Chapter 3

3.0 Requirements Analysis

Chapter 3 presents an overview of the requirements analysis conducted by the AN/BQH-7/7A IPT. The analysis begins with a look at all of the past operational, functional, physical and environmental requirements associated with the current surface ship and submarine bathythermograph recorders. A look into past requirements was necessary to ensure that all Commercial off the Shelf (COTS) and Non-developmental Item (NDI) component and software alternatives could and would meet all of the past as well as all current Navy bathythermograph recorder requirements. To help in tracking the large number of existing requirements, a detailed Requirements Allocation Matrix (Appendix E) was developed. The technical requirements derived at from the requirements analysis were then converted to a more detailed set of technical requirements through functional analysis. A Hardware Functional Allocation Matrix was developed (Appendix F) to ensure (in checklist format) that all requirements were addressed.

After the requirements and functional analysis, various hardware and software alternatives were selected by conducting COTS and NDI component tradeoff analysis. The current AN/BQH-7/7A recorder was then re-engineered by repackaging the recorder's circuit card chassis and subassemblies with COTS and NDI componentry using Open Systems Architecture (OSA) modular groupings for design simplification. Chapter 3 leads the reader through the conceptual design and preliminary reliability analysis, detailed requirements and tradeoff analysis, to the detailed design and first prototype Bill of Materials (BOM). All requirements were documented in a Prime Item Development Specification (PIDS) [Performance Specification].

3.1 Operational Requirements Analysis

The Operational Requirements were discussed in Section 1.1.1 "Operational Requirements" and a typical mission scenario was presented in Section 1.1.2 "Mission Description". This section discusses the operational requirements from a operator man-machine interface and training perspective.

Operability and Training Requirements

As stated in Chapter 1, the recorder system is used at infrequent intervals (i.e., whenever the CO feels the acoustics performance database needs updating), training is an important issue in order to ensure proper and consistent operation of the recorder. This was addressed in the design of the EC-3 Kit by (1) simplifying the design in order to make the recorder easier to operate and maintain and (2) using simple, effective, and easy to understand language in the operation manual(s). Because of these considerations early on in the EC-3 design, the operator is not likely to keep reviewing the operation manual(s) once he or she has looked at them more than once. Therefore, the operational description of the recorder in the operations manual(s) will be at a level that is simple, straightforward, and easy to understand. This requirement will have a positive affect on the initial training time required and in the time required for user certification for recorder operation. By making the recorder's operation manual easy to understand and use, the sailor will have an easier time of getting the results that are expected from him/her.

Providing an easy to learn and use recorder system and operator/machine interface (both hardware layout and display graphic user interface [GUI]) gives the sailor the confidence he/she needs in properly operating the recorder system. This user confidence inherently improves the overall system effectiveness and performance by reducing the number of human errors or "mistests" to be expected from the use of the overall system, in both the short and long term.

3.2 Maintenance and Supportability Requirements

The maintenance philosophy for the current AN/BQH-7/7A has been Organizational and Depot Level Maintenance. The decision was made over two decades ago not to use Intermediate Level Maintenance (I-Level Maintenance). The reason to exclude I-Level Maintenance was most likely due to the relatively low cost of the On Board Repair Parts (OBRPs) replacement spares.

3.2.1 Organizational Level (O-Level) Maintenance

AN/BQH-7/7A Requirement

Organizational - Ship Level

Maintenance Assist Modules (MAMs) are currently used for troubleshooting when there is a failure. MAMs are used to locate the failed board by removing the board(s) in questioned and replacing it with a known working board. Once the failed board is located, an On-Board Repair Part is requisitioned from Ship's Supply. The working MAM is then returned to it's MAM's case for future troubleshooting use.

AN/BQH-7/7A EC-3 Requirement

We propose to continue with O-Level maintenance but with a significant decreased in the number of OBRPs required for O-Level support and with a substantial reduction in the number of MAMs used for troubleshooting. Instead of a dependence on MAMs, the emphasis will be placed on the use of software diagnostics. In addition, the number of boards inside the recorder will be reduced from today's 12 board configuration to 4 or 5 boards (depending on ship class).

3.2.2 Depot Level Support

AN/BQH-7/7A Requirement

Navy Inventory Control Point (NAVICP) in Mechanicsburg, PA is the current and future Navy Supply and Support Depot for the current AN/BQH-7/7A recorder. NAVICP has a Basic Order Agreement (BOA) contract with the Contractor Depot (and AN/BQH-7/7A manufacturer) Sippican, Incorporated.

AN/BQH-7/7A EC-3 Requirement

We propose a major update to the Provisioning Technical Documentation (PTD) support documentation for all new AN/BQH-7/7A EC-3 components. The effort to update the PTD was initiated early-on in the TI engineering services letter which also funded Sippican to do a detailed analysis in updating the PTD and filling out the Logistics Support Analysis (LSA) 036 supportability/sparing datasheets. The information in the LSA-036 report will be enter into the NAVICPs database and analyzed for potential sparing candidates.

3.2.3 Depot Level Maintenance

AN/BQH-7/7A Requirement

Sippican Incorporated was also used as a depot location. NAVICP also worked closely with Sippican in repairing failed parts and in maintaining inventory levels.

AN/BQH-7/7A EC-3 Requirement

Sippican Incorporated will continue acting as the Contractor Depot for the foreseeable future.

3.2.4 Technical Design Agent (TDA) and In-Service Engineering Agent (ISEA)

AN/BQH-7/7A Requirement

The Navy TDA and ISEA for this system originally resided at NAVSEACOMBATSYSENG Station in Norfolk, Virginia. The Naval Undersea Warfare Center (NUWC); Newport, Rhode Island has been the ISEA since 1994.

AN/BQH-7/7A EC-3 Requirement

The current plans are to continue using NUWC as the TDA and ISEA for this system. However, consolidation and streamlining cost savings alternatives are being studied.

3.2.5 Ship Yard

AN/BQH-7/7A Requirement

Installation and Checkout Spares (INCOs) were required at all major shipyards.

AN/BQH-7/7A EC-3 Requirement

INCO Sparing will probably continue but will be reduced by approximately 75%.

3.3 Human Factors Considerations

The system operability human factor considerations that have a direct impact on training and operator effectiveness were discussed in Section 3.1 above. This section includes all of the direct human interfaces from the user-operator to the recorder.

There were two main goals to be achieved in optimizing the human factors requirements. They were to (1) achieve the lowest possible life time training and operational costs and to (2) maximize the effectiveness of the system. These goals could best be achieved through the maximum use of human interfaces which are already familiar to the typical user. The pertinent human factor interface decisions include both software and hardware. As stated, the software interface decision was to use the Windows 95 operating system and the Mk-12 operating software. The hardware decision was to use the keyboard, pointer, and display indicators discussed later in this chapter.

3.4 Functional Requirements Analysis

This section describes the steps used in our EC-3 requirements analysis and how these requirements were functionally allocated to the current AN/BQH-7/7A recorder in upgrading it to the AN/BQH-7/7A EC-3 recorder.

3.4.1Quality Function Deployment (QFD) and Analytic Hierarchy Process (AHP) Analysis

As discussed in Section 1.2 Problem Identification, extensive user briefings were conducted with the Fleet. We also participated in two Fleet conferences on ASW issues. Figure 10 was taken from a paper by Verna, Blanchard, & Griffin presented at the 1996 INCOSE Symposium.[5] The authors outlined a methodology to facilitate the prerequisite analysis and evaluation required before making a commitment to a COTS/NDI alternative. The paper recommended an integrated application of Quality Function Deployment (QFD) and Analytic Hierarchy Process (AHP) to facilitate the prerequisite analysis and evaluation process.

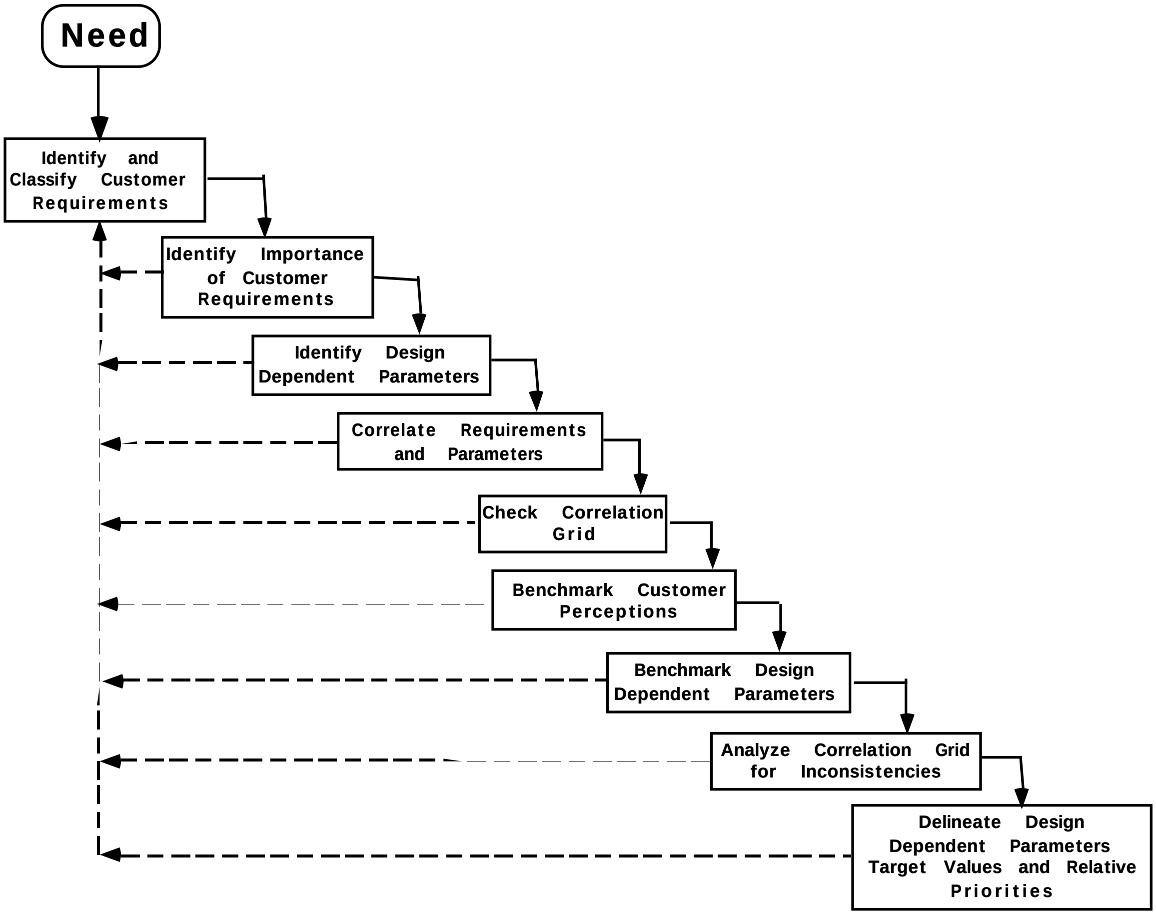

Figure 8 - Quality Function Deployment (QFD) Process [5]

Where the QFD method is utilized to identify the relevant criteria set, the AHP method is invoked to compute a consistent set of relative priorities for the attribute set to be followed by a comparative analysis of the potential alternatives. Figure 9 shows how the output from the QFD process was fed into the AHP process. The output of the AHP process is the recommended preferred COTS alternatives. Figures 8 and 9 were both included to show the exact procedure followed through our user interface meetings in cataloging of all of the requirements, to perform the design synthesis of the desired requirements, and to determine feasibility and reasonableness.

As discussed in Chapter 2, this needs analysis led us next into the development of our performance specification and follow-on functional allocation. From this point, we began identifying our COTS and NDI candidates for further tradeoff analysis. The only part of this process we failed to follow in it’s entirety, was in the formal development of an QFD Correlation Matrix due to limited financial and personnel resources.

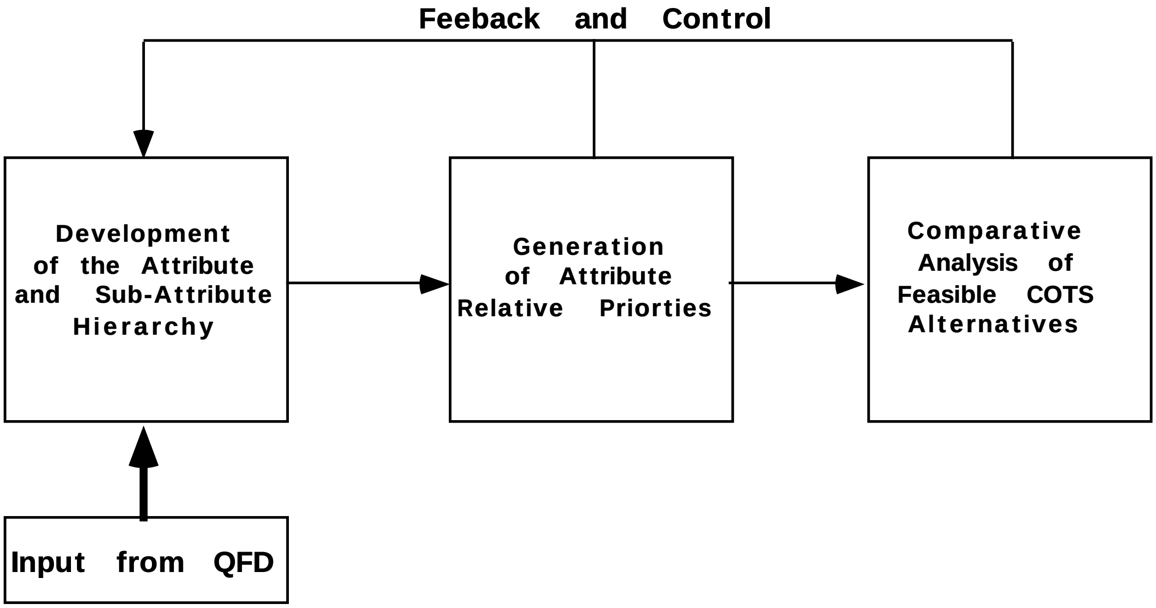

Figure 9 - Analytic Hierarchy Process [5]

3.4.2AN/BQH-7/7A EC-3 Requirements Synthesis

Our many user meetings resulted in a very interesting list of desired requirements. A few of the more interesting requests are highlighted below. For additional detail of all of the request, refer to Appendix E “AN/BQH-7/7A EC-3 Requirements Allocation Matrix” A few of the more interesting requests are as follows;

- Satellite uplink capability with Windows 95
- Netscape Application for Surfing the Web at-sea using the Satellite uplink capability
- Global Positioning Satellite (GPS) downlink capability to log latitude and longitude automatically to file
- 200+ MHz Pentium Processor

The IPT did choose Windows 95 and a pentium processor (100 MHz).

3.4.3AN/BQH-7/7A EC-3 Requirements Allocation to Current Requirements

The IPT is still reviewing the Appendix E Requirements Matrix for completeness and to ensure all of the requirements are valid and testable. The matrix was first assembled using existing AN/BQH-7/7A requirements documents. They were expanded upon after receiving input from the QFD and AHP process. The existing requirements documents were;

Contract N00024-78-PR-60118, Appendix C to Statement of Work
Recorder, AN/BQH-7 Submarine Expendable Bathythermograph (SSXBT)
Performance Specification

Contract N00024-79-C-6072, R-986, Performance Specification
TRIDENT Sonar System AN/BQQ-6 Bathythermograph Group Unit 76,
28 March 1980

Contract N00024-79-C-6215,
Performance Specification for Ship Expendable Bathythermograph (XBT)/Sound
Velocimeter Data Recorder AN/BQH-7A
(supplement to Appendix C to Statement of Work and Modification P00021 to
Contract N00024-79-C-6215, SSXBT Performance Specification), 22 January 1987

3.4.4AN/BQH-7/7A EC-3 Functional Flow Requirement

The Functional Flow Requirements were a direct outcome of the requirements analysis and functional allocation of hardware to those requirements. The functional flow diagram in Figure 10 below meets all of the requirements as specified in the Appendix E Requirements Matrix. Our first hardware prototype will be tested to verify that the final design meets the Appendix E requirements detailed in the AN/BQH-7/7A EC-3 Prime Item Development Specification (PIDS) [Performance Specification].

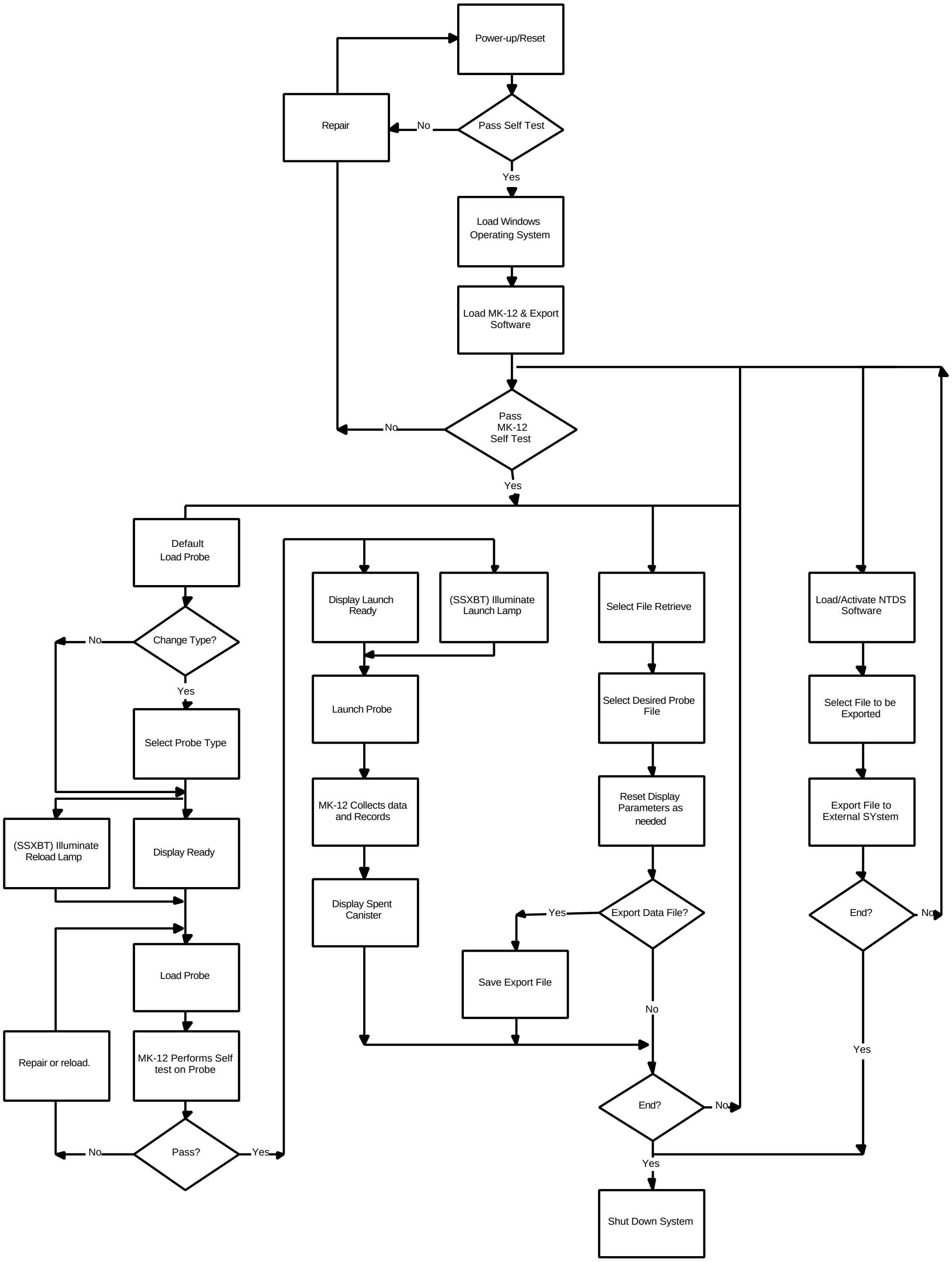

Figure 10 - AN/BQH-7/7A EC-3 Functional Flow Diagram

3.4.5Interface Requirements Analysis

The interface requirements in Table 6 are accommodated by the AN/BQH-7/7A to meet the ship class unique external interface requirements onboard surface ships and submarines. The interfaces will be implemented via hardware and software in the upgraded EC-3 recorder.

Table 6 - AN/BQH-7/7A EC-3 External Shipboard Interface Requirements

	NTDS Fast (Type B)	RS-232-C	NTDS Slow (Type A)	Trident Serial
System Interface	AN/BQH-7A (all surface ships except TAGOS)	AN/BQH-7A EC-1 (TAGOS)	AN/BQH-7 (637 and 688 classes)	AN/BQQ-5E(V)4 & AN/BQQ-6 (726 class)
Spec	MIL-STD-1397	Electronic Industries Association Standard RS-232-C	MIL-STD-1397	Part of the AN/BQQ-5E(V)4 & AN/BQQ-6 Performance Specification (Group G)
Lines	Three dedicated control lines (External Interrupt Request, Input Data Request, and Input Data Acknowledge) which provide handshaking between the data recorder and the external system; sixteen parallel interface lines.	Acts as an asynchronous simplex (receive only) interface with four lines (Transmit, Signal Ground, Ready to Send, and Clear to Send); there is no handshaking.	There are two dedicated control lines designated Enter and Read, which provide handshaking between the data recorder and the external system; sixteen parallel interface data lines.	Three status lines and a single data line; Clock, Descent, and EOT lines are provided for use by the external system for timing and synchronization.
Circuit Boards	CPU, External Interface, and NTDS Fast Driver	CPU and RS-232	CPU, External Interface, and NTDS Slow Driver	Investigating compatibility of either NTDS or RS-232-C

The IPT decided early-on not to interfere or impact any external physical or software interfaces. Therefore, no external physical constraints existed. All design changes were made internal to the recorder. This was possible by implementing the latest in technology insertion principals. Because the external physical interfaces were not changed, rework to other external shipboard equipment would not be required. This was possible by using the same housing assembly, power, heating, and cooling requirements as the current recorder. Figure 11 shows the internal interfaces of the new EC-3 recorder design.

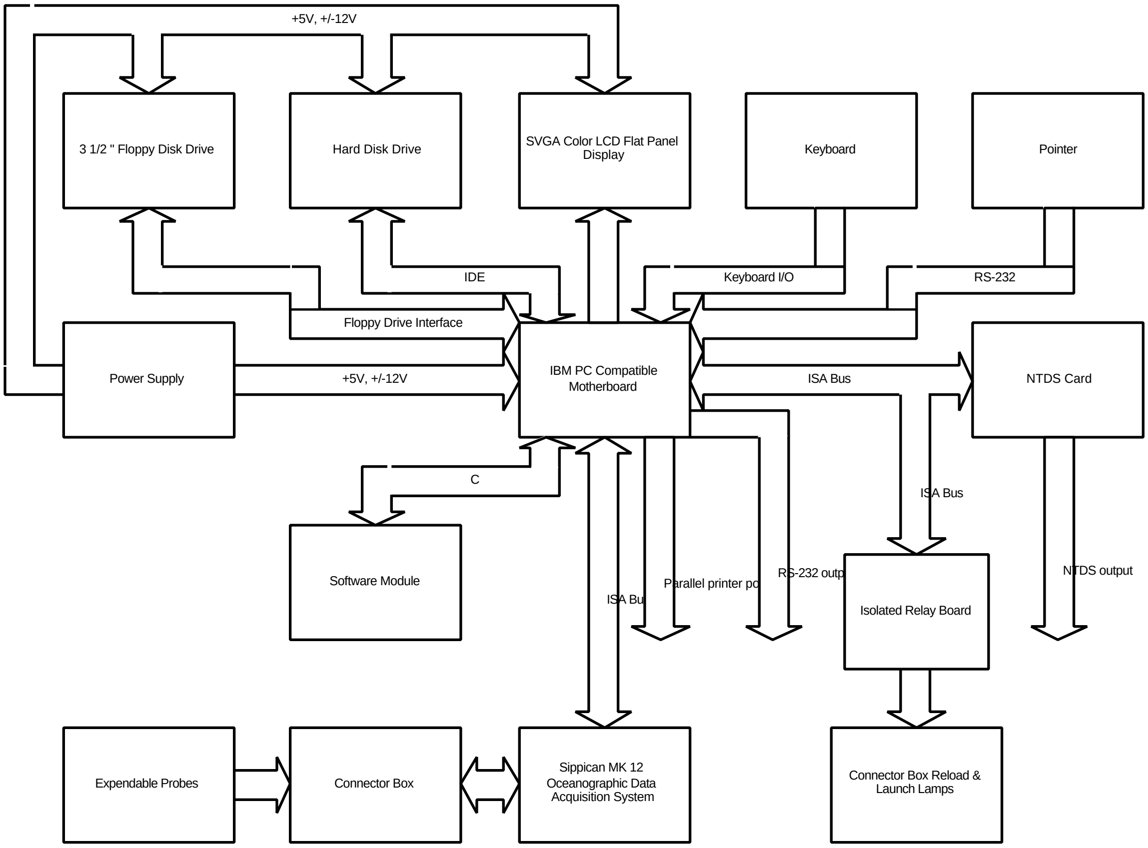

Figure 11 - AN/BQH-7/7A EC-3 System/Subsystem Interface Diagram

3.5 Preliminary Reliability Analysis

The initial reliability prediction was based on a market survey of components that would meet the function of our preliminary engineering design of EC-3. The proposed EC-3's predicted reliability was compared to the current AN/BQH-7/7A recorder's actual reliability MTBF of 783 hours as measured and verified in the operating environment over the years. The MTBF of the proposed EC-3 preliminary design, based on available industry components and data obtained in our market survey, was calculated to be 2,123 hours, a three-fold improvement. Table 7 breakouts the predicted failure rates (per million hours) of the EC-3 preliminary design componentry.

The actual reliability of the current recorder was calculated from historical failure data tracked at the contractor depot. As stated above, the predicted reliability was determined by conducting a market survey to determine typical failure rates for major subassemblies we proposed using in our concept design.

Table 7 - Actual versus Predicted Reliability Comparison (AN/BQH-7/7A versus AN/BQH-7/7A EC-3)

Subassembly	AN/BQH-7/7A	Upgraded Recorder
CPU	66	10
Panel Interface	150	0 (included in CPU)
External Interface	141	141 (similar design)
Memory Board	63	0 (included in CPU)
A/D & Bridge	103	103
		3 Hard disk drive
Cassette Interface	82	0 (not required)
Cassette Drive	209	0
Chart Drive Interface	74	0 (not required)
Power Supply	100	100 (no change)
Front Panel & Chassis	86	86
Chart Recorder	75	25 LCD display
Cassette Recorder	128	3 Floppy disk drive
Total (Failures/10^{-6} Hrs.)	1,277	471
MTBF (Hrs.)	783	2,123

In addition to the 3 fold reliability increase in reliability, other benefits will be realized.

- Performance - The performance capabilities will be enhanced because unlike the current recorder, the upgraded recorder will be utilizing the MK-12 Data Acquisition System, which can interface with every AN/BQH-7/7A probe.

- Survivability - The upgraded recorder is made of ruggedized COTS components. Major components have been individually ruggedized to provide shock and vibration protection. The PCBs will be stiffened with add-on rails and the display will have a clear protective cover. In addition, the components will be housed in the existing AN/BQH-7/7A splash-proof case and the existing AN/BQH-7/7A shock and vibration isolators will be retained to provide further protection. A 901 shock test is currently planned for one of the first production representative units. Additional shock hardening efforts will likely occur after this test.

- Maintainability - Maintainability will be improved because the mechanical components and subassemblies, which are subject to wear and whose components are experiencing component obsolescence, along with the chart drive mechanism which currently requires high operator maintenance and calibration, will be replaced by new digital COTS boards.

- Interoperability - The interoperability feature of the upgraded recorder will be greatly enhanced over the current recorders because each of the interfaces in Table 8 will be available in one hardware configuration with a modular open systems architecture approach. At the time of installation, a software setup selection will activate the desired interface for each individual platform.

- Service Life - The service life will be extended because of the ease of technology insertion.

- Life Cycle Costs - Life cycle costs (LCC) are expected to decrease significantly because the high-maintenance mechanical components and subassemblies will be replaced by digital COTS and NDI components. See Chapter 4 for more of projected LCC.

3.6 Component Tradeoff Analysis

The component tradeoff analysis was an ongoing interactive process until just recently. This section details some of the important aspects of the component tradeoff analysis effort.

3.6.1Component Tradeoffs

Table 8 is an example of one of the first initial tradeoff studies conducted. This initial study was conducted on various display options.

Table 8 - AN/BQH-7/7A EC-3 Display Options

	Option 1	Option 2	Option 3	Option 4	Option 5
DISPLAY	Monochrome LCD	Passive Color LCD	Active Color LCD	Electro-Luminescent Bright	Electro-Luminescent Standard
Type	Flat Panel	Flat Panel	Flat Panel	Flat Panel	Flat Panel
Active Diagonal Measurement (in.)	8	8	8.4	8.9	8.9
Visibility in Bright Light	Very good	Fair	Good	Excellent	Very good
Color	No	Yes	Yes	No	No
Electro-Magnetic Interface Exposure	Low	Low	Low	Low	Low

The IPT team eliminated the cathode ray tube (CRT) display because the AN/BQH-7/7A chassis could not sufficiently dissipate the heat generated by the CRT without extensive modifications. The flat panel displays were considered the only design option feasible. In the end, the IPT team selected Option 3 as the best alternative since active color LCD flat panel displays offered the (1) largest selection of design styles from a large vendor market, (2) largest physical display available in the market that could mount to the front of the existing recorder drawer, (3) good angle of viewability and (4) bright color and viewing pleasure. The second and third choice was a black and white display and a passive color display. The black and white display is normally difficult to view but it’s visibility in bright light is slightly better than the passive color display (a special concern for the 688 class boats). See the Tradeoff Analysis Tables in Appendix G.

3.6.2Component Selection

Specific emphasis was given to the selection of the display and keyboard because of Fleet user interest in human factors considerations (as determined from the QFD and AHP analysis). A brief discussion on the display and keyboard is presented below followed by a discussions of the issues surrounding the Sippican proprietary NDI circuit card, the Mk-12 Data Acquisition Card. A table containing the final selection of COTS/NDI subassemblies for the first AN/BQH-7/7A EC-3 prototype is then presented. The functionality of each major hardware subassembly is allocated to the AN/BQH-7/7A original system requirements as detailed in matrix format in Appendix F “AN/BQH-7/7A EC-3 Hardware Functional Allocation Matrix”.

3.6.2.1 Hardware

Display

The display selected was a Sharp 10.4” diagonal color active matrix LCD display. The TFT-LCD is a low reflection, high brightness and high color saturation type. It contains a backlight for additional clarity and sharpness. The wide viewing angle assures operator comfort from a wide range. The VGA resolution is set at 640x480 dots per inch. The display is extremely bright and easy on the eyes. All operating modes are readily visible to the operator through appropriate use of various colors and windowing of the modules.

Keyboard

For our purposes, the keyboard decision was to design a new layout for the AN/BQH-7/7A EC-3 configuration. This was one of the few non COTS/NDI developed items pursued and was necessary in order to fit an optimally designed ergonomic display into the front panel of the recorder within the given space constraints. The layout chosen was one which is extremely close to the standard IBM AT type keyboard which was compatible with the ISA backplane. All the normal alpha numeric keys are in the QWERTY format found on many personal computers and as shown in Figure 12 below. The function keys are at the top, as in most desktop keyboards. This layout was chosen to ensure compatibility with other systems on board and to allow for ease of use by the operator. Again, the keyboard contains a backlight to improve visibility and ease of use in low light conditions.

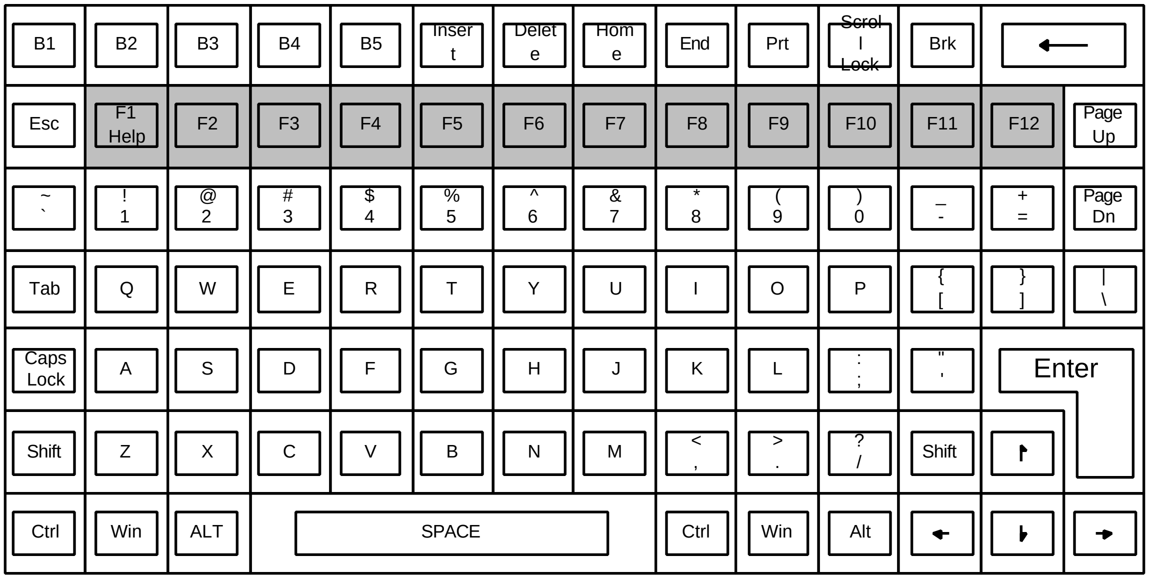

Figure 12 - AN/BQH-7/7A EC-3 Keyboard Design

Mk-12 NDI Data Acquisition Card

The use of the Sippican "Mk-12" Data Acquisition Card (shown in Figure 13 below) was chosen early on in the EC-3 effort because of it's capability to being able to interface with all of the probes in Tables 2 and 3. Even though the Mk-12 is a proprietary board (or CCA), it still meets the EC-3 OSA requirements. The OSA level was identified at the board level. As long as well defined interfaces were identified both internal and external to the EC-3 design, all OSA requirement were meet.

The Mk-12 CCA is the COTS and NDI card that allowed the IPT to lower the development cost of the EC-3 design by a factor of 3 during the subsystem tradeoff analysis. The Mk-12 has been in production for over 5 years, is fully developed and tested, and is in use worldwide by oceanographers and various foreign navies. It's availability without the need for development allowed the program to take the form of a simple re-packaging exercise of COTS subassemblies versus a complete major re-development effort. All further subsystem choices were driven by the need to maintain compatibility with the Mk-12 CCA.

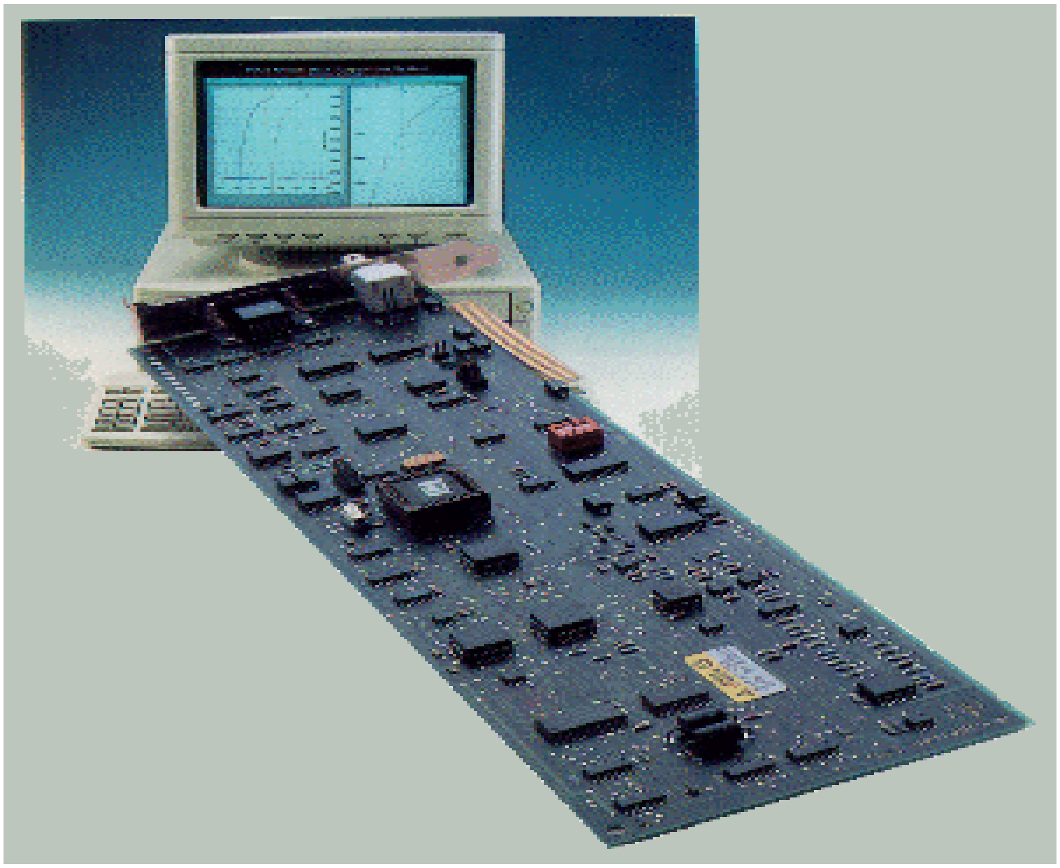

Figure 13 - Sippican Mk-12 Data Acquisition Card [6]

The other OSA COTS components were chosen from a wide availability of commercial and industrial grade components which further reduced the projected total system cost.

Subsystem	Standard Chosen	Reason for Choice
1. Mk-12 CCA		
a. Launcher Interface	Existing	Existing on all Ships (No Change Planned nor Likely)
b. Backplane	Active ISA	Plug in capability to common, low-cost, commercial PC's
2. Motherboard Backplane	Passive ISA	Good selection of plug in modules available. Fit in chassis space available. Compatible with Mk-12 CCA. Growth capability to other I/O interfaces at low cost.
3. CPU Board	ISA Plug-In	Works with Passive ISA Backplane.
4. Keyboard	PC-AT	
5. Pointer	Serial	
6. Display	X/S/VGA	Active Matrix High Resolution Color
7. I/O Standards	RS-232	TAGOS ShipClass Requirement
	NTDS Fast	AEGIS ShipClass Requirement
	NTDS Slow	688 Fast Attack Submarine ShipClass Requirement
8. Hard Drive	IDE	I-Omega Zip or Optical Disk
9. Floppy Drive	Floppy Drive Interface	

3.6.2.2 Software

The software utilized will be Microsoft Windows 95 graphical operating system. Windows 95 operating system will drive the Sippican's MK-12 COTS/NDI software. The Windows 95 graphical operating system was selected since it is quickly becoming the most widely used operating system in use today on millions of computers. This selection will provide a friendly graphical user interface (GUI) that will be inherently familiar to the user and will help reduce if not eliminate a majority of the initial training needs.

The MK-12 operating software is fully compatible with the Windows 95 environment. The MK-12 operating commands are issued through pull down menus, which are very similar to all other typical Windows 95 software packages. All MK-12 system setups and selection results are clearly identified on the screen. All menu selections come with immediate feedback and explanatory text to provide the operator immediate results of his/her selection. This provides the feedback needed to verify proper recorder operation and thus reduces human errors.

Subsystem	Standard Chosen	Reason for Choice
1. Mk-12 CCA		
S.W. Language	C++	Existing on COTS Mk-12
Operating System	Windows 95	Grew from initial DOS Mk-12 without a hardware or firmware change. Graphics Capability. Wide use in PCs and high volume commercial applications.

The Mk-12 Data Acquisition CCA consist of both hardware, firmware and software. The data gathering functionality is accomplished by software running on the PC motherboard over the ISA bus and by the firmware on the Mk-12 card itself. The Mk-12 hardware is configured so it does not have to have a separate dedicated circuit for each category of expendable probe. It is also configured to allow the Mk-12 processor to optimize it's hardware to the varying signal levels and data frequencies received from the expendable probes.

Proprietary Issues in OSA

The details of the data interchange that occurs during the Mk-12's data gathering period are proprietary and are at a level of detail beyond that required to ensure OSA system operating compatibility. Manufacturers are allowed to protect the proprietary aspects of their individual designs as long as they maintain backward compatibility. The details of the proprietary subassembly Mk-12 card (i.e., the internal operating details of the Mk-12) are not needed as long as the other subsystems can be procured to meet the OSA defined subsystem interfaces with the specified form, fit, and function of the EC-3 design.

All of the necessary subsystem specifications include the OSA system interfaces. These include the interfaces to the expendable probes, the external I/O requirements, and the operator interfaces. In addition, physical requirements, CPU requirements, operating system requirements, and system memory requirements are specified. With these requirements specified, compatibility will be ensured without revealing proprietary details of the Sippican Mk-12 COTS design and without needlessly encumbering any future designs with a specific implementation in hardware, firmware and software.

3.6.2.3 EC-3 Prototype Bill of Material (BOM)

The final selection of COTS/NDI subassemblies for the first AN/BQH-7/7A EC-3 prototype is presented below in Table 9. Three additional EC-3 prototypes will be built after the first is completed.

Table 9 - Selected AN/BQH-7/7A EC-3 Pre-Production Unit (PPU) Prototype Bill of Material (BOM)

Board Number	Description	Manufacturer	Manufacturer P/N	Supplier	Fully Loaded Price (Sell Price)
1	NTDS Board	Sabtech Industries	EA-01103-00	Sabtech Industries	$X,XXX.xx
2	Mk-12 Board	Sippican	306155	Sippican	X,XXX.xx
	Color Active Matrix Display	Sharp	LQ10D421	Milgray/New England	X,XXX.xx
3	Display Controller Board	Sage	S545-D421	“	XXX.xx
	Inverter Board	Endicott	K1918	“	XX.xx
	Display Connector	“	K1918-1-26	“	X.xx
	Display Cable Kit	Sage	CAB-D421	“	XX.xx
	6 Slot Chassis ISA Bus Backplane	Industrial Computer Supply	OEMC-06	Industrial Computer Supply	XXX.xx
	250 Watt Power Supply	“	OEMC-P25	“	XXX.xx
4	Isolated Relay Board	“	DI08-P	“	XXX.xx
	3.5” 1.44 MByte Floppy Disk Drive	“	FD-1.4M	“	XXX.xx
	Floppy Drive/Controller Cable	“	50091-01	“	XX.xx
5	SB586P/100 Processor Board	“		“	X,XXX.xx
	16 MB RAM	“		“	XXX.xx
	Industrial Sealed Keyboard	New England Keyboard	N/A	New England Keyboard	XXX.xx
	WINDOWS 95 Software	Industrial Computer Supply	WIN95/CD	Industrial Computer Supply	XXX.xx
	Removable Drive Carriage	“	DE1001-AT	“	XXX.xx
	1.2 GByte Hard Drive	“		“	XXX.xx
	Paint BQH-7 Case				XXX.xx
TOTAL COST					XX,XXX.xx

3.7 Pre-Production Unit (PPU) Prototype

The following system block diagram in Figure 14 is the IPT's first cut at developing a functional representation model in block diagram format of the first EC-3 prototype. This diagram was approved during the 4th IPT meeting on 26 March 1997 for use in the final hardware tradeoff studies and in developing a detailed design for implementation into the Pre-Production Unit (PPU) prototype (scheduled for assembly in June 1997). The IPT determined that all functional and operational requirements could be met with this design.

The IPT team decided to build a first prototype (referred to as the PPU) for form, fit, function studies. Minor modifications may be made to the PPU before environmental test are conducted. From these lessons learned, the next three prototypes would be built. These three would be production representative of what our Fleet customers would expect to see in a production unit.

Prototype No. 1 - **Pre-Production Unit (PPU)**

Prototype No. 2
Prototype No. 3 ⊢ **Production Representative Units**
Prototype No. 4

The box in Figure 14 represents the internal subassemblies of the AN/BQH-7/7A EC-3 recorder. It shows how each internal subassembly will interface with other EC-3 internal subassemblies. Everything outside the box represents the external interfaces. The reader should use Table 9 and Figure 14 together to get a clear picture of the ***detailed design*** of the ***first prototype*** unit. Again, modifications to the design may occur from lessons learned from assembling the first unit. This first prototype will also help to proof out and finalize all of the detailed requirements in the PIDS (performance spec).

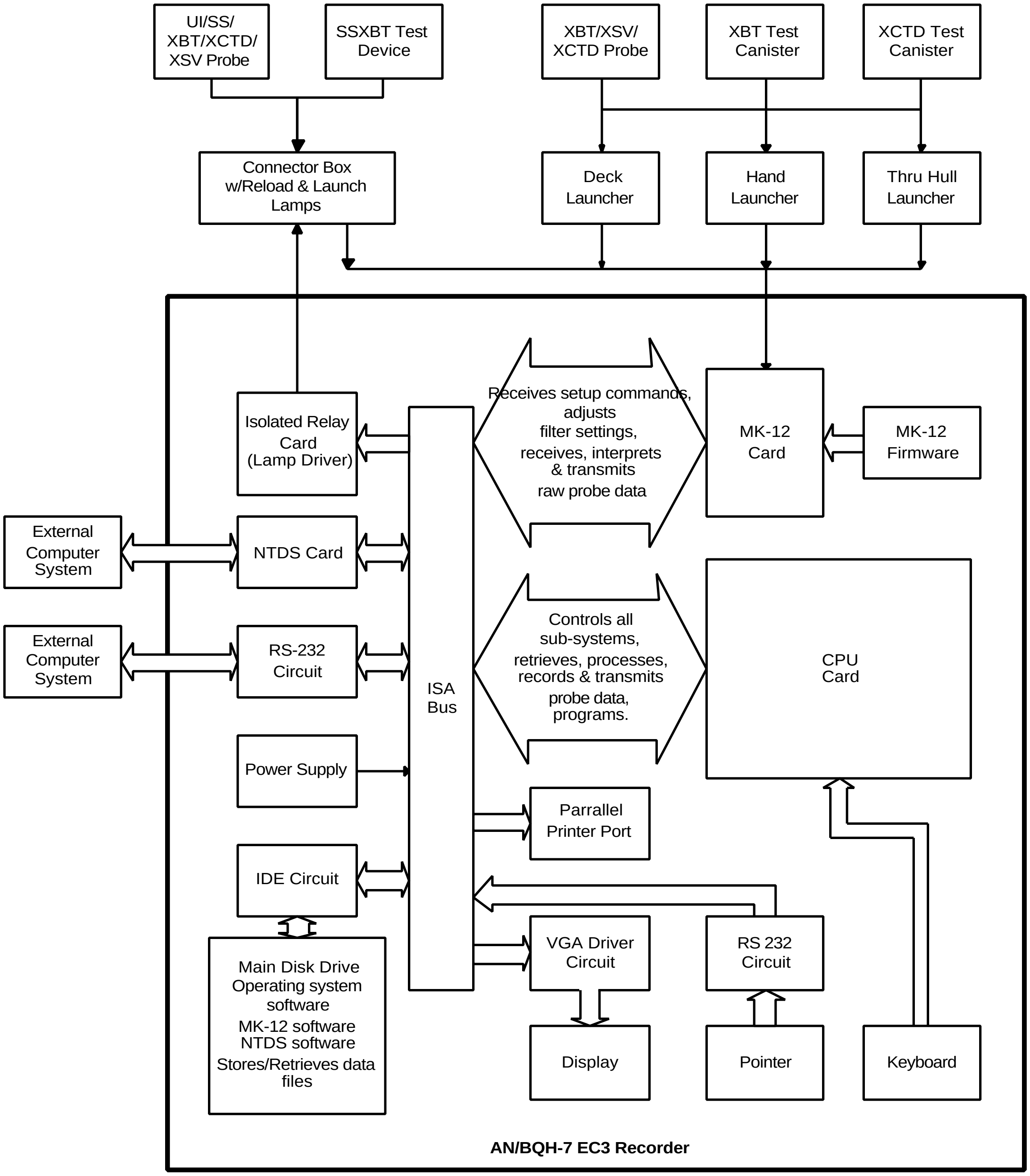

Figure 14 - AN/BQH-7/7A EC-3 Pre-Production Unit (PPU) Prototype Block Diagram

Figure 15 shows a picture of the current recorder and Figure 16 shows a computer generated representation of the new AN/BQH-7/7A EC-3 recorder.

Current AN/BQH-7/7A Configuration

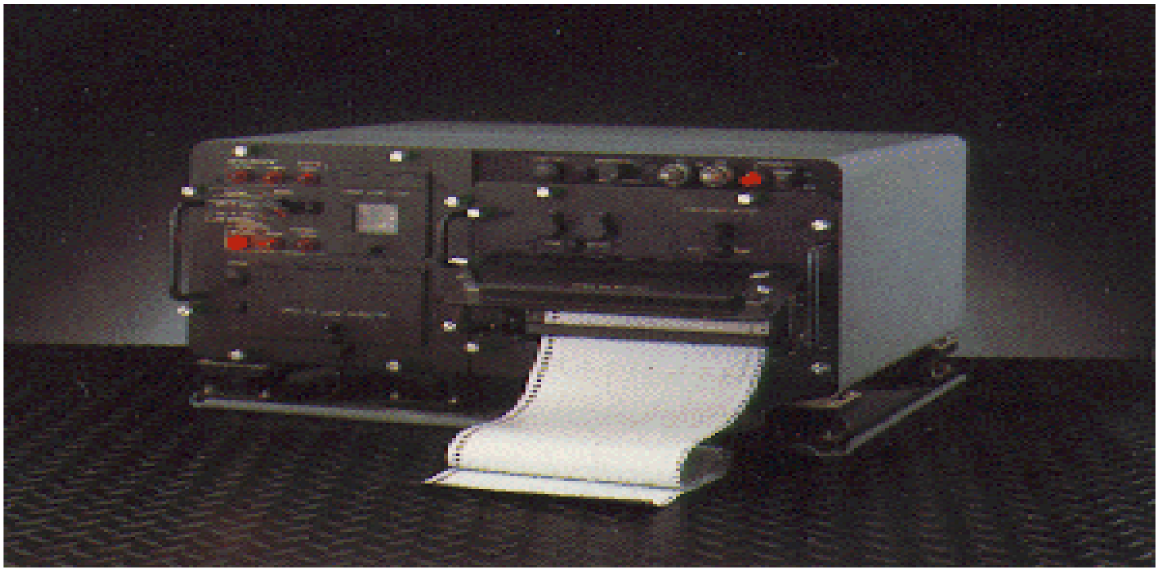

Figure 15 - Picture of the AN/BQH-7/7A (Current Recorder) [7]

AN/BQH-7/7A EC-3 Configuration

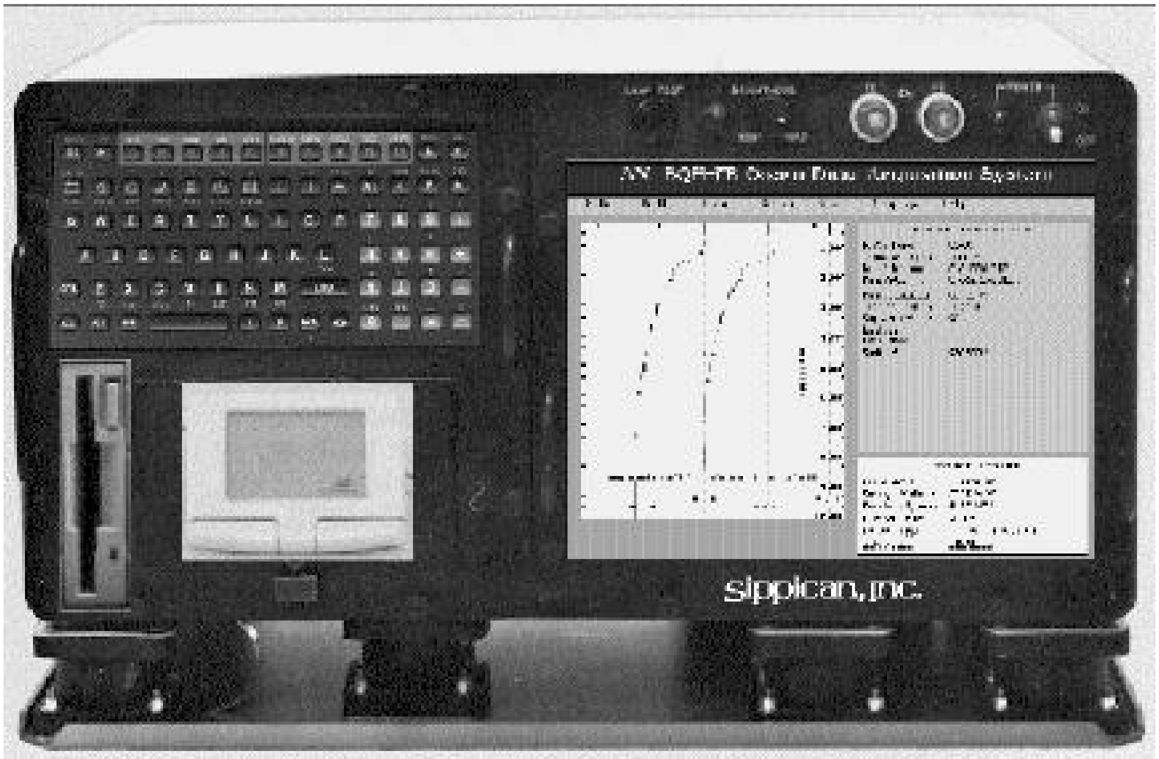

Figure 16 - Computer Generated Picture Composite of the AN/BQH-7/7A EC-3 (Future Recorder) [8]

3.8 Updated Reliability Analysis and Verification

In Table 7, our early analysis showed that we could expect a 3-fold increase in reliability from the current AN/BQH-7/7A design if we used COTS and NDI componentry in the EC-3 design upgrade. This analysis was based on available industry components and data obtained early on in a market survey.

We are very close to validating the earlier projected system reliability now that the Table 9 Bill of Material (BOM) components have been selected. However, an accurate analysis of reliability is being hampered due to ambiguous input from vendors. Two examples are given in the beginning of Chapter 4 which describe a scenario that appears to be prevalent today with vendors dealing in the sell of COTS and NDI components. The overzealous marketing experienced to date are not doubt contributed by the intense competitive environment that exists today. Therefore, though we do not have final numbers for reliability of all of the EC-3 BOM components listed to date, we should soon. Figure 17 presents the final reliability block diagram and model that will be used for the PPU prototype.

Critical System Reliability

Critical System Reliability is defined as that reliability associated with a failure that will bring the entire system down and render it unable to complete it's intended function or mission. The subassembly components that will directly impact the intended function of the recorder is denoted by solid boxes in Figure 17.

Overall System Reliability

Overall System Reliability is defined as that reliability associated with a failure that would not bring the system down thereby allowing the system to complete it's intended function or mission. The subassemblies that do not directly impact the operability of the recorder but would degrade the intended function is denoted by a dashed box in Figure 17.

Reliability Block Diagram

Figure 17 presents the Reliability Block Diagram Model for the AN/BQH-7/7A EC-3 recorder. The MTBF data will be filled in after we can be sure that the reliability numbers advertised by the COTS/NDI vendors are legitimate (i.e., verifiable).

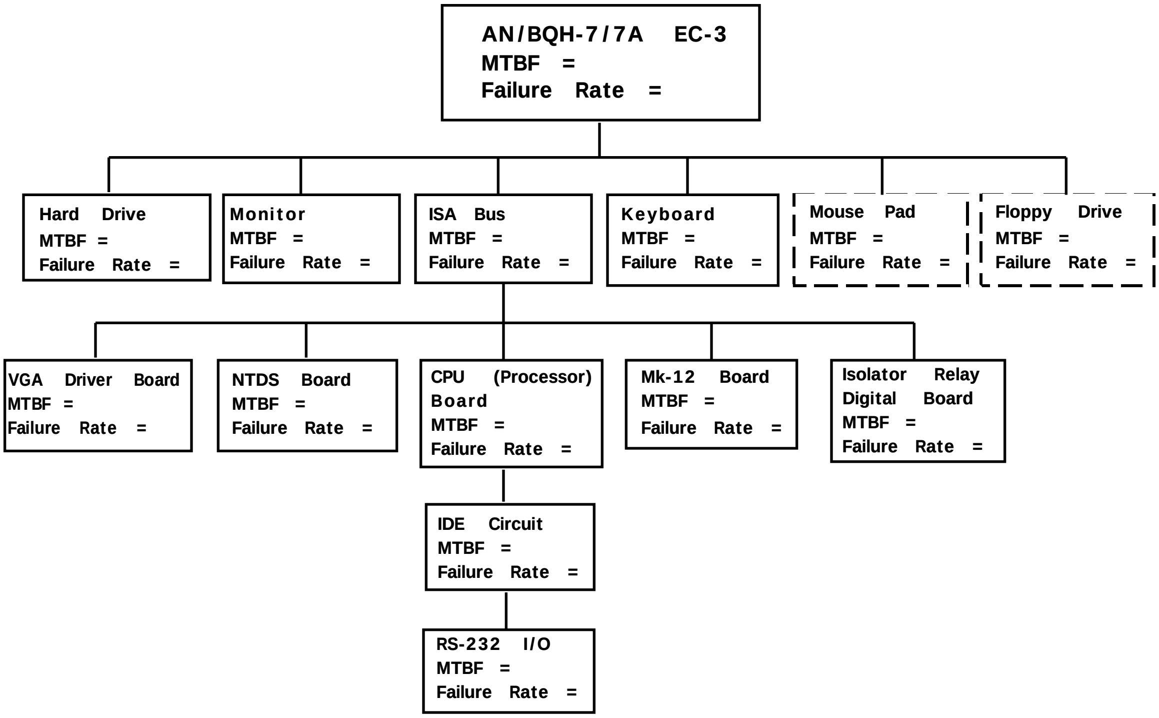

Figure 17 - AN/BQH-7/7A EC-3 Reliability Model

3.9 Validation Test Requirements Analysis

3.9.1 Laboratory Test

The overall test requirements will be documented in the Prime Item Development Specification (PIDS) [Performance Specification]. The detailed Factory Test Procedures (FAT) will be written and will list the detailed procedures for final validation checkout prior to acceptance of each AN/BQH-7/7A EC-3 Kit. Since Sippican is ISO-9001 certified, the detailed test procedures will be written to ISO 9001 requirements using EIA/IS-632 as guidance. Each of the COTS/NDI subassemblies will tested at the board level prior to assembly.

3.9.2 At-Sea Test

Two Navy platforms have been identified for "proof-of-concept" at-sea testing of the production representative AN/BQH-7/7A EC-3 recorder in 1998. The two platforms identified are;

Request made by SPAWAR SURTASS Program Office, PMW-182
TAGOS-12 SURTASS Surface Ship

Request made by SUBLANT, Code N43 Special Programs (SP)
SSN-719, USS Providence Submarine