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OPERATING AND SUPPORT HAZARD ANALYSIS
FOR
SELF-CONTAINED NAVIGATION SYSTEM
LSI MODEL 6216A, B, & C
GROUP "B"

Report No. 6216-019

30 May 1986

Contract No. 709603-85-C-1224

Data Item 0211

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SUMMARY

Review of the drawings, sketches and documentation available as of this writing reveal no serious Category I or II hazards with the exception of two items. One involves the DVS installation and removal related to dropping. If the T.O.s are followed and proper equipment used, this concern is minimized. The other concern is of overheat damage to the ICDU in event of fan failure. Recommendations are provided for resolving the concern and an open action item exists to assure follow-up.

Further analysis will be performed as drawings are completed. Changes and updates will be included in future edition of this document.

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1.0 GENERAL - This document constitutes the Operating and Support Hazard Analysis (O&SHA) for the C-130 Self-Contained Navigation System (SCNS) Group "B" LRUs. It provides a hazard assessment of use and maintenance of the individual LRUs provided by LSI.

1.1 PURPOSE - IAW MIL-STD-882A, the purpose of an O&SHA is to identify and control hazards to personnel and to the system, or related to production, installation, maintenance, test, operation, etc. This O&SHA is limited to design of the Group "B" LRUs as the design affects operational use and maintenance safety of personnel working in or around the equipment, including ground and flight crews. *500-ja-4*

1.2 SCOPE - The scope of this analysis is limited to the new SCNS "B" components, the Integrated Control Display Unit (ICDU), the Bus Integrated Computer Unit (BICU) and vendor data on the Doppler Velocity Sensor (DVS). The analysis is limited to LRU level safety concerns affecting their use and maintenance, shipping and storage.

2.0 APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS - The following documents of the exact issue shown are used in the preparation of this analysis and report.

MIL-STD-882A	System Safety Program Requirements (paragraph 5.5.1.4).
DI-H-7048	System Safety Hazard Analysis Report (paragraph 10.2.4)
DH1-6 (Edition 5)	System Safety Design Handbook
84-MMSRE-005-DVS	Doppler Velocity Sensor (DVS), C-130 Self-Contained Navigation System SCNS, Specification for
84-MMSRE-006-ICDS	Integration, Computation and Display System (ICDS) Self-Contained Navigation System SCNS Control, Specification for
84-MMSRE-009-C-130	Self-Contained Navigation System (SCNS) Integration, Fabrication, Installation and Test of, C-130 Aircraft



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2.2 NON-GOVERNMENT DOCUMENTS

Report No.
TRE/SD101766C-2

Navigation Set, Radar AN/APN-218
Operating Hazard Analysis for
C-130 Production (originally
submitted to ASD/ENAMD under
Contract No. F33657-77-C-0098
Data Item 200Z)

3.0 SYSTEM DESCRIPTION

3.1 GENERAL DESCRIPTION - The SCNS is comprised of a Doppler Velocity Sensor (DVS), Inertial Navigation System (INS), Integration Computation and Display System (ICDS), and the associated installation Group A kit to provide doppler aided INS navigation, INS only, Doppler only and TAS/HDG navigation modes, and control of the various C-130 communication/navigation (comm/nav) systems. The SCNS ICDS consists of three Integrated Control Display Units (ICDU) and one Bus Integration Computer Unit (BICU) for all C-130 aircraft except that the HC-130H will have an additional ICDU for the radio control. A block diagram is shown in figure 1.

In conjunction with the SCNS installation, the following systems/components will be removed from the various C-130 configurations.

AN/APN-147 Doppler
AN/ASN-35 Doppler Computer
ARN-131 Omega
AN/ASN-24 or PINS (C-130E AWADS only)

Radio controls for

AN/ARC-164 UHF (one control retained)
AN/ARC-186 VHF
AN/ARC-190 HF
AN/ARN-118 TACAN
AN/ARN-127 VOR/ILS
USAF Standard VOR/ILS

The communication and navigation radio control functions will be assumed by the ICDUs except during an emergency use of a UHF backup manual control head.

3.2 MAJOR COMPONENTS - A list of major components is provided in table I.

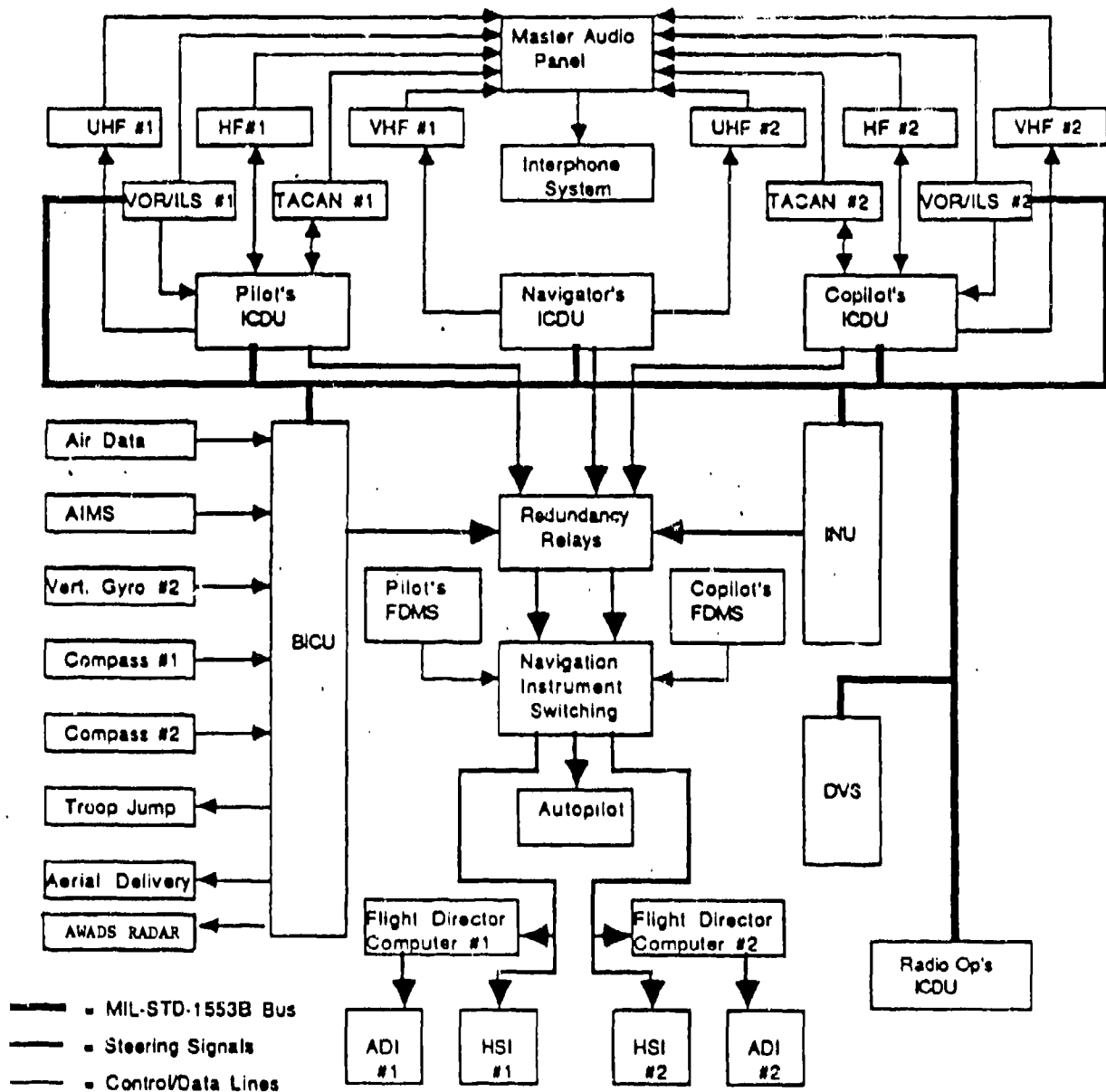


Figure 1. SCNS Block Diagram

Table I. Major Component List

MODEL NO.	GROUP		DESCRIPTION	LOCATION
	A	B		
LSI-2580F		✓	Integrated Control Display Unit	Left side forward on center console for pilot. Right side forward for co-pilot. Nav panel for navigator. Radio operator's panel for HC-130.
LSI-2905A		✓	Bus Interface Computer Unit	New equipment rack.
LSI-2905B		✓	Bus Interface Computer Unit with Added Radar Interface Card (AWADS)	New equipment rack.
LSI-2590A APN-218		✓	Doppler Velocity Sensor	Belly of aircraft
SNU 84-1		GFE	Inertial Navigation Sensor	Aircraft floor below new equipment rack
-	✓		Electrical A-Kit	Several variations
-	✓		Mechanical A-Kit	Several variations
-	✓		Flight Director Mode Select panel modifications	Instrument Panel (also a panel on the pedestal for C-130B)
-	✓		SCNS Control Panel	Nav Station
-	✓		INU Battery	Battery Compartment

- 3.2.1 ICDS - The ICDS consists of two major components: the Integrated Control Display Unit (ICDU) and the Bus Integration Computer Unit (BICU). All aircraft configurations utilize fully interchangeable ICDUs: pilot's, co-pilot's, navigator's and radio operator's (HC-130H). Jumper wires in the aircraft installation indicate its particular station location to each ICDU. One basic BICU design is utilized in all SCNS configurations with the exception of the BICU for the AWADS aircraft. It adds a third circular connector and SRUs for the radar interface. Connector jumper wires indicate to the BICU into which aircraft model it is installed.
- 3.2.2 INS - The Inertial Navigation System (INS) consists of three major components: the Inertial Navigation Unit (INU), the INU mount, and the SCNS battery subsystem. The SCNS INU conforms to requirements of the F³ SNU 84-1 and SNU 84-3 specifications and is GFE.
- 3.2.3 DVS - The Doppler Velocity Sensor (DVS) consists of the APN-218 Air Force Standard Doppler. The DVS provides basic navigation inputs for SCNS independent doppler navigation capability and for integrated INS/Doppler capability. It is contractor supplied.
- 3.3 SYSTEM FUNCTIONS - The SCNS primary function is to provide highly accurate and reliable self-contained navigation capability for the MAC C-130 Tactical Airlift Operations. These missions and operations are defined in MACR 55-130, Military Airlift Command Regulation.
- 3.3.1 MAJOR FUNCTIONS - The SCNS provides the following major functions.
- ☐ Navigation modes and position update capability.
 - ☐ Integrated control and display of navigation, communication, guidance, and steering functions.
 - ☐ Aircraft guidance and steering - including flight plan, time of arrival, CARP, SAR, and rendezvous.
- 3.3.2 SECONDARY FUNCTIONS - Additional features are provided to improve performance, reduce crew workload, and minimize aircraft maintenance time. Specifically, these are:
- ☐ TACAN mixing to improve navigation accuracy.



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- ☐ CARP capability that will reduce crew workload and increase mission flexibility.
 - ☐ Simple, accurate, and quick magnetic compass calibration procedures.
- 4.0 SAFETY CRITERIA - Certain safety criteria IAW MIL-STD-882A are followed in this O&SHA.
- 4.1 SYSTEM SAFETY PRECEDENCE - Any items detected as fitting into hazardous categories are treated in the following order:
 - a. Redesign to eliminate the hazard, if possible.
 - b. Change operating procedure to eliminate or reduce occurrence.
 - c. Provide training recommendations to allow personnel to safely work in the presence of the hazard.
 - d. Label or placard hazards and provide inputs to manuals.
- 4.2 HAZARD LEVEL CATEGORIES - (criticality definitions) For the purpose of the hazard analysis, the hazards will be defined and categorized IAW the criticality definitions set forth below (ref. MIL-STD-882A, para. 5.4.3.1).
- 4.2.1 HAZARD SEVERITY - Hazard severity categories are defined to provide a qualitative measure of the worst potential consequences resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, system, subsystem or component failure or malfunction as follows:
 - a. Category I - Catastrophic - May cause death or system loss.
 - b. Category II - Critical - May cause severe injury, severe occupational illness, or major system damage.
 - c. Category III - Marginal - May cause minor injury, minor occupational illness, or minor system damage.
 - d. Category IV - Negligible - Will not result in injury, occupational illness, or system damage.

4.2.2

HAZARD PROBABILITY - The probability of the defined hazard occurring is based on a qualitative judgment for the purpose of this hazard analysis. The probability levels quoted here are from MIL-STD-882A, Para. 5.4.3.2.

DESCRIPTIVE WORD	LEVEL	SPECIFIC INDIVIDUAL ITEM	FLEET OR INVENTORY
Frequent	A	Likely to occur frequently	Continuously experienced
Reasonably Probable	B	Will occur several times in life of an item	Will occur frequently
Occasional	C	Likely to occur sometime in life of an item	Will occur several times
Remote	D	So unlikely, it can be assumed that this hazard will not be experienced	Unlikely to occur but possible
Extremely Improbable	E	Probability of occurrence cannot be distinguished from zero.	So unlikely, it can be assumed that this hazard will not be experienced.
Impossible	F	Physically impossible to occur	Physically impossible to occur

4.2.3

DVS HAZARD CATEGORY LEVELS - It should be noted that the referenced Teledyne Ryan Electronic (TRE) DVS Operating Hazard Analysis uses the older MIL-STD-882 Hazard Category and probability rating system whereas this document uses categories prescribed in MIL-STD-882A.



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5.0 OPERATING AND SUPPORT HAZARD ANALYSIS - The Hazard Analysis is comprised of the following sections.

- ☐ Integrated Control Display Unit (ICDU)
- ☐ Bus Integration Computer Unit (BICU)
- ☐ Doppler Velocity Sensor (DVS)

The ICDU and BICU analyses are done as follows:

- ☐ Available mechanical drawings and sketches are reviewed and analyzed for safety critical items. Examples are mounting and removal methods, weights, handles, sharp edges, case of damage, temperatures, connector access and high voltage location.
- ☐ Available schematics and sketches are reviewed for high voltage hazards, relative location of voltages, signals and grounds in connectors and wiring and possible cascading failures.

The intent is to assure that operation and use of the ICDU and BICU do not create or cause hazardous conditions to airplane or crew when installed and in use or to the maintenance personnel during installation, removal, test and repair.

The DVS analysis is limited to a review of the Operating Hazard analysis received from the vendor and attached hereto.

5.1 ICDU AND BICU ANALYSIS - Tables II and III respectively list the available ICDU and BICU drawings, their status as of this analysis and an item reference number for use where cross indexing with text or matrix sheets may be useful. These listed drawings are both schematic and assembly drawings. Some are sketches. They will be reviewed again upon individual completion and again upon formal release. The results of these later reviews and analyses will be included in a later edition of this Safety Report.



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5.1.1 ICDU - Initial analysis does not indicate any Category I or II hazards in or out of the aircraft. High voltages used by the CRT portion of the ICDU are adequately protected, and required warning and caution placards are being provided. No problems in removal or installation that could prove hazardous have been found. The CRT appears to be safe from explosion hazards. There is some concern for the ultimate internal temperature in event of fan failure. This is presently considered more of a reliability problem than a safety problem and is the subject of an action item to be resolved. Weight and handling are not a problem.

5.1.2 BICU - Initial analysis does not indicate any Category I or II hazards. The highest voltage in the BICU is 115 volts 400 Hz primary power. Protection and caution labels will take care of this potential problem for maintenance personnel during open box test and repair. Weight and handling are not a problem.

5.2 DVS ANALYSIS - The OHA received from the DVS supplier is listed in section 2.2.

Review of this report indicates many equivalent Category I and II hazards listed. The hazards listed do not exist, however, because the necessary steps have been taken to prevent them. As listed, they are essentially what the hazard could be rather than what it is. The items listed are believed to be only marginal to negligible or Category III and IV IAW MIL-STD-882A.

An item not mentioned, relates to the weight and handling difficulty during removal and installation in the belly of the aircraft. The LRU could be easily dropped or bent (if partially attached) and be damaged or do injury to personnel. Proper tools and procedures must be used thus minimizing any handling hazard.



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Table II. ICDU Drawings Reviewed

ITEM NUMBER	DRAWING NUMBER	STATUS	TITLE	DESIGNATOR	COMMENTS
1	168002	Preliminary	Schem. Diag. CPU/Mem Board (SCNS)	A1	
2	168008	Not available	Schem. Diag. AMUX Interface Unit (DEP)	A2	Reviewed Similar Schem. #160888
3	168105	Preliminary	Schem. Diag. Display Gen/Mem Board (SCNS)	A3	
4	168152	Preliminary (proj. control change 6)	ICDU Digital I/O Control	A4	
5	168155	Preliminary	Discretes 2 (Radio Control) No formal title	A5	
6	168160	Preliminary	Schem. Diag. SCNS Deflection Circuit	A6	
7	WR168170	Sketches	CRT Assembly Schematic (preliminary title)	A7	
8	168196	Sketches	CRT Circuit Board (preliminary title)	A7A	Will be A7 TB-2. Also called Harmonization Board
9	?	?	CCI TE Buffer	A8	Used only in test - not evaluated

Table II. ICDU Drawings Reviewed (Continued)

ITEM NUMBER	DRAWING NUMBER	STATUS	TITLE	DESIGNATOR	COMMENTS
10	SC1285/A	Info. Dwg.	Schematic Diag. SCMS Intel Cont. Display Unit	A7	Interim top ass'y schematic
11	168181	Prelims & sketches	Low Voltage Power Supply	PS1	Made up of 4 cards A-D
12	168162	Preliminary Spec Control Dwg.	High Voltage Power Supply	PS2	Sealed unit, high voltage
13	168173	Sketch	Filter Assembly	F1	
14	168395	Prelims and sketches	ICDU Assembly	CH1	
15	168192	Preliminary	Electron Tube Assembly (CRT Assembly)	X	
16	168452	Preliminary	Switch panel, lighted (Keyboard Assembly)	KB1	Sometimes referred to as DS-1

Table III. BICU Drawings Reviewed

ITEM NUMBER	DRAWING NUMBER	STATUS	TITLE	DESIGNATOR	COMMENTS
1	168202	Preliminary	Schematic Diag. BICU Radar (AWADS)	A1	
2	168017	Preliminary	Schem. Diag. AC Output	A2	
3	168017	Preliminary	Schem. Diag. AC Output	A3	
4	168017	Preliminary	Schem. Diag. AC Output	A4	
5	168017	Preliminary	Schem. Diag. AC Output	A5	
6	168017	Preliminary	Schem. Diag. AC Output	A6	
7	168152	Preliminary 6th Rev.	ICDU Digital I/O Control	A7	Also BICU Board
8	168020	Sketches	Discretes (3)	A8	
9	168205	Preliminary	SCNS Analog Interface PWA	A9	
10	168011	Preliminary	Schematic Diag, SCNS Interface PWA	A10	Also called Control Converter
11	?	?	C.C.I. T.E. Buffer	A13	Used only in test, not evaluated
12	168002	Preliminary	Schematic Diag. CPU/Mem Board (SCNS)	A14	

Table III. BICU Drawings Reviewed (Continued)

ITEM NUMBER	DRAWING NUMBER	STATUS	TITLE	DESIGNATOR	COMMENTS
13	168008	Not available	Schem. Diag. AMUX Interface unit (DEP)	A15	Reviewed similar schem #160888
14	168219	Not available	Torque supply	PS1	
15	168175	Sketch	Post Reg. Supply	PS2	Possibly deleted
16	168183	Sketch	Control supply and output supply	PS3	2 boards
17	168165	Sketch	Filter Assembly	F1	
18	168399	Sketches	BICU Assembly	CH1	Layout Dwg LG2905A Rev 10
19	168417	Sketches	BICU Assembly AWADS	-	Additional connector and internal parts

SYSTEM _____ DVS _____		OPERATING HAZARD ANALYSIS				PREPARED BY: J. T. Reeves	
SUBSET _____		PAGE _____ OF _____				ISSUE DATE _____ REV _____	
ITEM NO.	CONDITION/EVENT	EFFECT/HAZARD	CAUSE	CLASS	LEV	CONTROLS & COMMENTS	
1	Removal and replacement	Bend, drop or damage LRU or injure personnel	Location, method of attachment weight and handling	II	B	Use proper equipment such as cradle on a jack (similar to a transmission jack) follow procedures in the T.O. This should lower the category to III and probability to "D"	

CLASS: I CATASTROPHIC
II CRITICAL
III MARGINAL
IV NEGLIGIBLE

LEVEL: A - FREQUENT
B - REASONABLE PROBABLE
C - OCCASIONAL
D - REMOTE

E - EXTREMELY IMPROBABLE
F - IMPOSSIBLE

SYSTEM		OPERATING HAZARD ANALYSIS				PREPARED BY: J. T. Reeves	
SUBSET		ICDU		PAGE		OF	
				ISSUE DATE		REV	
ITEM NO.	CONDITION/EVENT	EFFECT/HAZARD	CAUSE	CLASS	LEV	CONTROLS & COMMENTS	
2	Fan failure during normal flight or ground operation (particularly the pilots ICPU location)	Reduce LRU reliability or result in imminent failure possibly recoverable upon cooling. Allowed to remain on, may reach smoke temperature. Possible irreparable damage to LRU	Fan failure	II	C	It is believed that the ICPU will develop a functional circuit failure due to high temp before failure occurs or before smoke temp is reached. The failure will be apparent by display failure or annunciation. If this occurs, the ICPU should be carefully felt for temp rise or audible fan failure. Open circuit breaker if this occurs. Inclusion of an over-temperature thermal switch (above functional failure temp) would resolve the hazard concern but would allow degradation of long term reliability. A lower over-temp warning would be the preferred solution. Either method will reduce the category to III and damage probability to "D"	

CLASS: I CATASTROPHIC
II CRITICAL
III MARGINAL
IV NEGLIGIBLE

LEVEL: A - FREQUENT
B - REASONABLE
C - OCCASIONAL
D - REMOTE

E - EXTREMELY IMPROBABLE
F - IMPOSSIBLE

SYSTEM		BICU		OPERATING HAZARD ANALYSIS			PREPARED BY: J. T. Reeves	
SURSET							PAGE	OF
							ISSUE DATE	REV
ITEM NO.	CONDITION/EVENT	EFFECT/HAZARD	CAUSE	CLASS	LEV	CONTROLS & COMMENTS		
3	Normal operation	Over-temperature	Debris clogging bottom air inlets through extended use without cleaning or inspection. Location of IRU is near floor.	III	D	The probability of this occurring is difficult to evaluate. It is believed that periodic inspection should be called out in the T.O. A filter might be more of a problem than a solution in this case, and at this time is not recommended		

CLASS: I CATASTROPHIC
II CRITICAL
III MARGINAL
IV NEGLIGIBLE

LEVEL: A - FREQUENT
B - REASONABLE PROBABLE
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