sup>1</sup> 46A		
		Loss of monitoring ability. producing no alarnis.	Lose of standby ' course monitoring.	×		Ž	ONE	NONE	,	5. 390 Méě		
Provide the cour	mont fing of	Loss of monitoring abîlity producing akarms.	Loss of 2 of 3 mon- itor voting capabil- ity. Now dependent upon 1 of 2 remain- ing monitors for system control.	×		F < 5 F	MON BN'' hd MAIN''	MONI- TOR MIS- MATCH" ABN"	Alarm Lightts) on defective monitor channel.	736.9	If another corresponding mon- itor DDM failure occurred in one of the remaining two mon- itors, fimmediate localizer shutdgry will result.	**
		Loss of monitoring ability producing no alarma.	Loss of 2 of 3 mon- itor voing capabil- ity. Now dependent upon 2 of 2 remain- ing monices for system control.	×		2	ONE	NONE		2 892 <sup>3</sup> NB	Only DDM monitoring circuitry is critical.	-
Provide the star (DDM).	e monitoring of adby course widtl	Loss of mon'toring ability producing alarme.	Shutdown of the standby transmitter.		×	1441	MON BN" MAIN"	ABN''	Alarm light(s) on standby sensitivity monitor.	9.367 <sup>5</sup> 47A	Only DDM monitoring circuitry is critical.	12
		Loss of monitoring ability producing no alarms	Loss of standby course monitoring.	×	ی <mark>ہ جب</mark> ۱ ۱	7.	ONE	NONE		2.892 147B		1
Provie the ne positio	de monitoring af ar field course on (DDM),	Loss of monitoring ability producing alarms.	Loss of 2 of 2 mon- tior capability. Sow depradent upon fe- my inthe monitor for system control.	×		FKRE	MON BN" MAIN"	TCL:/IIS- TCL:/IIS- NATCH	Alarm light(s) ion defective near field monitor.	11. 099 1. 099	SDM and DDM are attapped to provide one general alarm output.	
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Page 5 of 27	Pare 5 of 27		Non-hazardous - near field momtoring considered not essential for Cat III operation.	If another corresponding moni- tor alarm failure occurred in one of the termaining two moni- tors, immediate localizer shut- tors. immediate.				"Transfer" would not occurrou failure of standby unit: Lossy of Cat. 111 status would occur even though "MAIN" is still operation-	<b>i</b>
	Failure	Kate ()	3. 822 <sup>1</sup> 7\B	14. 280 <sup>X</sup> NA	8% <sup>5</sup>	14.280 <sup>3</sup> 48 <b>A</b>	5.551 Å4rja-	3. 949. <sup>1</sup> N.A	13. 134 <sup>ANB</sup>
	018	Other		Alarm Light(a) on defective clearance monitor.		Alarm light(s) on standby clearance monitor.		Alarms on ID moni- tors.	Alarme on L. D. mone, itors.
	lure Indication	Control Unit	NONE	"WONI- TOR MIS- MATCH" And "ARN"	NONE	"ABN"	NONE	"ABN" and "TRANS- FER"	TABN TANS- FER
	Ē	Remote Control	NCYE	"MON ABN" and "MAIN'	NONE	"NOK" ABN" and MAIN"	NONE	Yary Mow.	WON ARN'i Lan Arn N'i STBY
	ration	лò п		·····					·
	tern Ope fter Fai	III Cat				×	<u>`</u>	×	×
	Sys	C.a.	×	×	×		×		<u></u>
		Failure Fifect	pas of near field nonitoring.	Loss of 2 of 3 mon- ttor veturk capabil- ity. Now dependent upon 1 of 2 remain- itsk montors for system control.	Loss of 2 of 3 mon- ttor voting capabil- ity. Now dependent upon 2 of 2 remain- ing monitors for system, control.	Shutdown of stand- by transmitter.	Loss of standby clearance monitor- ing.	I ransfer 'miland- by unit.	Transfer to stand- by unit.
	Function Kode		Loss of monitoring ability producing no alarms.	Loss of monitorink ability producink alarm.	Loss of monitoring ability producing no alarm.	Luss of runitoring ability producing alarm.	Lass of monitoring ability producing no alarm.	Loss of ID signal iaudiol.	Loss of
ZER STATION				Provide monitoring of the clearance DJM, " m-dulation and clear- ance RF piwer level		Same as muin clearancé montor channels except munitors clearance pas rameters of standby unit.		Provides a beyed 1220 "Is audio signal (1) TONE) to aircraft for runway and approach	identific stron.
LOCALI	101	i i	1 - 2 - 5 - 2 - 5	म स ह त मैं कु स इ के के टे क		4		* # =	
Syntem Subayatem 1	Identifica	lter. Vame	Near Field Monitor CHANNELS Continued	Clearance Wertor CHANSELS No. 1, 2, cr 3 MANN		Clearant e Munitor Channel IST ANDBY)		E D I fait MAIN of STANDBY	
		٢	Reproduce besi ava	ed from lable copy.	<b>9</b>	6			

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Page 6 of 27		Kertarba	After a nominal 70 second dalay, the "Far Field GO" light will go "off" and the "FF SHUT DOWN" light will come "on" at the control unit.		Oziy input gating circuitry may be basardous. (Etlecta monitoring circuitry).	Reduzdascy has been lacory- orated ao that performance dorrgrade is achieved in the even of a "True Cat III Alary condition." NOTE Lose of I.D. monitoring is not hashirdoun.	Not batarrdoue - Cut III integr and for field monitoring atill effoctive.
		R.)00	1.827 <sup>3</sup> 1A	3.507 11B	2. 88 0. 421 0. 421 0. 142 0. 145 0.	3.470 1.249 1.249 (redund) 1.249 0.140 0.140 (gate) 1.02 = 0.700 (logic)	2.256 <sup>3</sup> 1E
	*uc	Other	The FFM processes the "no signal" condition.	The FFM processes the 'no signal' condition.	No mis- match on monitor channels.	· · · · · · · · · · · · · · · · · · ·	
	iure Indicaîî	<sup>6</sup> Contrôl Enit	"TRANS- FER." "SHUT- DOWN" and "ABNOR- MAL"	"SHUT- DOWN" and "ABNOR- MAL"	"MIS- MATCH" ars MAL" MAL"	(NONE)	ISNON
	Fail	Remote	MON ABN" and ard	ABN" ABN" and "OFF"	MON" ABN" Bab MAIN"	(WOKE)	(NONE)
	at inn	2 S	×	×			
	Oper	nie Je E		*	, ,		
	Syatem	Cat III			×	×	×
		Failure Fliers	Guese both the main and the stand- by framitter to shudown immed- iaraly after the transfer.	Causes both the main and the stand- by tranamitter to sbutdom immed- istely.	Mismatch conditions do noi effect cate- gory partormance: bowever. failure of input gates may be hazardous.	Cat III parameter monitoria of the integral courae, ensitivity. I. D., ensitivity I. D., la virtuolly render- ed useless.	Results in Éless of ness field and/or far field Cat II monitoring capabil- ity.
		Fallure Elnde	Gencration of an erro- neous trans- fei Vignal. dud W alarm processing circuitry.	Ceneration of an erro- neous shut- down signal due to alarm processing circutry.	Conseration of an erro- neous mis- natch aig- nal.	Imability to process a signal from the integral course sen- stitutity. I. D and/ or clearance monitore.	Inability to process a sprocess a signal, in- itiated by d/or Cat d/or Cat DDM.
ZER STATION		Function The control unit process as alarma received from as monitor chambels. Providing signals to obtu- down the standby trans- mitter, to transfer min to		deale a montrof, mia- ranto, in addition, the control unit generates in- hibit útgalls. diaplays both locally and remotély transmiter and category transmiter and category	ous power/temperature alarm conditions for both alarm schelter and far field monitor operational features. such as bypass of monitors, main unit select, memorization of select, memorization of select, memorization of starmt, are also associ- sted with the scontrol unit.		
OCAL	Ę		5				
Subiyatein L	Identificat	liem Name	Control Unit				

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Page 7 of 21		Remarks	Not harardoue - Cat III par- formance and monitoring is unstituted.	Not basardous - mismatch conditions do not effect Cat 111 performance.	If a standby transmitter fall- urs also occurs, immedias abuidoes upon transfor will result.		Not haumerburs - prover/en- vircommonical alarzas mairely dormigrado performatione alles dorma doidy yer do trans- zudithere are et available.
		1. 10 1. 10	A1F	3. 746 11G	656.11		A13 2.367
•	onè	Öther		\$		No alarme en stir monitori.	
	wresindicatio	Control. Unit	INONE	(NONE)	(NONE)	MAL"	เสพอพ
	; Fell	Remote	ENON	(IVONE)	(NONE)	NDN:	SNON
	tián	2					· · · · · · · · · · · · · · · · · · ·
	2 9 0	Cat II	,			×	
	Syatem	Cat III	×	×	×		×
		Failure Fifeet	System will continue to radiate a signal ipoasibly faulty) during a shuidown atatus-oniy Cat II perfurmance effect- ed.	No serious extern on system opera- tion. Monitor mis- matches may not be recognized but parameter "out of tolerance" condi- tions are still pro- cessed normally-	ctandby unit mon- tioring is rendered useless.	Causes the standby transmitter to shut- down. Main con- timues to operate in Cat II status.	Loss of timote recognition of re- conditions: loss of domgrads sapabil- ity due to prover/ environmental elarma.
		f'allure Modê	Inability to process a shutdown signal, in- tiated by double transfer or transfer or transfer or transfer or transfer or transfer or transfer or transfer or transfer or trans	Inability (o process a miarratch condision of any or all monitor sets.	Inabli, v to process a standby alarm.	Generation of an errou- neous stand- by alarm.	Inability to process any or all power/er- virozmental alarma.
ER STATION		Function					
X ALIY	, E	÷.;	3				
Subsysten, 14	ldrain.ai	lten. Vame	Control Control				

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ldentificat	tion				Syafer	1 5 C 1 1	ion (	Fail	ure Indicate	, , , , , , , , , , , , , , , , , , ,	-	
ltern Name	1. D. No.	Function	Fallure Mode	Fallure Ellect	After Cat III	- 62 11.   Cat 11.		ternote Jontrol	Control Unit	Other	Falure Rate	Remarijs.
control Unit Continued)	5		Generation of an erro- neous bat- tery alarm.	No effect other than erroneoualy down- grading the system to Cat II atatus.				POW/ NVIR BN" nd MAIN"	"ABNOR- MAL" and "BATT FMIL"		0.415 NrK	NC hazardous ystem still has the ability to operate on both transmitting units.
			Generation of any erro- power/en- vironmental alarm ex- cept a bat- tery alarm.	No effect other than an erroneous abnor- mal indication.	×	Down- grade to Cat II af- ter ter ter	(± / ₩ ≪V₩ ±"	POW/ NVIX Ba MAIN"	"YIBNOR" MAL aid peasibly bis re- pover or terr peas- terr peas- tur alarm (ight		2.029 7.1L	Not hazardous
			Generation of an erro- neous con- trol signal that shuts down the main trans- mitting unit.	After the main down, the loss of radiation is detect- ed by the monitor far is and trans- fer is initiated to the standby unit.	1	×	11 < 7 I 	MON Bu TBY:	FEV" FEV" ABN	Alarms on some mon- tor.chan- neis.	1.420 1.420	Montor chame! a larm lighta are unpredictable due to a race condition between the generated inbitit signal and the "bo arg- nal" input a larm processing.
			Generation of an erro- neous con- troi nignal that/shut doym the training unit.	After the standby transmitter shura down, the loss of input signals to the standby monitor channels createn ditions which are gitions which are processed normally in the control unit.		×		NOW N NBA		Alarms on some standby montor channels.	, 11N,	This failure mode is not gen- erated by monitoring circuitry: bence, it may occur after a transfer to standby has occurred.
			Ceneration of an erro- neous con- trol aignat that shuts that shuts down both transmitting units.	After a total shut down as initiated, the loss of input signals to all mom- tor channels re- utar in both a si- ing of a transfer and a butdown condition		<i>V</i>	ा <u>र</u> आता	MON Bd OFF"	"TRANS" FER", "SHUT - DOWN", and "ABN"	Alarms on some mon- itor chan- nels.	110	

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Pare 9 of 27	Remarka		Not hazardous - performance category downgrade still poè- category downgrade still poè- capbulity still exista, bence. Cai III performance is not ef- fected.	Essentially renders the stand- by transmitter useless.	Essentially renders either the main or standby trans- mitter uselers.	Upon the generation of a con- modifications have been the corporated to take away Cat in and Cat III statum. Although both transmuters may still be "GOOD", all monitoring is lost. 'ISI is similar to 'IH-
	Failure	Rate 61	1, 782 1,1 P	0. 844 <sup>1</sup> 10	0,960 '1R	2. 514 151 151, - 0. 198 (etby 152 = 2. 316 (main hinbiti
	e ne	Other		· · · · · · · · · · · · · · · · · · ·	Alarma on some monitor channels.	•
	ure Indicati	Control Unit	(NONE)	(WONE)	"TRANS- FER" and "Abn"	"ABNOR- MAL"
	Fall	Remote Control	(NONE)	INONE	"MON ABN' and STBY''	NON: NGA NAIN''
	l noi	ŏ	· · · · · · · · · · · · · · · · · · ·			×
	1 Operat	Cat II			X tar- tar- tatus) fatus)	
	System	After Cat III	×	×		
ZER STATION		Failure Elfect	Yo failure effect or indication unit an- other failure oc- curred in the main or standby urdt. At that time all control estrals would be processed normally. except the respec- tive transmitting unit would not cesse transmission.	No failure effect or indication until a transfer command is received foue to some other failurel. At that time all radiation will cease.	If in MAIN, a trans- fer to STANDBY will occur, if in STANDBY, a trans- fer to OFF will oc- cur. This is due to a momentary loss of aignal.	The respective main and/or standby moin- tron channels are inhibited and, hence, rendered totally useitss. Atthough the inhibit does not cflect the far field monitor channels from alarming, the main inhibit does prevent the alarm from being process- ed in the control unit
		Failure Mode	faability to ahutdown ather the main or the standby transmitting init,	Inability to sirect a chanke of units feed- ink the an- ternas.	Pre-mature change of units feed- ink the an- tennas.	Seneration tanuou, main and/or haito the haito the monitor channela.
		Function				
CALL	ç	d e	10		,	
۲II	licaru		¥.			
Subayetem	Identi	ltes: Name	Continued: Continued:			

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System STILS Subayatem LOCALIZER STATI

			•	1	1	, ,	
Vare 10 of 27		Renarts	Failure mode virtually rendera the standby, truñamitter uselise.	Not hazardous - atmüby mon- ttoring ia meaningleas after a transfer.	Cat III and Cat II status taken away although both transmittors are still operational.	Nor baža tdous - only paycho- logical'implicationa.	Not hatardous - abutdown warm- ing not vital to system operation.
	Laibre	Hate A 10'	2.658 11	0.370 ÅIC	0.140 Alw	2."52 Å1X	2.693
	òns.	Ckher			c.		
	luré Indicati	Control I'nit	, Ianoni	(NONE)	"MON LOC BYPASS" and "NOR- MAL"	(NONE)	(KONE)
	() <b>F</b> . (	الديبيوند Control	INONE	(NONE)	"ABNOR- MAL" Maling" and "MAIN"	(NONE)	(INONE)
	l i n	JO			×	~	
	Opera	in II is	~	i I I			~
	System	Cat III	×	×		×.	×
ZER STATION		Faibure Filess	If another failure course which miti- ates a tranefer, an immadiate shutdown will uccur since fb . monitors are not inhibited during the transition period.	No effect on ayatem operation - merely produce - alarma on all standby monitor channels after a transfer has already occurred due to an- other fallure.	The control unit can- not process trans- fer and shutdown command signals and, hence. the en- tive monitoring is rendered vaeless.	No effect on ayatem operation - only causes the trana- mised of a false abutdown warning eignal.	System may shuck down instantancousty without any warning to pilot.
		Fallure Nõtte	Inability to process a main inhibit to the mon- itor chan- nele.	Inability to process a standby in- hibit to the hibit to the monitor channels.	Generation of an erro- neous mon- itors locally typassed signal:	Generation of an erro- neous shut- down alert signăl.	Inobility to generate a correct obstdown cjert signal.
		Function					
<b>TIVOO</b>	tin	ι. ŋ. 'śי.	5		, , , , , , , , , , , , , , , , , , ,		
Subavotem 1.	ldentificat	ltern Name	Control l'nit (Continued)				

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(Cont'd)
Analysis
Failure
Localizer
Table C-1.

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Fare 12 of 27	-	Hermarks			Note that although both the re ranning two reads deactors/ monitors monitor inagrash con poeition, only An alarm oa oa oe them is required to inithite a transfer.	
	I ather	Rate 12x1061		0, 386 NB	0.789 ANA	986-0
	100	Caher		RF and SUM lights "on" on the cor- reaponding near field monitor channel.	RF, and SNM lights "OSN" of the "OSN" of the "OSN" of the sponding the monitor the monitor the monitor the monitor the short the corre- the shorthe short the shorthe shorthe shorthe sho	ITF and SDM lights "ON" on y côrte- côrte roading course monitor channel.
	lure Indicati	Control 1'nit		ABN" and "MIS- MATCH"	ABN" and "MATCH" MATCH"	MATCH"
	i.e.	Renote	•	"NOM" abn" and	NOW.	N(VX pare NqV
	A1-05	CIL		·		~
	0.0	11 10			, 	
	Svaten	ניו ווו		×	×	×
		i'ailure Effect	will result if re- maining peak detect- or/monitor also fails.	The corresponding monitor channel processes the fail- ure as being a drop in course RF pow- is course RF pow- er and an increase in modulation per- centage. Now de- centage. Now de- pendent upon 1 of 1 "for near field mon- ivaring.	Loss of vrput ssg- nal to correspond- ing monitor, cus- ing a mexitor mis- ing a mexitor mis- ing a mexitor mis- upon remaining two pask detectors /mon- tiors for justers/ tors for justers/ tors for justers/ tors for justers/ tors for justers/ tors for monitors for system control.	The corresponding momion channal processes the fall- ure as being a drop in course RF por- er and an increase in modulation per- pendent upon 1 of 2 for integral course position monitoring.
		Failur Mode		Incorrect (low) DC output eig- nal.	Total load of output a Gand (both A C and DCI.	Incerrect output sig- pal.
LER STATION		Punction			Each of the course peak detectors receives a sum- ultated course position un- put signal. This input signal is obtained by a combination of signals obtained by 7 voximity probes at the radiating recore then converte the RF signal into a low fre- quency signal. both DC areasably of the RF researably of the RF	preder the AL of the de- He eignel. He signel.
511.S OC.AL.I	ucj	. D.	2 2 2	<u></u>	27.52	
System Subsystem L	Idontificat	ltern Name	Near Field Peak Drtei - tor (cuntinued)		Course Peak Drestors No. 1, No. 2, IMAIN) IMAIN)	

No. States

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	1:			<b>.</b> .
Pare_13_0[_27		Remarks	Atthough the remaining two peak detectors /monitore mon itor the daregrad monitor and parameter, only alfourned one of them is required to jui tisse a transfer.	Atthough there sull also be a los of algual to the standby I. D. montor, the standby lab hibit signal will preveat the alarm from being processed.
,	Fallure	Rate (A 10%)	2,789 2,786 0. 386	0. 789
	óns 👘	Other :	RF, SDM, and DDM (18ths "ON" on corre- ponding senativity monutor channel. (18ths and DDM lights and DDM lights and DDM neurer sponding corre- sponding corre- channel.	RF and SDM lights •ON* on corre- corre- standby course moritor channel.
5	lure Indicati	Control C Unit	"ABN" and "MAS" "MAS" "MIS- MATCH"	- NRV.
	Fall	Remote Control	"NUAN" "NUAN" "NUAN" "NUAN" "NUAN" "NUAN"	NOM" ABN" "NAIN"
	u u	or		
	Operal		12	×
	System	Cat III 0	××××	
		failure Fffect	Lusa of input signal to corresponding emaitvily monitor channel, causing a mionitor mismatch. Dispendence upon re- maining two peab ditectora/monitors directora/monitor directora/monitor directora/monitor signal signal monitor for system monitor channel monitor channel an increase the signal a decrease the ulation percentage and a decrease in ulation percentage and a decrease in course width mon- ent upon 1 of 2 for corresponding monitor channel).	Loss of input signal to the standby course monitor. This, in turn, is proceased as a fail- ure in the standby transmitting unit, causing the standby unit to be shut do a.
	,	Failure Mode	Total Jone of output signal houth AC and NCJ. A hour JK output suc- nal	Total loss of output signal tooth AC and DCI.
ZER STATION		t unclos	Fach of the senativity predict of a receives a simulated input aircal, course width idiaplas e- ment senatively? This miput signal is obtained by a combination of signal by obtained by proven at the radiating anterimas. Each pead de- tector - converts the RF anterimas. Each pead de- guent, signal both 1% and AC. The DC is the quent, signal both 1% and AC. The DC is the quent, signal both 1% and AC. The DC is the de- modulated "0, 130 1% signal power the AC is the de- modulated "0, 130 1% signal power the AC is the de- modulated "0, 130 1% signal	The peak detector re- cerves its input signal directly from the signaly transmitting unit after proper attenuation. It proper attenuation. It essentially converts the standby C-SB signal into a low frequency signal. Doth AC and DC. The DC component represents the standby RF power level: the AC component is the demodulated 90/150/1020 Hiz signals.
DCALL	Ę	9		
System St Subayaten <u>1.</u> 1	Identificati	lten Kame	Sensitivity Peak Detro- Sor No. 1. N. ISAIN	Standby Course Peak Detuctor

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(Cont'd)
Analysis
Failure
Localizer
C-1.
Table

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1 Although the reraining two peak detector/monitors mon-tion the clastance signal parameters, only an alarm on one of them is required to initiate a transfer. Page 14 of: 27 Reciards Rate 61 i ailire 0.386 0.789 0.789 0.386 118 A32A A32B ×NA RF and SDM lights 1 "ON" on respoilding standby course R.F., SDM., and DDM lighte "OX" on "OX lights ON" on the corre-sponding standby sensitivity monifory ligkta "ON" on corre-syinding standby. sensitivity monitor. RF, SDM. and DDM RF, SDM. monitor channels. Chher the cor-Failure Indications, "ABN" abd "MIS-MATCH" rinit 1.nit "ABN" .VB: "ABN" NOM" NOM" "MON" ABN" and MAIN" Remote Control "NIAM" "Nak "Nak "MON" ABN" and "MAIN" Car' III Car II OU Svatem Operation After Failure × × × × DDM causes an alarni which, in turn, shuts down tha chamel, causing a monitor misser h. Dependence upon re-maining two peak detectors/monitors Loss of input signal to the standby sen-sitivity monitor, This, in turn, is monitor recognizes this as being a fall-ure in the standby transmitting unit and hence, causes the standby unit to be shut down. The standby sensi-tivity monitor re-cognizes this as being a drop in RF power. an increasion SDM, and a deprocessed as a fail-ure in the standby standby transmitting causing the standby unit to be shut down. Loss of input signal to corresponding The standby cours? clearance monitor for clearance pa-rameter monitransmitting unit. crease in DDM. The decrease in Failure Fffeit toring. unit. Total loss of output signal fboth AC and DC) Total loss of output aignal (both AC and DC1 In-orrect (low) DC output aig-nal. Incorrect (low) DC output sig-Failure Mode nal. Each of the clearance peak detectors receives a simulated clearance in-put signal. This input signal is obtained by a combination of signal by obtained by a combination both prosimity probe both prosimity probe into a low frequency sig-mal, both AC and DC. The DC component repre-sents the course RF pow-nent is demodulated 90/ 150 Hz signal. mitting unit. After proper atteauation, the linput signal in a combina-trandy course CoSB and SBO. This RF input signal is converted This peak detector re-ceives its input signal from the standby trans-Function System SSILS Subsystem LOCALIZER STATION t. D. `n. 22 2 Identification Clearance Peak Detec-tors No. 1, No. 2, or No. 3 (MAIN) Standby Courae Peak Detector (Continued) Standby Sen-sitivity Peak Detector lten Name

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<u>12 %</u>	-		?			
l'art 15		Restarba				
	Failure .	Rate (		0.386	0.789 A33A	386.0. 866' 
8	ione de	Cabler	2	RF. SDM. and DDM lights "ON" cn the corre- sponding clearance montor channel.	RF. SDM. and DIDM lighte: ON' on the corre- sponding clearance monitor.	RF. SDM. ights 'ON'' 'ON'' 'ON'' the corre- sponding standby citaarance monitor.
-	lúre <sup>2</sup> Indicati	Control Main		"ABN" and "MIS- MATCH"	"NBA"	"XBA"
	ie'i	Remote		"MON" ABN" and "MAIN"	"MON" ABN" and "MAIN"	"NIA" "NIA" "NIA" "NIA"
~ ~	• u ••	ór	-		*	
	, Operal	Cat II	·		×.	x
	Systen	Cat III		x		
		Failure Fffect	Now de pendent upon 1 of 2- learan e muniter for Ayatem control.	The cuitesponding monitor channel processes the fai- ure as being a drop in clearance RF power, an increase power, an increase in SDM, and a de- crease in DDM, Now dependent upon 10 2 clearance monitor for system control.	Loss of the input signal to the stand- signal to the stand- fror. This in turn is processed as a failure in the stand- by transmiting unit, cousing the shut down.	The standby clear- parce munitur rec- openizes this as he- ing a failure in the standby clearance transmitter and, hence, causes the entire standby unit to be shut down.
		l ailurr Möde		in orrect liow. DC output arg- nal.	Total loss of output signal rboth AC and DCi	Incorrect output sig- nal,
ER STATION		Function	tlearance C-SB and SBO. Thus RF roput extral to converted to a low fre- query a signal. both AC and D.C. The D.C. is rep- re-extitive if the ilear- and B.C. The D.C. is rep- to the demodiated '0/150 IV elearance signal	ed from able copy.	This peak detector re- ceives its input aignal from the standby trans- miting unit. After proper altenuation, this input signal is a com- bination of standby clear- bination of standby clear- bination of standby its This RF input signal is	concreted into a low fre- quency strat, both AT and DC. The IXC com- proment represents the learante RF power fevel. the AC component is the demodulated 90/150 Hz clearance signal.
SCAL	Ę		22.22	oduc evair	<u>۳</u>	
Subayatem Lo	Identificati	lten. Name	Clearan e Peak Drier - tura (Continued)	Repr.	Standby Clearance Peak Detector	

Pare 16 of 27		Renates	ther such failure occurs other 1. D. monicar, the in will limmediately trans- ad then shut doen.	azardous - the I. D. aig- s asoumed non-essential at 111 operation.		
	ailure	Rate Ax 106)	.742 " [f mo mail] in any 34A1 = syute 34A2 = fer a 34A3 = fer a	. 050 Not b 34 B mal if 34 Cor C	- 914 34 C	9 A
	0.01 · · · · · · · · · · · · · · · · · · ·	Öller	L. D. J. Mon-5 itor alarm (1 light "ON", A		Alarm on 1 standby 1. P. Monitor.	04
	lure Indicati	Control	"ABN" and VMIS- MATCH"	(NONE)	"NBV"	(a) (a) (a) (a) (a) (a) (a) (a) (a) (a)
	Fail	Remain	"NOM" Put "NALN"	(NONE)	"MON" ABN" ABN" MAIN"	INONE
	f	हि			,	· · · · · · · · · · · · · · · · · · ·
	Operat		;	^	×	
	Syatem	Cat III o	×	×		×
	, ,	Failure Fffect	Loss of 2 of 3 1, D. monitor voting ca- pability. Now de- penden, upon 1 of 2. remaining 1, D. monitors for system control.	Loss of 2 of 3 1. D. monitor voting ca- pability. Now de- pendent upon 2 of 2 remaining monitors for systern control.	Causes the standby transmitting unit to shu down after a 2-5 sec time delay.	Loss of stardby L.D. signal mosi- toring. Abbough the I.D. signal is not essential for Cat III operation. this failure mode this failure mode and occurs on thoi and occurs on thoi the failure mode. the failure mode. the failure mode. the remunant an immediate abuidown will result.
		Fàilure Mode	Loss of monitoring chility of one of the main I. D. monitors: producing an alarm.	Loss of monitoring ability of one of the monitors, producing no alarm.	Loss of standby I. D. mon- itoring ability pro- ducing an alarm.	Loss of Loss of I.D. mon- ttoring po- ducing po alarm.
ZER STATION		Function	Each I. D. monitor re- ceives its respective in- put from the ACC ourputs of the tistegral cource position musitor channels Each I. D. manior checks its input eigual for the presence of a keyed	(coded) audio (1020 Hz) tone. An alun m is pro- duced whenever a losa of audio or keying exists over a definite time in- terval.	Same as main 1. D. mon- itors except it monitore the 1. D. signal of the standby transmitter.	
SAL	Ę	Ċġ	*		X	
System 551 Subsystem 1.0	Identificath	Item Name	Idamitic fidentian Manuar Assembly Assembly (I. D. MONI- TORS No. 1. NO. 2. or No. 3)		Identification Moutor Assembly (Sta Aby L. D. Mouttor)	

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NOIL					-	5	,			17 10 11 11 01 71
			System	Operatin Failure	5	Faire	re Indicati	07.8	Failure,	Personal Persona Personal Personal Pe Personal Personal P
	Móde	Fallure Effect	Cat III	Cat II C	U U U	ntrol	Unit	Other	( <sup>م</sup> ة آمار	
	Loss of +12 volta of reg- ulator.	All I. D. monitors (both main and atmidbyl ar render- ed useless. No alarm'are produced and, hence, Cat III and, hence, Cat III operation continues. J. D. signal monitor- ing is totally lost.	×		Ž	ONE	NONE	, ,	57 53 1996	Not hasarious - 1. D. signat asumed not critical for Cat III operation.
	Loss of •5 volts of reg- ulator.	1. D. alarm outpute (both main and atandby) go to a "high" logic level. The control unit processes this as an frommediate transfer and then a shutdown.		· · · · · · · · · · · · · · · · · · ·	X A A A A A A A A A A A A A A A A A A A	10N 10N 10N	ABN". TRANS- FER". Bad "SHUT - DOWN"	I. D. Moo- itor Ala <sup>5</sup> m lights will not be lit.	0.137 34F	
	Loss of -12 volts of ref- ulator.	Alarms on all J. D. monitors (both main and standy) caue- ing an immedite transfer and then a shutdown.			X	d d dFF"	"ABN", "TRANS- FER", "SHUT- DOWN"	Alarm Lights "ON", on "ON", on "ON", on 1. D. No. 2, No. 2, and standby 1. D. mon- itor.	0.290 Å34G	- - 
1	Alarm logi causing a main 1. D. alarm.	The control unit processes this as an immediate it ans- fer and then a'shut- down.		-	X	AON 3N" d FF"	"ABN", TRANS- FER", FER", SHUT- DOWN"	I. D. aîsrm lights will not be lit.	0.262 <sup>3</sup> 34H	- - -
P 4	Alarm logic finibuting the main I. D. alarm.	Loss of main I. D. monitoring ability.	×		Ž	(ZNO	NONE		0.437 341	Noțhamardous 1: D. signal aspumed noț critical for Cat 111 operation.

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System SSIIS

	_		*		1	
Pare 10 of 27		Kentra		Hazardous - hják is similar to Njáp	Not hazardous.	Essentially renders the stand- by util uncless. Essentially renders the main of standing transmitter useless.
	'F'ailure'	Rate A	0. 172 134J	0. 242 <sup>1,</sup> 34K	0.160 ×34L	112A
	inne i i	Other	Stby I. D. alarm light may or may not be lift.		No mis- match on monitor chaméis	Alarma est Marma est montiór chamièn.
,	lure Indicati	Control Usée		, (SNONE)	"NUS- MATCH" and "ABN"	(NONE) ABN TRANS- FER"
	î <sup>1</sup> a:	Renute Control	"NOM" NOM"	(NONE)	NIVM	Nower Now Now Now Now Now Now Now
-	n Operation r Pailure	Ĵ	÷	e.		· · · · · · · · · · · · · · · · · · ·
		r Failur Cat II	×			X x team- tea
	System	Cat III	4	×	×	×
	2	Failure Effect	Shutdow. of stand- by transmitting unit	Loss of standby I. D. monitoring ability.	No serious effection system since a mon- itor mismatch does not effect Cat III operation.	Aithough this fail- ure mode does nis immediately effect interdiately effect the does isoparciate CALIII status. This is due to the fact that any failure on the main unit, which that any failure on the main unit, which that any failure on the main unit, which is due to the fact of STANDA down. If in STANDA down. If in STANDA down. Court: If in STAND- BY, a transitive to OFF will occur. This is due to a momentary lose of signal.
		· Failure Mode	Alarm logic unhibiting the main I. D. alarm.	Alarm logic inhibiting the standby I. D. alarm.	Alarm logic causing a mismatch.	fraability to traansurver traansurting awtiching circuitry. Fremature traansfer of traanser t
ER STATION	4	Function				The chargeover and test circults provide the auto- matic chargeover capa- bility for the redundant transmiting units. It selects upon command from the control unit voich transmitting unit stadiates into the arternas stadiates that the arternas stadiates that the arternas iso dummy loads.
VCAL	Ę	. n. 	*			2
Subsystem 14	Uentificati	ltem Name	Idervilication Monitor Assembly (Regulator/ Alarns Logic)	Continued		Changeover cuita Paak Derectors Excluded)

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311SS System

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Page 13.01 22		Remarks	A stardby montoring circuit faibure.		. •	A 2% Include bith the course and and the course of the cou	It should be need that since signal degradation sufficient be 'our of Cat III to arsince'' the 'Noue net effoct, all post failu,'s modes may be treated an agregate basis. 'ij3A'la the failure state of th 'ij3A'la the failure's rate of th 'ijadition'si.e., up to and ind ing the anternas.
	Fallure	Rate (Ax 10 <sup>6</sup> )	0. 782 Å12Ĉ	0. 070 Å12D	0.070 Å12E	7:417 1:25 (Total) AI2F1 AI2F A12F a 1.209 = 1.209	0.859 113 - 0.509
	ene	Othes,	Alp rm(s) on respec- tive stand- by monitor channel.	Alarms on sensitivity monitor channels.	Alarms on clearance monitor channels.	Alarma cu édine szada livr cháné nels.	Alarma on the sensi- crycty and/ crycty and/ mrynitor channels.
	lure Indicati	Control Unit	"NBA"	"ABN" and "TRANS- FER"	FER "	"ABN"? "ThANS- FER" and "SHUT- DOWN"	"ABN", and "SHUT- "DOWN", and "TRANS- FER"
	Fai	Rèmote Control	"NIAM" Nok" "Nak "Nak	"MON" ABN" and "STBY"	NOM" NBV" ABV" STBY"	ABN" ABN" ABN" OFF"	NOM"
	tion	2			·	X	×
	Oper	Fallu Cat II	×	×	×		-
ł	System	Cat III					
		Failure F'fect	The alarm on the standb' monitor will shudoen the stand- by transmitting unit- the main unit con- tinues to operate cormally.	Alarms on monitor channels initiate a transfer to standby and system operates on standby.	Alarms on the clearance monitors initiate a transfer to standby and sys- tem operates on chardby.	Immediate ahutdown after an automatic transfor.	Since a failure of this type is inde- penden to the trans- mitting unit. An im- médiate shutdown after an autornatic transfer will result.
CK ST AT 10N		Fallure Mode	Failure causing a loss (or in- correct) signal to one of the stand- by monitors.	Total loss for incorrect phasing) of course SBO signal of the main trans- mitting unit.	Total loss for incorrect phasing) of clearance SBO signal of the riain transmitting unit.	Lose of any one or all of. CSE CoSB. CCE SBO. CL CoSB. CL SBO. (to main transmitter)	A total loss any signal path; incor- rect phasing radiated sig- nals or the adjected sig- nal: distor- tion suffic- cient to
		Function					The course distribution circuits serve two pri- mary functions: (1) to route and distribute the course C4SB and SBO signals to the antennas: (2) to construct by use of proximity probes, bridge networks and phase shifters the sig- nals used for monitor- ing course position.
OCAL	lon	1. D. No.	21				5
Subsystem	ldentificat	ltem Name	Changeover and Test Circuita (Continue1)				Course Dis- tribution Cita (Peak Detec- tora,Excluded)

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Table C-1. Localizer Failure Analysis (Cont'd)

System SSILS Subayatem LOCALIZER ST

ent
or alarms, .e., aut of Cat. III tol- trance.
A Joys for Upon fa major dis- immedia cortical of follows ignal for media: ny clear- will oc anto eignal due to to path. the common transm
A loss of Since U ignal (y/a) arappu or p( (a) albut to or p( (a) albut to field peak will re- field peak normina detectors. Note th alert w
Loss of Mar Aarger out- farger out- bour the rempu- put voltage and out- aryout bot voltage and out- aryout bot voltage and out- aryout that the rempu- terise

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SSILS System \_\_\_\_

Page 21 of 27		Remarka	Not hazardové - bodh trans- mittere still available after downgrade.	Not hazardous - a total die- charge of the hattaries can cour only After the system is operated on battaries for some astranded period of time (greater than 3 bours). Sys- tem operation on battaries is a result of ether primary or a failure of both chargers - both of which would downgrade performance to Carli.	To result in a station shutdown both convertors must fall.	Not basardous - both trans- mitters still available after downgrade.
		Rate (Ax 10 <sup>6</sup> )	0.801 AN <sup>A</sup>	6. 436 ANC	6: 598	۷¢۱۷ ۵01 .0
	one	Other	"Charger fall" and/ or "ac or "ac light "on" on respec- tive charg- er.			;
	lure Indicati	Control Unit	"ABN" and "CHARG- ER FAIL" and/or "AC POW- ER FAIL"	(NONE)	"ABN" and "CON- VERTER FAIL"	"ABN" and "TEMP"
	Fail	Remote Control	"PWR/ ENVIR ABN" anù. "MAIN"	(NONE)	The second secon	"PWR/ ENVIR ABN" and "MAIN"
	nci	J		,		
	Operat	Sallur Cat II	Down- grade to Cat II af- ter delay.		Down- grade to Cat il af- ter delay.	Down- grade to Cat il af- ter time delay.
	System	Alter Cat III	×	×	×	×
		Failure Evect	No immadiate effect on system opera- tion - after the pre- set time delay the system will be falssly downgraded to Cat II status.	With the loss at the qualitie capability on one charger, the remaining charger can still provide the equalitie capability as long as the bar- teries are not tecally discharged.	Station maintains normal operation or remaining con- verter voltages. Each of the con- recter voltages is recter voltages is returned in the con- trol unit for abnor- mal tolerartes.	System maintains normal operation - only an erroneous failure indication.
		Fallure Mode	Charger failure in- dication only while output voltage is atill main- tained on tained on tained on	Loss of cualize voltage ca- pability - ual and/or au/omatic. au/omatic acqualize voltage is voltage is voltage is thus provid- thus provid- the batteries	Loss of any one of all of the folloming volta	Failure producing an alarm indication.
ER STATION	-	Function	In the event of a primary power failure the two bat- teries (in parallel) sup- ply the necessary de power.		Each of the DC/DC con- verters transfrom the +30 volts normal input voltage to three different output voltages - 95, 5v, -18v, and -50, The out- put voltages - 00 each con- verter are respectively used in parallel and feed bystem.	The temperature at moors provide alarm inducations whenever the temperature exceeds or drops below preset timits. These tim- its are set to give indica- ion of air conditioner/
OCAL	lon	t. D. Xa.	2 1 2		12 12	£
Subsystem L	Identificat	liem Name	Battery Charger No. 1 or No. 2 (Continued)		DC/DC Converter No. 2 No. 2	Temp Sensors

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			:		System	Operati Failure		Fally	re Indicatio	2	Failure	Pare 22 01 21
Function Fallure Mode	Function Fallure Made	Fallure Mode	<u> </u>	Fallure Effect	111 V	11 100	ž	Remote Ceatrol	Control Unit	Other	Rate f	Renarka
Failures. Producing n alarm in- dication.	Failure producing n alarm in- dication.	Failure Producing n a larm in- dication. dication.	Q	There are two sen- there are two sen- one for high temp- eratures and one for low temperatures. A fallure of the stype in one of the sensors operation of the other. Heade, the other. Heade, the other. Heade, the low of temp. mon- itoring ability for itoring ability for or low. or low.	×			, NONE)	13 NOV		001 0 001 0	Not hazardous - li tamperatura elfecta systém operation, other alarma will occur.
he combining circuits Generation esembly of the far field of an erro- outior processes the neous Cat larms of the monitor III diable larms i, the bot/bC onvertors, the battery barger, and a tempera-	combining circuits Generation mbly of the far field of an erro- lior processes the mous Cat ms of the monitor lif disable meta, the battery servers, the battery ger, and a tempera-	Generation of an erro- neous Cat III disable signal.		No effect other than Safety disabiling Cat III status at the remote control tow- ez.	×	Down- grade to Cat ter time delay.		Vone ex)	NONE)		0.676 	Not basardous - both trans- mitters still avaltable after downgrade.
are sharm. I have yoo- laability to me delays mecesary for Cat III dis- r field monitor champel harme.	tag include 200- tag include 200- dataya mecasary for Cat III dis- field monitor champel me.	Inability to generate a Cat III dis- able signal.		Inability to recog- use far field Cat III "out of tolorance" conditions.	×		<u> </u>	NONE	NONE)		0.874 1.498 1.498 0.102 1.4982 0.102 1.4982 0.530 0.530 0.242	Redundancy/as bean incor- porated in the design to minimize the failure mode propability of occurrence.
Generation da a cro- neous ca fi monitor alarm.	Generation of an erro- monitor alarm.	Generation Botan erró- monitor alarm.		After a nominal 70 accord time delay. the emite localiser etation will abut down. Five accords down. Five accords the soundown. the soundown.			×		"NANOC - LOHS -		0.512 249C	Siace this failure mode' can lead directly to a shutdown withour a Cat III disable. It is basardous.

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SILS System

12 10 27		×.	only paycho-		Cat III far stift avail-	to system	r gates) effect 1 circultry ardoue.	affect Cat,
e d		Remar	Not hazardous logical implicatio		Not hazardous	Not hazardous warning née vital operation.	Only 49HI (inpu actual monitoring which can be hau	Not hasardous - 1 conditions do not III performance.
		Rate (Ax 10 <sup>6</sup> )	0.514 Å9E	0.525 <sup>3</sup> 49E	3.986 19F	1.214 1.214	0. 621 <sup>349H</sup> (rotal) <sup>3</sup> 49H1 = 0. 213	1.476 <sup>.</sup>
	<b>s</b> uc	Other						
	ure Indicati	Control Unit	(NONE)	ABN", SHUT- LOWN" and FIELD SHUT- DOWN"	(NONE)	(NONE)	"ABN" *nd "FAR FIELD MONITOR XIS- MATCH"	(NONE)
1	Fall	Remote	(NONE)	"MON ABN" and OFF"	(NONE)	(NONE)	NON AEN" and "MAIN"	(NONE)
	r.	Ĭ		×				
	Operat	Futur Cat II						
	Sy atem	After Cat III	×	,	×	×	×	×
		Failure Effect	No effect on ayatem operation - only a false shutdown warn- ing signal is gener- ated.	Jmmediate shutdown of the emite local- iter atation with no warning signal gen- erated prior to shut- down.	Loss of Cat II far field monitoring capability. Cat III diable signal still processed normally.	Loss of shutdown warning capability to pilot priar to shutdon priar to "true" far field alarm.	Only the input gat- ing circultry may be basardous match conditions in themselves are not.	No asrious effect on aystern - alarm status conditions are still processed normally.
		Fallure Mode	Gencration of a shut- down alert only.	Generation cf a shut- down signal. (No warning)	Inability to process a Cat II mon- itor alarm.	Inability to process a shutdown alert.	Generation of an erro- neous mis- match sig- nal.	Inability to process a milamatch condition at the FFM.
K F AK F IELU MUNITUK		Function						
	ton	t. D. No.	6					
Subsystem LOC	[dentificat	ltem Name	Jombining Circuita Continued					

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System SSILS Subvision 1 OCAT 17 FB FAB FIFT D V

Page 24 of 27		Remarks	ardora wilden stil avallably after ada.	ardous;	ardous - if power of effect far field monitor nance, the monitors will nance, the monitors will	4. 
			Not has mitter downgy	Not bas	Not has temp dr perform alarm.	
	Fullers	Rate fAx 10 <sup>6</sup>	0. 357 1491	0. 436 <sup>3</sup> 49K	0. 852 <sup>14</sup> 9L	<b>269</b> 0
	suc	Other	A power or temp light may or by "on" at fifm,	"pwr" on "temp" light at the fim.		AL FFM no power or temp alarma displayed. displayed. channels relit alarm after shut- down.
	lure(Indicati	Control Unit	"ABN" "FAR "FIELD PWR/ TEMP"	(NONE)	(NONE)	"ADR" "SHUT- "SHUT- "FAR" "FAR" "FAR" "FAR" TELD MIS- MATCH", TEAP" TEAP"
	Fai	Remate Col. Jol	"POW - ER/ ENVIR ABN" ABN" . MAIN"	(NONE)	(NONE)	NBN", ABN", ABN" ABN" OFF.
	Ę	, ž				×
	oper-	Cat II	Down Brade II af- ter driay			
	System	After Cat 15	×	×	×	
	,	Failure Effect	System falsely down- graded to Cat II status after a set time dulay.	No effect on system appration whatsoo ever - only a filse light "on" at far field monitor sta- tion.	Loss of pur/temp monitoring ability of the far field monitor;	Immediate shutdown of the emire local- laser station, coused by the generation of a shutdown signal from the far field monitor.
		Fallure Mode	Generation of an erro- usous per/ temy alarm.	Generation of an erro- neous pers/ temp alarm that is dia- played only locally.	Inability to process a pyritemp atarm for atarm for either re- mote or local dis- play.	Loss of dc output volt- age on +5v regulator.
R FAR FIELD MONITOP		Function				
IJZTIV:	uo	Υ. D.	49			
Subeyatem LOC	Identificati	ftem Name	Corry aing Circuite (Continued)			

Localizer Failure Analysis (Cont'd) Table C.I.

A STATE

Not hazardous - both converters still operational after downgrade. Note failure mode, has the same effect as an fim hattery failure. Design changes provided down-grade capability. Page.25 of 21 Not bazardous - ( oth traca-mitters still available after downgrade. Remarko NOTE Failure Fate (Ax 10<sup>6</sup>) 0. 095 Å9N 2.412 0.050 Å 5.790 0.519 <sup>3</sup>50B ¥50A ΥNΥ light "on" at FFM. "Charger FAIU" light "on" at FFM "CONV FALL" light "on" at FFM. Other FALL" Fallure Indications Control Unit "ABN" and "FAR FIELD PWR/ TEMP" "ABN" and "FAR FIELD PWR/ TEMP" TEMP (NONE) (NONE) "NBA' None ex-cept "Cat II" after tims de-lay. "PWR/ ENVIR ABN" and "MAIN" Remote Control "NIAN" "MAIN" (NONE) "PWR/ ENVIR ABN" and "PWR/ ENVIR ABN" AbN" Cat III Cat II OII System Operation After Failure Down-grade to Cat II af-Down-grade to Cat II af-Down-grade to Cat 21 af-Down-grade to Cat ter time delay. delay. delaý. time delay. ter time time ter л Ц × ×. × × × If the remaining con-verter also fails, the localizer station will be shut down, due to channels, hence, losing al: far field monitoring capabil-System falsely downgraded to Cat II status after a set If another failure of the battery charg-er causing loss of +24v occura, im-mediate shutdown of the localizer station will result. Insbility to turn on far fleic monitor maining converter. System maintains operation on far field monitor bat-System maintair operation on remonitor channel Fallure Effect time delay. alarms. tery. Γζ. "Low volt-age" battery disconnect circuit fail-ure, discon-ure, discon-battery from the load. Loss of -18 volts output. Loss of +24 volts output. Loss of monitor en-able signal. Generation of an erro-neous con-verter fail alarm. Fallure Mode The battery charger aup-plies +24 volts to each of the units at the fin field monitor - the two con-verters. the three re-ceivers and their respect-ive monitor channels, and the combining circuits assembly. The battery assembly. The battery assembly and battery at the combine charger and battery and the combine charger and the charger and the combine charger and the charger and the combine charger and the c Each of the DC/DC con-verters of the fir field monitor provides -18v. used in the monitor chan-nels and the receivers. They are in parallel and lsohated by diodes. System SSIIS Subsystein LOCALIZER FAR FIELD MONITOR Function 20 ş 2 2 3 Identification Circuite (Ccatinued) Item Combining DC/DC Converter Name No. 1 or No. 2 (FFM) Battery Charger

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Fage 26-of 27	Svaterie Operations Failure Indications	After Failure Remain Control Control Cabor Patience Pernarba	- X (NONE) (NONE	X     Journ-     'PWR/     "ABN"     "Charger     0' 126     Not harardoun - far field       II     X     X and     FAIL"     No     No     harardoun - far field       II     Kodz     ENVIR     FAIL"     NO     No     harardoun - far field       II     ABN"     'FAR     Italt     NO     No     harardoun - far field       II al.     ABN"     'FAR     Italt     NO     no     harardoun - far field       II al.     ABN"     'FAR     Italt     on     harardoun - far field       II al.     ABN"     'FAR     Italt     on     harardoun - far field       II al.     MAN"     'FAR     Italt     on     harardoun - far field       tore     TEMP     at FFM.     tore     tore     harardoun - far field       time     'MAN"     TEMP     tore     tore     harardoun - far field	X ISONEJ (NONE) 7.656 Not basardous - preventive Soft maintenance required for Extremy chech.	X NAON "ABN" RF, Cad bo 879 The SDM strap option provided ABN" and SDM ights NN remote reception of failure. "WAIN" FIELD the control of failure. "WAIN" FIELD respecting MIS- monitor MIS- monitor MIS- monitor MIS- monitor	- X (INONE) (NONE) 0.825 Not hazardous - far field Cat NA 111 monitoring cannot laad to a abutdown, only a performance degradation.
		r Failure Ff	Does not eff. tem operation trickic chart af- still be appli ver the battery.	on System false co- downgraded arg. sistus after sistus after sistos delay.	us Far field me maintain ne maintain at anly. operation at slightly high ply woltage.	<ul> <li>Loss of the signal to the rearry responding 1 will produce monitor mis nonitor wit pablity. Nor product upon for system of for system of for system of</li> </ul>	Loan of 2-of ag itor voting co for the Cati Cat dent upon 1. for Cat III pr for Cat III pr for Cat III pr
TOR		'Failur Mode	Loss of equalize charge c publity ( ter a pro	Generiju of an e'r neous ch er fai alarm	Conticio equalize voltage o	rion Total loi ree of output ig- signal or the major si al distortio re t to t the eld	Loss of monitori a monitori s of shifty - 1 s of ducing a t = 111 DDM ag. alarm.
ER FAR FIELD MONE		Function				Zach of the far field i fior receivers receive a low level of topus ai wal and converts it to it.S audo and dc aign which is then the upu tha respective mention tha respective mention. auduo of gail or opus estative of the far fi course position.	To provide monitorin, of the course position in the far field region the nursery. It provid both Cai III and Cai II both Cai III and Cai II alarm librit monitoric
SILS CALLZI	lin I	. n. . v.	ŝ			នឺភឺ៖ន	35.25
Syatem System 1.00	Identificat	ltem Name	Battery Charger (Continued)			Receiver No. 1, No. 2, or No. 3	Monattor Clarmels No. 1. No. 2. or No. 3

C-27

(Cont'd)
Analysis
Failure
Localizer
C-1.
<b>Fable</b>

SSILS System \_

Pare 27 of 27	Indications Failure	ntrol Other Rate Rate init. Other (Ax 106)	N" DDM light 11.099 A Category III DDM alarm .on" at ANB may or may not be produced. ILD NITOR NITOR FFM.	NE) 4.422 Note that this failure mode <sup>A</sup> NC applies to either or both Cat III or Cat II DDM alarma.	IN" Temp 0.050 Not baraıdous - far field a larm lighd <sup>3</sup> 59A monitorna, etill avállablo LÖ FFM. after downgrivde. AP.	NE) 0.050 Not hazardous - if temperature A59B effect monitoring, alarre, will occur.
	Failu	Remote Control	NOW. NBN. NALN.	(NONE)	"POW- "POW- "FR/ "FR/ "FR/ "FR/ "FR/ "FR/ "FR/ "FR/	(G NON)
<u> </u>	ration .	ure II Oti			1	·
	in Ope	r Fail			Dows grad to Cd ter délay	
	Syate	Cat III	×	×	×	×
		Failure Flfect	Loss of 2 of 3 mon- itor voting capabil- ity. Now dependent upon 1 of 2 remain- ing monitors for system operation.	Loss of 2 of 3 mon- itor voting capabil- ity. Now dependent upon 2 of 2 remain- ing monitor for far field monitoring.	System falsely downgraded to Cat II status after a set time delay	Loss of temperature monitoring ability without recognition.
		Failure Mode	Loss of monitoring ability pro- ducing Cat II DDM alarrn.	Loss of monitoring ability producing no alarme.	Generation of an erro- neous temp. alarm.	Inability to Produce a temp. alarm.
ER FAR FIELD MONITOR		Function			Monitors the tomperature of the FFM for out of tolerance conditions.	
CALIZ	tion	I. D. No.	56, 57, 58 58		65	
Subeyetem LO	Identifica	ltem Name	Monitor Chemiele (Continued)		Temp. Sensor	

Appendix D Glideslope Failure Analysis

## Appendix D

## Glideslope Failure Analysis

This appendix, referred to in section 7.0, consists of the failure analysis for the glideslope, as shown in table D-1.

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Svetem St Subsveteni G	SILS LIDESI	LOPF STATION									['asseo[_] <u>8</u>
ldentificat	Ľ			1	System C	peration		Failure Ind	ications	P'ailu	ې •
lten: Name		Function	l ailure Mode	Failure Flicet		•1 II 0	Rent Cunti	ste Contre rol Whit	other Other	Rair IAX J	16) Remarks.
Course Transe mitter (MAIN or STANDRY)	5225	The course transmitter in contunction with the 10 watt amplifier de- livers a l'111° carrier to the modulator.	Inss or de- gradation of l'HF carrier.	Loss of all course signal radiation. effecting the entire glidepath angle and width.		×	AB AB	NN NN NN NN NN NN NN NN NN NN NN NN NN	Alarme course. NS- sensitiv and nea field m tors.	on 6.73	<ul> <li>Failure of standby unit keeps</li> <li>"main" operational and shuts standby down.</li> <li>NOTE</li> <li>Although mear field monitor</li> <li>lights are "on", their alarms</li> <li>are not processed.</li> </ul>
Clearance Transmitter (MAIN or STANDBY)	2 2 2	The clearance trans- mutter supplies a l'HF carrier modulated at 15012 which is used to ensure low approach angle coverace.	Loss or de- kradation of the 150112 modulation.	Loss of clearance coverage of approach angle. (Pure carrier radiated)		) ¥	MC AB XII ST	NN ABN N and A TRA BY FER	<ul> <li>"SDM A DDM"</li> <li>NS- lights of clearant monitor</li> </ul>	16-1 UN	<ul> <li>Failure of standby unit keeps</li> <li>'main" operational and shute</li> <li>standby down.</li> </ul>
			loss or de- cradation of UHF carrier	Loss of clearance coverage of approach angle.		×	AB AB ST	NN ABN N and BY FER	<ul> <li>SDM"</li> <li>DDM"</li> <li>DDM"</li> <li>ND- RND - R</li> <li>NNS- AND - R</li> <li>Ilights or</li> <li>Clearant</li> <li>monitor</li> </ul>	6.73	· · · · · · · · · · · · · · · · · · ·
10 Watt Ampli- fier (MAIN or STANDBY)	03 C	The 10 watt amplifier merely amplifies the course UHF carrier.	Loss or de- gradation of UHF carrier.	Loss of all course signal radiation.		×	ABN ABA ABA ABA ABA	NN "ABN" F and A "TRA BY" FER	" Alarma course. NS- sensitiv " and near field mo tors.	on 0.68 lty, <sup>Å</sup> N ni-	<ul> <li>Evaluate of standby unit keeps</li> <li>"main" operational and ohute standby down.</li> </ul>
Modulator (MAIN or STANDBY)	0.03	Provides course liff carrier amplitude modu- lated by a OHY and 150 late and CSE C+SB. 150 late at CSE C+SB. 150 signal: a low frequency iSOH2 signal which feeda mitter.	Inse of low frequency os- cillator (14.4 kHz) reult- ing in loss of all 90Hz and 150Hz modu- 150Hz modu- lation.	Loss of the follow- (rg system signals: L. LF 150 2. SB in clearance C-SB 3. Course SBO 4. SB in course C+SB		×	AB AB ST ST	NU "ANN "ANN "ANN "ANN "ANN "ANN "ANN "A		on 2.61 ity. <sup>A</sup> N <sup>2</sup> ity. <sup>a</sup> e. Id.	<ol> <li>"Transfer" would not occur on failure of tandby unit. Loss of Cat. III status would occur even though "main" is still operational.</li> </ol>
			Loss of UHF carrier to digital phas- ing chts. (to either or both of the both of the bhase shifter	Loss of SB in course C-SB signal and course SBO signal,		×	AB AB AT AB AB AB AB AB AB AB AB AB AB AB AB AB	NU "ABN Nu" and BY" FER BY"	" Alarma all cour NS- sensitiv and near field mo tora.	on 0.42 He <sup>A</sup> N1 Ity, <sup>n</sup> i-	

Table D-1. Glideslope Failure Analysis

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Subsystem	1011	ILOPE STATION									Page 2 of 18
Identifica	tion				Syatem	Operation		Fallure Indic	ations		
ltern Name	1. D. No.	Function	Failure Mode	Fallure Effect	After Cat III	Failure Cat II   01	Contr	te Control ol Unit	Other	Rate ()	Remarks
Modulator (MAR) or STANDBY) (continued)	3 7 9		Less of 90 or 150 Hz div- iders. syn- chronization chronization of SoHz shift regis- ters.	Out of tolerance course C45B and SBO and clearance C45B signals.	-/// ·····	×	10W. 14V	N XABNT Pad TRAN	Alarmo on all courses. . sernitivity. near field and clear- ance moni- tors.	1.453 <sup>1</sup> .NC	
			Loas of <sup>3</sup> 2 driving signal to delay linc feither the 90Hz or 150 Hz phase shifter1.	Silght diatortion of the course C4SB and S90 aignals.	×		NON I	E NONE		2.426 DN/	Not-hazardous-signal atili within Cat. 111 tolerance.
			Loss of V <sub>16</sub> driving signal to the delay Unes (either the 90Kz or 150Kz phase shifters).	Distortion somewhat more than A <sub>32</sub> of the course C+SB and SBO signals.	×	<u> </u>	NON	NONE		2.426 <sup>A</sup> NE	Not-hazardous-signal still within Cat. III tolerance.
			Loss of A <sub>8</sub> . <sup>1</sup> <sup>1</sup> <sup>2</sup> <sup>2</sup> <sup>2</sup> <sup>2</sup> <sup>1</sup> <sup>2</sup> <sup>2</sup> <sup>2</sup> <sup>2</sup> <sup>1</sup> <sup>2</sup> <sup>2</sup> <sup>2</sup> <sup>2</sup> <sup>1</sup> <sup>2</sup> <sup>2</sup> <sup>2</sup> <sup>1</sup> <sup>2</sup> <sup>2</sup> <sup>2</sup> <sup>1</sup> <sup>2</sup> <sup>2</sup> <sup>2</sup> <sup>1</sup> <sup>2</sup> <sup>2</sup> <sup>1</sup> <sup>2</sup> <sup>2</sup> <sup>1</sup> <sup>2</sup> <sup>2</sup> <sup>1</sup>	Out of tolerance course C45B and SBO eignals.		×	BLS.	NR ABN Ara and Y FER	Alarms on all course, sensitivity, and near fiel' moni- tors.	<sup>12.632</sup>	
			Lous of +90. -90. +150. or -150Hz phace shifter RF signal.	Our of tolerance C45B aigcal,		× <sup>.</sup>	DATE CONTRACTOR	NN	Alarms on all course. sensitivity and near fors.	1.302 NG	

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System SSIIS Subsystem GIJDESLOPE STATION

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Subsystem G	- IOLI	TOPE STATION								٢		Page 3 of 18
Identificat	nai				System	Operativ	╞	Fallu	re Indicatic	500	Failure	
Item Name		Function	Failure Mode	Failure Effec	After Gat III	Failure Cat II	10	termate "antrol	Control Unit	Other	Rate (IXX 10 <sup>6</sup> )	Remarks .
Modulator Icontinued			Less of the 15011 sinu- sridal signal for clearance transriission-	Out of tolerance clearance C*SB signal.	, ,	×	;	MON ABN' and STBY''	"ABN" and "TRAKS- FER"	Alarme on all čicar- ance moni- tore.	HN.	×
Course Noni- tor Channels 11.2. or 31 MARN	## ##	Pr v ide monitoring of the course position path angle (2)231, the modulation (SDMI) and the course TTHP power level.	Loss of noni- torine ability- producine alarma.	Loss of 2 of 3 moni- tor voing tapabilitu. Now diperdent on 1 No 2 remaining moni- tors for avatem control.	×	·- <u>`</u> ,		MON ARN ARN And MAIN	MONI- TOR MIS- MATCH and ABN	Alarm light(s)'u. defective monitor channel.	12.689 <sup>X</sup> :XA	If another corresponding moni- tor alarm failure occurred in one of the remaining two moni- tors, immediate glidestope shut- down will result.
			Lots of moni- toring ability, producing no alarms.	Loss of 2 of 3 moni- tor voting capability. Now dependent upon 2 of 2 remaining monators for evetent control.	¢ X	1		NONE	NONE		4.836 \`xB	<b>,</b>
Course Moni- tor Channel (STANDBY)	4	Same as main course monitor channels except moditors course para- meters of standby unit.	Loss of moni- toring ability. producing alarms.	Shutdow n of standby transmitter.		x		MON ABN and MAIN	ABN	Alarm líght(s) on standby course monitor.	12.689 46A	
			Loss of moni- torine ability. prodecine no alarms.	Lots of standby course nonitoring.	×			NONE	NCYE		4.836 \46B	
Senaitivity Monstor Channels 1, 2, or 3 (MATV)	3 4 2 6	Provide monitorine of the the course width (DDVI)	Loss of noni- toring ability. producing alarnis.	Loss of 2 al. 3 moni- tor votine capability. Now dependent upon Now dependent upon a d 2 . emiainine nonitors for system control.	×			MON ABN and MAIN	MONI- TOR MIS- MATCH <sup>-</sup> and ABN	Alarm light(s) on defective monitor channel.	1.367 `.XA	If another corresponding moni- tor DDM failure occur red in one of the remaining two moni- tors. innrediate glideslope shújdown.will result.
			Loss of rroni- toring ability- producing no (larms.	Loss of 2 of 3 moni- tor voting capability. Now dependent upon v 2 of 2 remaining monitors for system control.	×			NOXE	NONE		2.802 \.xr	'unly DDM monttorink circuitry is critical.
			a.s	aproduced from est available cop					<u> </u>			

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(Cont'd)
Analysis
Failure
Glideslope
Table D-1.

vatem ClJD		OPE STATION										Pare 4 of 18
lification	Ţ				System	Operati	Ę	315	ure Indicati	a u c	Failure	
<u>- ș</u>	ċ ċ	Function	Fallure Mode	Failure Effect	Cat III	11 10	ž	Penule Control	Control Unit	Other	RAIC 6	Remarks
enst- 47 Attor	5	Provide monitoring of the standby course width (DDM).	late af moni- taring ability producing alarma.	Shutdown of the standby transmitter.		×		"MON" ABN" and "MAIN"	ABN	Alarm Light(a) on standby sensitivity monitor.	9.367 Å 47Å	Only DJJM monitoring circuitry is critical.
			Loss of moni- toring ability producing no alarms.	Loss of standby course monitoring.	×	Ţ	4	NONE	NONE		2.802 <sup>1</sup> 47B	, , , ,
1, 2, 41	2.2.7.2 2.2.7.2	Provide monitoring of the near field cnurse posi- tion path angle (DDNI)	Loss of moni- toring ability producing alarms.	Losa of 2 of 3 moni- tor voting capability. Sow dependent upon 1 of 2 remaining monitors for system control.	×	k		-MON- ADN and MAIN-	"MONI- TOR MIS- MATCH" and "ABN"	Alarm light(s) on defective near field monitor.	\$20.11	SDM and DDM are strapped to provide one general alarm output.
			Loss of moni- toring ability producing no alarma.	Loss of 2 of 3 moni- tor voting capability. Novi dependent upon 2 / 2 remaining montors for system control.	×			NONE	' NONE	- -	3,872 - ÅNB	
* 44 11,2 11,2 12,1 12,1 12,1 12,1 12,1 12	2	Provide monitoring of the clearance DDM. & mod- ulation, and clearance UVIF power level.	Lous of moni- toring ability producing alarm.	Loss of 2 of 3 mont- tor voting čapability. Now dependent upon 1 of 2 remaining monitors för system control.	×			NOW.	WMONT- TOR MIS- MATCH" and "ABN"	Alarm Maht(e) on defective clearance montror.	13.044	If another corrisponding membor a larm failure eccurried to each of the remaining two members, timmediate glideslope shutdewn will result.
		<b></b>	Loss of moni- toring ability producing no alarm.	Loss of 2 of 3 mont- tor voting capability. Now dependent upon Not dependent upon 2 of 2 gemaining monitors for system control.	×			NONE	NON	,	4.848 , MB	
¥ • E		Same a Main Cloarance Monitor Channels except mostrar clearance partmeters of standby unit.	Love of moni- toring ability producing alarm.	Shutdown of standby ti namitter.		×	<u> </u>	NOW.	"ABN"	Alarm Alarm etandby clearance	13.044 Å48Å	

200

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Pare 5 of 18 Remarke Failure Rate Ax 10<sup>6</sup>) 4. R48 1 • Other Failuse Indications Control Unit NONE System Operation Fail After Failure Remote Cat III Cat II Off Control NONE × Loss of Soont- Loss of standby toring shility clastance monitor-producing not ing. Jarm. Fallure Eifect Fallure Mode Function System SSIIS Subeystem <u>GIJDFSI,OPF</u> STATION ċġ Identification Monitor Channel ISTANDRY<sup>5</sup> Icontinue J ltern Name Clearance

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Pare & of 18		Remarka			Only Input gating circuit-RY may be hazardous. (Elfecta monitoring circuitry)	Redundancy has been lacor- ported so that performance downgrade is achieved in the event of a "true Cat. III alarm condition."
	Failure	Rate (10')	12.805 11	2.004 <sup>1</sup> .1B	2. R46 (1, 1C) 0.42) (3, 1C2 (1, 1C2 0.14) (3, 1C3 (3, 1C4 (3, 1C4 (3, 1C4) 0.42)	3.470 1.249 1.249 1.249 1.249 0.140 0.140 0.700 (logic)
	ane	Other			%5 mis- match on monitor channels.	
	ure Indicati	Control Unit	TRANS- TFER SHITT- DOWN- and ABKOR- MAL"	"SHUT- DOWN" and `ABNOR- MAL	MIS- MATCH and "ABNOR- MAL"	ANON
	Failt	Remote	NOW.		SIVM. Put SOK.	A NON
	ation	ğ	×	×		
	1 Operal	Cat ff			、 、	
	Syaten	After Cat III			×	×
		Fallure File 1	Causes both the main and the standby trans- mitter to shutdow n immediately after the transfer.	Gauses both the main mat the standby trans mitter to shuidown immediately.	Miematch conditions do not effect category do formance: how- ever, failure of in- put gates may be hazardous.	Cat. Iff parameter monitoring of the finegral course. sensitivity, and/or clearance is vir- tually rendered useless.
	Fallure Mode		Generation of an erroreous transfer sig- nal, due to alsym prn- cessing cir- cuitry.	Generation of an erroneous shut-down signal due to alarm pro- cealing cir- cuitry.	Generation of marroseous mismatch signsi.	Inability to transfer a nal from the ntegral course, and or clearance monitors.
LOPE STATION		Function	The control unit process. es alarms received from the montior channels, providing signals to shut- down the signaby trans- mitter, to transfer main to standy, to shutdown	book in transmitters. At for indicate a monitor mis- match. In addition, the control unit experates timbibit signals, displays both locally and remotely transmitter and cateory transmitter and cateory	various power femper- aure alarm conditions operational features. such as bypass of moni- tors, main unit select, memorization alarms are also associated with the control unit.	
Sig	8	ů;	5			
Subsystem G	Identificati	ltern Name	Control Unit			

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Pare 2 of 18		Remarka		Redundancy has been incorporated so that performance down grade is achieved in the event of a "true near field alarm condition".	Not hazardous_mismatch condi- tions do not el uct Cat. III per- formance.	If a standby transmitter failure also occurs, immediate shut- down upon transfer will result.	0
2	Failure	Rate 61	1.107 <sup>1</sup> 1E	1.737 <sup>1</sup> 1F	2.146 1.0 1.0	1. 300 1. 1 1. 1	<b>1</b> 1 1
	200	Other			<pre></pre>	Í.	Xo alarma on aby. monitors.
	re Indicatio	Control 1'nit	NONE	NOXE	NONE	XONF	WAL.
-	Failu	Remot: Control	XOXE	1 NON NON	NONF	NONE	NOW. NRV NIVY
	tion	or.			······································		
!	0 Der	Patlu Pat II					×
	Syater	Alter Cat III	×	×	×	x	¥-
		Failure Filer	Results in a loss of tower alignment monitoring.	System will continue to radiate a suchal for subby faulty durine a shutdor in status.	Xo serious effects on svaten opera- tion. Monitor mis- natches may poi be recognized, but parameter out of parameter out of tions are still processed mernally.	Standby unit moni- torix is rendered useless.	Causes the standby shutdown. Main continues to gperate in Cat. 12 status.
		Failure . Mode	bility to ceas a chutdown sig- nal, initiated by the mis- alignow at detector.	Irability to process a abilitydwo ale- abilitydwo ale- by cuther a double trans- fer or the orar 'self alarnus.	Inability to process a ruisnatch condition of any or all noming sets.	Inability to process a standby alarm	Generation of an erroneous standuy alarm.
<b>OPF: STATION</b>		t unction		Reproduced best availab	from ole copy.		
LINESI	E C	1. D. No.	10				
System S. Suhayateni G	ldentificat	ltem Name	Control Unit (continued)				

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12889 3 01 18		Ker.ach s	Not hazardoua-power/environ- mental alarms merely down- grade performance after a time delay yet buth transmitter are still available.	Not hizardous-system still has the ability to operate on both transmitting units.	Yor Yuxardous.	Monitor channel a larm lights are unpredictable due to a race condi- tion between the generated inhibit eignal and the "no signal" fingut a larm processing.	This failure mode is not generated by monitoring circuitry; hence, it may occur.after a transfer to standby has occurred.
		Rate (	2.364	0.415 1K	1.775 \1 L	0.420 <sup>1</sup> 1M	0.286 <sup>1</sup> 1N
	28.	Chher			,	Alarms on some monitor chamels.	Alarma cá some standby monitor channels.
	lure Indicati	Control	NONF	ABNORS MAL ANL And BATT FAIL.	"A3NOR- MA". MA". and possibly the re- spective power or temp- erature alarm	"TRANS. FER" and "Abn"	.Na%.
		Renute Control	NONE	POW/ F.VVIR ABN ABN and MAIN	"POW / ENVIR" ABN" "MAIN"	NOM" NOM"	NOM"
	L I	10					
	Operation			×	Down- grade to Cat. If af after time delay.	×	<b>x</b>
	Synten	Cat III	×		×		
		Failure Filect	Lass of remote recognition of re- spective alarm condutions loss of downgrade capability downgrade capability downental alarma.	No effect other than erroneously down- grading the system to Cat. Il status,	No effect other than an erroncous ab- normal indication.	After the main down, the lose of tadation is detected by the monitor channels and trans- channels and trans- et a initiated to the standy unit.	After the standby transmitter shutc down, the lose of input signals to the standby monitor channels creates standby alarm condi- tions which are processed normally in the control unit.
		t ailure Mode	lability in process any or all pracer' environ- niental alarms.	Generation of an erroneous battery alarm	Generation of cous power/ rous power/ environ- mental marm except a battery alarm.	Generation of an errone- oue control elenal that signal that signal that the main the main transmitting unit.	Genervation of an errone- ous centrol signal that shutdown the standoy transmitting unit
ATTON		+ 1nct 100					
11S TDFS	ę	÷.;	6				
Suhavatem C	Identificati	Iten. Name	Control Units Continueds				

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	Failure		System After	n Operat r Failur	Ę	Failt	Control		Failure Rate	Remarka
	r allure Made	Failure Fife 1	Cát III	7at 11	ž	Control	r ontrol	Other	14 106	Nemarka
	Teneration of In erroneous control ers- libat abute for n both ramemitting inits.	After a total shut- down is initilated, the loss of input argals to all montlor char- nels results in both a simultaneous pro- cessurs of transfer cessurs of transfer tion in the é utrol			×	MON ABN ABN OrF OrF	TRANS- FER SHUT- DOWN ABN	Alarma on some monitor channele.	5.5	, , ,
1277272	ubility to autown autow the ann or the annthy trans- itting unit- itting unit-	Yo failure offect or inducation until conder tabure oc- curred in the main or standby unit. At that time all control signals would be signals would be processed normally. except the respec- tive transmitting unit would not cease transmission.	2			NOXE -	HOX	-	1.782 1.1P	Not hazardous-performance category downgrade also that trans- possible. Note also that trans- fer capability still catists, hore. Cat.III performance is not effected.
22525	ability to fect <sup>2</sup> ance of its feeding r antennas.	No failure effect or indication until a transfer command is received fdue to some other failure). At that time all radiation will cease.	×	5		NONF	NOVE		10	Essentially renders the stand'y transmitter useless.
4 4 5 2	e-mature ance of its feeding Antennas.	If in MAIN, a trans- fer to STANDBY will occurr if in STAND- BY, a transfer to OFF will occur. This is due to a momen- tary loss of signal. tary loss of signal.		X fas- sum- int ini- mAIN status)		MON ABN And ATRY	TRANS- FER ABN ABN	Alarms on some monitor channels.	0.960 JR	Esentially renders either the main or standby transmitter useless.

(Cont'ả)
Analysis
Failure
Glidëslope
D-1.
Table

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System SSILS Subsystem GLIDESLOPF, STATIO

1.ase 10 of 18		Remarks	Upon the generation of a continuous main inhibit. design modifications have been incorporated to take away Car. III and Cat. II status. Althouch both transmitters may still be good . all monitoring is lost. <sup>A</sup> IS1 is similar to 'IH	Fallure mode virtually rendere the standby transmitter useles.	Not hazardous-standby monitoriag is meaningless after a transfer.	Cat.III and Cat. II status taken way although both transmitters are still operational.
	F. 2.1	1 U X 1	2.514 <sup>1</sup> 15 <sup>1</sup> 151 *151 =0.198 (atby. [atby. [abibit] *2.316 (main [abibit]	2.658 \1T	0.370 گال	0.140 W 1 <sup>K</sup>
	8 U C	Other		,		
	lure Indicati	Control T'nit	ABNOR- MAL	NONE	NONE	LOC BYPASS" End NORMALE
	Fail	Permote Control	MON ABN And Main	Jinox	NONE	"ABNOR MAL" Adha and and "MAIN"
	tion	orí	×			×
	Operativ	r Failur Cat II	<b>~</b>			
	System	After Cat III		×	×	•
		Failure Fllect	The respective main and/or standby moni- tor channels are in- hibited and hence. rendered totally useless.	If another failure oc- curs which initiates a transfer, an im- mediate shutdown will occur since the will occur since the inhibited during the transition period.	No effect on system - produces alarms on all standby monitor chamels after a occurred due to amother	The control unit can- not process transfer and shutdown com- mand signals and, bence, the entire monitoring is rendered uselsas.
		Failure Mode	Generation of main and/or standby in- hibit to the monitor channels.	Inability to process a main inhibit to the moni- tor charmels.	Inability to process a standby in- hibit' to the standby moni- standby moni- tor channels.	Ceneration of monitors locally by- passed ignal.
OPE STATION		Function	•			
Sun Sun Sun Sun Sun Sun Sun Sun Sun Sun	Ę	ė į				
Subayatem G	ldentificati	ltern Name	Control Unit (continued)			

11 of 18			· ·		SDM alarma detect "no ons.
Page		Remarks			The atrap option for will be employed to algual" input conditi
	Failure	Rate (1) A 106	0.339 <sup>°</sup> 2. <sup>X</sup> IX	1-464 1.464	S11.2 2
	an	Other	No alarms present on main cabi- net due to inhibit.		RF and SDM lighta the cor- ing near- field moni- tor channel
,	are Indicatio	Control Unit	FER". FER". "SHUT- DOWN". ABNOR- MAL"	ALL FRONT PANEL LIGHTS OFF.	
	Fallur	Remate Cantral	"MON" ABN" and "OFF"	"POW/ "ENVIR" ABN" ABN" and "OFF"	NDN ABN Ard NAIN
	ation	, ŭ	×	×	
	oper-	Cat II			
	System	Cat III			×
		Failure Effect	All delay circuits produce an alarm output; both a con- tinuous main and tinuous main and tiandby inhibit are generated. An im- mediate shutdown will reaul due to the near field delay circuits.	All control logic is rendered uselesa. Both transmitters shuddown: monitors channels. however are inhibited and. alarm.	Loss of the input responding near field monitor chan- neal, causing a moni- tor mismatch. De- pendence upon re- maining two peak detectors/monitor for near field moni- toring now depen- toring now depen- toring now depen- toring now depen- toring now depen- toring now depen- toring result if one of the remaining two peak detector/moni- tors also fails.
~	in the second second second second second second second second second second second second second second second	Fallure Mode	Loss of -12. volts in con- trol unit power supply	Loss of +12 volts in cor- trol unit power supply force: loss of suitched 28 u is also included. J	Loss of de- tected out- put signal.
OPE STATION	3	Function			Each of the near field peak detectors receives near field anterna. The received RF agaal is representative of the course path alignment converts the RF signal into a low frequency sig- nal to be processed by its respective monitor.
	L.	r. D. No.	**	······	28. 307 307
System System GL	Identificati	ltem Name	Control Unit (continued)		Near Field Peak Detector al. a2. or a3. a2. or

Page 12 of 16

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System	SSILS								
Subeystem	CLIDES	LOPE STATION						·	
Identific	atton			Ĩ	System	Operat	ľ	Fall	ure Indicat
líem	L.D.	!	Fallure	:	After	Failure		Remote	101100
Name	хо. Х	Function	Mode	Fallure Effect	Cat III	Cat II	ЭĽ	Control	Unit
Course Peak Detectors 81, 82, or 83 (MAR)	\$ \$ \$ <b>5</b>	Each of the course peak detectors receives a simulated course posi- imput signal is obtained by a combination of sig- mile obtained by prox- imity probes at the radiating antennas. Each peak detector then con- verts the RF signal into a low frequency signal.	Loss of de- tected output signal,	Loss of input signal to corresponding monitor, causing a monitor miarnatch. Dependence upon re- maining two peak maining two peak for integral course position (path angle) monitoring. Now de- position (path angle) course parameter munitors (* s system	×	······································		-MCN ABN" and C "MAIN"	"ABN" and "MIS- MATCH"

、				E
	Remarko .	Note that although both the remaining two paak detectors/ monitors monitor integral court position, only an alarm on one of them is required to initiate a transfer.	Although the remaining two peal detectors incontors the detectors incontors monitor the largest course with parameter only an alarm on one of them is vequired to faitiate a treasfer-	Although there will also be a los cignal will prevent the alarm fr signal will prevent the alarm fr being processed.
Failure?	Rate N× 10	1.115 N	11.11 N <sup>A</sup>	11.1 الأ <sup>ل</sup>
suo	Other	RF and SDM 11ghts correspond- ing course monitor channel.	RF. SDM. and DDM lights "on" on corre- sponding seastithtly monitor channel.	RF and "on" on "the cor- treponding that reauthy course monitor channel.
ure Indicati	Control Unit	and and "MATCH" MATCH"	ABN" and "MIS- MATCH"	NBV.
Fail	Remote Control	MCN ABN" and MAIN"	NMAN Naba Nalain	
Operation	ĕ		s	*
	Cat II			×
System	After Cat III	×	×	
1	Fallure Effect	Loss of input signal to corresponding monitor causing a monitor mismatch. Dependence upon re- aning two peak detectors/monitors for integral course for integral course monitoring. Now de- pendent upon 1 of 2 pendent upon 1 of 2 course parameter munitors for system control.	Loss of imput signal to corresponding to corresponding to corresponding to anomitor manusch. Dependence upon remaining two peak for the system control. Now dependent upon 1 of 2 monitoring for system control.	Lose of imput signal monitor. This, in turn, is processed a sishure in the standby transmitting unit, ceusing the standby unit to be shut down.
	Fallure Mode	Loss of de- tected output signal.	Loss of de- tected output signal.	Loss of de- tected output signal.
	Function	Each of the course peak detectors receives a thom input signal. This input signal is obtained by a combination of sig- mais obtained by prox- fimity probes at the redisting attomas. Each peak detector then con- verts the RF signal into a low frequency signal.	Each of the sensitivity pask detectors receives a simulative disput signal, representative of the course width, This input signal is obtained by a com- bination of signals ob- bination of signal ob- priobes at the radiating asternase. Each pack detector converts the detector converts the	This peak detector re- circle from the stand- by traxemitting unit by traxemitting unit be essentially convertion. Research CSE C45B signal into a low fre- queery signal.
ton	1. D. No.	20, 21, 21,	x x * x	Ā
Identificat	líem Name	Course Peak Detectors 81, 82, or 83 (MARN)	Santity ity Feak Feats 12. or 13 (MAD)	Sitaedby Course Peak Detector

Page 13 of 18		Remarks .		Although the remaining two peak detector /monitors monitor the clearance signal parameters only an alarm on one of them is required to initiate a transfer.	•
	Fallure	Rate (Ax 1C <sup>6</sup> )	1,115 Å32	л. 1 М	811-1 66,
	one	Other	RF.SDM, and DDM Itgha "on" on the cor- creporting standby sensitivity monitor.	RF. SDM. Ilghts "on" on corres- ponding clearance monitor channel.	RF. SDM, and DDM (Ighis 'oon' on the cor- responding clastance monitor.
	are Indicati	Control Unit		"ABN" and "MATCH" MATCH"	
	. Fall	Remote Control	NOM" bra "NIAX"		"MON" ABN" And MAIN"
	tion	ŏ			
	Opera	Fallur Cat II	×		×
	System	After Cat III	·	×	
		Failure Effect	Lose of input signal to the standby sen- stitivity monitor. This. in turn, is processed as a failure in the stand- by transmitting unit causing the standby unit to be shut down.	Loss of input/signal to corresponding clearance monitor channel, causing a monitor miarnatch. Dependene upon re- maining two peak detectors/monitors detectors/monitors for clearance para- monitors for system nonitors for system	Loss of the input signal to the standby clearance monitor. This, in turn, is processed as a failure in the standby by transmitting unit causing the standby unit to be shut down.
		Fallure Mode	Loss of de- tected output signal.	Loss of de- tected output signal,	Loss of de- tected output signal.
OPE STATION		Function	This peak detector re- ceives its input signal from the standby trans- mitting unit. After pro- per attenuation, the input signal is a com- bination of standby course C4SB and SBO. This RF input signal is converted into a low frequency signal.	Each of the clearance peak detectors receives a simulated clearance and signal. This unput signal is obtained by a combination of signal botained from both proz- imity probes. This RF input signal is then converted to a low fre- quency signal.	This peak detector re- ceives its input signal frem the standby trans- mitting unit. After pro- per axtenuation, this thou signal is simply the standby clearance C4SB signal. This RF input signal is then con- verted into a low fre- quency signal.
TLS DESI	E	К. D. Хо.	25	25. 26. 27	£
System Subsystem CI	Identificati	ltern Name	Standby Sanaltivity Feak De- tector	Clearance Feak Do- tectora 11, 12, (MAIN) (MAIN)	Standby Clearance Peak Detector

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	1		<b> </b>	•	e.	
Pare 14 of 18		Remarks ,	Essentially renders the standby unit useless.	Eacritially render a either the math or standby transmitter useless.	A staadby monitoring circuitry failure.	
	Failure	Rate 61	0.221 <sup>A</sup> 10A <sup>A</sup>	0.134 <sup>1</sup> 10B	0.572 <sup>, 1</sup> 10C	00. 070 کا الڈ
	200	Other	2	Alarma on some monitor channels.	Alarm(s) on rsé- pective standby monitor channel.	Alarme on sensitivity monitor channels.
,	lure Indicati	Control Ur <sub>j</sub> i	NONE	"ABN" and "TRANS- FER"	,	
	Fai	Remate Cantroj	JNON	NOW.	"MON" ABN" abad "MAIN"	NBN: Pas TBY:
	tion	r ye	,			
	n Operat	Cat II		X fassur ing ini tial MAIN status	×	×
	System	Cat III	×			
		Failure Effect	Although this tailure mode does not im- mediately effect system operation, it does jeopardize Cat. III atatus. This is due to the fact that any failure on the and only ženerate should only ženerate a changeover to a changeover to tha system shut- down.	If in MAIN, a trans- fer to STANDBY will by a transfer to OFF will occur. This a due to a momen- tary lose of Aignal.	The alarm on the standby monitor will shut down the standby transmitting unit - the main unit con- tinues to operate normally.	Alarms on monitors channels initiate u trasfer o standby and system operates on standby.
		Failure Mode	Inability to transmitting units by switching circuitry.	Pre-mature transfer of transmitting units to an- tennas by switching. circuitry.	Fallure caus- ing a loss (or incorrect) signal to one of the standby monitors.	Total loss (or phasing) of course SBO signal of the main trans- mitting unit.
OPT STATION		Function	The changeover and test circuls provide the auto- matic changeover capa- bility for the redundant transmitting units. It transmitting units from the control unit which transmitting unit radiates into the anternas into dummy foads.			
s115	lion	1. D. No.	<u>0</u>			
System Subsystem C	Identificat	ltem Name	Changeover and Test Cir- Delactor Delactor Excluded)			

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Page 15 of 18		Remarks		It should be noted that since any signal degradation sufficient to be "out of Cat. III "olerance" has the same net effect, all "possible failure modes may be treated on an aggregute basis.	,	
	Fallure	Rate (Ax 10 <sup>6</sup> )	1.951 Å10E 10E1 10E1 0.466 (each pin ewiich circuit)	11.11	0.778 <sup>1</sup> 12	0.098 18
	840	Other	Alarma on some mont tor chan- nels.	Alarms on any or all of the monitor channels.	Alarms on any or all monitor channels.	Alarms on near field monitors.
	lure Indicati	Control Unit	"A SN". "TRANS- FER" and "SHUT- DOWN"	"ABN" and "TRANS- FER" and "SHUT- DOWN"		"ABN" and "TRANS- FER" and SHUT- DOWN"
;	Fall	Remote Control	NGK ABN" ABN" ABN" ABN"	ABN". ABN" And Ard OFF	MON ABN Abnd Of F	ABN" ABN" ABN"
	Ę	18	×	×	×	×
	Dera					
OPE STATION	System	Cat IT' C				
	۲. ۲.	Fallure Effert	Immediate shuidown after an automatic transfêr	Since a failure of thin type is independent of the transmitting unit (signal paths common to both transmitters), an immediate shutdown after an automatic transfer will result.	The actual field ra- diasion is uneffected. However, the moni- tor channels believe an "out of tolerance" condition exists and initiate a transfer, since the circuitry is common to both transmitting unit, the monitors will again nolerance" condition down.	The erroncous for total foss off signal is processed as a near field alarm. fer and a shudown after the nominal time delay
		Fallure Mode	Loss of any one or all of: CSE C+SB, CSE S30, CLC C+SB, to main trans- mitter)	A loss, de- gradation, or incorrect phasing of any signal freding any one of the anternas.	A loss, de- gradation, or ghosorret phase of any signal feed- ing any of the monitors.	A loss of de- gradation of ignal feed- ing the moni- tors.
		Fraction		The CHF distribution circuits combine and distribute the CSF C+SB. CSF SBQ, and CL C+SB signals to the three 2- lambda antennas.	The UHF recombining circuits, receiving in- puts from prodes, com- detector probes, com- bine the CSE C+SB, CSE SBD and CLC+SB to provide inputs to moni- provide inputs to moni- to mo	Provides the input for the three near field monitors.
ILS	ő	1. D. No.	2	=	2	8
System Subayatem GI	Identificati	ltern Name	Changeover and Teat Circu'is (continued)	Distribution Ciccuita (Antennaa included)	UHF Recombi- ning Circuite and Probes (pask detectors ercluded)	Near Field Anterna and Power Spitter (peak Gspitter (peak cluded)

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SSILS System \_

Pare 16 of 18		Remarke,	Not hazardous-redundancy of rémuing chaiger and the two, batteries provide negligible probability of station shutdown.	Not hazardous-both transmitters still available after downgrade.	Not hazardous-a total diacharge of the bathrias can occur only after the system is operated an batterles for some artended batterles is a realt of either baurs). System operation on batterles is a realt of either failure of both chargers - bedy of thick would downgrade performance to Cat. IL.
	Failure		10.477 ÅNÅ	0.801 ÅNB	
	ano	Other	charger fau" light "on" on charger.	"charger fail" and/ or "AC or "Ight fail" light "on" on re- specive charger.	·
	lure Indicati	Control Unit	TABN" and CHARGER FAILURE"	"ABN" and "CHARGER FAILURE" and /or "AC POW- ER FAIL"	NONE
	Fal	Remate Cantrol		-PWR/ ENVIR ABN" and "MAIN"	NON
	tion	, Sir		,	
	Opera	Cat II	Cown- rrade (a Cat. (a Iter felaý. felaý.	Down- Frade Cat. So Cat. Jelay.	
	Syatem	Alter Cat III	×	×	x
	Fallure Fflect		When one charger fails (total loss of output voltage), the remaining charger aupplies the necec- aryphies the necec- current to continue normal operation. It also still supplies the voltage to maintain fail charge on both batteries.	No immediate effect on system operation- after the pre-set time daixy the ys- tem will be falsely downgraded to Cat. If status.	With the loss of the equalize capability on one clarger, the remaining charger can still provide the equalize capability as long as the battories are not totally discharged.
		Failure Mode	Loss of charger out- put voltage norminal out- put voltage is 30 volta DC)	Charger (ailure indi- cation only while ocipit voltage is still main- tained on both chargers.	Loss of equalize espa- vojtage espa- bility-stiber manual and/ or automatic. Nore: the équalize evolta DC. voltage i a appendad 33 voltage i a tag 4 "bard charge" to the batteriet.
SLOPE STATION		Function	The two bittery chargers which are supply all the parallel, supply all the equipment of the glide- slope station. In addition to supplying the power to the electronic equipment, each battery charger charge is constantly maintained on both	batterice. In the event of a primary power (alure the two batteries (in parallel) aupply the necessary DC power.	
1102	E G	1. D.	2 2 4		
Subvyetem G	Identificat	lten Name	Batter's Charler #1 or #2		

Pare 17 of 18	System Operation Failure Indications Failure	Failure Filere Cat III Cat II Cot 1 Control Control Other Rate Remarks	Insert of Say     Station maintains     X     Down     "PWR/     ABN"     6.598     To result in a station shutdom       one or all of mormal operation on the frace     EXVIR     and     N     6.598     To result in a station shutdom       the four all of mormal operation on the frace     EXVIR     and     N     N     both converters     must fail.       the following     remaining     To result in a station shutdom     N     N     both converters     must fail.       the following     remaining     To result in a station shutdom     ASN"     CON.     N     both converters     must fail.       the observation     If after     ASN"     To result in a station shutdom     N     N     both converters     must fail.       s5.5V.     converter     time     ''MAIN"     'FAIL"     ''N     ''N     both converters     must fail.       s5.5V.     unit for abnormal     time     ''MAIN"     'FAIL"     ''N     ''N     both converters     must fail.       s50V.     unit for abnormal     to result     ''N     ''N     ''N     ''N     ''N	Failure pro- ducing an ducing an only an erroneous     X     Down- Furde     "PWR/     "ABN"     0.100     Not harardous - both transmitters       ducing an ducing an only an erroneous     normal operation - to Cat.     ENVIR     and ABN" $\lambda_{ITA}$ still available after downgrade.       alarm     only an erroneous     to Cat.     ABN"     TEMP"     and $\lambda_{ITA}$ still available after downgrade.       indication.     failure indication.     filer     and $\lambda_{ITA}$ still available after downgrade.       indication.     failure indication.     filer     and $\lambda_{ITA}$ still available after downgrade.	Failure pro- ducing no area two sen- ducing no area (thermocouples) ducing no area (thermocouples) alarma will accur. indication. the ad one for low temperatures. A time of the the does not effect in the one of the onty effect is the low of temp. monitoring of temp. monitoring temperature extreme fully for only one femperature currents	Loss of Erroneous shutdown X "MON "ABN" ABN" ABN" As 4.915 alignment of the glideslope and "SHUT. ABN" AgA detection, station
	Failure Ind	note Contr itrol Unit	WR/ "ABN VIR and BN" "CON NG VERT AIN" "FAIL"	WR/ "ABN" VIR "ABN" BN" "TEM AIN" AIN"	NON	INIT ALL ALL ALL ALL ALL ALL ALL ALL ALL AL
	u c	0.1 Part			2	× * •
	Operati	Failure	Down	Down- crade o Cat. 1 after ime elay.		
	System	Cat III	×	×	×	
		Fallure Fllect	Station maintai 18 wormal operation on wormal operation on voltages. Fach of the converter voltages is converter voltages is unit for abnormal unit for abnormal tolerances.	System maintains normal operation - only an erroneous failure Indication.	There are two sen- one for high tempera- one for high tempera- tures and one for low temperatures. A temperatures. A detainter of this type in one of the sensors does not effect the only effect is the loss of temp. monitering a temperature extreme thigh or low).	Erroneous shutdown of the glideslope station.
		Failure Mode	1.028 of Sny one or all of the following the following +5.5V -18V. -50V.	Fallure pro- ducing an alarm indication.	Failure provident no ducing no ducing no indication.	Loss of alignment detection, producing an alarm.
OPF STATION	Function Fach of the DC /DC con- verters transforms the +10 volts normal input voltage to three different output voltages 0 +5.5V, -18V, and -50V, The converter are respec- tively used in parallel and fed both modulators in the system.		The temperature armoors provide alarm indications whenever the temperature exceeds or drops below pre-set limits. These limits are set to give indication of air-condi- tioner/heater failures.		The misalignment de- tector detects perma- nent misalignment or deformation of the glidealope antenna tower. A nominal 135 seconds de lay is pro- vided to process alarma.	
ISTUS	tìon	1. D. No.	15 15 16	13		ç
System Subaystem C	Identifica	ltern Name	DC/DC Con- verter #1 or #2	Temp Sensors		Misalignment Detector

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Page 10 of 48 Design modifications have incorporated a "quick test functional check. Remarka Failure Rate (Ax 10<sup>6</sup>) 2.354 29B Other Failuré) Indications Control Unit NONE Remote Control NONE Cat III Cat II Off System Operation After Failure × Although the near field monitors de-field rudiarion. an erroneous signal radiation can still radiation can still mialignment in the horizontal plane chiefly effects the width of the glide path angle and the clearance radiation. Fallure Effect Lces of alignment detection. producing no alarm. Fallure Mode Function System SSILS Subeystem <u>GLIDESLOPE STATION</u> . Identification Misalignment Dytector (continued) lten Name

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Table D-1. Glidesløpe Failure Analysis (Cont'd)

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Appendix E Localizer Math Models

# Appendix E

# Localizer Math Models

This appendix consists of tables E-1 and E-2, referred to in section 8.0, which give, respectively, probability math models for localizer hazardous signal radiation and shutdown.

Pare Lol Z	Remarks	Note: The failure rate for A MON s worst case since no discrimination is mide with regards to RF, SDM, and DDM alarms. The failure rate for MON FF worst case alato. Worst case lailure rates are again used for A XMTR SEDDM sible failure mode failure rates have been included which can produce a Cat. III course position DDA out of to toter analysis. Hence, a worst case analysis. Hence, a worst case analysis. Hence, a worst case analysis. However, the calculation is extremely simpli- fied by a worst case analysis. A weekly monitor and control logic preventive maintenance, cycle is as- which result in a loss of mönitoring which result in a loss of mönitoring which result in a loss of mönitoring ability.
	l'aflure Rate Data	MONCSE '3511 3.11 MONCSE' '3511 3.11 CATE '111 0.140 × 10 <sup>-6</sup> 1.0010 112 0.700 × 10 <sup>-6</sup> 1.0010 112 0.700 × 10 <sup>-6</sup> NONF 5.00 500 × 10 <sup>-6</sup> AONFF 5.00 500 × 10 <sup>-6</sup> 2.800 4.122 × 10 <sup>-6</sup> 2.810 1.222 × 10 <sup>-6</sup> 2.810 1.221 2.832 × 10 <sup>-6</sup> 3.000 4.13 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 × 10 <sup>-6</sup> 3.000 ×
	Probability Calculation	$P^{\text{MIN}}_{\text{F}}(\text{csr}_{\text{DDM}} + P^{\text{MIN}}_{\text{F}}(\text{csr}_{\text{DDM}} + P^{\text{MIN}}_{\text{F}}(\text{csr}_{\text{DDM}} + P^{\text{MON}}_{\text{F}}) + P^{\text{MON}}_{\text{F}}(\text{csr}_{\text{DDM}} + P^{\text{MON}}_{\text{Csr}}) + P^{\text{MON}}_{\text{Csr}}(\text{csr}_{\text{DDM}} + P^{\text{MON}}_{\text{Csr}}) + P^{\text{MON}}_{\text{F}}(\text{csr}_{\text{DM}} + P^{\text{MON}}_{\text{F}}) + P^{\text{MON}}_{\text{F}}(\text{csr}_{\text{DM}} + P^{\text{MON}}_{\text{F}}) + P^{\text{MON}}_{\text{F}}(\text{csr}_{\text{F}}) + P^{\text{MON}}_{\text{F}}(\text{csr}_{\text{F}}) + P^{\text{MON}}_{\text{F}}) + P^{\text{MON}}_{\text{F}}(\text{csr}_{\text{F}}) + P^{\text{MON}}_{\text{F}}) + P^{\text{MON}}_{\text{F}}(\text{csr}_{\text{F}}) + P^{\text{MON}}_{\text{F}}(\text{csr}_{\text{DDM}}) + P^{\text{MON}}_{\text{F}}(\text{csr}_{\text{DDM}}) + P^{\text{MON}}_{\text{F}}(\text{csr}_{\text{DDM}}) + P^{\text{MON}}_{\text{F}}) + P^{\text{MON}}_{\text{F}} + P^{\text{MON}$
	Probabilitiv Description	Probability of the radiation of a hazardous course position Cat. III DDM signal due to equip- note. Far field hazardous DDM signal due to external runway disturbances is not included in this calculation.

Table E-1. Localizer Hazardous Signal Radiation Probabilities

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Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

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Remarks		For the probability PFCSEDDM some number must be assumed since this number is unpredictable, being a function of runway activity. For convenience, let PFCSEDDM
Fatlure Rate Data		$\frac{1}{2} MON_{FF} = ^{3}5LC = ^{4}57C$ $= ^{5}8C = 4.422 \times 10^{-6}$ $\frac{1}{CATE_{FF}} = ^{4}981 = 0.102 \times 10^{-6}$ $\frac{1}{1} LOCIC_{FF} = ^{4}982 = 0.530 \times 10^{-6}$ $\frac{1}{1} REDUND_{FF} = ^{4}983 = 0.242 \times 10^{-6}$
Probability Calculation	$P_{XMTR}CSE_{DDM}$ The probability that an actual hazard oue Cat. III course DDM will be radiated, with no other parameters being effected. $P_{INT}CSE_{DDM} = 8,200 \times 10^{-7}$ $P_{INT}CSE_{DDM} = 1.301 \times 10^{-14}$ $+ 0.247 \times 10^{-7}$ $+ 0.247 \times 10^{-7}$ $+ 0.247 \times 10^{-7}$ $P_{MON} = 5,519 \times 10^{-7}$ $P_{MON} = 5,519 \times 10^{-7}$ $+ 5,013 \times 10^{-7}$ $+ 5,032 \times 10^{-7}$ $+ 5,032 \times 10^{-7}$ $+ 5,555 \times 10^{-7}$	$P(HS)_{FF} - P_{MON}_{FF} \cdot P_{FF}_{CSE} CSE_{DDM}$ $P_{MON}_{FF} + (^{MON}_{FF} + 168)^{3} + (^{CATE}_{FF} + 168)^{3} + (^{LOCIC}_{FF} + 16$
Probability Description	Probability of the radiation of a hazardous course position Cat. III DDM signal due to equipment failure. (continued)	Probability of the radiation of a hazardous signal that is out of Cat. Ill course position toler- ance at the far field only.

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Page 1 of 1	Remarka		Note: Since the proceesing for any parameter is virtually identical in the control unit, the same failure rates for AGTE' LOGIC' 201 Are utilised. By employing ANON in the calculation of PiNT CSE SDM worst case analysis again recults.
	Failure Rate Dáta		$\lambda_{MON}_{CSE} = \lambda_{35B} = \lambda_{36B}$ $= \lambda_{37B} = 5.390 \times 10^{-6}$ $\lambda_{GATE} = \lambda_{1D1} = 0.1402.6 \cdot 0^{-6}$ $\lambda_{LOGIC} = \lambda_{1D2} = 0.700 \times 10^{-6}$ $\lambda_{REDUND} = \lambda_{1D3} = 1.249 \times 10^{-6}$ $\lambda_{3B} = 0.413 \times 10^{-6}$ $\lambda_{3B} = 0.413 \times 10^{-6}$ $\lambda_{3G} = 1.302 \times 10^{-6}$ $\lambda_{12D} = 0.070 \times 10^{-6}$ $\lambda_{12} = 0.070 \times 10^{-6}$
	Probability Calculation	$P_{MON_{FF}}$ = The probability of a hidden failure in the far field Cat. III DDM monitoring circuitry. $P_{MON_{FF}}$ = 5,555 x 10 <sup>-7</sup> $P_{MON_{FF}}$ = 5,555 x 10 <sup>-7</sup> $P_{FCSE}$ $P_{FCSE}$ The probability that the ILS signal will be out of Cat. III DDM toler- ance at the far field due to external runway disturbances during the crit- ical landing phase of a Cat. III land- ing. P(HS)_{FF} = 5,555 x 10 <sup>-10</sup>	P(HS)_CSE_SDM * PINT_CSE_SDM * PXMTR_CSE_SDM * CSE_SDM * (1, DOSLCS * 168) * (1, LOGIC * 168) * (1, LOGIC * 168) * (1, LOGIC * 168) * (1, LOGIC * 168) * (1, LOGIC * 168) * (1, LOGIC * 168) * (1, SE_SDM * (1, XMTR_CSE_SDM * 168)
	Probability Description	Probability of the radiation of a hazardous aignal that is out of Cat. III course position toler- ance at the far field only. (continued)	Probability of the radiation of a hazardous course position Cat. III SDM signal, i.e., incorrect percentage modulation.

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Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

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Remarks	7	Worst case analysiy performed.
Failure Pute Data		Utilisation of $\lambda_{MON}_{CSE}$ is general and worst case; hence. $P_{INT}_{CSE}_{RF}$ = $P_{INT}_{CSE}_{DDM}$ int $CSE_{SDM}$ $\lambda_{XMTR}_{CSE_{RF}}$ ; $\lambda_{2B} = 7.150 \times 10^{-6}$ $\lambda_{3B} = 0.413 \times 10^{-6}$ $\lambda_{3B} = 0.413 \times 10^{-6}$ $\lambda_{12F1} = 1.209 \times 10^{-6}$ $\lambda_{12F1} = 1.209 \times 10^{-6}$ $\lambda_{12F1} = 1.209 \times 10^{-6}$ $\lambda_{13A} = 0.509 \times 10^{-6}$ $\lambda_{MTR}_{CSE}$
Prohability Calculation	PINT CSE <sub>SDM</sub> The probability of a 'f. flure of the course Cat. 111 SDM integral moni- toring circuitry, (hidden) PXMTR CSE SDM The probability that an actual harard our Cat. 111 SDM will be radiated, with no other parameters effected. "It'T GSE SDM The probability that an actual harard our Cat. 111 SDM will be radiated, with no other parameters effected. "It'T GSE SDM P (HS) CSE SDM P(HS) CSE SDM	$P_{IHS})_{CSE}_{RF} = P_{IMT}_{CSE}_{RF}$ $= P_{XMTR}_{CSE}_{RF} = (\frac{1}{2}MON_{CSE} - 168)^{2}$ $= (1 - \frac{1}{2}MON_{CSE} - 168)^{2}$ $= (1 - \frac{1}{2}MON_{CSE} - 168)^{2}$ $= (1 - \frac{1}{2}MON_{CSE} - 168)^{2}$ $= (\frac{1}{2}MTR_{CSE}_{RF} - 168)^{2}$ $= (\frac{1}{2}MTR_{CSE}_{RF} - 168)^{2}$
Probability Description	Probability of the radiation of a haardore course position Cat. III SDM signal, i.e., incorrect percentage modulation. (continued)	Frobability of the radiation of a signal that is cut of Cat. III. limit with respect to course RF power.

Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

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Pake 5 of 7	Remarks -	- -	Worst case analysis performed.
	Failure Rote Data	5	$\lambda_{MON_{SEN}} = ^{38B} = ^{39B}$ $= ^{40B} = 2.892 \times 10^{-6}$ $\lambda_{GATE} = ^{101} = 0.140 \times 10^{-6}$ $\lambda_{GATE} = ^{101} = 0.700 \times 10^{-6}$ $\lambda_{EDUHD} = ^{103} = 1.249 \times 10^{-6}$ $\lambda_{SEN}$
	: Calculation	$P_{INT}^{F} CSE_{R}^{F}$ The probability of a failure of the course Cat. III RF intragral monitor-ing circuitry. (hidden) $P_{XMTR}^{F} CSE_{R}^{F}$ The probability that an actual harard-ous signal outside of Cat. III power limit will be radiated, with no other parameters effected. $P_{INT}^{F} CSE_{R}^{F} P_{INT}^{F} CSE_{DDM}^{F}$ $= 8.447 \times 10^{-7}$ $= 8.447 \times 10^{-7}$ $= 8.447 \times 10^{-7}$ $= 1.778 \times 10^{-3}$ $P_{(HS)}^{F} CSE_{R}^{F} = 1.778 \times 10^{-3}$	P(H5) <sub>SEN</sub> = P <sub>INT<sub>SEN</sub> · P<sub>XMTR<sub>SEN</sub></sub> P<sub>INT<sub>SEN</sub> = (<sup>A</sup>MON<sub>SEN</sub> · 168)<sup>2</sup> + (A<sub>GATE</sub> · 168)<sup>3</sup> + [(A<sub>LOGIC</sub> · 168) * · <sup>T</sup>A<sub>LOGIC</sub> · 168) * · <sup>T</sup>ATTR<sub>SEN</sub> · <sup>163</sup></sub></sub>
	Prohability Description	Probability of the radiation of a signal that is out of Cat. III limit with respect to course RF powers. (continued)	Probability of the radiation of a signal the is out of Cat. III limit with respect to course width-sensitivity. DDM.

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Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

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Remarko		As in the case of the course param- eters, a general failure rate ( $\lambda_{MON}$ ) of the hidden failures within the clearance monitor chan- nels will be utilized, leading to a worst case analysis. Note: Probabilities of the radi- ation of a harardous signal that is out of clearance Cat.JIII SDM or RF tolerances are virtually zero. This is due to the fact that any change in the percentage of modulation or RF power simultaneously effect the clear ance DDM. No isolated failure rates for these two parameters exists.
Failure Rate Data		$MON_{CL} = \frac{1}{43B} = \frac{1}{44B}$ $= \frac{1}{45B} = 5.551 \times 10^{-6}$ $CATE = ^{1}D1 = 0.140 \times 10^{-6}$ $COCIC = ^{1}D2 = 0.700 \times 10^{-6}$ $REDUND = ^{1}D3 = 1.249 \times 10^{-6}$ $REDUND = ^{1}D3 = 1.249 \times 10^{-6}$ $= \frac{1}{4A} = 1.446 \times 10^{-6}$ $= \frac{1}{4A} = 7.150 \times 10^{-6}$ $= \frac{1}{4B} = 7.150 \times 10^{-6}$ $= \frac{1}{3} = 0.250 \times 10^{-6}$ $= \frac{1}{3} = 0.388 \times 10^{-6}$ $= \frac{1}{3} = 0.388 \times 10^{-6}$
P <sub>5</sub> obability Calculation	PINTSEN INTSEN Tra probability of a failure of the sensitivity Cat. III DDM integral monitoring circuitry. (hidden) "ZMTRSEN The probability that a signal that is out of Cat. III tolerance for course width be radiated, with no other parameters effected. PINTSEN + 1, 301 × 10 <sup>-7</sup> 1NTSEN + 1, 301 × 10 <sup>-7</sup> + 0:247 × 10 <sup>-7</sup> 2, 605 × 10 <sup>-7</sup> 2, 205 × 10 <sup></sup>	$P(BS) = PINT CL_{DDM} = PINT CL_{DDM}$ $PXMTR CL_{DDM}$ $PINT CL_{DDM} = (A_{MON}CL = 168)^3 + (A_{CATE} = 168)^3 + (A_{CATE} = 168)^3 + (A_{LOCIC} = 168)^3 + (A_{LOCIC} = 168)^3 + (A_{TCIC} = (A_{TT} R_{CL} = (A_{TT} R_{CL} = A_{TT} R_{CL} = A_{TT} R_{CL} + A_{TT} R_{CL} + A_{TT} R_{CL} + A_{TT} R_{CL} + A_{TT} R_{CL} + A_{TT} R_{CL} + A_{TT} R_{TT} R_{TT} + A_{TT} + A_{TT} R_{TT} + A_{TT} + A$
Probibility Desci-iption	Probability of the radiation of a signal that is out of Cat. III limit with respect to course width-sensitivity DDM. (continued)	Frobability of the radiation of a hararatdous signal that is out of clearance Cat. III DDM tolerance.

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Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

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Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

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Remarks	
Failure Rate Data	$\frac{x_{12F}}{x_{12F}} = 1.209 \times 10^{-6}$ $\frac{x_{12F}}{x_{12F}} = 0.070 \times 10^{-6}$ $\frac{x_{14A}}{x_{MTR}} = 1.032 \times 10^{-6}$ $\frac{x_{MTR}}{CL_{DDM}} = 23.853 \times 10^{-6}$
Probability Calculation	PINT $CL_{DDM}$ The probability of failure of the clearance Cat. III DDM integral monitoring circuitry. (hidden) PXMTR $CL_{DDM}$ The probability that the radiation of the clearance signal will be out of Cat. III tolerance for DDM, with no other parameters effected. FINT $CL_{DDM}$ $T_{11} CL_{DDM}$ $10^{-7}$ $R_{11} CL_{DDM}$ $10^{-7}$ $= 8.944 \pm 10^{-7}$ $= 8.944 \pm 10^{-7}$
Prchability Description	Probability of the radiation of a basardous signal that is out of clearance Cat. III DDM toler- ance. (continued)

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Table E-2. Localizer Shutdown Probabilities

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Remarke	The subscript on A refers to the failure mode: hence, failure rate identification is readily accomplish- ed.
Failuro Rate Data	$\begin{aligned} \lambda_{1} = 3.507 \pm 10^{\circ} \\ \lambda_{1} = 3.507 \pm 10^{\circ} \\ \lambda_{1} = 0.140 \pm 10^{-6} \\ \lambda_{1} = 0.339 \pm 10^{-6} \\ \lambda_{1} = 1.506 \pm 10^{-6} \\ \lambda_{1} = 0.859 \pm 0^{\circ} 0^{-6} \\ 13.6 = 0.397 \pm 10^{-6} \\ \lambda_{2} = 0.060 \pm 10^{-6} \\ \lambda_{3} = 0.000 \pm 10^{-6} \\ \lambda_{4} = 0.000 \pm 10^{-6} \\ \lambda_{4} = 0.252 \pm 10^{-6} \\ \lambda_{4} = 0.252 \pm 10^{-6} \\ \lambda_{4} = 0.525 \pm 10^{-6} \\ \lambda_{4} = 0.525 \pm 10^{-6} \\ \lambda_{4} = 0.525 \pm 10^{-6} \\ \lambda_{1} = 0.525 \pm 10^{-6} \\ \lambda_{1} = 0.690 \pm 10^{-6} \\ \lambda_{1} = 0.610 \pm 10^{-6} \\ \lambda_{1} = 0.525 \pm 10^{-6} \\ \lambda_{1} = 0.525 \pm 10^{-6} \\ \lambda_{1} = 0.525 \pm 10^{-6} \\ \lambda_{1} = 0.525 \pm 10^{-6} \\ \lambda_{1} = 0.512 \pm 10^{-6} \\ \lambda_{1} = 0.512 \pm 10^{-6} \\ \lambda_{1} = 0.525 \pm 10^{-6} \\ \lambda_{1} = 0.52$
Probability Calculation	F = E <sup>3</sup> . Single Fallures : 10 SEC P <sub>S</sub> = (14.083 × 10 <sup>-6</sup> ) × 10/3600 P <sub>S</sub> = 3.912 × 10 <sup>-8</sup> P <sub>S</sub> = 3.912 × 10 <sup>-8</sup>
Probability Description	Single failures in the localizer equipment that cause immediate localizer ahudown.

e Remarks	Any failure mode of $\lambda_{B}$ will abut down the failure mode of $\lambda_{B}$ will abut down the localizer station. Note that all failure modes considered in $\lambda_{A}$ and $\lambda_{B}$ are free of hidden fail- ures: hence, the IO second time inter- val for probability calculations is common to all failure modes.
Failure Rafe Data	A: $\frac{1}{2}$ A = 1.446 × 10^{-6} $\frac{1}{2}$ B = 7.150 × 10^{-6} $\frac{1}{2}$ A = 1.446 × 10^{-6} $\frac{1}{3}$ A = 2.413 × 10^{-6} $\frac{1}{3}$ A = 2.413 × 10^{-6} $\frac{1}{3}$ A = 2.413 × 10^{-6} $\frac{1}{3}$ A = 1.453 × 10^{-6} $\frac{1}{3}$ A = 1.2.832 × 10^{-6} $\frac{1}{3}$ A = 1.322 × 10^{-6} $\frac{1}{3}$ A = 1.368 × 10^{-6} $\frac{1}{3}$ B = 1.3134 × 10^{-6} $\frac{1}{3}$ B = 1.3134 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.338 × 10^{-6} $\frac{1}{3}$ B = 0.050 ×
Probability Calculation	$P_{AB} = P_A \cdot P_B$ $P_A =$ $P_A =$ $P_B =$ The probability of loss of the main transmitting unit. $P_B = (A_A \cdot 10 \text{ SEC})A_B \cdot 10 \text{ SEC};$ $P_{AB} = (A_A \cdot 10 \text{ SEC})A_B \cdot 10 \text{ SEC};$ $P_A = 7.626 \times 10^{-6} \cdot 10 \text{ SEC};$ $P_A : 1.879 \times 10^{-7};$ $P_A : (1.871 \times 10^{-7};$
Probability Deacription	Failure in the main transmit- ting unit and a failure in the standby transmitting unit. Both failures occur within the critical phase of the Cat. III landing (10 seconds) and it is immaterial of which failure occurs first.

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Table E-2. Localizer Shutdown Probabilițies (Cont'd)

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Remarks		
Failure Rate Data	$\begin{array}{llllllllllllllllllllllllllllllllllll$	
Probability Calculation		
Probability Description		

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Table E-2. Localizer Shutdown Probabilities (Cont'd)

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Fage 4 of 14	Remarks	The factor $\left(\frac{\lambda_{C}}{\lambda_{A}+\lambda_{C}}\right)$ is the conditional probability that the hidden failure modes $(\lambda_{C})$ will occur prior to a main transmitting unit failure that initiates a transfer $(\lambda_{A})$ . A two weak preventive maintenance cycle is assumed to check the transfer force the transfer explisity of the localitare station.	The factor, $\left(\frac{\lambda_D}{\lambda + \lambda_D}\right)$ , is the conditional probability that a failure of $\lambda_D$ will occur prior to a failure of $\lambda_A$ . Note that after a failure in the main transmitting unit has occurred and a transmitting unit has occurred and a transmitting is meaninglese.
	Failure Rate Data	$\lambda_{G}: \lambda_{IQ} = 0.844 \times 10^{-6}$ $\lambda_{IT} = 2.658 \times 10^{-6}$ $\lambda_{1ZA} = 0.221 \times 10^{-6}$ $\lambda_{G} = 3.723 \times 10^{-6}$ $\lambda_{A} = 67.626 \times 10^{-6}$	$\lambda_{D}: \frac{\lambda_{12}C}{\lambda_{4}CA} = 0.782 \times 10^{-6}$ $\lambda_{4}CA = 13.310 \times 10^{-6}$ $\lambda_{4}AA = 14.280 \times 10^{-6}$ $\lambda_{11} = 1.164 \times 10^{-6}$ $\lambda_{11} = 1.164 \times 10^{-6}$ $\lambda_{11} = 1.164 \times 10^{-6}$ $\lambda_{12} = 0.789 \times 10^{-6}$ $\lambda_{313} = 0.789 \times 10^{-6}$ $\lambda_{323} = 0.789 \times 10^{-6}$ $\lambda_{323} = 0.789 \times 10^{-6}$ $\lambda_{333} = 0.789 \times 10^{-6}$ $\lambda_{343} = 0.172 \times 10^{-6}$ $\lambda_{44} = 1.514 \times 10^{-6}$ $\lambda_{6} = 44.514 \times 10^{-6}$ $\lambda_{6} = 67.626 \times 10^{-6}$
	Probability Calculation	$P_{AC} = \frac{A_{C}}{A + A_{C}} (P_{A} \cdot P_{C})$ $P_{A} =$ $P_{reviously identified.}$ $P_{C} =$ $The probability of the loss of the transfer to standby capability.$ $P_{A} = 1.879 \times 10^{-7}$ $P_{C} = (A_{C} - 336 \text{ HR})$ $= 1.251 \times 10^{-3}$ $P_{AC} = 1.227 \times 10^{-11}$	$P_{AD} = \frac{^{A}D}{^{A} + ^{A}D}$ $P_{A} =$ $P_{A} =$ $P_{reviously identified.}$ $P_{D} =$ $P_{D} =$ $P_{D} = 1.879 \times 10^{-7}$ $P_{A} = 1.879 \times 10^{-7}$ $P_{D} = 1.237 \times 10^{-7}$ $P_{D} = 1.237 \times 10^{-7}$ $P_{D} = 9.226 \times 10^{-13}$
	Protability Description	A hidden fallure in the equipment which essentially inhibits the transfer capability of the trans- mitting units and then a failure in the main transmitting unit.	A failure in the standby monitor- ing system initiating a shudown of the standby tranamitting unit and then a failure in the main tranamitting unit.

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Table E-2. Localizer Shutdown Probabilities (Cont'd)

Remarks	Factors $\left(\frac{\lambda_{0B}}{\lambda_{0}} + \frac{\lambda_{B}}{\lambda_{BCD}}\right)$ and $\frac{\lambda_{BCE}}{\lambda_{0}}$ are conditional $\left(\frac{\lambda_{1}}{\lambda_{1}} + \frac{\lambda_{BCE}}{\lambda_{CE}}\right)$ are conditional equation for the sequence ordering of $P_{66B}$ and $P_{BC}$ respectively. Note that worst case failure rate 'for $\lambda_{B}$ has been used a not some of the failure rate of $\lambda_{B}$ may also produce a secultivity Cat. III DDM elarm. Also no discrimination has ever the antire probability calculation is worst case.
Failure Rate Data	$\lambda_{46B} = 5.390 \cdot .10^{-6}$ $\lambda_{BCD} : \lambda_{B} = 67.346 \times 10^{-6}$ $\lambda_{C} = 3.723 \times 10^{-6}$ $\lambda_{C} = 3.723 \times 10^{-6}$ $\lambda_{B} = 144.514 \times 10^{-6}$ $\lambda_{BB} = 1.150 \times 10^{-6}$ $\lambda_{BB} = 1.1302 \times 10^{-6}$ $\lambda_{B} = 12.632 \times 10^{-6}$
Probability Calculation	$P_{STBY}CSE \left\{ \frac{A_{46B}}{A_{46B}} + \frac{A_{46B}}{A_{BCD}} \right\} P_{46B}$ $\times \left\{ \frac{A_{65E}}{A} + \frac{A_{55E}}{B_{CSE}} \right\} P_{BCSE}$ $\times P_{A}$ $P_{6B} =$ $P_{6B} =$ $P_{Cobability of sequence (1)}$ $P_{B}CSE =$ $P_{Cobability of sequence (2)}$ $P_{B}CSE =$ $P_{6B} = \left\{ A_{6B} = 336 \text{ HR} \right\}$ $P_{B}CSE = \left\{ B_{CSE} = 336 \text{ HR} \right\}$ $P_{B}CSE = \left\{ B_{CSE} = 336 \text{ HR} \right\}$ $P_{STBY}CSE = \left\{ B_{CSE} = 336 \text{ HR} \right\}$ $P_{STBY}CSE = \left\{ B_{CSE} = 336 \text{ HR} \right\}$ $P_{STBY}CSE = \left\{ B_{CSE} = 336 \text{ HR} \right\}$ $P_{STBY}CSE = \left\{ B_{CSE} = 1,722 \times 10^{-14} \text{ STBY}CSE$
Probability Description	Faiture sequence leading to a shutdown for P_STBY CaSE (1) Lose of monitoring ability of the standby course moni- tor. (2) Faiture causing the genera- tion of a faulty oranser from SDM, or RF parameter from tion of a faulty transmitting unit. (3) Any failure in the main trans- mitting unit which can initi- ate a transfor.

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Remarka	Factors $\left(\frac{47B}{4^{4}B} + \frac{47B}{ABCD}\right)$ and $\left(\frac{A}{\lambda^{4} + B_{SEN}}\right)$ are conditional probabilities that compensate for sequence ordering of $P_{47B}$ and $P_{SEN}$ . Note that worst case failure rate for basis. Note that worst case failure rate for a failure rate of $A_{SEN}$ may also produce Cat. III course monitor alarm, thus leading to a worst case $S_{TB}Y_{SEN}$
Fáilúre Rate Data	$A_{4TB} = 2.892 \times 10^{-6}$ $A_{BCD} = 183.207 \times 10^{-6}$ $A_{BCD} = 183.207 \times 10^{-6}$ $B_{SEN} : A_{BE} = 0.413 \times 10^{-6}$ $A_{B} = 12.832 \times 10^{-6}$ $A_{B} = 1.302 \times 10^{-6}$
Probability Calculation	PSTBYSEN $\left(\frac{\lambda}{\lambda TB} + \frac{\lambda}{\lambda BCD}\right)$ , PATB $\left(\frac{\lambda}{\lambda T} + \frac{\lambda}{\lambda TB} + \frac{\lambda}{\lambda BCD}\right)$ , PBSEN $\left(\frac{\lambda}{\lambda} + \frac{\lambda}{BSEN}\right)$ , PBSEN $\left(\frac{\lambda}{\lambda} + \frac{\lambda}{BSEN}\right)$ , PBSEN $\left(\frac{\lambda}{\lambda} + \frac{\lambda}{BSEN}\right)$ , PBSEN $\left(\frac{\lambda}{\lambda} + \frac{\lambda}{BSEN}\right)$ , PBSEN $\left(\frac{\lambda}{2} + \frac{\lambda}{2}\right)$ , PBSEN $\left(\frac{\lambda}{2} + $
Probability Description	Sailure sequence leading to a jhuidown for PSTBY SEN [1] Loss of monitoring ability of the standby sensitivity monitor. (2) Failure causing the gener- ation of a faulty course width (DDM) parameter from the standby transmit- ting with. (3) Any failure in the main transmitting unit which can initiate a transfer.

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Page 7 of 16	Remarks	Factors $\left(\frac{\lambda_{aBB}}{\lambda_{aBB} + \lambda_{BCD}}\right)^{and}$ $\left(\frac{\lambda_{a} + \lambda_{BCL}}{\lambda_{aCL}}\right)$ are conditional probabilities that compensate for sequence ordering of $P_{ABB}$ and $P_{BC}$ respectively. A worst case probability calculation is made alnce the failury rate $\lambda_{aBB}$ is nondiscriminatory as to which clearance parameter (DDM, SDM, or RF) is faulty.
	Failure.Rate Data	$\lambda_{BCD} = 103, 209 \times 10^{-6}$ $\lambda_{BCD} = 103, 209 \times 10^{-6}$ $\lambda_{B} = 7, 150 \times 10^{-6}$ $\lambda_{B} = 7, 150 \times 10^{-6}$ $\lambda_{B} = 1, 552 \times 10^{-6}$ $\lambda_{B} = 1, 552 \times 10^{-6}$ $\lambda_{B} = 0, 388 \times 10^{-6}$ $\lambda_{B} = 21, 542 \times 10^{-6}$ $\lambda_{B} = 1, 542 \times 10^{-6}$ $\lambda_{B} = 1, 542 \times 10^{-6}$
	Probability Calculation	$P_{STBYCL} = \left(\frac{48B}{ABCD}\right)^{P} P_{48B}$ $\times \left(\frac{{}^{A}_{A} + {}^{A}_{B}_{CL}}{{}^{A}_{A} + {}^{A}_{B}_{CL}}\right)^{P} P_{CL}$ $P_{48B} = \times P_{A}$ $P_{48B} = \times P_{A}$ $P_{48B} = \left(\frac{1}{A}\right)^{P} P_{CL}$ $P_{2} P_{2} P_$
	Probability Description	Failure acquence leading to a ahudown for PSTBYC. (1) Losa of monitoring ability of the standby clearance mon- itor. (2) Failure causing the genera- tion of a fully clearance tion of a fully clearance mitting unit. (3) Any failure in the main transmitting unit which can initiate a transfer.

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Table E-2. Localizer Shutdown Probabilities (Cont'd)

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Remarks	Factors $\left(\frac{\lambda_{34D} + \lambda_{34K}}{\lambda_{34D} + \lambda_{34K} + \lambda_{BCD}}\right)$ and $\left(\frac{\lambda_{B_{1D}}}{B_{1D} + \lambda_{A}}\right)$ are conditional probabilities that com- pensate for sequence ordering of (P <sub>34D</sub> + P <sub>34K</sub> ) and P <sub>B</sub> respec- tively.
Failure Rate Data	$ \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 &$
Prehability Calculation	$P_{STBY_{ID}} \left\{ \begin{array}{l} \sum_{i=1}^{i} \frac{1}{i_{1}i_{D}} \cdot \frac{1}{i_{1}i_{D}} + \frac{1}{i_{1}i_{1}i_{D}} + \frac{1}{i_{1}i_{1}i_{1}i_{1}i_{1}i_{1}i_{1}i$
Probabilie Description	Failure sequence leading to a shuddiwn for "STBY 13" (1) Lusis of the monitoring ability of the standby 1,13, mon- itor. (2) Failure causing the genera- torn of a laulty 1,13, signal (or loss) of the standby transmitting unit. (3) Any failure in the main transmitting unit which can initiate a transfer.

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Remarks .	Factors $\left(\frac{\lambda_{1H} + \lambda_{1S1}}{\lambda_{1H} + \lambda_{1S1}} + \frac{\lambda_{BCD}}{\lambda_{BCD}}\right)$ and $\left(\frac{\lambda_{B}}{\lambda_{1} + \lambda_{B}}\right)$ are conditional probabilities that compensate for sequence ordering of $\left(P_{1H} + P_{1S1}\right)$ and $\left(\lambda_{B} - 356  HR\right)$ respectively. Note that the probability $\left(\lambda_{B} - 356  HR\right)$ must be used rather than $P_{B}$ because a two week period of failure fpreven- tive maintenance cycle) must be used rather than the 10 secord critical landing phase period.
Fallure Rate Data	$A_{1H} = 1.399 \times 10^{-6}$ $A_{1S1} = 0.198 \times 10^{-6}$ $A_{BCD} = 181.209 \times 10^{-6}$ $V_{B} = 67.626 \times 10^{-6}$ $A_{A} = 67.626 \times 10^{-6}$
Probability Calculation	$P_{STBY} = \left(\frac{\lambda_{1H} + \lambda_{1S1}}{\lambda_{1H} + \lambda_{1S1}}\right) \times \left(P_{1H} + P_{1S1}\right) \times \left(P_{1H} + P_{1S1}\right) \times \left(P_{1H} + P_{1S1}\right) \times \left(\frac{\lambda_{B}}{(\lambda + \lambda_{B}}\right) + \sum_{X \in A} \left(\lambda_{B} - 336 \text{ HR}\right) \times P_{X} + P_$
Probability Description	Failure acquence leading to a shutdown for P <sub>STB</sub> y: (1) Loss of <u>all</u> standby monitor- ing ability. (2) Faviure causing the genera- tios of any faulty parameter of the standby transmitting unit. (3) Any failure in the main transmitting unit which can initiate a transfer.

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Remarks	Note that since a power/environ- mental alarm will be produced if one of the converters fails, a down- grade from Cas, III performance will occur within 3 hours; hence a 3 hour time intervalvis used. A monthly preventive maintenance cycle is assumed to check that the far fiz'd monitor battery and bat- tery disconnect circuit.	 <u>.</u>
Failure Rate Data	AIT 18 (598 × 10 <sup>-6</sup> 3.1A 5.740 × 10 <sup>-6</sup> 5.0A 5.740 × 10 <sup>-6</sup> 5.0B 0.519 × 10 <sup>-6</sup> ATTF 4.0 × 10 <sup>-6</sup> ATTF (assumed)	
Prohability Calculation	$P_{PS/CONV} = P_{CONV_{MAIN}} + P_{SFF} + P_{SFF} + P_{SFF} + P_{SONV_{MAIN}} + P_{SONV_{FF}} + P_{SFF} + P_{SONVFF} + P_{SONVFF} + P_{SFF} + P_$	
Prohahsluts Descryption	Power Aupply/Lonverter failures	

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Remärka	It should be noted that since an output from the course monitor chan- itor-wingul, a worst case analysis may be accomplished by treating both on an aggregute basis. Furthermore- course RF. SDM, ani DDM alarma- again leading to worst case analysis. Note that it is assumed maintenance action will be employed within 2 weeks (336 HR) after a monitor abmor- mal due to a monitor mismatch occurs mal due to a monitor mismatch occurs
Failure Rate Data	$\sum_{ACSF/ID}^{ACSF/ID} = ^{CSF/ID}_{CSF/ID} = ^{CSF/ID}_{CSE/ID}_{S}$ $\sum_{ACSE/ID}^{A} = ^{2}CSE/ID_{3}$ $\sum_{ACSE/ID}^{A} = ^{13.310 \times 10^{-6}} + ^{35A} = ^{13.310 \times 10^{-6}} + ^{32AA} = ^{13.31A} = ^{1.914 \times 10^{-6}} + ^{32AA} = ^{1.914 \times 10^{-6}} + ^{32AA} = ^{1.914 \times 10^{-6}} + ^{32AA} = ^{1.914 \times 10^{-6}} + ^{1.33}_{CSE/ID} = ^{16.539 \times 10^{-6}} = ^{16.539 \times 10^{-6}} + ^{1.33}_{CSE/ID} = ^{16.539 \times 10^{-6}} + ^{32AA} = ^{1.33A}_{1.21} = ^{16.539 \times 10^{-6}} + ^{1.33A}_{CSE/ID} = ^{16.539 \times 10^{-6}} = ^{16.539 \times$
Probability Calculation	$P_{GSE/ID} = (\lambda_{GSE/ID} \cdot 10 SEC) \times (2 \cdot \lambda_{CSE/ID} \cdot 10 SEC) = (5 \cdot 557 \times 10^{-3}) \times 19 \cdot 10^{-8}) = 5 \cdot 106 \times 10^{-10}$ Note: If each monitor were considuation of a second separately, the properties in the billity of failure of each of the billity of each of the billity of failure of each of the billity of failure of each of the billity of failure of each of the billity of failure of each of the billity of the billi
Probability Description	Two of the three course/I. D. monito's (including respective peak detectors) failing, pro- ducing an alarm.

Remarks	
Failure Rate Data	$\begin{cases} k_{SEN} = k_{SEN} = k_{SEN} = k_{SEN} = k_{SEN} \\ k_{SEN} = k_{SSN} = 0.367 \times 10^{-6} \\ k_{23A} = 0.789 \times 10^{-6} \\ k_{23B} = 0.386 \times 10^{-6} \\ k_{SEN} = 10.589 \times 10^{-6} \\ k_{SEN} = k_{24B} + 1/3\lambda + 1C2 \\ k_{25N} = k_{0A} + \lambda_{25A} \\ k_{25N} = k_{0A} + \lambda_{25A} \\ k_{25N} = k_{0A} + \lambda_{25A} \\ k_{25N} = k_{0A} + \lambda_{25A} \\ k_{25N} = k_{0A} + \lambda_{25A} \\ k_{25B} = k_{0A} + \lambda_{25A} \\ k_{25B} = k_{0A} + \lambda_{25A} \\ k_{25B} = k_{0} + k_{25A} \\ k_{25B} = k_{0} + k_{25B} \\ k_{25B} = k_{0} + k_{25A} \\ k_{25B} = k_{0} + k_{25B} \\ k_{25B} = k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k_{25} + k_{25} \\ k$
Prohability Calculation	Psex 'sex' 136 HR • 2 • 'sex' 10 SEC - 2,090 × 10 <sup>-10</sup>
Probability Description	Two of the sensitivity monitors/ peak detectors failing, producing an alarm.

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# Table E-2. Localizer Shutdown Probabilities (Cont'd)

Failure'Rate Remarko	$\sum_{k=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{i$	
Probability Calculation	PCL = (LL - 3 <sup>16</sup> HR) - (LL - 10 SEC) = 4.540 × 10 <sup>-10</sup> = 4.540 × 10 <sup>-10</sup>	
Probability Description	Two of the clearance monitors/ peak detectors falling. producing an alartit.	

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Rémarka	Note that the failure of both the DDM and SDM has been included in the near field monitor channel failure rate, since the SDM strap option for a general alarm will be utilized.	Note that the failure rate of the SDM is also included, since the SDM strap option for a general Cat. II alarm will be utilized. Although a time delay (nominal 120 seconds) exists at the far field for alarm processing, the 10 sec time interval in the probability calculation is still used. Only the initial arbi- trary reference has changed.	
Failure Rate Data	$\begin{cases} \lambda_{NF} = \lambda_{NF1} = \lambda_{NF2} \\ \lambda_{NF1} + \lambda_{1A} = 11.099 \times 10^{-6} \\ \lambda_{2A} = 0.769 \times 10^{-6} \\ \lambda_{29B} = 0.386 \times 10^{-6} \\ \lambda_{29B} = 0.386 \times 10^{-6} \\ \lambda_{F1} = 12^{2} 344 \times 10^{-6} \\ \lambda_{F1} = 12^{2} 344 \times 10^{-6} \\ \lambda_{F1} = 12^{2} 348 \times 10^{-6} \\ \lambda_{F$	YEF * YEFI * YEF2 * YEF3 YEF1:	1 <sub>52</sub> 2, 31: × 10 <sup>-6</sup> <sup>1</sup> 12 0, 140 × 10 <sup>-6</sup>
Probability Catrulation	P <sub>NF</sub> = ( <sub>NF</sub> · 33) HR) = ( <sub>NF</sub> · 10 SEC) = 1,422 × 10-10	PFF (\FF 330.11R) × {2 • \FF • 16 SEC} •081 × 10-10	P <sub>INHIR</sub> ( <u>1</u> 52 * <sup>1</sup> <sub>1 w</sub> )- In SEC 6. 822 × 10 <sup>-9</sup>
Probability Description	Buth of the near field monitors/ peak detectors failing, producing an alarm.	Two of the three far field mun- itors/ receivers failing. produc- ing an alarm,	Failure inhibiting the monitors while the ILS signal is radiated. A shutdown status will result- loss of Cat. III and Cat. II sta- tus.

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Table E-2. Localizer Shutdown Probabilities (Cont'd)

Appendix F Glideslope Math Models

## Appendix F

### Glideslope Math Model's

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This appendix consists of tables F-l and F-2, referred to in section 8.0, which give respectively, probability math models for glideslope hazardous signal radiation and shutdown. Table F-1. Glideslope Hazardous Signal Radiation Probabilities

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Table F-1. Glideslope Hazardous Signal Radiation Probabilities (Cont'd)

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adure Pate Data	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	
Productificy Calculation	$P_{XMTR} CSE_{DDM}$ The probability that an actual harardous Gat. III course DDM will harardous Gat. III course DDM will be radiated, while no other parameters are effected. First CSE_DDM = 6.001 × 10^{-7} * 0.001 × 10^{-7} * 0.001 × 10^{-7} * 0.01 × 0.01 ×	P(HS) CSE SDM = PINT CSE SDM * PXMTR CSE SDM * PXMTR CSE SDM PINT CSE SDM + ( <sup>A</sup> CATE · 168) <sup>2</sup> + ( <sup>A</sup> CATE · 168) * ( <sup>A</sup> ALDCIC · 168) * ( <sup>A</sup> AEDUND · 168)] * ( <sup>A</sup> AEDUND · 168)]
Probabílity Drecription	Probability of the radiation of a hazardoun course position (path anglei Cat. III DDM signal. (continued)	Probability of the radiation of a hazardous course position Cat. III SDM signal signal, i.e., incorrect percentage modulation.

Rematks	Worst case and yale performed.
. Fållure Rate Data	$MON_{GSE} = ^{3}4B = ^{3}5B$ $= ^{3}_{36B} = 4.836 \times 10^{-6}$ $Catte = ^{1}1D1 = 0.700 \times 10^{-6}$ $LOGIC = ^{1}1D2 = 0.700 \times 10^{-6}$ $h = 1.249 \times 10^{-6}$ $\sum_{s = 0.686 \times 10^{-6}}$ $\sum_{s = 0.686 \times 10^{-6}}$ $\sum_{s = 0.686 \times 10^{-6}}$ $\sum_{s = 0.427 \times 10^{-6}}$ $\sum_{s = 0.427 \times 10^{-6}}$ $\sum_{s = 0.427 \times 10^{-6}}$ $\sum_{s = 0.466 \times 10^{-6}}$ $\sum_{s = 0.466 \times 10^{-6}}$ $\sum_{s = 0.466 \times 10^{-6}}$ $\sum_{s = 0.466 \times 10^{-6}}$ $\sum_{s = 1.231 \times 10^{-6}}$ $\sum_{s = 1.231 \times 10^{-6}}$ $\sum_{s = 1.231 \times 10^{-6}}$ $\sum_{s = 1.231 \times 10^{-6}}$ $\sum_{s = 1.231 \times 10^{-6}}$ $\sum_{s = 1.231 \times 10^{-6}}$ $\sum_{s = 0.846 \times 10^{-6}}$ $\sum_{s = 0.846 \times 10^{-6}}$ $\sum_{s = 0.427 \times 10^{-6}}$ $\sum_{s = 0.427 \times 10^{-6}}$ $\sum_{s = 0.427 \times 10^{-6}}$ $\sum_{s = 0.427 \times 10^{-6}}$
Protability Calculation	PRHS) CSE RF <sup>2</sup> PINT CSE RF * PXMTR CSE RF * PINT CSE RF PINT CSE RF + ( $ACTE \cdot 168$ ) + ( $AEDUND \cdot 168$ )] * ( $AEERF \cdot 1.822 \times 10^{-3}$ ] * ( $AERF \cdot 1.248 \times 10^{-7}$ ]
Probability Description	Probability of the radiation of a signal that is out of Cat. III limit with respect to course RF power.

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Table F-1. Glideslope Hazardous Signal Radiation Probabilities (Cont'd)

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Table F-I. Glideslope Hazardous Signal Radiation Probabilities (Cont'd)

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Remarks	Worst case analysis performed.
Failure Rate Data	$\frac{1}{3}MON_{SEN} = \frac{3}{3}9B = 2.892 \times 15^{-5} = \frac{3}{3}9B = 2.892 \times 15^{-5} = \frac{3}{2}MON_{SEN} = \frac{3}{1}D3 = 2.892 \times 10^{-6} = \frac{1}{1}D3 = 0.700 \times 10^{-6} = \frac{1}{1}D3 = 1.249 \times 10^{-6} = \frac{1}{3}C = 1.302 \times 10^{-6} = \frac{1}{3}C = 1.302 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 1.231 \times 10^{-6} = \frac{1}{1}D3 = 0.700 \times 10^{-6} = \frac{1}{1}D3 = 0.700 \times 10^{-6} = \frac{1}{1}D3 = 0.700 \times 10^{-6} = \frac{1}{1}D3 = 0.700 \times 10^{-6} = \frac{1}{1}D3 = 0.700 \times 10^{-6} = \frac{1}{1}D3 = 0.700 \times 10^{-6} = \frac{1}{1}D3 = 0.700 \times 10^{-6} = \frac{1}{1}D3 \times 10^{-6} = $
Probability Calculation	$P(HS)_{SEN} = P_{INT}_{SEN} P_{IN}^{II} P_{IN} P_{IN}^{II} P_{IN}^{I$
Probability Description	Probability of the radiation of a signal that is out of Cat. III limit with respect to course angle width- sensitivity DDM.

14×Ke 2 01 6	Remarks	Note that by considering the three clearance parameters (DDM, SDM, RF) collectively, a worst case analysis results.	For the probability $P_{TM'}$ some number must be assumed since this number is unpredictable, being a function of external and uncontrol- lable forces. For convenience, let $P_{TM} = 10^{-5}$ .
	Failure Rate Data	$\sum_{i=1}^{1} NON_{CL} = \frac{1}{40B} = \frac{1}{41B}$ $= \frac{1}{42B} = 4.848 \times 10^{-6}$ $= \frac{1}{42B} = 0.140 \times 10^{-6}$ $\sum_{i=10CIC} = \frac{1}{1D2} = 0.700 \times 10^{-6}$ $\sum_{i=10CIC} = \frac{1}{1D3} = 0.700 \times 10^{-6}$ $\sum_{i=10CIC} = \frac{1}{1D3} = 1.249 \times 10^{-6}$ $\sum_{i=10}^{1} = 1.176 \times 10^{-6}$ $\sum_{i=10}^{1} = 1.176 \times 10^{-6}$ $\sum_{i=10}^{1} = 1.231 \times 10^{-6}$ $\sum_{i=10}^{1} = 1.231 \times 10^{-6}$ $\sum_{i=10}^{1} = 1.521 \times 10^{-6}$ $\sum_{i=10}^{1} = 1.521 \times 10^{-6}$ $\sum_{i=10}^{1} = 1.521 \times 10^{-6}$	$^{A}_{MD}^{i}$ $^{A}_{49B} = 2.354 \times 10^{-6}$ $^{A}_{1\Sigma} = 1.102 \times 10^{-6}$ $^{A}_{MD}^{i} = 3.456 \times 10^{-6}$
	Probability Calculation	PIIIS] CL $\cdot$ P. Tr $_{CL}$ P. P. $_{RT} _{R} _{CL}$ P. Tr $_{L}$ $\cdot$ ( $^{A}_{MON} _{CL}$ $\cdot$ 16 $^{D}_{10}$ $+$ ( $^{3} \cdot ^{A}_{GATE} \cdot$ 16 $^{B}_{10}$ $+$ ( $^{3} \cdot ^{A}_{LOCIC} \cdot$ 16 $^{B}_{10}$ $+$ ( $^{1}_{A} _{LOCIC} \cdot$ 16 $^{B}_{10}$ ) $\times (^{A}_{REDUND} \cdot$ 16 $^{B}_{10}$ ) $\times (^{A}_{REDUND} \cdot$ 16 $^{B}_{10}$ ) $P_{TNT} _{CL} = (^{A}_{XMTR} _{CL} \cdot$ 16 $^{B}_{10}$ ) $P_{INT} _{CL} = (^{A}_{23} + 10^{-7})$ $P_{INT} _{CL} = 0.536 \times 10^{-7}$ $P_{INT} _{CL} = 1.935 \times 10^{-3}$ $P_{THR} _{CL} = 1.935 \times 10^{-3}$ $P_{THS} _{CL} = 1.427 \times 10^{-9}$	P(HS) <sub>ATM</sub> = P <sub>MD</sub> - P <sub>TM</sub> P <sub>MD</sub> = ( <sup>1</sup> <sub>MD</sub> - 168HR) = 5,806 × 10 <sup>-4</sup>
	Probability Description	Probability of the radiation of a hazardous clearance signal (DDM, SDM, or RF)	Probability of the radiation of a hazardout signal, due to antenna tower misalignment.

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Table F-1. Glideslope Hazardous Signal Radiation Probabilities (Contrd)

Table F-1. Glideslope Hazardous Signal Radiation Probabilities (Cont'd)

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Remarks .	
Failure Rate Data	
Probability Calculation	$P_{MD}^{2}$ . The privability of the loss of tover slignment detection an not not producing an alarm. $P_{TM}^{2}$ The probability that the glideslope ant.nna tower will become mis- mained within the preventive maintenance cycle time of one week. Note-mat the misalignment must effect only the path angle width (field monitored by the near field monitore. $P(HS) = 5,806 \times 10^{-9}$ .
Probability Descript/on	Probability of the radiation of a hazardous signed, due to antenna towar missilesconent. (continued) (continued)

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	Remarke	The subscript on A refers to the failure mode, hance, failure rate identification is readily accomplished. Note: The same nomenclature as for the focalizer will be employed for the glidenlope in specifying and determining probabilities.	Any failure mode of A with any Any failure mode of A with any other failure mode of A <sub>B</sub> will shut down the glidealope station. Note that all failure modes con- sidered in A <sub>A</sub> apple, are figs of hidden failures: hence, the 5 sec- ond time interval for probability calculations is common to all failure modes.
Fallure Rate	Data	$ \frac{1}{1A} = 2.895^{\circ} \times 19^{-6} $ $ \frac{1}{1B} = 2.004 \times 10^{-6} $ $ \frac{1}{1A} = 0.140 \times 10^{-6} $ $ \frac{1}{1Z} = 6.339 \times 10^{-6} $ $ \frac{1}{1A} = 1.464 \times 10^{-6} $ $ \frac{1}{1A} = 1.951 \times 10^{-6} $ $ \frac{1}{1} = 2.0.778 \times 10^{-6} $ $ \frac{1}{12} \times 0.778 \times 10^{-6} $ $ \frac{1}{12} \times 0.778 \times 10^{-6} $ $ \frac{1}{12} = 0.098 \times 10^{-6} $ $ \frac{1}{18} = 0.098 \times 10^{-6} $ $ \frac{1}{15.815 \times 10^{-6} } $ $ \frac{1}{15.815 \times 10^{-6} } $	$\lambda_{1} \cdot \lambda_{2} = 5.734 \times 10^{-6}$ $\lambda_{3} = 1.914 \times 10^{-6}$ $\lambda_{4B} = 6.734 \times 10^{-6}$ $\lambda_{3} = 6.734 \times 10^{-6}$ $\lambda_{3} = 0.686 \times 10^{-6}$ $\lambda_{3} = 2.613 \times 10^{-6}$ $\lambda_{3} = 2.613 \times 10^{-6}$ $\lambda_{3} = 1.453 \times 10^{-6}$ $\lambda_{3} = 1.302 \times 10^{-6}$ $\lambda_{1} = 0.420 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.134 \times 10^{-6}$ $\lambda_{1} = 0.070 \times 10^{-6}$
Probability	Calculation	Ps = 2. NSINGLE FAILURES - 5 SEC Ps = 15.815 x 10 <sup>-6</sup> x 5 SEC Ps = 2.197 x 10 <sup>-8</sup>	$P_{AB} = P_{A} \cdot P_{B}$ $P_{A} =$ $The probability of loss of the main transmitting unit.$ $P_{B} =$ $The probability of loss of the stand-by transmitting unit.$ $P_{AB} = (\Lambda_{A} \cdot 5 SEC) (\Lambda_{B} \cdot 5 SEC)$ $P_{AB} = (\Lambda_{A} \cdot 5 SEC) (\Lambda_{B} \cdot 5 SEC)$ $P_{AB} = (17, 245 \times 10^{-6} \times 5 SEC)$ $= 2.691 \times 10^{-15}$
Probability	Description	Single fallures in glideslope equipment that cause immediate glideslope shutdown.	Failure in the main transmitting unit and a failure in the standby transmitting unit. Both failures occur within the critical phase of the Cat. III landing (5 seconds for gludeslope) and it is immaterial of which failure occurs first.

Table F-2. Glideslope Shutdown Probabilities

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Remarks		The factor $\left( \begin{array}{c} \sqrt{C} \\ M + \lambda C \end{array} \right)$ is the condi- tional probability that the hidden failure invides $(\lambda_C)$ will occur prior to a mein transmitting unit failure that initiates a transfer $(\lambda_A)^{(1)}$ A two week preventive graintenance cycle is assumed to chick the trans- station.
Failure Rate Data	$ \begin{array}{llllllllllllllllllllllllllllllllllll$	B $A = 37.455 \times 10^{-6}$ $A = 3.455 \times 10^{-6}$ $A = 0.844 \times 10^{-6}$ $A = 0.221 \times 10^{-6}$ $A = 3.723 \times 10^{-6}$
Probability Calculation		$P_{AC} = \frac{\lambda_{C}}{M + \lambda_{C}} (P_{A} \cdot P_{C})$ $P_{A} = \text{previoually idintified}$ $P_{C} = \text{the probability.}$ $P_{C} = 5.202 \times 10^{-8}$ $P_{A} = 5.202 \times 10^{-8}$ $P_{C} = (\lambda_{C}^{-2} \cdot 2 \cdot w_{L})$ $= 1.251 \times 10^{-12}$ $z^{2}A_{C} = 5.884 \times 10^{-12}$
Probabilit; Description	Failure in the main transmitting unit and a failure in the standby transmitting unit. Both failures occur within the critical phase of the Cat III lynding (5 seconds for glideslope) and it is immaterial of which failure occurs. (irr). (continued)	A hidon fallure in the equipment which essentially inhibite the transfer capability of the trans- mitting units and then a fallure in the main transmitting unit.

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Table F-2. Glideslope Shutdown Probabilities (Cont'a)

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Pare 4 of 8	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	
	Probability Description	ailure sequence leading to z hutdown for PSTBY SEN Loss of monitoring ability monitor. Faulure causing the genera- tion of a faulty path angle course width (DDM) para- meter from the standby irransmitting unit. Any failure in the main . Any failure in the main . Tanamitting unit which can initiate a transfer.

Table F-2. Glideslope Shutdown Probabilities (Cont<sup>1</sup>d)

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Table F-2. Glideslope Shutdown Probabilities (Cont'd)

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Remarks	The factor $\left(\frac{\lambda}{\Lambda + \Lambda}\right)$ is the conditional probability that a failure of $\lambda_{\Lambda}$ will occur prior to a failure of $\lambda_{\Lambda}$ . Note that after a failure in the main note that after a compliched, standby monitoring is meaningless.	Factors $\left(\frac{\lambda_{4,B}}{4,6B} + \frac{\lambda_{4,B}}{\Lambda B,CD}\right)$ and $\left(\frac{\lambda_{4,B}}{4,6B} + \frac{\lambda_{4,B,CD}}{\Lambda B,CSE}\right)^{-1}$ are conditional prob- ( $\left(\frac{\lambda_{4,B}}{\Lambda^{+,B}}\right)^{-1}$ are conditional prob- difficient and compensate for sequence ordering of P <sub>46B</sub> and P <sub>B</sub> compense tively. Second and P <sub>B</sub> compense tively. And P <sub>B</sub> compense tively. And P <sub>B</sub> may also the failure rate of $\lambda_{B}$ may also produce a sensitivity (path angle produce a sensitivity (path angle width) Cat. III DDM alarm. Also produce a sensitivity (path angle of discrimination has been made as to which course prameter (DDM, SDM, probability calculation is worst case.
Failure Rate Data	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{rcl} \lambda_{dB} & = & 4.836 \times 10^{-6} \\ \lambda_{BGL} & \lambda_{B} & 37.245 \times 10^{-6} \\ \lambda_{B} & 3.7245 \times 10^{-6} \\ \lambda_{B} & 3.723 \times 10^{-6} \\ \lambda_{C} & 3.723 \times 10^{-6} \\ \lambda_{C} & 3.724 \times 10^{-6} \\ \lambda_{D} & 118.604 \times 10^{-6} \\ \lambda_{D} & 0.427 \times 10^{-6} \\ \lambda_{T} & 0.427 \times 10^{-6} \\ \lambda_{T} & 0.427 \times 10^{-6} \\ \lambda_{T} & 1.232 \times 10^{-6} \\ \lambda_{T} & 1.232 \times 10^{-6} \\ \lambda_{D} & 1.265 \\ \lambda_{D} & 1.265 \\ \lambda_{D} & 1.263 \times 10^{-6} \\ \lambda_{D} & 1.265 \\ \lambda_{D} & 1.263 \times 10^{-6} \\ \lambda_{D} & 1.263 \times 10^{-6} \\ \lambda_{D} & 1.263 \times 10^{-6} \\ \lambda_{D} & 1.265 \\ \lambda_{D} & 1.263 \times 10^{-6} \\ \lambda_{D} & 1.265 \\ \lambda_{D} & 1.263 \times 10^{-6} \\ \lambda_{D} & 1.265 \\ \lambda_{D} & 1.263 \times 10^{-6} \\ \lambda_{D} & 1.265 \\ \lambda_{D$
Probability Calculation	$P_{AD} = \frac{h_D}{\lambda + \lambda_D} \left( P_A \cdot P_D \right)$ $P_A = Previoualy identified.$ $P_D = The probability of the loas of the standby transmitting unit due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stillure in the standby due to a stallare a standby due to a stallare a standby due to a stallare a standby due to a stallare in the standby due to a stallare in the standby due to a stallare in the standby due to a stallare a stallare in the standby due to a stallare in the s$	PSTBY CSE = $\begin{pmatrix} \lambda_{46B} + \lambda_{ABCD} \end{pmatrix}$ P $_{46B} = \frac{\gamma_{46B}}{\gamma_{A} + \lambda_{BCD}}$ P $_{46B} = \frac{\gamma_{AB}}{\gamma_{A} + \lambda_{BCSE}}$ , P $_{BCSE}$ P $_{46B} = Frobability of sequence (1)$ P $_{BCSE} = Frobability of sequence (3)$ , P $_{BCSE}$ P $_{AB} = Frobability of sequence (3)$ , P $_{BCSE}$ P $_{AB} = 1$ $_{AB}$
Probability Description	A fallure in the damp monitoring system initiating a shutdown of the standby transmitting unit and then a fallure in the main transmitting unit.	Fallure sequence leading to a shut- down for STBY CSE: (1) Lose of monitoring abisity of the standby course smonitor. (2) Faluer causing the generation of a faulty course DDM, SDM, or RF parameter from the standby transmitting unit. (3) Any failure in the main trans- mitting unit which can initiate a transfer.
Table F-2. Glideslope Shutdown Probrailities (Cont'd)

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Remarks	Factors ABB ABCD ABB ABCD A ABCL probabilities that compensate for sequence ordering of P4BB and PL respectively. A worst case probability caïcula- tion is made since the failure rate ABB is nondiscriminatory as to which clearance párameter (DDM, SDM, or RF) is faulty.
Failure Rate Data	$\lambda_{ABCD}^{46B} : 4.848 \times 10^{-6}$ $\lambda_{ABCD}^{2} : 118.604 \times 10^{-6}$ $\lambda_{ABCD}^{2} : 5.734 \times 10^{-6}$ $\gamma_{BB}^{3} : 5.734 \times 10^{-6}$ $\lambda_{DCL}^{3} : 9.824 \times 10^{-6}$
Probability Calculation	$P_{STBYC1} = \frac{1}{48B} + \frac{1}{ABCD} + P_{48B} + \frac{1}{ABCD} + P_{BCL} + P_{AC} + P_{AB} + P_{AB} + P_{AB} + P_{AB} + P_{AB} + P_{BCL} + P_{AB} + P_{BCL} + P_{AB} + P_{BCL} + P_{BCL} + P_{BCL} + P_{BB} + P_{BCL} + P_{AB} + $
Prnhahility Deerstption	<ul> <li>Iure sequence leading to a down for PTTY.</li> <li>10. Loss of monitoring ability of the standby clearan c monitor.</li> <li>12. Ealinte causing the generation of a faulty clearance DD91, SDM, or RF parameter from the standby transmitting unit.</li> <li>(3) Apy failure in the main transfer.</li> </ul>

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Pare <u>ta</u> ol <u>a</u> .	Remarke	Factors $\left(\frac{\lambda_{1}}{\lambda_{1}+\lambda_{1}}S_{1}+\frac{\lambda_{1}}{\lambda_{B}CD}\right)$ and $\left(\frac{\lambda_{B}}{\lambda_{1}+\lambda_{B}}\right)$ are conditional probabilities that compensate for sequence ordering of $(P_{11}+P_{1S1})$ and $(\lambda_{B}, 366)$ respectively. Note that the probability $(\lambda_{B}, 356)$ must be used reperied of failure (preven- tive maintenance cycle) must be used rather than the 5 second critical land- ing phase period for the glideslope. Note that since a power/contronnental alarm will be produced if one of the converters fails, a domegrade farm Cat. III performance will occur within 3 hours; hence, a 3 hour time interval- is used.
	Fallure Rate Data	$\lambda_{11}^{1} = 1.399 \times 10^{-6}$ $\lambda_{151}^{1} = 0.198 \times 10^{-6}$ $\lambda_{ABCD}^{2} = 118.604 \times 10^{-6}$ $\lambda_{1}^{2} = 37.245 \times 10^{-6}$ $\lambda_{15}^{1} = \lambda_{16}^{1} = 5.593 \times 10^{-6}$ $\lambda_{15}^{1} = \lambda_{16}^{1} = 5.593 \times 10^{-6}$
	Probability Calculation	$P_{STBY} = \frac{\lambda_{1H} + \lambda_{1S1}}{\lambda_{1H} + \lambda_{1S1}} + \lambda_{BCD}$ $\times P_{1H} + P_{1S1}$ $\times \frac{\lambda_{B}}{\lambda + \lambda_{B}}$ $\cdot \left(\lambda_{B} \cdot 336 \text{ HR}\right)$ $\times P_{A}$ $\left(P_{1H} + P_{1S1}\right) =$ $Probability of equence (1).$ $(N_{B} \cdot 336 \text{ HR}) =$ $Probability of equence (2).$ $P_{1H} = (\lambda_{1H} \cdot 336)$ $P_{2ONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$ $P_{CONV} = (\lambda_{15} \times 341\text{ HR}) \cdot (\lambda_{10} \times 5 \text{ SEC})$
	Probebility Description	Failure acquence leading to a abuidown for P <sub>STBY</sub> : (1) Loss of all standby monitor- ing ability. (2) Failure causing the genera- tion of any faulty parameter of the standby transmitting unit. (3) Any failure in the main transmitting unit which can initiate a transfer. Converture failures leading to a shuddown.

Table F-2. Glideslope Shutdown Probabilities (Cont'd)

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Table F-2. Gliäeslope Shutdown Präbabilities (Cont'd)

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Remarka	No diacrimination is made among the course RF, SDM, and DDM alarins; hence. a worst case analy- sif creaults. Note that if each monitor ware con- sidered separately. The probability of failure of each of the 3 monitors is 1/5 of P <sub>CSE</sub> . Note that if 3 assumed maintenance action will be employed within 2 weeks (336 HR) after a monitor ab- normal due to a monitor mismatch occurs.	
Fajlure Rate Data	$\begin{cases} CSE^{-1} CSEI^{-1} CSE2^{-1} CSE2^{-1} CSE3 \\ CSE1: \\ CSE1: \\ \gamma_{34} = \frac{1}{2} 2.689 \times 10^{-6} \\ \gamma_{19} = 1.115 \times 10^{-6} \\ 1/3 \lambda_{1C1} = 0.140 \times 10^{-6} \\ CSE1 = 13.944 \times 10^{-6} \\ CSE2 = \lambda_{35} \Lambda + \lambda_{21} + 1/3 \lambda_{1C1} \\ = 13.944 \times 10^{-6} \\ \lambda_{CSE3} = \lambda_{36} \Lambda + \lambda_{21} + 1/3 \lambda_{1C1} \\ = 13.944 \times 10^{-6} \end{cases}$	$\lambda_{SEN} = \lambda_{SENI} = \lambda_{SENI} = \lambda_{SENI3}$ $\lambda_{SENI} : 0^{-6}$ $\lambda_{22} = 1.115 = 10^{-6}$ $\lambda_{22} = 1.115 = 10^{-6}$ $\lambda_{SENI} = 10.529 \times 10^{-6}$ $\lambda_{SEN2} = \lambda_{38A} + \lambda_{23} + 1/3\lambda_{1C2}$ $= 10.529 \times 10^{-6}$ $\lambda_{SEN3} = \lambda_{39A} + \lambda_{24} + 1/3\lambda_{1C2}$ $= 10.529 \times 10^{-6}$
Probability Calculation	PcsE * ( <sup>x</sup> csE * <sup>336</sup> HRS) x (2 * <sup>x</sup> csE * 5 SEC) * 1.815 x 10 <sup>-10</sup>	Psew = ( <sup>x</sup> sew * 336 HR) x (2 * <sup>x</sup> sew * 5 gec) = 1.035 x 10 <sup>-10</sup>
Probability Description	Two of the three course moni- tors/peak detectors failing, producing an alarm.	Two of the aensitivity monitors/ peak detectors failing, produc- ing an alarm.

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Remarke	Worst case analysis is again con- sidured since no discrimination han been made among the clearance DDM, SDM, or RF alarme.	Note that the failure of both the DDM and SDM has been included in the near field monitor channel failure rute, since the SDM atrap option for a gen- eral alarm will be utilized.	
Failure Rate Data	$\lambda_{CL} = \lambda_{CL1} = \lambda_{CL2} = \lambda_{CL3}$ $\lambda_{40\Lambda} = 13.044 \times 10^{-6}$ $\lambda_{25} = 1.115 \times 10^{-6}$ $\lambda_{25} = 1.115 \times 10^{-6}$ $\lambda_{25} = 1.115 \times 10^{-6}$ $\lambda_{CL1} = 14.299 \times 10^{-6}$ $\lambda_{CL2} = \lambda_{41\Lambda} + \lambda_{26} + \frac{1/3}{12} \lambda_{C4}$ $\lambda_{CL3} = \lambda_{42\Lambda} + \lambda_{27} + \frac{1/3}{12} \lambda_{C4}$ $= 14.299 \times 10^{-6}$	$\lambda_{\rm NF} \stackrel{\Lambda}{=} NF1 \stackrel{\Lambda}{=} \lambda_{\rm NF2} \stackrel{\Lambda}{=} \lambda_{\rm NF3}$ $\lambda_{\rm SF1} \stackrel{\Lambda}{=} 11.099 \times 10^{-6}$ $\lambda_{\rm 2S} \stackrel{\Lambda}{=} 1.115 \times 10^{-6}$ $\lambda_{\rm 2S} \stackrel{\Lambda}{=} 1.115 \times 10^{-6}$ $\lambda_{\rm NF1} \stackrel{\Lambda}{=} 12.261 \times 10^{-6}$ $\lambda_{\rm NF2} \stackrel{\Lambda}{=} \lambda_{\rm 2A} \stackrel{\Lambda}{=} \lambda_{\rm 2} \stackrel{\Lambda}{=} 1/3^{\Lambda} \Gamma_{\rm C3}$ $\lambda_{\rm NF2} \stackrel{\Lambda}{=} \lambda_{\rm 2A} \stackrel{\Lambda}{=} \lambda_{\rm 2} \stackrel{\Lambda}{=} 1/3^{\Lambda} \Gamma_{\rm C3}$ $\lambda_{\rm NF3} \stackrel{\Lambda}{=} \lambda_{\rm 2A} \stackrel{\Lambda}{=} \lambda_{\rm 30} \stackrel{\Lambda}{=} 1/3^{\Lambda} \Gamma_{\rm C3}$ $\lambda_{\rm NF3} \stackrel{\Lambda}{=} \lambda_{\rm 2A} \stackrel{\Lambda}{=} \lambda_{\rm 30} \stackrel{\Lambda}{=} 1/3^{\Lambda} \Gamma_{\rm C3}$	$r_{1S2}^{1} = 2.316 \times 10^{-6}$ $r_{1W}^{1} = 0.140 \times 10^{-6}$
Probability Calculation	P <sub>CL</sub> <sup>-</sup> ( <sup>1</sup> <sub>CL</sub> - 336 HR) <b>*</b> (2 - <sup>1</sup> <sub>CL</sub> - 5 SEC) <sup>-</sup> 1.908 × 10 <sup>-10</sup>	$P_{\rm MF} = \left( \lambda_{\rm NF} \cdot 336 \text{ HR} \right) \\ \times \left( 2 \cdot \lambda_{\rm MF} \cdot 5 \text{ SEC} \right) \\ = 1.403 \times 10^{-10}$	P <sub>1NHIB</sub> = ( <sup>1</sup> <sub>152</sub> + <sup>1</sup> <sub>1W</sub> • 5 SEC) = 3.411 × 10 <sup>-9</sup>
Probability Description	Two of the clearance monitore/ peak detectora faliing, produc- ing an alarm.	Two of the near field monitora/ peak detectora failing. produc- ing an alarm.	Failure inhibiting the monitors while the ILS signal is radiated. A shutdown status will reault - loss of Cat, III and Cat. II sta- tus.

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Appendix G

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Localizer Preventive Maintenance Checks

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## Appendix G

## Localizer Preventive Maintenance Checks

This appendix consisting of table G-1, details the preventive maintenance checks necessary to detect hidden failures in the localizer.

Identificat	nci	Esilitre Mode	Preventive Maintenance	Recommended Task	Estimuted Task
ltem	No.		Task Description	Frequency	Time
urae onitor annela (Allii)	۵. <sup>۲</sup> ۲.	1 oss of monitoring ability. producing no alarme.	<ol> <li>Flip switch on each monitor to check DDM alarm.</li> <li>Misalign SDM phase shifter and front panel meter. realign SDM phase shifter.</li> <li>Iower course transmitter power. and check RF alarms: then using front panel meter. readjust RF power level.</li> <li>Note: Control unit logic for transfer capability may be simultaneously checked it "ijocal" or "remote" mode of õpirtation is selected.</li> </ol>	W cekiy	3.0°min.
ns itivity onitor hannels fAIN1	30 30 40	Same as above.	<ul> <li>(1) Flip switch on each monitor to check DDM alarm.<sup>n</sup></li> </ul>	W eekly	0.5 min.
learance onitor hannels AAIN)	43 44 45	Same as above.	<ol> <li>(1) Flip switch on each monitor to check DDM alarm.<sup>*</sup></li> <li>(2) Disconnect output of clearance transmitter to check RF and SDM alarms.<sup>*</sup></li> </ol>	.Weekly	1.0 min.
car Field Ionitor hannels		Same as above. (Not hazardous)	<ol> <li>Flip switch on sach monitor to check DDM alarm.</li> <li>Note: Control unit logic for shut- down can be checked simul- taneously.</li> </ol>	Monthly	0.5 min.
andby ourse fonitor hannel	<b>.</b>	l ass of relative ability. producing no alarm.	Same as main course monitor's except misalignment of standby transmitter: (1), (2), (3) rrNote: Control unit logic for stand- by alarm processing may he simulaneously checked if "iocal" or "remote" mode of operation is selected.	2 weeks	(2.0 min.

Table G-1. Localizer Preventive Maintenance Checks

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timated	Task Time	.2 min.	.6 min.	5 min.	.5 min.	,				-
Recommended Es	Frequency	2 weeks 0	2 weeks 0.	Monthly 0.	2 weeks 0.		Weekly	Monthly	Monthly	2 waeka
Preventive Maintenance	Task Déscription	<ol> <li>Flip switch on monitor to check</li> <li>DDM slarm.**</li> </ol>	<ol> <li>Flip switch on monitor to check DDM alarm.**</li> <li>Disconnect output of clearance transmitter to check RF and SDM alarms.**</li> </ol>	<ol> <li>Flip switch on main I. D. unit to "CONTINUOUS" to check if alarms occur on all I. D. monitore.</li> </ol>	(2) Filp switch on standby 1. D. unit to "CONTINUOUS" to check if alarm occurs.	Note: 1. D. monitor ase'y logic and 1. D. centrol unit processing may be checked simultaneously.	By checking the individual monitor channel alarms this hidden (allure mode can also be checked. Note that the "local" or "remote" mode of operation is required for control unit processing logic checks.	Same as above: (indication - "SHUT- DOWN" on control unit front panel).	Same as above: (indication - "MIS- MATCH" on control unit front panel).	Same as above: (indication - "AB- NORMAL" only on control unit front ( panel).
	Fallure Mode	1.000 of monitoring sbility. producing no alarm.	Sane as above.	l oss of one of the main I.D. monitors, producing no alarms. (Not hazaro,)	1.088 of standby 1. D. monitor. producing no alarm.		Inability to process a trans- fer signal from the integral course. sensitivity. I.D., and/or clsarance monitors.	Inability to process a shut- down signal initiated by the NF. FF. and/or Cat. II course DDM. (Not hazardous)	Inability to process a mis- match condition of any or all monitor sets. [Not hazardous]	Inability to process a standby alarm.
ion	No.	47	4 <b>4</b>	34			10			
Identificat	ltem	Standby Senoitivity Monitor Channel	Standby Clearance Monitor Channel	Identification Monitor Ass'y			Control Unit	***		

•	Tablé	e G-l. Localizer Pı	reventive Maintenance CF	iecks (Cont'd)	l'are 3 of 5
ldentifica	tion	Esilure Mode	Preventive Maintenance	Recommended Tack	Fatimated
Stera"	۲'n.		Task Description	if statency	uic
Control T'nıf 'continuedl	5	Inability to process any or all power (environmental alarma, (Not harardous)	<ol> <li>[1] Flip pach voltage circuit breaker switch on each converter and check if "CONVERTER FAII light lights.</li> <li>[2] Flip DC 10AD" and AC IN- PUT circuit breakers and check if CHARGER FAII. and AC FAII hughts respectively light.</li> </ol>	v months	5.0 min.
		Inability to shutdown either the main or standby transmitting mit. /'Sot hazardous)	By checking the individual monitor channel alarms this hidden failure mode can also be checked. Note that the local or remote mude of operation is required for control unit processing logic checks.	Monthly	
		Inability to effect a change of units feeding the antennas.	Same as above findication - TRANS- FFR' on control unit front panel).	2 weeks	
		Inability to process a main inhibit to the monitor channels.	Same as ahove (note that when two integral monitor alarms exist, a transfer will occur. If an immediate shutdown does not follow (within 2 seconds 1 the main inhibit is function- ing properly. (If the alarms are left on longer than 2 ecconds - monitor channel'simulated alarm with switch- a shutdown will occur.)	2 wreks	
	·	Inability to process a r nubv inhibit to the standby lamibit to the standby monitor chan- nels. [Not hazardous]	Same as above (note that it a standby Di)M alarm :s generated from a standby monitor channel. the standby transmitter should shut down and the standby monitor channels be inhibited if the inhibit is not generated. all R f and SDM lights on all standby monitore will light).	Monthly	
		Inability to generate a correct shutdown alert signal. (Not hazardous)	Same as above (note dat when the two near field alarms are simulated, a shutdown after a time delay will result. Prior to that shutdown, the shutdown alert should be generated).	Monthly	
		Reproc best a	duced from Conversion of the copy.		

hat'd)	Page 4 of 5	Imended Estimated	juency Time	4	onthe 15.0 min.	skiy 3.0 min.		coka	e;;e	ceka
scks (Co		Recon	Freq	2	9 9	Wee		2 æ	2 &	ŝ N
ventive Maintenance Che		Preventive Maintenance	Task Description	When the SDM phase chilter is mis- aligned in checking the SDM monitor- ing circuitry of the course monitors, a transfer and <u>not</u> a shutdown should result to indicate failure mode has not occurred.	<ol> <li>Turn "EOUALIZE TIMER" dial and then check front panel meter to are if voltage is approximately 33 volts. (each charger)</li> <li>Check respective batteries of each charger to see if full charge has been maintained (all cells).</li> </ol>	<ul> <li>Flip awitch on each monitor to check DDM alarm.</li> <li>Note: Both hidden failure modes are checked.</li> </ul>	Note: FFM combining logic may be simultaneously checked.	When two far field monitor alarms are activated (above), a Cat. III diable abould occur at the remote control tower after a nominal 20 second delay. Signal check may be accomplished with a vom.	When two far field monitor alarms are activated, both a shutdown alert and a Cat. II monitor alarm (shut- down) should occur after their res- pective time delays. Signal checks may be accomplished with a VOM.	When only one far field monitor alarm is activated, a mismatch sig- nal should occur after a time delay (120 sec). Signal check may be ac- complished with a VOM.
i-l. Localizer Pre			r allure mode	Inability to changeover trans- mitting units by switching circuitry.	foss of the equalize voltage capability. (Not hazardous)	Loss of monttoring ability. producing a Cat. III DDM alarm. (Not hazardous)	Loss of monitoring ability. producing no alarms.	Inability to generate a Cat. III dizable signal.	Inability to process a Cat. If monitor alarm. (Not hazardous) Inability to process a shut- down alert. (Not hazard2005)	Inability to process a mis- match condition at the FFM. (Not harardous)
able G		tion	No.	12	16	56 57 58		Ş		
Ţ	•	fdentifica	ltem	Changeover and Test	Battery Charger	Far Field Monitor Channels		Combining Circuite		

Fairmared		1.0 m.in.	0.5 mi . 5.0 min.	2.0 min.
Pertary ended Task	Frequency	• the •	Starrbly 6. norths	Mouth New York State
Breventive Maintenance	Tack there repres	Tura for fueld monitor charger corrue arraiger of and observe CHAPCSR FAIL Tich Light, frae SCM to check PARK TRMP FAIL argual to breaker station.	Turn far fu ki munitor charger cit- cus heraier off and are far fuch monitor munitor alarmal, operation for monitor starmal, unbage af FTM haitery during mermul operation. (1) Check terminal unbager af FTM haitery during mermul operation. (2) Escenarci FTM charger and aberts a rise in FTM battery unhage (oqualize vehaget). None Abore procedure che, is belli failure medee.	Check all cella of butters.
		lability to process a FWP TFMP alarm for either re- more or local displa (Not hazardous)	I nu voltage hutery dis- connect circuit failers, dis- connecting the harres from the load. I na of equalize charge capability after a power outage foot hazardoust foot hazardoust foot hazardoust foot hazardoust foot hazardoust	Inability to main and full charge
1.00		-	¢,	
لطحطالادعا	lten:	Combining Circuits Acont. ard	Ratteru Charger Far Firdd)	Ratery

Table G-1. Localizer Preventive Maintenance Checks (Cont'd)

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## Áppendix H

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## Glideslope Preventive Maintenance Checks

Identifica	tlon		Preventive Maintenance	Recommended	Estimated
ltem	No.	ranure mode	Task Description	Frequency	Time
Course Monitor Channels (MAIN)	\$ 10 9 • 10 9 • 10 9	I.nee of monitoring ability. producing no elarme.	<ul> <li>(1) Titp awitch on sach staltor to chick DDM sharm.</li> <li>(2) Misting SDM phase shifter and front panel meter. realign SDM phase shifter.</li> <li>(3) Lower course strangmitter power.</li> <li>(3) Lower course strangmitter power.</li> <li>(3) Lower course strangmitter power.</li> <li>(3) Lower course strange then using front panel meter. readjust RF power tevel.</li> <li>*Note: Control unit logic for transfer capability may be simultaneously checked.</li> </ul>	Weekly	3.0 mfn.
Senaítivity Monitor Channels (MAIN)	38.3	Same as above.	(1) Flip switch on each monitor to check DDM alarm."	Weekly	0.5 min.
Clearance Monitor Channels (MAIN)	<del>5</del> <del>2</del> <del>2</del>	Same at above.	<ul> <li>(1) Flip switch on each monitor to check DDM alarm.*</li> <li>(2) Disconnect output of clearance transmitter to check RF and SDM alarms.*</li> </ul>	Weekly	1.0 min.
Near Field Monitor Channels	÷ 4 ÷	Same as above.	<ol> <li>(1) Flip switch on each monitor to check DDM alarm.*</li> </ol>	Monthly	0. ŝ min.
Standby Course Monitor Channel	<b>4</b> 5	Lots of monitoring ability. producing no alarm.	Same as ynain course monitors except misallghment of staidby transmitter: (1), (2), (3) r*Note Control unit logic for stand- by alarm processing may be by alarm processing may be 'poal' or "rerrote' mode of 'poration is selected if	2 weeks	<b>2.0</b> min. ~
Standby Eenaltivity Monitor Channel	4	Same as above.	(1) Filp switch on monitor to check DDM alarm. **	2 weeks	0.2 min.

Table H-1. Glideslope Preventive Maintenance Checks

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Table H-1. Glideslope Preventive Maintenance Checks

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Identificat	íon		Preventive Maintenance	Recommended Tech	Fstimated	
Item	Ng.	200W 210117 /	Task Description	Frequency	Time	
Standby Clearance Monitoř Channel	48	Loss of monitoring ability. producing no alarm.	<ol> <li>Fitp switch on monitor.to check DDM alarm.**</li> <li>Disconnect-output of clearance transmitter'to check PF.and SDM alarms.**</li> </ol>	2 weeks	0.6 min.	
Misalignment Detector	<b>°4</b>	I ose of alignment detection, producing no alarm.	Flip switch on control unit front panel (MISALIGNMENT DETECTOR TEST switch) to "test" and wait for glideslope shutdown. Note control unit logic is simultaneously checked.	Weeklý	0.2 min. (time delay of 2.25 minutés not included)	
Control Unit Unit	õ	Inability to process a transfer signal from the integral course. sensitivity. and/or clearance monitors.	By checking the individual monitor channel alarms this hidden failure mode can also be checked. Note that the "local" or "remote" mode of operation is required for control unit processing logic checks.	Weekly	,	
<u></u>		Inability to process a shut- down signal initiated by the misalignment detector.	Checked by testing the misalignment détevior alarm when in "local" or "remote" mode of operation.	Wcekly		
		Inability to process a mis- match condition of any ör all monitor gets. (Not hazardous)	Checked when tey "monitor channel alatme (Indication - "MISMATCH" on control unit front panel).		-	
		frability to process a stand- by alarm.	Checked when testing monitor channel alarms: lindication - "ABNORMAL" only on control unit front smell.	2 weeks	· 	
		Inability to process any or all power/ënvironmental alarms. (Not hazardous)	<ol> <li>FIIp each voltage circinit breaker switch on each convertier and check if "CONVERTER FAIL" light lights.</li> <li>Filp "DC LOAD" and "AC IN- FUT" circuit breakers and check if "CHARGER FAIL" and "AC FAIL" lights.respectively light.</li> </ol>	6 months	5.0 min.	
		Inability to shutdown either the mainsor standby trans- mitting unit. (Not hazardous)	By checking the individual monitor chamel alarnis this hidden failure mode can also be checked. Nothing the "local" or "remote" mode of operation is required for control unit processing logic checks.	Monthlý		
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Estimated Task Timé					15.0 min.
Recommended Task Frequency	2 weeks	Zówceks.	Móathly	· · · 2 weeks	6 months
Prevêntive Maîntenance Task Descriptiôn	By checking the individual monitor channel alarms this hidden failure mode can i'so be checked. Note that the 'local' or 'remote' mode of operation is required for control unit processing logic checke. (indication - 'transfer' on control unit front panell,	Same as above: (note that when two. integral monitor alarms exist, a transfer will occur. If an immediate shutdown does not follow (within 2 seconds) the main inhibit is function- seconds) the main inhibit is function- in properly. (If the alarms are left on longer than 2 seconds - monitor channel sinulated alarm with switch- a shutdown will occur).	Sane as above: (note that if a standby DDM alarm is generated from: standby monitor channel. the standby transmitter should intudown and the standby monitor chonels be if the inhibit is not generated. all R T and SDM lights on all standby monitors will light).	When the SDM phase shifter is mis- aligned in checking the SDM monitoring circuitry of the course monitors. a transfer and <u>not</u> a shut- down should result to indicate failure mode has not occured.	<ol> <li>Turn "EQUALIZE TIMER" dial and then check front panel meter to see if voltage is approximately 33 volts. (each charger)</li> <li>Check respective batteries of each charger to see if full charge has been maintained (all cells).</li> </ol>
Failure Mode	Inibility to effict a change of units feeding the antennas.	Inability to process a main inhibit to the monitor chancels	fnability to process a standby inhibit to the standby monitor channels. (Not hazardous)	. Inablijty-to changeover trana- mitting unite by switching cefcuitry.	Loss of the equalize voltage capability. (Not hazardous)
vo.	5			01	<u>e.</u> z
Identificat	Cantrol Unit (continued)			Changeover and Test	Battery Charger

Fyle Preventive Maintenance Checks

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