TA-ENG: SESC - FFG DIVISION

FFG COMBAT SYSTEM LEARNERS GUIDE

VERSION 2.01, DATED 10 Dec 2014

SECTION 4 – Fire Control Systems

TABLE OF CONTENTS

TABLE OF FIGURES

TABLES

Chapter 1. FIRE CONTROL SYSTEM MK 92 MOD 12

Introduction

1. The MK92 FCS is a system that provides search surveillance, rapid detection and engagements of fast air targets. The system also provides simultaneous tracking of surface or shore targets. Nine air targets or eleven surface targets can be tracked simultaneously. Five of the tracked targets can be engaged by the Gun and Two by Missile fire. Fire-Control Channel allocations are shown in the table below.

CHANNEL	EQUIPMENT	MODE	WEAPON
FC-1	CAS Track	Air/Surface	Missile/Gun
FC-2	STIR	Air/Surface	Missile/Gun
FC-4	CAS Search(TWS)	Surface	Gun only
FC-5	CAS Search(TWS)	Surface/NGS	Gun only

Table 1: Mk92 FCS Fire Channel Allocations

2. Search surveillance is provided by a continuously rotating antenna which is part of the combined antenna system (CAS). Remote search radar data is also available to the FCS from other search radars located on the ship. The combination of local and remote search radar data provides the FCS console operates with a multi target plan position indicator (PPI) display consisting of air and surface targets. The local air surveillance range extends to 128,000 yards, and the surface surveillance extends to the horizon. Remote air surveillance is provided for targets at ranges exceeding 200,000 yards. The PPI display provides the FCS console operators with a complete tactical picture of the surrounding environment.

3. FC 11-16 is a pseudo automatic tracker built within the Weapon Control Program (WCP). The functionality is similar to FC 4/5 which enables command to 'watch' targets of interest without actually making the target aware that it is being tracked. No engagements are able to be conducted from FC 11-16. Both air and surface targets are able to be tracked by this method.

4. Two focused beam antennas, the CAS track antenna and the separate track and illuminating radar (STIR) antenna, are available for acquiring and tracking designated air targets. Local designation can be implemented by the FCS console operators using the PPI surveillance displays. However, remote designation of the FCS from Australian Distributed Architecture Combat System (ADACS) is the normal mode of operation. Also available for designating air targets is an inter-director designation (IDD) mode for transferring targets between the CAS and STIR tracker. Except for IDD mode, the selected track beam is programmed through an acquisition pattern in order to detect the targets.

5. Once tracking of the target has commenced the operator has the option of engaging by Gun (Gun mount Mk 75 Mod 0) or missile (SM-2, ESSM). Missile engagement of the tracked target is performed by illuminating the target with a continuous wave beam from the tracking antenna. A standard SM-2 with a terminal homing phase or the Evolved Sea Sparrow (ESSM) are used for missile engagements. Gun engagement is performed by positioning a 76mm/62 calibre Mk 75 gun using ballistically corrected target track data.

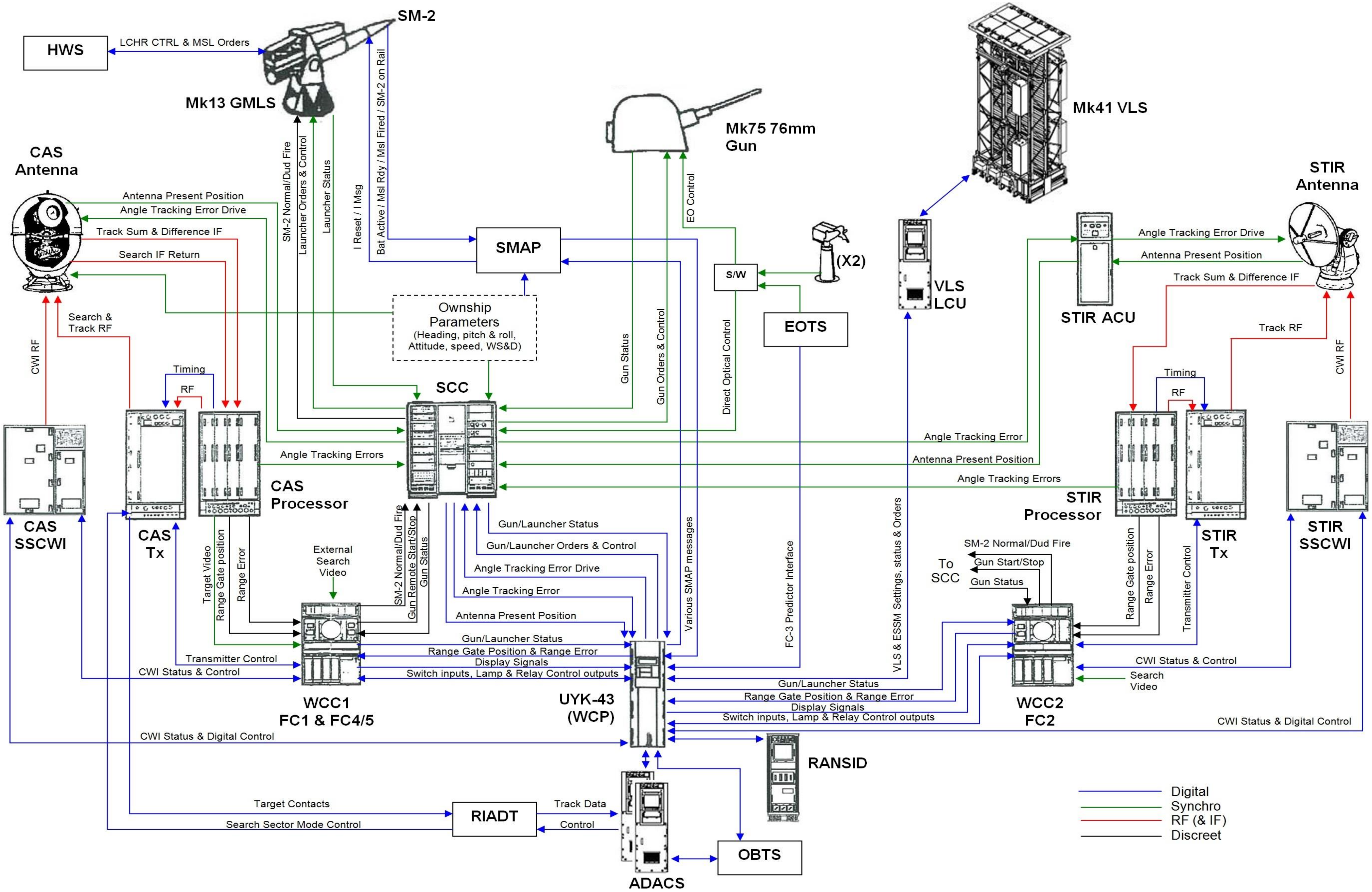

Figure 1-1: Mk92 FCS Block Diagram

Functional Description of Major Equipment

6. The MK92 FCS is a large system located within several compartments of the ship. The equipment can be divided into 3 main functional groups.

CAS EQUIPMENT	**STIR EQUIPMENT**	**COMMON & SUPPORT**
CAS DOME	STIR DIRECTOR	WCP (AN/UYK-43)
CAS PROCESSOR CABINET	STIR PROCESSOR CABINET	RANSID
CAS TRANSMITTER CABINET	STIR TRANSMITTER CABINET	SERVO CONT CAB (SCC)
CAS WCC	STIR WCC	LOW PRESSURE COOLING LOOP
CAS SSCWI	STIR SSCWI	HIGH PRESSURE COOLING LOOP
	STIR ANT. CONTROL (ACU)	CHANNEL SELECTOR

Table 2: Mk92 FCS Functional Groups

CAS ANTENNA MK 53 MOD 2

7. The CAS dome, located above the Gun Direction Platform (GDP), houses the CAS Search and Track Antenna mounted on a Stabilised platform. The radome protects the track and search antenna against wind, spray and ice. The Stabilisation Bridge is positioned halfway up the radome structure and provides roll and pitch information to the WCP for use in the generation of stable pointing orders to the GMLS, Gun, and STIR Director in both external and internal stabilisation modes of operation. The CAS Search antenna is mounted below the stabilisation bridge. The search antenna provides radar warning against air and surface targets and is used for surface target acquisition and tracking (TWS). The search antenna is a parabolic antenna additionally equipped with 10 dipoles for IFF. The search antenna revolves continuously at a constant speed of 60 RPM in a clockwise direction. The CAS Track antenna provides air acquisition, air target tracking, sidelobe energy detection, CW target illumination, and rear reference for missiles. The track antenna is a monopulse antenna (Cassegrain type) that is equipped with an auxiliary horn for sidelobe blanking processing and a rear reference horn for missile guidance.

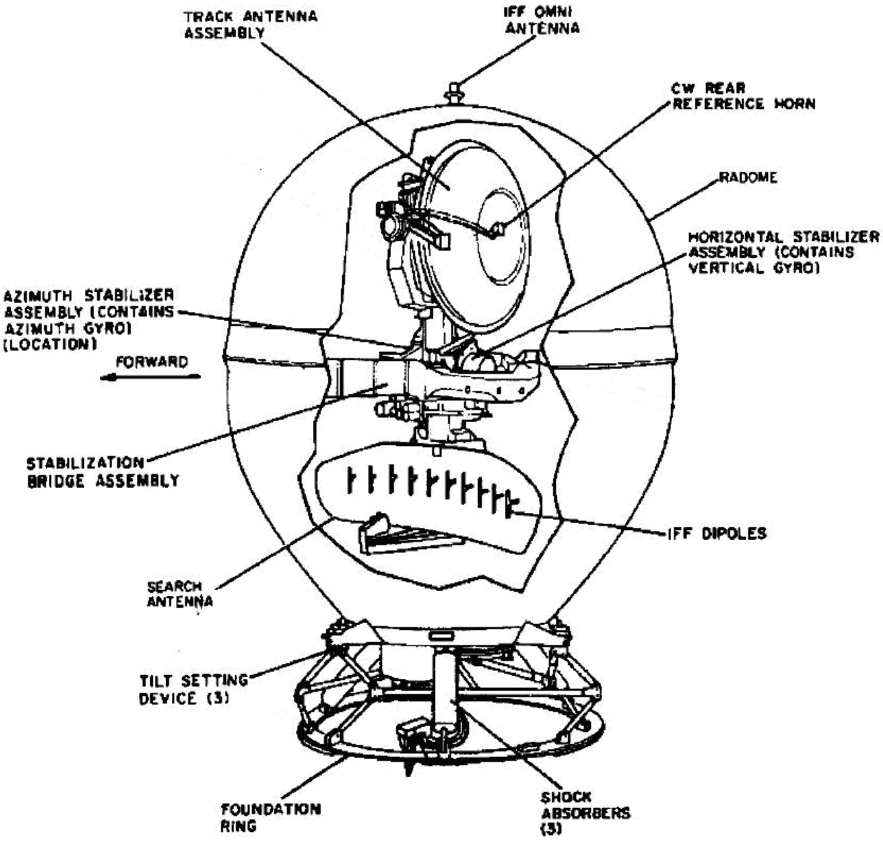

Figure 1-2: CAS Antenna MK 53 Mod 2

STIR DIRECTOR MK 54 MOD 1

8. The STIR director antenna, located on 02 deck, provides a longer range tracking capability than CAS. The STIR is a mono pulse antenna used for 3-D tracking of targets. The antenna is equipped with CWI capability which is used for guidance of semi-active homing missiles. Horizon search and sector modes are available for detection of low-flying targets.

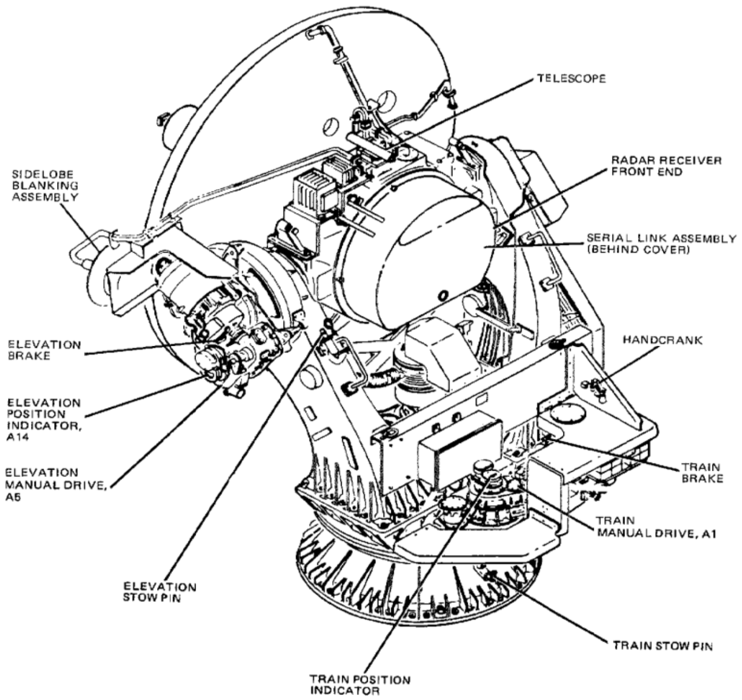

Figure 1-3: STIR DIRECTOR MK 54 Mod 1

STIR ANTENNA CONTROL UNIT MK 161 MOD 0

9. The STIR Antenna Control Unit (ACU), located in STIR equipment room, contains the power distribution circuits and portions of the servo electronics for the STIR Director Antenna. Front panel controls permit local control of antenna operation for maintenance and testing.

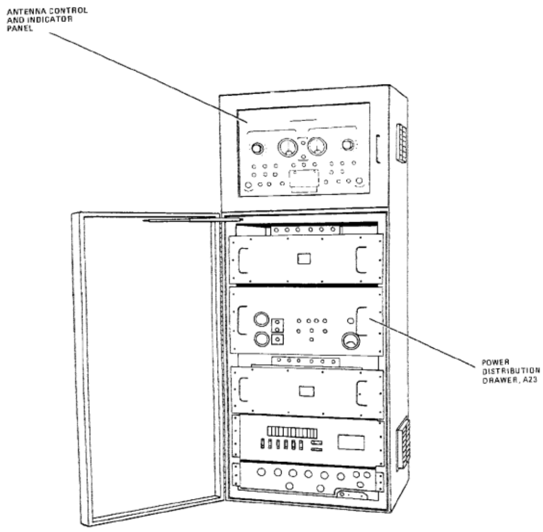

Figure 1-4: STIR ACU MK 161 Mod 0

CAS/STIR PROCESSOR AND TRANSMITTER CABINETS

10. The CAS/STIR Processor Cabinets process returned RF for both Search and Track for CAS and Track only for STIR. Search video and antenna position data is displayed on the Weapon Control Consoles (WCCs) and Q-70’s. Search receiver options are selected from the CAS WCC only. Surface target video used for the TWS function is processed to provide positional errors (Range & Bearing) to the Weapon Control Processor (WCP). The CAS Search processor also provides target and splash video for display on B-Scope. The track processor circuit processes track video from CAS/STIR Track Antennas to provide positional errors (Range, Elevation and Bearing) to the WCP and for display on the WCC A-Scopes. The Processor cabinet also houses the Exciter which develops the frequency at which the RF is transmitted.

11. The Transmitter Cabinet converts the low power Exciter output pulse into the high power RF output pulse that is radiated from the antenna. The Microwave assembly contains two Travelling Wave Tubes (TWTs) which provide the 100KW peak, 2KW average, RF power. In CAS the RF power is split 50/50 between the Search and Track Antennas, STIR does not have a Search Antenna so RF is feed directly to the Track antenna.

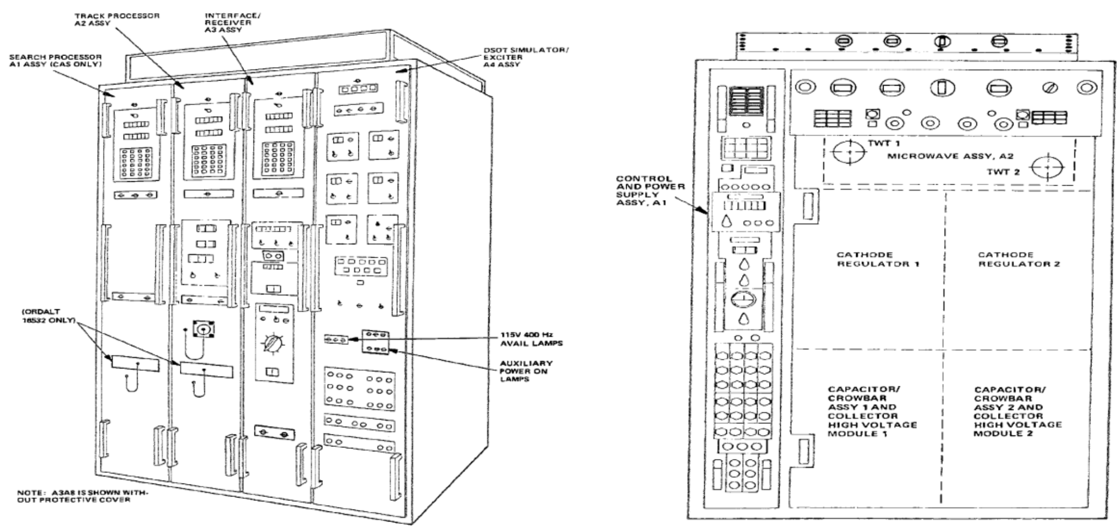

Figure 1-5: Processor and Transmitter Cabinets

CAS/STIR SOLID STATE CWI (SSCWI) and ISOLATION TRANFORMERS

12. The SSCWI is a solid state microwave synthesizer and amplifier system that provides Continuous Wave Illumination (CWI) Radio Frequency (RF) energy for the guidance of missiles against air targets in response to commands from the MK 92 FCS and WCP. The SSCWI can provide CWI RF for the guidance of Evolved Sea Sparrow Missile (ESSM) and SM-2. The CWI transmitter is assigned a specific channel, 19 Channels for SM-2 and 34 Channels for ESSM (53 Channels Total), to ensure correct missile - target pairing. Each SSCWI system consists of the Isolation Transformer and Transmitter Cabinet. The Transmitter cabinet contains low voltage power supplies, Stable Master Oscillator (STAMO), microwave amplifiers, combining networks, control logic and fault detection circuitry. The Isolation Transformer converts ship's AC power for the use by the Transmitter Cabinet.

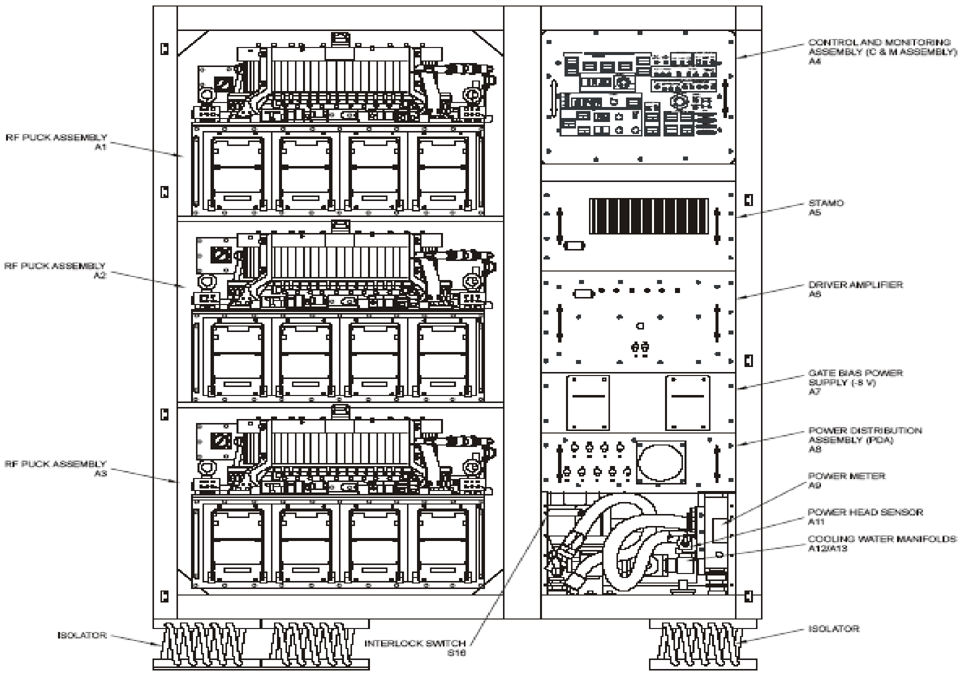

Figure 1-6: SSCWI

CHANNEL SELECTOR (CWI)

13. The channel selector is a self contained unit which upon command causes the Standard missile loaded on an assigned Guided Missile Launcher System (GMLS) to lock onto the CWI frequency of the controlling radar. The channel selector causes the SM-2 missile to sweep the frequency band searching for a channel match with the assigned CWI transmitter. Once the frequencies are matched a firing interlock is made allowing the missile to be fired. A channel match condition is indicated by the illumination of the "channel match" lamp on the EP-2 panel in launcher control.

CAS WCC MK 106 MOD 2

14. The CAS WCC (WCC 1) is a 2 operator console. The FC-1 operator is responsible for the acquisition, tracking and engagement by gun or missile of air or surface targets. The second operator is responsible for the acquisition, tracking and engagement by gun of surface or shore targets utilising FC-4 & 5. It also allows monitoring and controlling missile/launcher functions; gun functions; stabilisation and coolant functions; system status and override functions; and displaying search, tracking and engagement data on the PPI, A Scope, B Scope, and two total evaluation (TOTE) displays. The console interfaces with the WCP and provides switching and control functions for signals routed between the WCP and the CAS processor cabinet.

STIR WCC MK 107 MOD 1

15. The STIR WCC (WCC 2) is a one operator console. The operator is responsible for the acquisition, tracking and engagement using gun or missile of targets utilising FC-2. WCC 2 is physically very similar to WCC 1 except that certain controls are not included on WCC 2 and the upper panel arrangement is modified to suit a single operator. WCC 2 does not have a B Scope or second TOTE as required for FC-4 & 5. Also the search receiver panel is not available as STIR does not have the search radar. All other functions are as described for the CAS WCC.

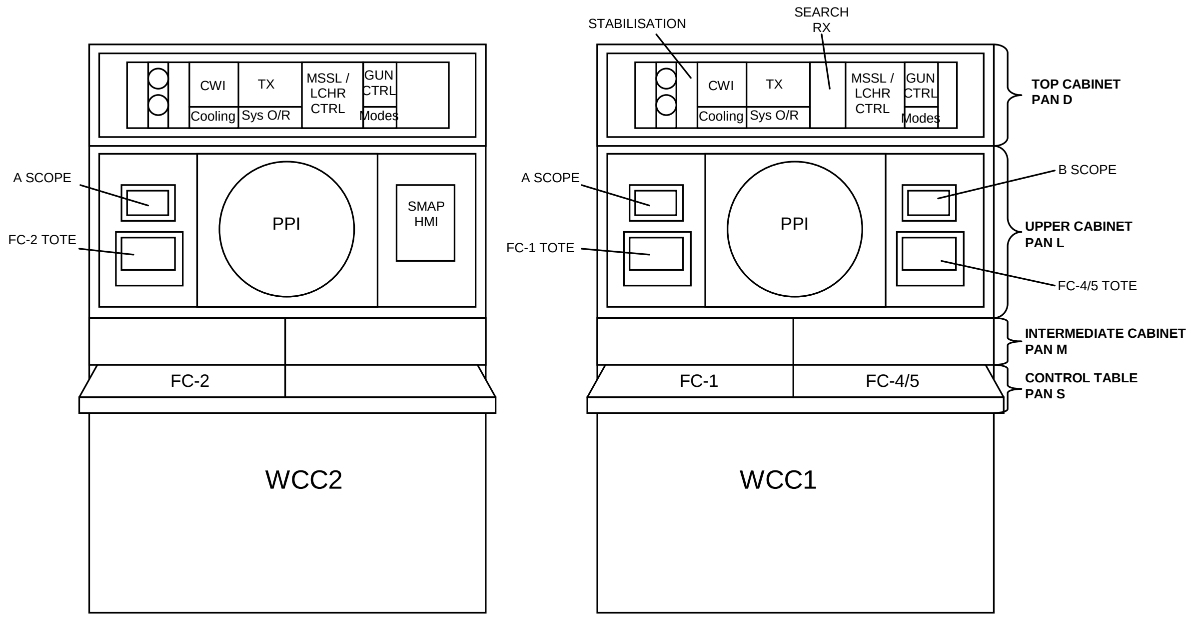

Figure 1-7: WCC MK 106 Mod 1 & 2

SERVO CONTROL CABINET (SCC) MK 160 MOD 2

16. The SCC is the central interface point between the WCP and the remaining units of the Mk 92 FCS. It provides A/D and D/A conversion as well as system monitoring of the interface signals. It also provides Servo Control and interfacing with the Gun, GMLS and CAS track antenna. Located within the SCC is the DSOT controller for CAS and STIR DSOT test sets, and the system status control panel (SSCP). The SSCP provides the status and fault code of any on-line or off-line faults detected.

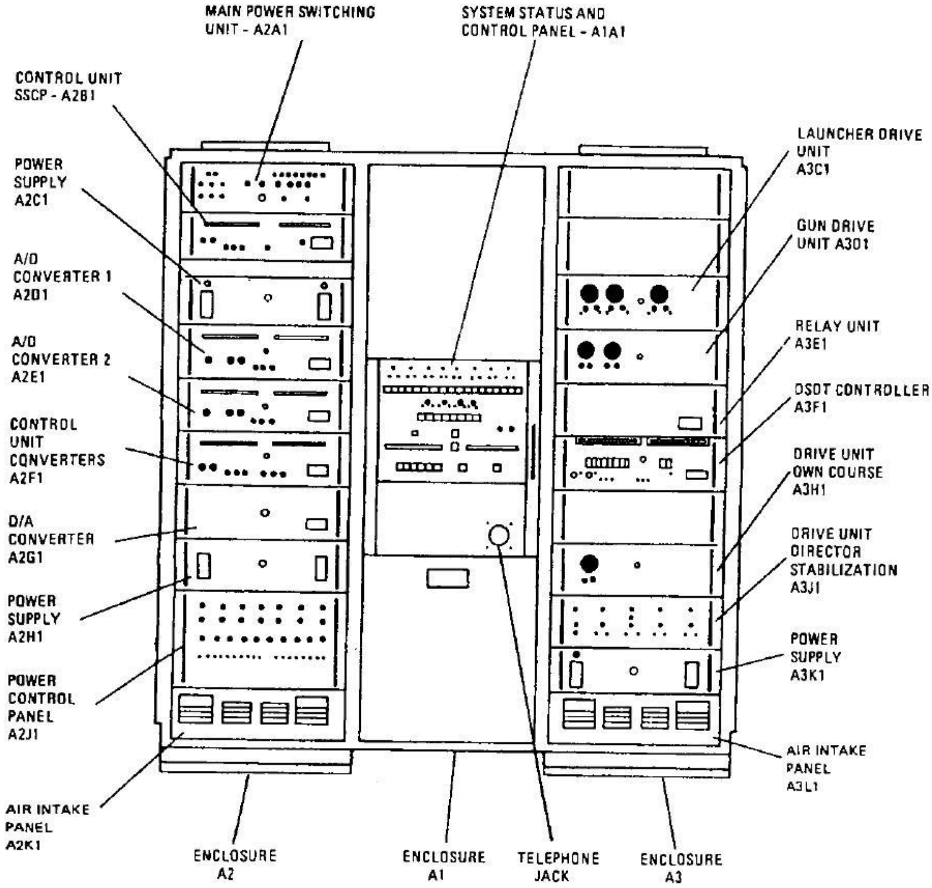

Figure 1-8: SCC MK 160 Mod2

AN/UYK-43 COMPUTER

17. The UYK-43 is a general purpose, modular design, digital computer that may be configured as a single or multi processor computer. Its primary purpose is to host the Weapon Control Program (WCP), the Hardware Maintenance Program (HMP) and Utility Package (UPAK) program. The computer has two processors, 0 and 1, which provide separate but identical interfaces to the ADS to provide automatic dual redundancy.

RAN STANDARD INPUT OUTPUT DEVICE (RANSID)

18. The RANSID provides a variety of input and output capabilities for the UYK-43 and ADS computers. It consists of a ruggedized VME bus computer and printer that incorporate a removable hard disk, CD ROM and floppy drive. Used as the primary loading device for the UYK-43 computer and is also used to record WCP data for records or analysis.

DATA EXTRACTION (DE)

19. The function of Data Extraction is to enable in-depth analysis of System Performance. The WCP Data Extraction is a time-based recording facility that writes data to a file on the RANSID hard drive at a user-defined rate. DE is activated as an on-line activity (WCP operation program running) and can be stopped and restarted as required. DE is normally forwarded to AMWC for evaluation of Serial performance and fault isolation.

DAILY SYSTEM OPERABILITY TEST (DSOT)

20. The DSOT hardware and software package allows for the dynamic system testing, evaluation and operator training for the Mk 92 FCS. Two DSOT Simulators are fitted: one to the CAS and one to STIR Processor cabinets. Both are controlled by the WCP computer via the DSOT Control unit in the Servo Control Cabinet (SCC).

LAUNCHER/GUN/VLS SIM

21. The launcher and Gun simulators are custom made modules fitted to the Combat System Switchboard. The VLS Simulator is a stand alone unit also located in RICER. They are designed to emulate as accurately as possible the loading, assigning and firing of Gun, SM1, Harpoon and ESSM missiles. The purpose of the simulators are to achieve realistic training of operations room staff in the air defence environment without causing wear and tear on systems.

TVDAC

22. The MK92 FCS is fitted with a Television Director Aim Camera (TVDAC) system to accompany data extraction in evaluating system performance. The following equipment comprises the TVDAC system:

a. Graticule and Character Generator – Overlays the video image with a graticule to provide means of measure target location within the track antenna beam or Gun boresight.

b. Director Mount Camera (STIR) - Provides video evidence of STIR tracking performance.

c. Gun Bore Camera and Camera Control Unit - Provides video evidence of complete system performance using gun align mode.

d. Video Monitor's (2 or 3).Used to display video Image for observation in CIC and RICER.

e. Video cassette Recorder (DVD Recorder) – Records video image for post fire evaluations by ships staff and RANRAU.

MK 92 Characteristics, Capabilities and limitations

References: ABR 6684 Mk 92 FCS Volume 1 Part 1

23. MK 92 Mod 12 Characteristics, Capabilities and Limitations are Confidential. They can be found in the above reference on Tables1-1 and 1-7

MK 92 SUPPORT SYSTEMS

POWER REQUIREMENTS

24. MK 92 requires the following Ships power input to function:

- 440v 60Hz
- 440v 400Hz
- 115v 60Hz
- 115v 400Hz
- 50 VDC

AIR, COOLING, WATER AND HEATERS

25. Due to the high average power generated by both the Pulse and CWI transmitters, the MK92 cooling water system supplies water to the radar processor cabinets, transmitter cabinets, CWI cabinets, water load assemblies and Travelling Wave tubes.

26. The waveguide is maintained dry by ships pressurised dry air supply.

27. Thermostatic switches regulate the operation of space heaters in the CAS dome. Warm air is distributed at different levels in the dome to protect antenna components from freezing and to prevent ice building up on the exterior surfaces.

MK 92 MOD 12 STABILISATION

28. The tactical program (WCP) normally receives Zdo (Roll) and Eio (Pitch) via the CAS platform (stabilization bridge). The CAS platform is stabilized by the WSN-7B gyro compass (primary mode – External) or the CAS platform Vertical gyro (Internal). Cqo (Own ship course) is received from the SCC Cqo servo drawer. The Cqo drawer receives Cqo directly from the WSN-7B or MK 27 gyro compass or indirectly from the gyro compasses via the CAS platform Azimuth gyro.

29. In case of a CAS platform casualty, the tactical program receives WSN-7B stabilization, including Cqo, directly from the WSN-7B via one of two redundant digital channels or digitally via the Signal Data Converter (SDC) to provide stabilization for STIR, launcher and gun. The WSN-7B gyro is located in IC GYRO and provides Zdo, Eio and Cqo. The MK 27 gyro is located in Engineering Central Control Station (CCS) and provides only Cqo.

Stabilisation Modes.

30. There are five stabilisation modes. The modes that can be operator selected or automatically selected as the result of equipment availability are:

a. External (primary mode).
   i. Digital data is received directly from the WSN-7B and drives all stabilization of the CAS, STIR and launcher. This mode is selectable by the operator. There is no tactical program indication or alert that Platform Casualty mode should be selected. WCC-2 will indicate when this mode is available for selection by lighting the WSN-7B AVAIL indicator
   ii. The WSN-7B gyro compass drives the CAS platform in all axes and is operator selected.

b. Internal (also known as Casualty Stable Platform Reference – CSPR)

i. Operator selected. The CAS Vertical gyro drives the CAS platform in Zdo and Eio. The WSN-7B or MK 27 gyro compasses drive the CAS Azimuth gyro, which in turn drives the Cqo servo drive drawer. The MK 27 gyro compass provides only Cqo.

ii. Automatically selected. If the MK 27 gyro is selected in IC Gyro, external stabilization is not available. The CAS platform will automatically be in internal stabilization if MK 92 gyros have been energized, else the CAS platform will be in Zero Set.

c. Free Drift

d. Zero Set - The CAS platform Zero Set synchros position Zdo and Eio parallel to the deck plane (zero degrees) and Cqo to zero degree relative, hence the name Zero Set. This mode is basically a transitional mode, i.e., from External to Internal and used to hold the CAS platform steady while the CAS platform gyros come up to operate (if just turned on). This mode can also be operator selected for testing or troubleshooting purposes.

e. CAS Platform Casualty - This mode is operator selected, if the Signal Data Converter (SDC) is on line, in the event of a CAS platform casualty. When selected, the tactical program uses SDC provided values of Zdo, Eio and Cqo from the WSN-7B analog channel to stabilize STIR, Launcher and the GUN. There is no tactical program indication or alert that Platform Casualty mode should be selected. The operator will have to rely on hardware indications that CAS normal stabilization is not available, e.g., STIR elevation abnormal, etc.

WSN-7B Direct Digital Data.

31. The WSN-7B also transmits data to the WCP via a direct digital interface. The presence of such data is indicated by the WSN-7B AVAIL lamp on the WCC-2 console. Illumination of this lamp indicates that error-free data is currently being received from the WSN-7B. The WSN-7B ENABLE lamp indicates that this is being used as the stabilization data source. If the lamp is flashing, the WCP is communicating with the WSN-7B but data is invalid, usually due to the WSN-7B being in alignment mode, in a test mode where output is simulated, or the interface is experiencing checksum errors.

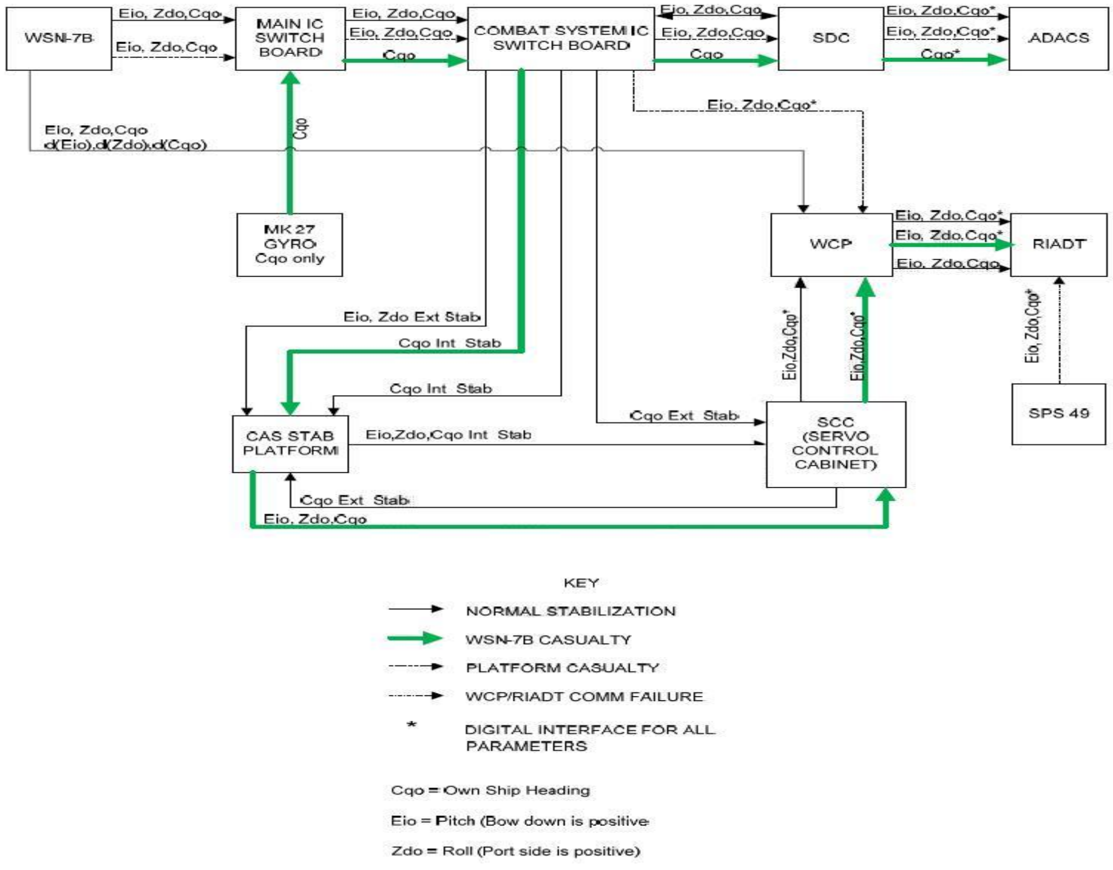

Figure 1-9: Mk92 Stabilisation

MK 92 System operation

NORMAL/LOCAL MODE

32. In a normal tactical situation, the MK 92 FCS is under the control of the C2 system. This allows the AWO to designate the desired Fire control channel to targets of interest, as well as allocation Effectors. Normal mode also provides the WCC operators a full tactical picture with the inclusion of SPS-49 and SPS-55 video as well as target symbology. In local mode the WCC operators control all missile and gun engagements. The only targets tracked are those designated locally at the WCCs.

AREA SURVEILLANCE

33. The CAS and STIR WCCs are equipped with PPI's and TOTEs to provide an operator with sufficient information concerning a tactical situation. The PPI's are used to display synthetic data generated by the computer and video from SPS-49, SPS 55 and CAS search. The Combined of video and symbology allows the operator to successfully conduct area surveillance.

CAS SEARCH

34. CAS Search is the primary radar used by WCC operators during Area Surveillance. The high rotational speed of the search antenna (60 RPM) allows for the detection of Pop up Targets. The antenna is also equipped with IFF dipoles for interrogation purposes. The CAS WCC operator also has receiver mode selections to assist in obtaining the best possible picture for the current environment. Listed below are some of those mode selections:

a. Processed Video

b. Raw Video

c. Horizontal/Circular Polarisation

d. Sensitivity Time Control (STC)

e. Coho/ Non Coho

ENGAGEMENT SEQUENCE

35. **:** During any engagement a number of variables determine the sequence of events. Variables such as:

- Command priority
- Sensor data (SPS-49, SPS-55, reliable elevation etc.)
- Target Type (Air, Surface or Shore)
- Target elevation (Pop-up, high elevation)
- Target Range (CAS or STIR designation) and
- Effecter selection. (Gun, GMLS, VLS)

36. Following is a standard FC1 Air engagement broken up into the four major engagement phases Designate, Acquisition, Track and Engagement.

DESIGNATION

37. Remote designation of the FCS originates in the C2 where the video from the MK92, SPS-49, SPS-55 search radars and associated fused tracks from RIADT, or EW bearing information from the ES are monitored. Remote designation of an air target is initiated by the operator of the C2 console (AWO) by hooking the track of interest or enabling the ball tab cursor over the track or video of interest and designating a fire control channel.

ACQUISTION

38. The designated target coordinates received from the C2 are processed by the WCP to position the CAS tracking antenna and the Acquisition-range gate. On the PPI of the CAS WCC, the FC-1 tracking gate symbol flashes and moves to the remotely designated target symbol where it continues to flash. The elevation marker, in the fourth quadrant of the PPI display, indicates the elevation of the CAS Track antenna which is positioned at the designated target elevation. On the control table of the CAS WCC, the legend of the AIR TARGET DES switch lights indicating that the designated target is being acquired.

39. If the elevation component of the remote designation is reliable, power split is commanded when the following conditions are obtained:

a. The bearing and elevation of the CAS track antenna are within approximately 1.2 degrees of the computed target position.

b. The acquisition-range gate is within 16 yards of the computed target range.

40. If the remote designation does not contain reliable elevation, the CAS track antenna is initially driven to an elevation of 1.2 degrees. Power split is commanded when the following conditions are obtained:

a. The bearing of the CAS track antenna is within approximately 2.2 degrees of the computed target position in bearing.

b. The acquisition-range gate is within 62.5 yards of the computed target range.

42. When power split is initiated, the RF output of the CAS transmitter is divided between the CAS search and Track antennas. At the same time, the detection circuitry is enabled to allow target detection to occur. The target detection circuitry consists of 192 range bins which make up the acquisition range gate. Detection of a target is accomplished when the target signal-to-noise ratio exceeds a prescribed threshold thereby activating one of the range bins. If the elevation component of the remote designation is unreliable, the CAS track antenna is programmed through a sector scan about the designated target position after power split in an attempt to acquire the target. If the remote designation is to an EW target, a bearing and elevation scan is performed about the EW bearing line at a predetermined range. This scan pattern is based on the EW profile. Acquisition is confirmed by the appearance of target video in one of 192 range bins which comprise the acquisition range gate.

43. The A-scope display provides target range information along the track beam line-of-sight. The display consists of two horizontal traces. The upper trace represents the fully instrumental radar range. The lower trace represents the range interval of the acquisition-range gate. Prior to designation, the range gate is held at 25,000 yards. During normal tracking the upper trace provides the operator with a video display which shows the environmental characteristics (clutter, ECM). The lower trace displays the target video for use in monitoring track status and assessing track quality.

44. A region of the upper trace is intensified to show the position of the 192 range bin acquisition gate. During target acquisition an intensified region is centred on the lower trace to represent the 20 range bin secondary acquisition on re-acquisition gate. During track, the intensified region represents the 2 range bin track gate. If the target echo is weak, the track antenna may continue to scan as indicated by the continuing movement of the elevation marker on the PPI. If this occurs, the operator may depress the EL MANUAL switch on the control table permitting antenna elevation to be controlled by the ELEVATION hand wheel to maximum the target video. Acquisition is confirmed by the appearance of target video in the acquisition – range gate. The EL MANUAL switch lamp is automatically switched to the off condition when range acquisition occurs.

45. To ensure that target tracking starts at approximately the same position at which the antenna first detected the target, the computer stores the initial antenna detection position. This is done because the antenna tends to overshoot this position and as a result, target tracking could start with the target being illuminated by a lower gain. The computer than repositions the antenna back to the stored position and the system waits for a second target detection. When second target detect occurs, the AUTO TRACK AIR (ATA) lamp lights, and the AIR TARGET DES (ATD) switch is automatically switched to the off position.

TRACKING

46. For the next 2.5 seconds, the antenna angle servos are positioned by the angle error signals developed in the radar processor cabinet (RPC). During this interval, the WCP is initialising the stored track filter with range and angle error data from the RPC. At the end of this interval, the WCP has sampled sufficient data to declare an air solution valid status (ASV) condition. When the air solution valid status is achieved, the following events occur:

a. The AIR SOLUTION VALID lamp on the control table is illuminated.

b. WCP assumes control of the radar angle tracking function.

c. The flashing FC-1 tracking gate symbol at the target position on the PPI is displayed steady.

d. An on target signal is sent to the designated source.

e. The range tracking loop is closed in the track processor.

f. The ATA lamp remains illuminated

g. On the A-scope, target video is positioned at the target range on the upper trace. Target video is centred on the lower trace which represents the action-range gate interval.

h. Relevant target data is made available for presentation on the TOTE display.

47. If automatic tracking becomes difficult or impossible, one of the following modes can be used to track the target.

MANUAL RANGE TRACKING MODE

48. During automatic tracking and coast operation, target range can be manually updated by the operator of the applicable WCC if required. This is accomplished by the operator depressing the RANGE MANUAL switch on the console, which places the position of the range gate under the control of the designation ball while the CORRECTION push button is depressed. The operator then observes his A-scope and adjusts the designation ball to position the target echo in the centre of the range gate.

LOW ELEVATION TRACKING MODE

49. The low target made is entered automatically after the AIR SOLUTION VALID switch is lit and when the altitude of the target being tracked drops below a preset level. When in low target tracking mode the LOW TARGET switch on the left control table assembly of the WCC is automatically placed in the on condition. In the low target mode, target height is computed by the WCP using bore sight errors. It can be expected that the radar return from a low target may exhibit recurring fades as the range to the target changes. These fades are due to radar returns that reflect from the target, bounce off the water surface and then reach the antenna. The system will automatically enter COAST mode during these fades.

COAST MODE

50. Coast operation is usually initiated automatically under weak target echo conditions: however, the WCC operator can force coast operation by depressing the COAST switch to the on condition. Coast operation is automatically initiated and the coast switch on the console is placed in the on condition when any of the following conditions occur:

a. Automatically under weak target echo conditions and no barrage jamming.

b. Automatically under weak target echo condition and SIDELOBE jamming indicators is lit.

c. Automatically under weak target echo conditions and MAINLOBE jamming indicators is lit but passive tracking is not enabled.

51. In coast operation, the target trajectory is computed assuming a uniform and straight course with a constant speed line using the last known target vectors. If coast operation has been initiated as a result of target fading, automatic tracing is resumed when target echo strength is restored. Coast conditions prior to solution valid will cause the system to automatically re-enter designate mode.

COHERENT/NON-COHERENT TRACKING

52. When in the non-coherent tracking mode and a target being tracked enters a clutter environment containing stationary targets, the operator depresses the COHERENT TRACKING switch on the WCC. Selecting coherent tracking eliminates the stationary and slow moving (Clutter) targets from the A-scope display without affecting the moving target. However, target video fades may occur at certain target speeds during coherent tracking. The operator may select non-coherent tracking mode of operation by depressing the NON-COHERENT TRACKING switch on the console. The operator should remain in the mode that results in the best target video display.

ENGAGEMENT

53. The basic engagements modes are assignment, control, firing and post fire evaluation. Two air targets can be simultaneously engaged by the FCS, one by gun fire and the second by missile fire, or two air targets may be simultaneously engaged by two missiles. The system provides control of one Mk 75 Gun, MK 13 Missile Launcher (SM-2) and VLS (ESSM). Control of the gun, launcher, and missile selection can be excised from either console. Each operator has the necessary controls to select, load, fire missiles and perform post fire evaluation for the target being tracked by the assigned fire control channel. Control of the launching system is assigned to the operator at the console that is firing the next missile. Gun control, firing evaluation can also be performed at either console.

54. During Gun/Missile air engagements modes, the PPI display provides engagement status data by modifying the basic target symbol to indicate gun/launcher assignment, FC ready, ready to fire and gun firing/missile in flight conditions. Additionally, missile and gun intercept data is provided on the PPI while missile engagement limits and maximum gun range are displayed on the A-scope.

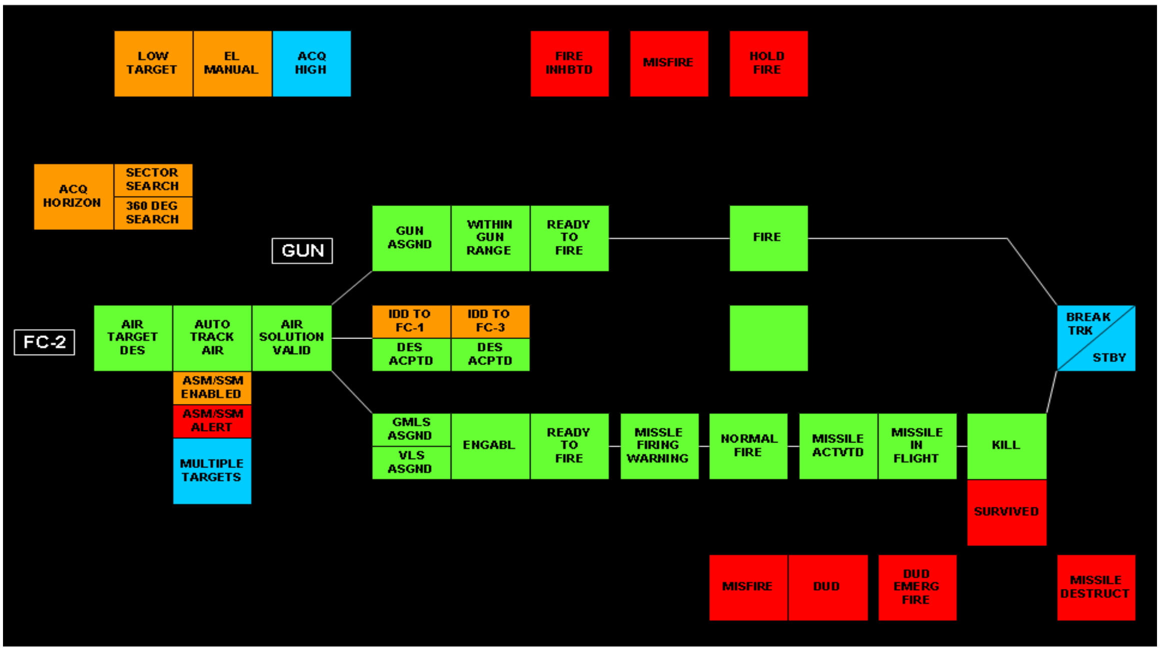

Figure 1-10: FC2 Controls (WCC 2)

Special Modes of Operation - ECCM

55. The following Electronic Counter-Countermeasures (ECCM) modes of operation in the non-coherent modes of operation are available:

Cover Pulse

56. The cover pulse mode of operation arises when a repeater noise jammer overlaps the signal return. When the track processor detects a cover pulse jammer the lower half of the CMD COVER PULSE/COVER PULSE switch is brightly illuminated. Upon depressing the upper half of the above switch the track processor will enable its cover pulse circuits.

Sidelobe Blanking

57. Sidelobe blanking is employed against coherent repeater jammers radiating into the antenna sidelobes which would cause false lock-on to occur at the wrong antenna angle. An auxiliary antenna matched to the sidelobes of the main antenna with associated electronic and logic is used to discriminate against this type of jamming. Blanking is inhibited in the presence of sidelobe barrage jamming.

Passive Angle Track

58. A strong barrage jammer is capable of masking the return, which results in the inability of the radar to measure the range of the target. In this case, interference sensing circuits within the track processor react to noise levels that occur in the main lobe or sidelobe of the antenna beam. When this happens, the WCC operator observes that either the MAINLOBE or SIDELOBE lamp is brightly illuminated. If the MAINLOBE lamp is lit, PSIV TRK ENABLED to initiate passive tracking of a self-screening jammer. However, if the SIDELOBE lamp is lit, PSIV TRK ENABLED should not be selected. In passive tracking mode, the FCS angle tracks the jamming signals produced by the target. The applicable tracking antenna tracks the jamming signal in bearing and elevation and target range data is generated by the WCP. If available, the target range from C2 is used. Otherwise, the target range generation assumes that the target's linear velocity remains constant at the last measured value. If the interference is activated at lock-on so that the target range is not determined, a canned solution of 20,000 yards is used to position the range gate. When the interference is deactivated, automatic tracking is restored provided the target video is within the re-acquisition range window of 20 Range bins. During passive angle tracking, the mode is automatically set to non-coherent 32 NM for FC-1 and non-coherent 64NM for FC-2.

Hole Seeker

59. When the WCC operator depresses the CMD HOLE SEEKER switch, the radar automatically searches the operating RF spectrum seeking to find a "hole" (lowest energy line) in the jammer power output. The radar measures the jammer power at a different frequency each pulse repetition time (PRT) prior to each transmission, always looking for the lowest energy level.

Burnthrough

60. This mode is only allowed during passive angle tracking and can be used by the WCC operator to resume normal tracking provided the target echo is sufficient to achieve burnthrough detection. When WCC1 operator selects BURNTHROUGH, CAS transmits coded waveform with the track antenna and an uncoiled waveform with the track antenna on alternate PRT's the uncoiled waveform is used so that the entire instrumented range to 42 Range bins. The STIR transmitter transmits uncoiled waveforms each PRT during the burnthrough mode.

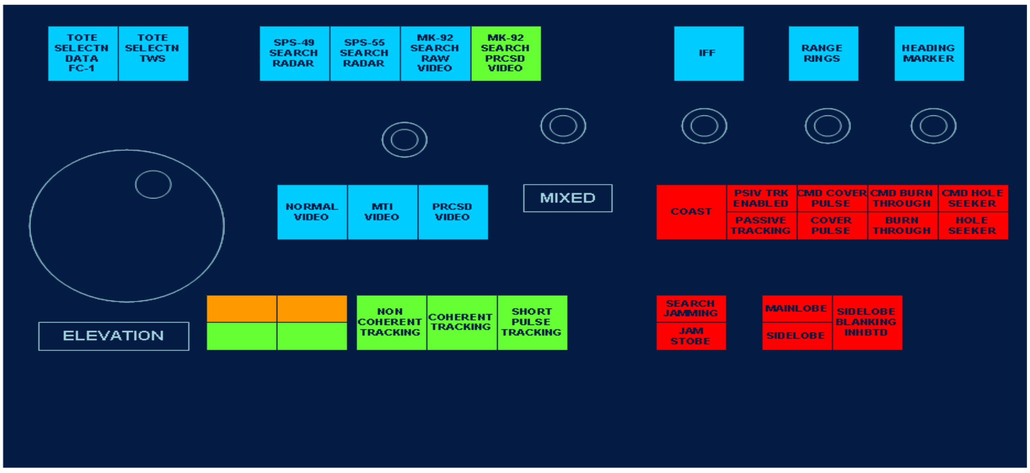

Figure 1-11: ECCM Push buttons and Video selection

GUN CONTROL

Dither Mode

61. When tracking low flying targets (Approximately 0.6 degrees above the surface) the radar uses the lower quarter of the beam to maintain track and off bore sight errors to direct the Gun. In this region Target height is estimated, so to effectively engage the target with the gun, dither mode is entered. Dither mode allows a spray of projectiles throughout the elevation region, to increase the probability of a target intercept.

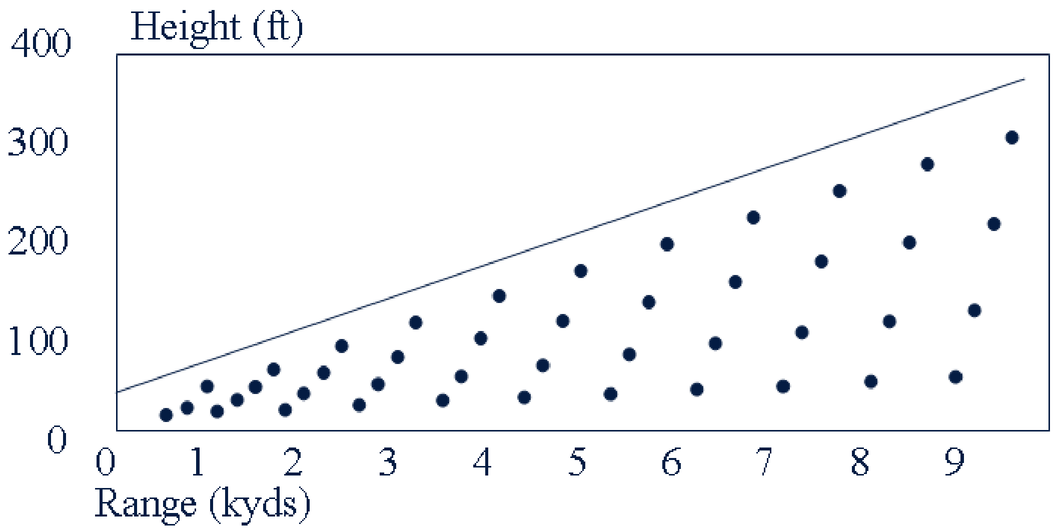

Figure 1-12: Gun Dither mode

Concentrate Low Mode

62. When the target is determined to be below the 0.6 degrees for Dither mode than the operator can selected Concentrate Low Mode. Concentrate Low mode is a modified dither mode with only the lowest two points used.

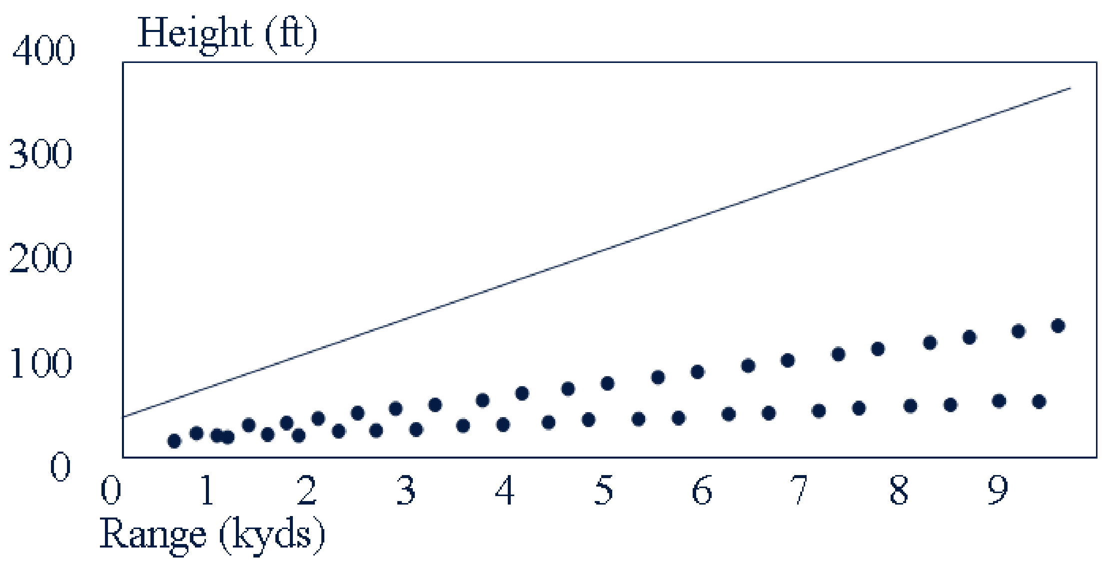

Figure 1-13: Gun Concentrate Low mode

HSMST Mode

63. Operator selectable HSMST Modes for the Gun improves the capability to defend against high-speed surface threats by providing a pattern of rounds to be fired at the target and an area surrounding the target rather than just pointing and aiming each round directly at the target itself. This reduces the targets ability to evade being hit by performing rapid turns. Two patterns are available differing only in width and timing of the gun firing:

a. HSMST 1: Sweeping pattern against Planning-hull Targets

b. HSMST 2: Sweeping pattern against Patrol boats.

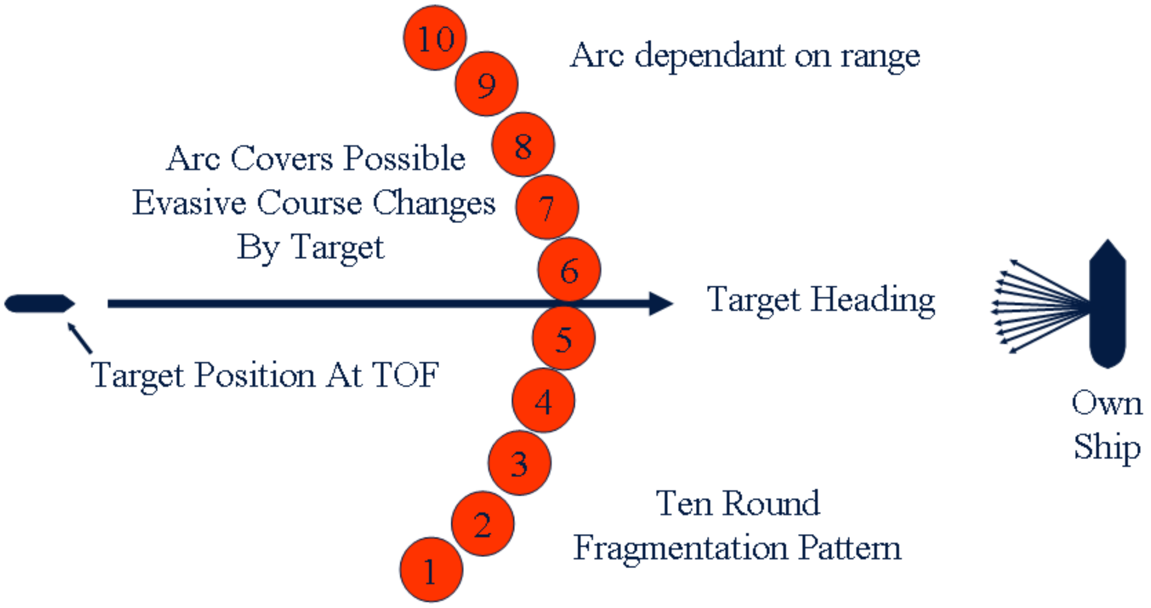

Figure 1-14: Gun HSMT Mode

SYSTEM CONTROL

ASD Mode

64. In ASD mode the system will automatically engage threats to own ship with ESSM using FC 1 and 2. ASD Mode is not available in local mode as Authorisation and target parameters originate in ADACS and the AWO or PWO console. A key on the WCC console allows the operator to enter ASD mode.

FC3

65. FC-3 is the fire control channel specifically designated for surface or air engagements targets tracked by EOTS. FC-3 can be assigned at WCC-1 or and IDD from the other fire control channels. Signal flow for gun engagements follows a similar path as FC-5 with all splash corrections entered via WCC 1.

Blank Page

Chapter 2. WEAPON CONTROL PROGRAM (WCP) AND ASSOCIATED ELEMENTS

References:

A. TW271-RD-PPS - WCP Program Performance Specification

B. ABR 6511 Rev 0 – Combat System Operator's Manual

1. The Fire Control computer program group consists of a computer (AN/UYK-43), a load device (RANSID) and three Computer Software Configuration Items (CSCI):

   a. UPAK – Utility Package.

   b. WCP – Weapon Control Program

   c. HMP – Hardware Maintenance Program

2. UPAK provides the necessary man-machine interface to enable an operator to load a program, verify memory contents, change contents, write contents, and dump memory (using the RANSID).

3. WCP is the software that performs fire control calculations, engagement evaluations, and housekeeping functions associated with tracking and displaying of targets at WCC 1 and 2.

4. HMP is the computer program that controls the offline testing capabilities of the Mk 92 FCS. The tests are divided into six functional categories. Control of the tests is either from the CAS or STIR WCC TOTE or the RANSID Keyboard.

5. The above CSCIs use the program naming convention NNNNRVVVHS where:

   a. **NNNN** is the CSCI:

      i. WCP is 0126

      ii. HMP is 0127,

      iii. UPAK is 0128, and

      iv. SMAP is 0129. (Note: SMAP CSCI is delivered separately to the Mk 92 CSCIs, and it is loaded and operated in the CDLMS cabinet rather than the UYK-43).

   b. **R** is the program revision;

   c. **VVV** is the program version;

   d. **H** is the Hardware configuration; and

   e. **S** is the site location

e.g.: $\underbrace{0126}_{\text{WCP}}\underbrace{\text{D}}_{\text{RevD}}\underbrace{001}_{\text{Ver 1}}\underbrace{\text{FA}}_{\text{Final All sites}}$

AN/UYK-43 Computer

References:

A. SE610-NV-MMO-A10 - Operation and Maintenance Instructions for AN/UYK-43(V).

B. ABR 6511 Rev 0 – Combat System Operator's Manual

General

1. The AN/UYK-43 is a 32 bit Mil-Spec computer of modular design that is used in the FFG Combat System as the host processor for the WCP. As such, it is capable of providing virtually real time compilation of the tactical environment. The AN/UYK-43 features high reliability, ease of maintenance, built in diagnostic routines, and fault tolerance.

System Inputs

2. The AN/UYK-43 has the following input requirements from the ship:

115 V_{AC}, 60 Hz, 3ϕ primary power, and

Low Pressure Cooling Loop chilled water (7.5 gpm).

Functional Characteristics

3. Characteristics of the AN/UYK-43, as fitted to RAN FFGs, are detailed in Table 12-1.

Characteristic	Description
Location	RICER (1-100-0-Q)
Enclosure	1 water cooled type 'B' enclosure
CPU/IOC/IOA Configuration	2 x CPUs (CPU0 & CPU1) 2 x IOCs (IOC0 & IOC1) up to 32 IOA channels per IOC
Memory Configuration	8 x semiconductor memory modules (switchable capacity up to 512 K each)
Power Supply Units	2 x fully redundant modules (PS0 & PS1)
Interface Type/Configuration	Most channels NTDS Slow (Mil-Std-1397 Type A) VLS Channels are Mil-Std-1553B (serial)

Table 3: AN/UYK-43 Characteristics

AN/UYK-43 Modules

4. The AN/UYK-43 conforms to a basic computer set-up in a modular design. The basic modular units are:

CPU	***Central Processing Unit***
IOC	***Input/Output Controller***
IOA	***Input/Output Adaptor***
MEM	***Main Memory***
PPS	***Primary Power Supply***
DCU	***Display Control Unit***

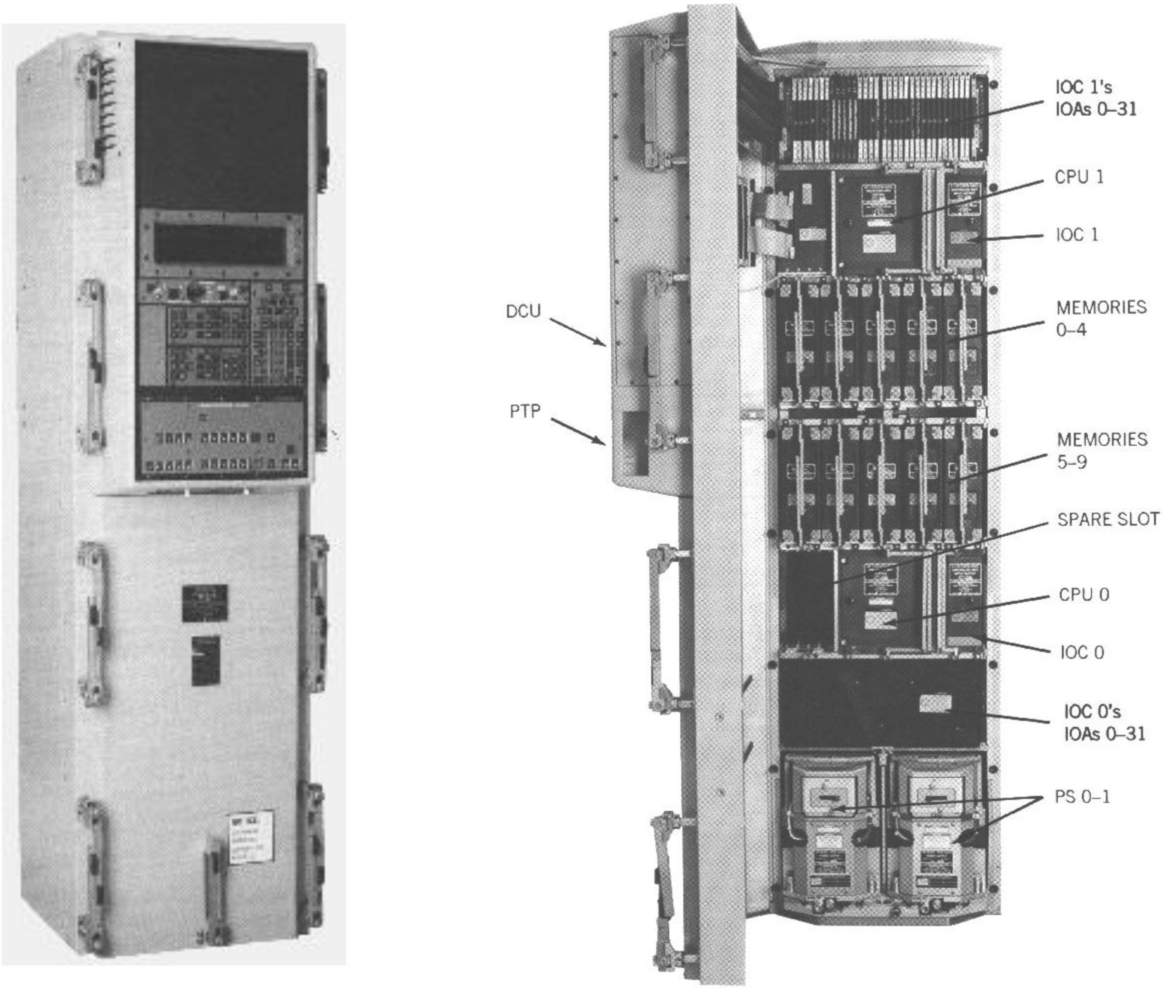

Figure 2-1: AN/UYK-43 Computer

5. Central Processor Unit - CPU The CPUs are the functional modules whose role is to execute the main WCP program and to perform all the associated arithmetic computations. They have a macro instruction set of over 200 instructions. The actual execution of the macro instructions is by micro routines,

which are sequenced by an AMD 2910A series micro sequencer and are 'pipelined' for reduced execution time. The two CPUs are completely independent units, and, for WCP program execution, only one is used at any time.

6. Each CPU contains two blocks of 16K of cache memory for increased performance, and a P-History capability. Additionally, a CPU can operate in one of five states (Task sate, and Interrupt states I through IV). The operational program achieves its real time capability largely through its utilization of these different states and the transitions between them (via 'interrupts').

7. Each CPU also contains a block of Non Destructive Read Out (NDRO) memory. This is non-volatile firmware, and contains both the routines used for program bootstrap loading, and also the Fault Tolerant and System Reconfiguration Module (FTSRM). The FTSRM is a set of routines designed to support a user's utilization of the AN/UYK-43's in-built fault-tolerant capabilities through computer resource monitoring, support for the diagnostic analysis for all hardware logic faults, and the isolation of faulty or failed functional modules.

8. Input Output Controller - IOC The IOCs are functional modules that are tasked to take care of all I/O related functions, thus allowing the main program to utilise the CPU for the core program functions. Each IOC is composed of a Micro-Programmable Controller dedicated to non-buffered I/O operation and a separate hardwired Buffer Control Unit dedicated to buffered I/O operations. Again, the two IOCs are independent units, and, although either or both can be utilized by either CPU, the WCP program can only utilize one IOC.

9. The IOCs must be initiated by command from (one of) the CPUs, but, once initiated, run their own specialized programs (called chains) independently of the CPU(s). These programs are mainly concerned with the control of data transfers into and out of areas of main memory, called buffers. An IOC can, in principal, have 134 such chains active simultaneously. Each IOC can support up to 32 IOAs (channels).

10. Input Output Adaptor - IOA Each of the 32 possible external I/O channels (per IOC) is controlled by its own IOA circuit card assembly (CCA). One of the roles of this CCA is to provide the required interface protocol on the channel (i.e.) NTDS Slow, 1553B etc. The NTDS Slow IOA CCAs have DIP switches to configure for the required interface mode (e.g.) Normal or Inter-Computer (IC).

11. Memory Modules The main memory used in RAN AN/UYK-43 is a volatile, semiconductor type with a fitted capacity of 512 K (32 bit words) per module. Eight such modules are fitted. The accessed capacity of each fitted module can be switched, in steps, from 0 K through 512 K. The WCP Rev B OP program has each module switched to 64 K. Data is retained for only 150 milliseconds after power loss. A memory module will (automatically) correct single bit errors detected during a read, and will flag double bit errors with an 'error' signal.

12. Display Control Unit (DCU) The DCU module provides the man/machine interface using an operator panel and display as depicted in Figure 12-2. As shown in the figure, the display shows the configuration status of available resources along the top two lines: a flashing module name would indicate a failed module. Controls are available for all aspects of AN/UYK-43 operation including normal operation and maintenance support. The execution of all (inbuilt) diagnostic routines is controlled by the DCU. The DCU is micro-processor controlled, and a functional DCU is absolutely essential for computer operation.

13. Power/Temperature Panel (P/TP). The P/TP is located on the front door of the enclosure below the DCU and provides power control, and power and temperature indications for all the installed modules. Power switches for each individual module enable repairs to be undertaken without having to power-down the entire unit.

14. Power Supplies (PS0 & PS1). The two power supplies installed provide regulated DC power to each of the AN/UYK-43's modules. The two supplies are fully redundant - each supply is capable of supplying uninterrupted power to the entire enclosure in the event of the loss of the other supply. The power is supplied on three busses – two at +75 Vdc, and one at –75 Vdc. These busses are only nominally balanced with respect to ground, and in-built circuitry constantly checks for leakage between any bus and ground. Within each module, one (or two) Secondary Power Converter CCAs convert the supplied +75 Vdc and –75 Vdc to the DC voltages required by that module. It is the output of these CCAs that is reported at the P/TP.

15. The redundancy available with the AN/UYK-43, and its flexibility for reconfiguration, means that a defect would normally result in a maximum down-time of only 5 minutes (i.e.) time to reconfigure the system, reload the software, and re-enter WCP initial parameters. Repair of the failed component does not take much longer - Mean Time To Repair (MTTR) is specified as 15 minutes. However, fault analysis on some modules (particularly memory) cannot be performed with the WCP software on-line. Mean Time Between Failures (MTBF) is also very large - approx 6000 hrs. The number of operational failures fleet wide has been very small.

16. Execution of the diagnostics leading to a failure will produce an error code, in accordance with which the DCU will display one of a number of Line Replaceable Units (LRUs) to replace. In general, 90% of faults will be repaired with the first call-out, 95% with the second and 98+% with subsequent call-outs.

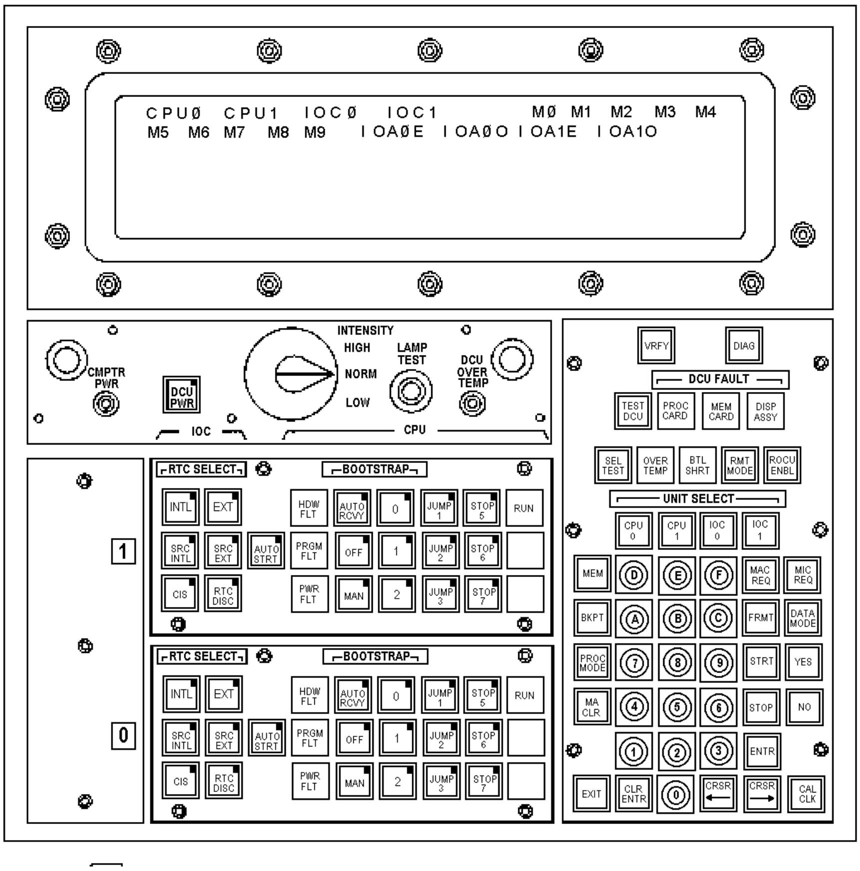

Figure 2-2: AN/UYK-43 Computer - Display Control Unit

Normal and Casualty Configurations

17. The normal utilization of the AN/UYK-43 to execute the WCP Rev B software is to have CPU0 on-line utilizing IOC0 and thus using the required channels out of IOA0. . Options available in case of an AN/UYK-43 hardware failure include:

a. CPU0 fail: Reload using CPU1 (usually with IOC0)

b. IOC0 fail: Power down, swap IOC 0 with IOC1 power up and reload WCP program.

c. IOA fail: Power down, swap/replace defective IOA

d. Mem fail: Power-down the faulty module, and reload

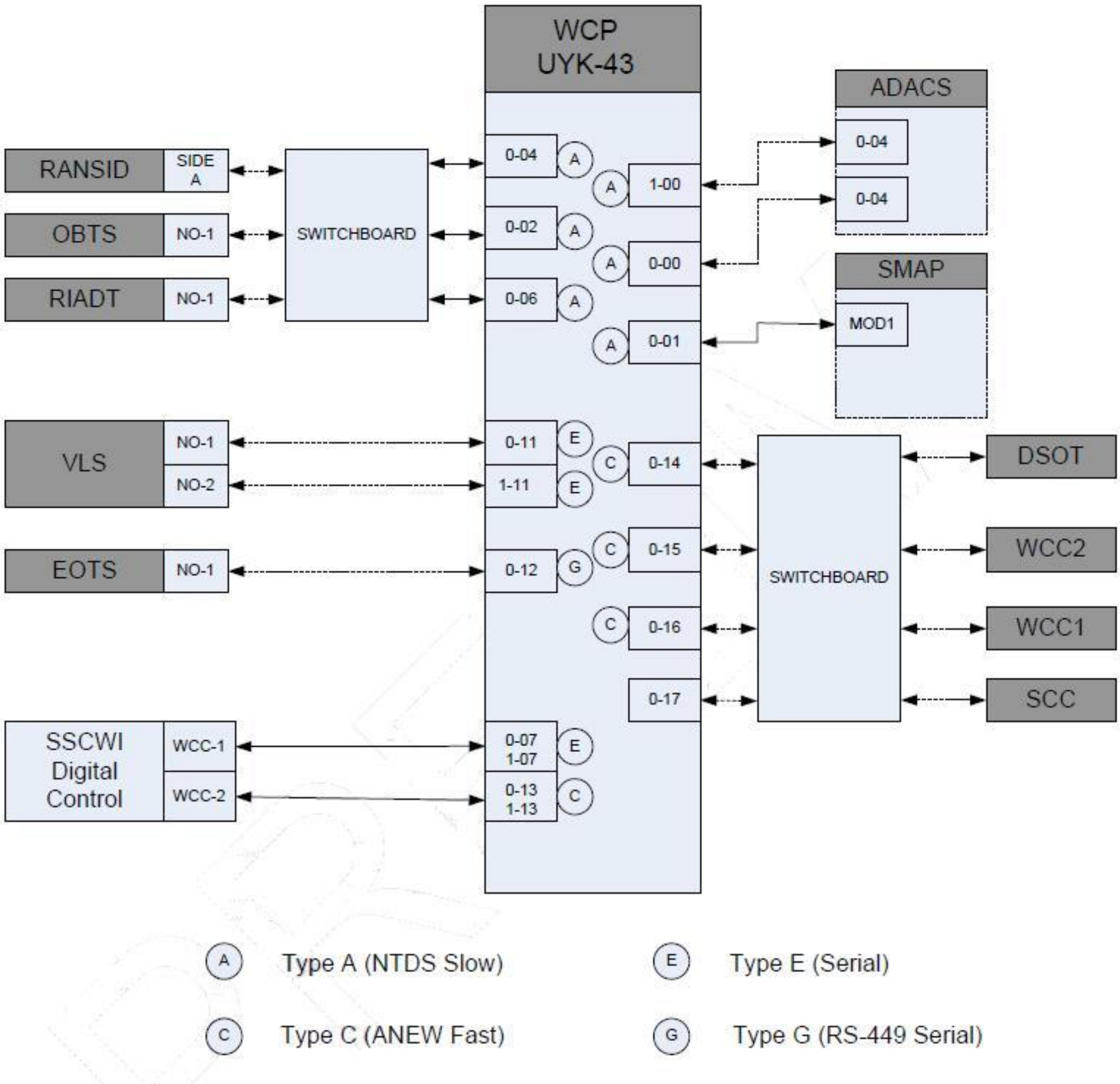

Figure 2-3: UYK-43 Mod 12 Channel Assignments

RANSID

General

6. The RAN Standard Interface Device, or RANSID, is a micro-processor controlled device that replaces and emulates the OJ-172 DEAC (Data Exchange Auxiliary Console). It is used as the load and data storage device for the WCP software.

7. Four computers may be connected to RANSID, and access RANSID simultaneously, via NTDS Slow interfaces. Each computer communicates via a Computer Interface Device (CID) window displayed on the RANSID's monitor screen. In 2003, RANSID was upgraded to Field Change 2, with numerous hardware and software changes. Field change 3 allows for ADACS to FTP data to RANSID for CD recording. This was introduced during FFGUP.

System Inputs

8. RANSID has the following input requirements from the ship:

a. 115 V_{AC}, 400 Hz, 1ϕ primary power.

b. Air cooled

Description

9. Essentially, the heart of RANSID consists of a processor (CPU), communicating with a set of NTDS CCAs over a VME bus, plus a variety of peripheral load/storage devices. The CPU is now (FC2) a General Micro Systems Intel Coppermine Pentium processor, running a Solaris UNIX operating system. The CPU, NTDS CCAs, and the load/storage peripherals are contained in the VME chassis. Additionally to the VME chassis, the RANSID consists of:

a. a keyboard (and ball-tab), for operator entries to the RANSID.

b. a monitor, for displaying information to the operator.

c. a printer, which can be used (off-line) to obtain a hard copy of any monitor output.

d. a Performance Monitoring Unit (PMU), which controls the power application, thermal monitoring and cut-out, and battle-short circuitry.

e. an Auxiliary Power Supply Drawer (APSD), which contains the 28 V_{DC} power supply (essential for input power application), plus the Uninterruptable Power Supply (UPS) unit.

10. The 4 x receiver/drivers SABTECH "Hawke" 1397 circuit cards are used to enable communications between the CPU and each of the connected computers over NTDS Slow interfaces. In addition, the VME chassis contains the following load/storage peripherals:

a. re-writeable CD ROM drive. CD ROMs are the original source of all programs, including both the UNIX program for the CPU/emulator, and also the various WCP Operational programs, diagnostics, POFAs, etc. This drive can also be used for the transfer of recorded tactical data (WCP Data Extraction recording & WCP Data Analysis recording) for later analysis at RANRAU, as well as for enabling updates to the stored Operating system, RANSID emulation, and Operational programs.

b. a removable Hard Disk drive. This is the working drive, and has the contents of the original CD ROM stored onto it, plus all other recorded data, print files, etc.

c. a 3.5" Floppy Disc drive. This provides the means where patches, etc can be delivered for inclusion onto the hard drive, and also where SDE dumps are downloaded for forwarding to CDSC for analysis.

11. It must be noted that the RANSID contains virtually no redundancy (apart from the 4 x Sabtech cards), and all components except the hard copy printer must be functional for its operation.

UTILITY PACKAGE (UPAK)

12. The utility package (UPAK) provides the necessary man-machine interface to enable an operator to load a program, verify memory contents, change contents, write contents, and dump memory using the RANSID. To enable the WCP CSCI to be loaded onto the UYK-43, UPAK must first be installed. Once UPAK is initialised, it awaits the instruction to extract the WCP operational program file from the media onto the UYK-43 via RANSID. This software is generally included with the WCP CSCI media.

Weapon Control Program (WCP)

13. The WCP, as the Mk 92 operational program, operates as an integral part of the FFG-7 combat system through message communication with the Australian Distributed Architecture Combat System (ADACS). The WCP provides the following major functions:

a. implementation of track-while-scan capability for tracking surface targets by dedicated channels for gun engagement and six air or surface targets using the Mk 92 CAS search radar;

b. radar tracking and illumination of two targets using the CAS track radar and the STIR respectively;

c. calculation of gun, launcher and missile orders (including interfacing with the SMAP for SM-2 engagements);

d. CAS and STIR WCC display functions;

e. Engagement modes against aircraft, surface vessels, and shore targets;

f. Computations to support command and decision functions including engageability determination, scheduling of targets ordered for engagement, management of data and alert displays;

g. Daily system operability test (DSOT);

h. Target information to/from the RIADT; and

i. Ability to train WCC operators via the scenario generation program, or on a larger scale, interface with OBTS.

14. The WCP has a modular structure, with each module designed for specific functions. WCP runs under the control of the Standard ordnance Executive (SE) module.

Standard Executive (SE) Module

15. The five major functions of the SE are as follows:

a. Initialisation

b. Scheduling

c. Interrupt management

d. Input/Output management

e. Error management

Support Modules

16. In conjunction with the SE module, executive support software is also provided.

System Loader

17. A **system loader (SL)** module furnishes SE with the memory location of each module. The module also retrieves the RANSID channel for use by other modules.

Operator Interface

18. The **Operator Interface (OI)** module provides the interface between the RANSID and each of the other task modules as follows:

a. Accept, schedule, and initiate requests from other modules for input from and output to the RANSID.

b. Process internal and external interrupts associated with the RANSID I/O channel and, in most instances, forward the interrupts to the modules responsible for the indicated activities.

Program Maintenance

19. The **Program Maintenance (PM)** Module is designed to assist in the on-line real-time debugging of other program modules by providing the capability to perform the following functions:

a. Operation system timing analyses

b. Dynamic alteration of program module instructions and data

c. Retrieve and display the contents of selected memory locations, addressable registers, intermodule messages, and module histories

d. Search for a masked constant in a specified area of memory

e. Locate references to a specified operand

f. Send an intermodule message to a specified module

g. Return the base address of a specified program module

h. Repeat and sequence the above debugging functions, and clear previous debugging requests

Common Systems

20. The **Common Systems (CS)** Module provides a set of common procedures and math routines that can be used by any system module to perform operations required by two or more modules. The CS Module also provides the data storage for all system data required by two or more system modules. A significant saving in core is realized by making such procedures and storage available to any system module rather than by having each requiring module include them.

Functional Element Modules

21. To fulfil the functional requirements of the Mk 92 Mod 12 FCS, the WCP CSCI contains functional elements (modules) in addition to the support modules listed above. The functional element modules are:

a. Functional Scheduler (FS)

b. Sensor Weapon Converter (SW)

c. Track Radar (*CAS and STIR*) (TR)

d. Search Radar (SR)

e. Gun Control (GC)

f. DSOT (DT)

g. System Monitor (SM)

h. Data Extraction (DE)

i. Display Processing (DP)

j. Weapon Control (WC)

k. Weapon Direction (WD)

l. RIADT Interface (RI)

m. Scheduler (SK)

n. Interface Manager (IM)

o. On Board Training (OB)

p. EOTS Control (EO)

q. VLS Control (VM)

r. SMAP Interface (SP)

22. The **Function Scheduler (FS)** function provides interface to the CAS/STIR track processors. It accomplishes this by performing the following major tasks:

a. Initiating inputs of CAS and STIR radar range measurements and converting range data to system units.

b. Initiating input of search bearing measurement.

c. Initiating loop test to the track processor and radar receiver/processor and checking results for validity.

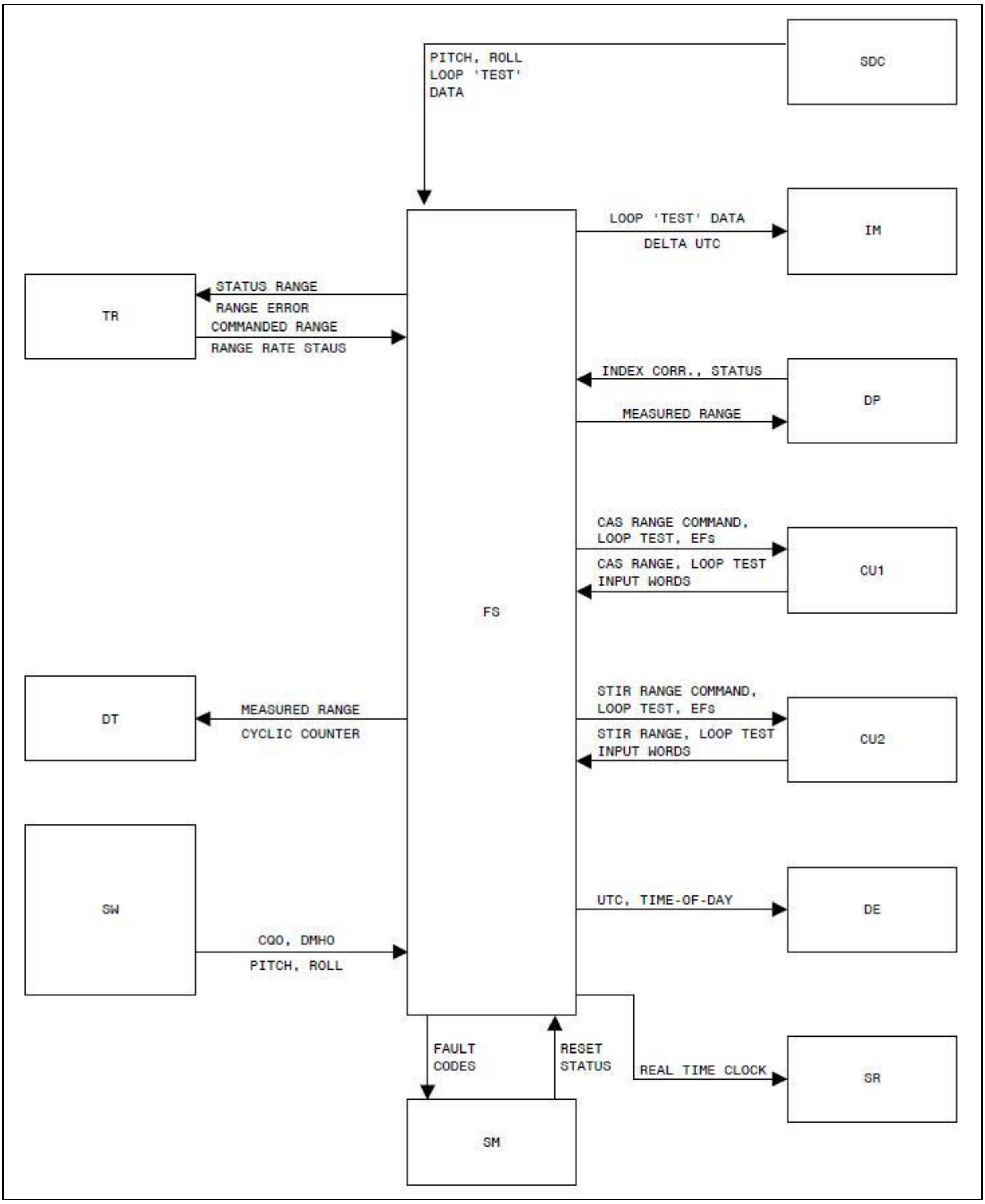

Figure 2-4: FS Function Interconnection

23. The **Sensor Weapons (SW)** function processes data that flows to and from the weapon converter control unit. SW processing tasks are as follows:

a. Own ship data

b. A/D and D/A formatting

c. Discrete signal processing

d. Track radar control (CAS and STIR)

e. Gun control

f. Launcher and missile control

g. Stabilization correction

h. Process platform ship parameters

i. Scheduling of WCP modules

j. Monitor WCP to Weapon Converter Control Unit interface statuses

k. Simulate the CAS Track and STIR antennas during the OBTS “SIM ONLY” training mode function.

24. The **Track Radar (TR)** function supports the fire control system in engagements against air and surface targets. It performs logic and mathematical processing to establish target track, thereby providing the CAS and STIR track radar with command and control signals throughout Designate, Acquisition, and Tracking Modes. It also provides smoothed target data for gun-aiming, launcher-aiming, and missile calculations. Submode track functions supported by the TR function also include Auto Track Air, Low Angle Track, Passive Track, and Coast.

25. The **Search Radar (SR)** function defines the surface firing channels (FC-4, FC-5) and track-while-scan (TWS) track channels (FC-11 thru FC-16) target parameters and to generate track data. Processing for eight designated targets is possible. Corrections for a track can be derived from the search processor, or the B-scope, depending on the operator-selected mode. SR provides smoothed target data to the GC function for gun-aiming orders.

26. The **Gun Control (GC)** function calculates the gun-aiming position for air or surface targets. It determines engageability based on target position and rate data. GC also performs spotting correction computations.

27. The **DSOT (DT)** function controls the Daily System Operability Testing (DSOT) and processes the OBTS training mode. This process is described below:

a. Control the DSOT instrumentation for both performance/training tests and on-line maintenance tests as follows:

   i. Monitor the DSOT controller and RF generator.

   ii. Monitor the CAS and STIR RF simulators for Manual Mode Status.

   iii. Calibrate search and track DSOT channels.

   iv. Provide required signals and controls for maintenance testing.

   v. Generate target, clutter, ECM, SM-2 missile, and gun splash data.

   vi. Formulate and transfer messages to the DSOT controller.

   vii. Perform weapon system evaluation.

   viii. Generate status reports for printout on the RANSID.

   ix. Provide summary results for display at the WCC consoles.

   x. Forward CAS and STIR DSOT data from OBTS to the DSOT controller.

28. The **System Monitor (SM)** function enables fault monitoring and fault isolation of the other system functions. It provides fault signals to the system status and control panel for fault indication and display. SM provides processing for the Relative Alignment Test (RAT).

29. The **Data Extraction (DE)** function provides the ability to extract system data from the computer program. This data is recorded for use in analysing system performance and utilisation. This provides data for war diaries, personnel training, and exercise firings.

30. The **Display Processing (DP)** function processes manual entry data from the Weapon Control Consoles and supports the WCC displays. Entry and display processes are handled as follows:

a. Keyset entries

b. PPI display of figures defined by other functions and modifications of this display

c. TOTE displays

d. B-Scope marker display (for WCC1)

e. A-Scope markers display

31. The **Weapon Control (WC)** function processes the following:

a. Button entries

b. Ball and hand wheel entries

c. Lamp and relay processing, launcher status processing

d. Process weapon control logic

e. Process mode transitions relating to Normal and Local modes

32. In Normal Mode, the Weapon Direction element processes those requirements of the Weapon Direction System (WDS), Mk 13 Mod 2, which are allocated to the WCP. The WD function interfaces with the ADACS to maintain target tracks and data and to compute engageability of targets. The WD function also transfers status/data of fire control channels and active engagements to ADACS.

33. The **RIADT Interface (RI)** function handles all data transfers between the WCP and RIADT. The RI function performs the following major tasks:

a. Enable/disable communications between WCP and RIADT

b. Interface testing

c. Clock synchronization

d. Process data and statuses from WCP modules for transfer to RIADT

e. Error detection and recovery

f. Periodic processing of ship parameters message

34. The **Scheduler (SK)** function performs the WDS functions for target-FC scheduling, launcher scheduling, and guns in trail recommendations. The SK processes the following functions:

a. Computes the segmented engageability of targets.

b. Computes the order of engagement (schedule) of all targets ordered for engagement by the AWO.

c. Assigns fire control radars in support of the computed schedule.

d. Schedules, loads, and assigns the GMLS launcher in support of the computed schedule and Harpoon engagements.

e. Schedules and assigns the VLS launcher in support of the computed schedule.

f. Computes and provides gun-in-trail recommendation for gun assignment to targets order for engagement.

35. The **Interface Manager (IM)** function provides intercomputer communications handling capability to manage intercomputer transfers; intermodule message transfers; and error detection, reporting, and recovery processing logic to process hardware and software errors. IM manages the WCP/ADACS intercomputer interface.

36. The **On Board Training (OB)** module provides all of the intercomputer communications functions for the WCP/OBTS intercomputer interface. The OB module is responsible for establishing communications with OBTS, detecting and resolving interface communications anomalies, establishing the WCP training mode as directed by ADACS, terminating WCP training mode as directed by ADACS, terminating WCP training mode when unsafe conditions are detected and returning to tactical state safely.

37. The **Electro-Optical Tracking System Control (EO)** module supports the fire control system in engagements against air and surface targets. It performs logic and mathematical processing to establish target track, thereby providing the Electro-Optical Tracking System with command and control signals throughout Designate, Acquisition, and Tracking Modes. It also provides smoothed target data for gun-aiming.

38. The **VLS Control (VM)** Module supports the fire control system in engagements against air targets. It provides the control signals to the Mk 41 Vertical Launching System and monitors the status signals received from that system. It performs the computations necessary to support ESSM engagements. These include the missile's initial parameters based on ships position and motion and the target's initial parameters.

39. The **Standard Missile Adjunct Processor (SP)** Module is responsible for all aspects of communication between the WCP and SMAP computers. SP supports the established interface protocol, determines the logic sequence for message types, controls I/O processing, and performs error detection, recovery and reporting.

WCP CSCI System States and Modes.

40. The WCP CSCI exists in two states: off-line and on-line. The off-line modes are power-off, initialisation and maintenance. The on-line modes are normal and local. The normal mode supports the three Combat System modes of tactical, training or test.

Hardware Maintenance Program (HMP)

41. The HMP CSCI provides off-line testing of the Mk92 FCS. The software is provided with the WCP CSCI package to conduct loop and status tests, or analogue/digital conversion tests. These tests are divided into six functional categories:

a. system status control panel;

b. servo control cabinet (SCC) group;

c. CAS WCC;

d. STIR WCC;

e. CAS radar; and

f. STIR

Blank Page

Chapter 3. STANDARD MISSILE ADJUNCT PROCESSOR (SMAP)

Reference:

A. USN RAN FFG SM-2 Operation & Maintenance Manual Standard Missile Adjunct Processor (SMAP)

Overview

1. The STANDARD Missile Adjunct Processor (SMAP) is a “black-box” rack-mounted computer with interface devices and software that enable the Royal Australian Navy (RAN) FFG AAW System to support deployment of SM-2 missiles.

2. The SMAP currently physically resides in the lower 18 slot VME (Versa Module European) Chassis of System B in the existing AN/UYQ-86 Common Data Link Management System (CDLMS) Embedded System Processor Group (ESPG) cabinet, but functionally does not form any part of the CDLMS.

Figure 3-1: STANDARD Missile Adjunct Processor

3. The overall SM-2 upgrade includes changes to the GMLS Mk 13, the Combat System Switchboard (CSSB) Mk 60, Interior Communications Switchboards, and the FCS Mk 92, including changes to the Weapon Control Processor (WCP) software, the Solid State Continuous Wave Illuminators (SSCWIs), and the Weapon Control Consoles (WCCs). Additionally, the AN/WSN-2 Inertial Navigation System (INS) is replaced by an AN/WSN-7B INS.

4. For the SM-2 upgrade, SMAP supports the Dedicated Director engagement mode employed by RAN FFG-7 SM-2 AAW system, where the Combined Antenna System (CAS) and the Separate Tracking and Illuminating Radar (STIR) will be required to track the target to obtain adequate data for missile initialization and launch, and will be dedicated to the target for the duration of the engagement.

5. SMAP will set the guidance mode of the missile to either Home-All-the-Way (HAW) or one of the two Midcourse Guidance (MCG) modes, Midcourse or Extended Midcourse. In the HAW mode, the target must be illuminated for the missile's entire flight. The two MCG modes allow for intercepts at greater ranges than HAW, and only require CWI radiation during command uplinks and illumination during terminal homing. Whereas the Anti- Air Warfare (AAW) system previously could not communicate with the SM-1 after launch, SM-2 missiles can receive communications (uplinks) from the system while in flight. This allows the AAW system to update the predicted intercept point, or to command the missile to destruct.

SMAP Operation

6. SMAP can operate in two modes, Tactical or Range Safety. Range Safety Mode is normally used during conduct of live missile firings on a test missile range.

7. In Range Safety Mode, SMAP will be capable of supporting multiple missiles in flight against a given target/radar pairing. However, SMAP will destroy all missiles in flight against the target/radar pair if any of the associated missiles in flight exits the Missile Free Zone (MFZ) (if Auto Command Destruct is enabled), or upon receipt of a Break Engage, Hold Fire, or destruct order from WCP against the target.

8. In Tactical Mode, no Range Safety features are invoked; however, the SMAP ensures that SM-2 tactical employment safety requirements (i.e., SMAP Ready and no engagement termination orders) are satisfied prior to proceeding with missile launch activity.

9. In range safety mode, whenever the missile is to be destructed or an engagement is completed, SMAP ensures that at least three Command Destruct uplink sequence periods complete prior to clearing the missile file to WCP. SMAP also ensures that Rear Reference radiation is terminated for sufficient time to allow the missile's alternate self-destruct mechanism to be invoked between Command Destruct uplink attempts.

10. In tactical mode whenever the missile is to be destructed or an engagement is completed, SMAP sends CD uplinks periodically until an uplink appears successful or five seconds has passed since the first CD was issued.

11. The SMAP supports two unique SM-2 configurations, uplink capable and non-uplink capable. The non-uplink capable configuration will be used when both digital interfaces with the SSCWI are unavailable for SMAP use (as determined by the WCP), or the assigned SSCWI is unable to support uplink processing. For the non-uplink capable configuration, the SM-2 missile will be initialized in HAW guidance mode, where the target must be illuminated during the missile's entire flight. For the uplink capable configuration, the SMAP will compute the guidance mode based on target intercept predictions and provide uplinks to the missile as needed.

12. The SMAP automatically executes processing to accomplish the following:

   a. Upon receipt of a track ordered for engagement:
      i. Establish and maintain a local SMAP track data file
      ii. Determine target engageability

   b. Upon GMLS Mk 13 assigned:

i. Compute stable aim point data

c. Upon Missile Fire Order Normal (MFON):

i. Support the launch/firing sequence

d. Upon Battery Activate:

i. Compute missile initialization requirements

e. Upon Missile in Flight (MIF):

i. Calculate missile track position keeping

ii. Compute target intercept prediction

iii. For the uplink capable configuration, issue Frequency, Pre-Uplink and Radiate orders to the STIR/CAS SSCWI for uplink and terminal engagement support

iv. For the uplink capable configuration, compute missile uplink requirements and provide to SSCWI (via WCP) for transmission to SM-2 missiles

13. SMAP will continually monitor and determine status concerning the SMAP, its interfaces, and the Navigation System and Combat System equipment’s ability to support SM-2 engagements. Information related to ongoing engagements and system status is provided to WCP for processing and console display and is also displayed on the SMAP Human Machine Interface (HMI) displays.

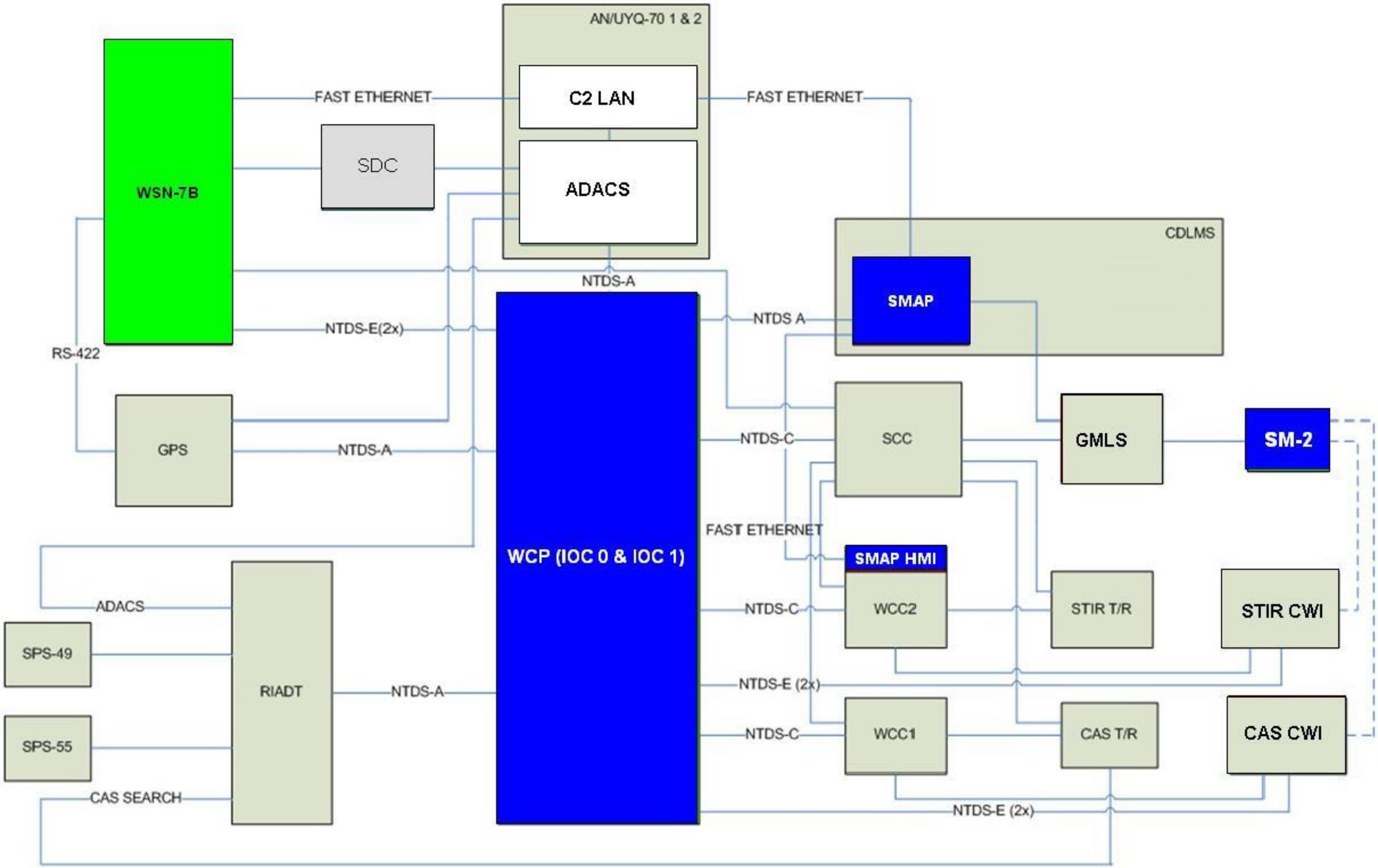

Figure 3-2: RAN FFG SM-2 AAW System Block Diagram

Blank Page

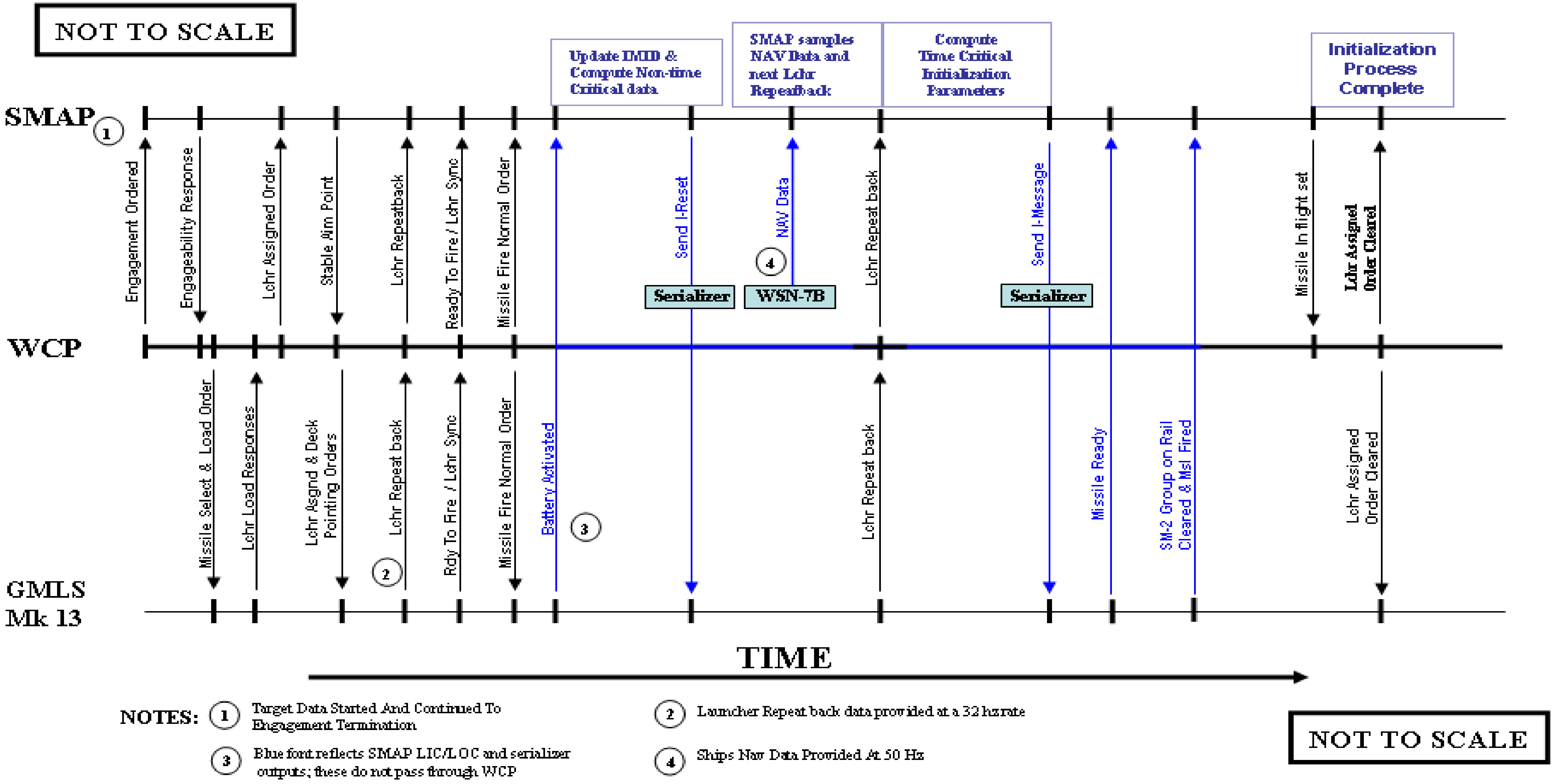

Figure 3-3: SM-2 Initialization Data Flow Diagram

Blank Page

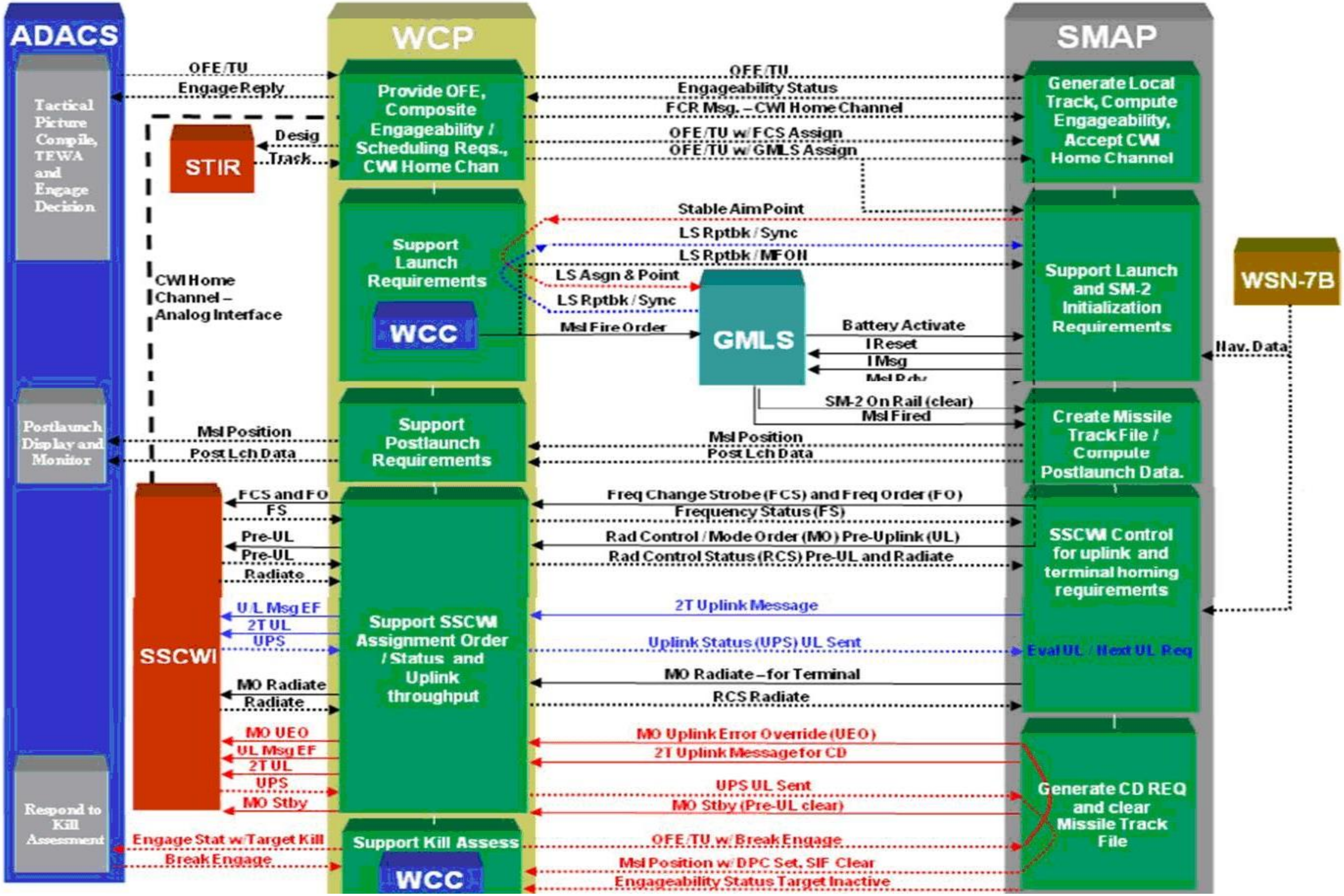

Figure 3-4: SMAP / WCP / ADACS / SSCWI Interfaces for SM-2 Mid-Course Guidance

Blank Page

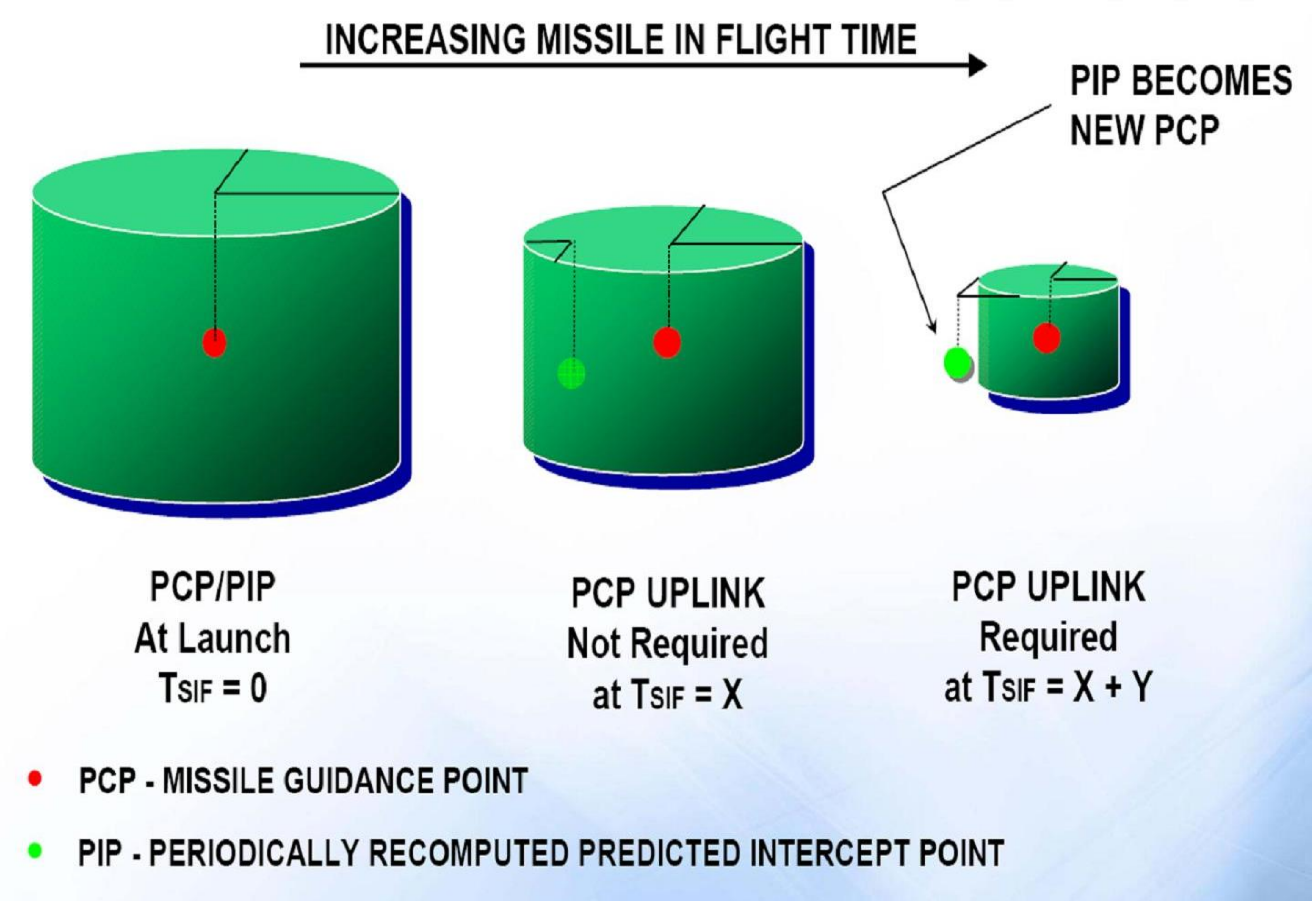

Figure 3-5: SMAP / SM-2 Mid-Course Guidance

Points to Note:

1. The SM-2 is always flying towards the Missile Guidance Point (PCP)

2. The cylinder surrounding the PCP represents the area within which a target can be flying and still be successfully prosecuted by the SM-2.

3 This cylinder is referred to as the "Tuna Can".

4. During flight the SMAP will constantly receive target position data from the WCP and recalculate the PIP.

5. If the PIP remains within the "Tuna Can" there is no need to alter the SM-2's PCP.

6. If the PIP falls outside the "Tuna Can", SMAP is required to update the SM-2 with a new PCP.

7. This occurs via an uplink message sent through the SSCWI.

8. Once this Mid-Course guidance message is received, the SM-2 alters course to bring the PIP within the "Tuna Can" again.

9. The "Tuna Can" gets smaller as the SM-2 approaches as the missile has less time to manoeuvre if the PIP changes during the final phases of flight.

SMAP Hardware Configuration

14. The SMAP Computer Software Configuration Item (CSCI) executes in a VP-327 Single Board Computer (SBC), which includes a Pentium M Central Processing Unit (CPU). The VP-327 SBC resides in the SMAP VME cage, which is in the Lower Half of the Lower VME Chassis of the existing AN/UYQ-86 Common Data Link Management System. SMAP communicates with the WCP via two Naval Tactical Data System (NTDS) I/O cards resident in the SMAP VME cage. The WCP <> SMAP interface consists of two full-duplex parallel NTDS Slow, computer to computer (Type A, Category II) channels, as specified in MIL-STD-1397C (Navy). For the WCP <> SMAP interface, the first channel to complete the enable communications process is set as the primary channel, and the other is set to alternate. Upon failure of the primary channel, an automatic switchover to the alternate channel will immediately occur. SMAP also uses this interface to assign and receive status from the SSCWIs. SMAP uses Dual 100Base TX PMC675 I/O Ethernet ports to receive data from the Inertial Navigation System (INS) AN/WSN-7B and to communicate with the Royal Australian Navy Standard Interface Device (RANSID), both via the Combat System Local Area Network (CS LAN) located in ADS 1 and ADS 2. SMAP communications to and from the GMLS are routed through a single 28 Volts DC (VDC) Logical Input Channel/Logical Output Channel (LIC/LOC) card resident in the SMAP VME cage. SMAP uses an SM-2 Serializer card, resident in the SMAP VME cage, to send an initialization message and initialization reset order to the SM-2 missile. Signal transfers to or from the LIC/LOC card, and from the SM-2 Serializer card, pass through the Mk 60 CSSB.
I

15. SMAP provides the operator with an HMI. The HMI provides the operator with the ability to control data extract and perform the SMAP Hardware Test, view key engagement related events, and to view the health of SMAP and other system components. One HMI is displayed on a dedicated touch screen flat panel display, located in Pan J of Weapons Control Console-2 (WCC-2) and transmitted via an independent Fast Ethernet channel. The other HMI is displayed at RANSID via the CS LAN

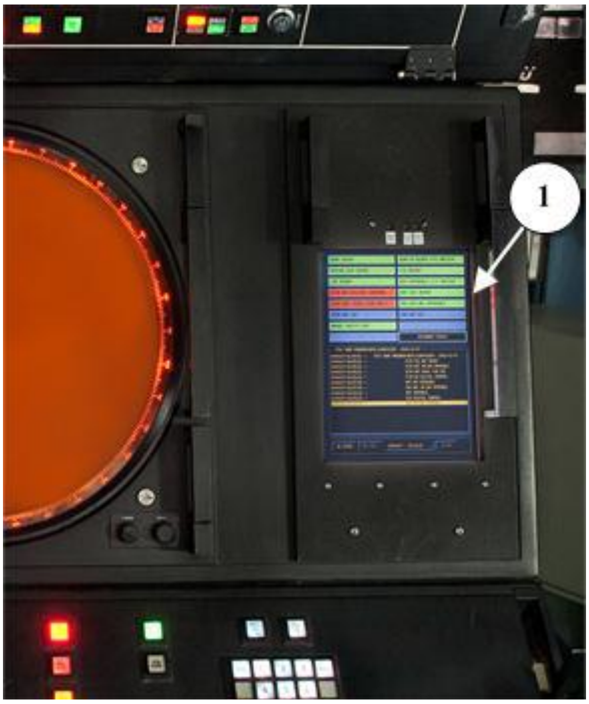

Figure 3-6: WCC-2 SMAP HMI

SMAP Functions

Target Track

16. The Target Track function manages and processes track data, received from WCP, in support of other functions within the SMAP. Target Track includes the following functions:

a. Establishes and maintains up to seven OFE tracks received from WCP.
b. Creates a track file and associated unique Track File Number (TFN) for each new track received from WCP.
c. Maintains an association between the WCP-assigned Target ID and the SMAP-assigned TFN to distinguish new tracks from updates to existing tracks.
d. Clears the track file and the associated TFN upon receipt of a Break Engage order from WCP following the clearing of all missiles-in-flight and launch operations for the track.
e. Updates track position and velocity data upon receipt of periodic track data updates from WCP.
f. Primary track data source and associated track position parameters used throughout SMAP are determined as a function of input range and/or angular positional data received from WCP.
g. In the absence of valid range data, the Target Track function computes track positional data based on angular position derived from range inputs from WCP and either a preserved or canned range solution.
h. Accepts track related commands from the WCP and sets or clears them as appropriate for the specified TFN.
i. Processes the Engageability Request message for the specified track from WCP and provides the related track data for use by the Target Engageability function.

Target Engageability

17. The Target Engageability function computes pre-launch SM-2 missile flight time to intercept and provides information on the engageability of targets with the SM-2 missile to WCP. This function performs pre-screening of target engageability by comparing target parameters with the maximum capability limits of the missile. For those targets that pass pre-screening, the SMAP computes the SM-2 outer contour and determines whether the target's path brings it within the outer contour boundaries. The engageability status reported to WCP is based on the SM-2 outer contour, as well as an evaluation of the target against the extreme limits of the SM-2 missile's capability. Cannot Comply (CANTCO) is reported if the target is not engageable with SM-2 missiles. Otherwise, SMAP computes Times-to-Wait (TW) to fire for intercept at the intersection points with the SM-2 outer contour (TW1 and TW2) and provides them to WCP. SMAP also provides to WCP the intersection points with the SM-2 outer and inner contours, and the GMLS Mk 13 Blind Zones. The last intercept point prior to entering a CAS/STIR Blind Zone and the earliest intercept point following exit from a CAS/STIR Blind Zone are also provided to WCP along with Diving Target engageability data.

18. Target Engageability includes the following functional and performance requirements:

a. Performs the engageability evaluation upon receipt of each OFE/Track Update message.
b. Performs the engageability evaluation upon receipt of each Engageability Request message.
c. Evaluates the engageability of a target as follows:
   i. Check target position, course, and speed to determine if it comes within the extreme limits of the SM-2 missile's capability;
   ii. For targets within the extreme limits, determine the target's path across outer and inner engageability contours. If the target's path brings it within the outer contour boundaries, the target is engageable; otherwise SMAP will declare CANTCO for the target.
d. For engageable targets, Target Engageability computes target engageability data for use by WCP in scheduling the launch and intercept.
e. Provides target CANTCO status and engageability data to WCP.

Executing Equipment Scheduler

19. The Executing Equipment Scheduler (EES) function monitors engagement events executed by WCP to support other functions within the SMAP. The EES includes the following functions.

a. Directs Launching System (LS) Control and Missile Initialization & Missile Orders functions to support missile initialization and launch.
b. Directs the SSCWI Control function to support illumination for terminal homing for the SM-2 missile in flight.

Launching System Control

20. The LS Control function monitors the GMLS Mk 13 and support missile launch activities. LS Control includes the following functions:

a. Supports SMAP system monitoring of LIC/LOC and Serialiser cards.
b. Monitors for MFON and Mk 13 Launching System Synchronised from the WCP, and GMLS status inputs for firing via the LIC/LOC card.
c. Supports missile firing as directed by the EES as follows:
    i. Monitors for Battery Activated and Missile Ready status indications from the GMLS following the issuance of the WCP generated MFON signal, and provides these statuses to the Missile Initialization and Missile Orders function.
    ii. Monitors for the Missile Fired and clearing of SM-2 Group On Rail indications from GMLS following missile initialization, and sets Salvo-In-Flight for SMAP and WCP usage.
    iii. Issues a Dud Order to the GMLS upon determination of missile initialization failure, detection of GMLS dud status, early clearing of the MFON signal from WCP, or if the missile fails to leave the rail after completing missile initialization.

Launch Doctrine

21. The Launch Doctrine (LD) function selects target data, calculates projected intercept time and position, calculates launcher stable aim point, and determines guidance mode to support an SM-2 engagement. Launch Doctrine includes the following functions:

a. Requests the extrapolation of target position and velocity from the Target Track function for use in LD computations.
b. Computes missile time-of-flight to intercept (T2).
c. Computes predicted intercept point based on T2 value computed.
d. Determines guidance mode for the SM-2 missile round to be initialized.
e. Computes launcher stable aim point to support the generation of pointing orders for GMLS Mk 13 by WCP.

Missile Initialisation and Missile Orders

66. The Missile Initialisation and Missile Orders (MIMO) function computes and outputs the SM-2 missile initialization message to the GMLS Mk 13, and provides a canned initialisation message to the Guided Missile Training Round (GMTR) during Auto Test. MIMO includes the following functions:

a. Receives and processes ships attitude and positional data inputs from the WSN-7B.
b. Generates the following missile initialization data upon receiving Battery Activated from GMLS:
    i. Initialized Missile Identification for identification during uplink
    ii. Command Destruct Code
    iii. Gravity Bias
    iv. Acceleration due to Gravity
    v. Variable Navigation Ratio
    vi. Direction Cosines
    vii. Initial Missile Velocity due to ship's motion
    viii. Firing Site Velocity due to earth's rotation
    ix. Target position and velocity parameters from the Launch Doctrine function transformed to missile coordinates
    x. Missile Guidance Mode (Home-All-the-Way, Midcourse Mode, Extended Midcourse Mode) as computed by the Launch Doctrine function
    xi. Quiet Mode depending on the availability and operability of the SSCWI to support uplink
    xii. Guidance Channel based on the primary channel of the assigned SSCWI.
    xiii. Missile time-of-flight to the predicted intercept point (T2) as computed by the Launch Doctrine function

xiv. Primary Command Point (PCP) from the Launch Doctrine function transformed to missile coordinates
xv. Vertical Launch Elevation Angle
xvi. Vertical Launch Command
xvii. Low Altitude Mode (uplink capable configuration only).
xviii. Slow Mode
xix. Time of Start Search Limit

c. Formats missile initialization data and encodes each word to enable the missile to detect transmission errors.
d. Monitors Missile Ready status for determining success or failure of the initialization transmission to the missile. MIMO automatically recomputes and outputs a new initialization message if transmission is determined to be a failure. MIMO terminates further initialization attempts for the missile after three failures.
e. Upon receiving Battery Activated from GMLS, MIMO generates a unique System Missile Identification (SMID) for use in tracking the missile.
f. Provides missile launch bearing and elevation angles to the Missile Track function for establishing initial missile position data.
g. Determines WSN-7B readiness by evaluating data validity bits contained within the navigation inputs.

Missile Link Control

67. The Missile Link (ML) Control function determines uplink requirements for the SM-2 missile, selects the SSCWI to support uplink, and formats, encodes and transfers the uplink message via WCP to the SSCWI for transmission to the missile. The ML Control function includes the following functions:

a. Generates target positional data indexed by SMID based on inputs from the Target Track function and determines requirements necessary to support range denied mode and the missile’s low air mode.
b. Generates salvo in flight and calculates time to go to intercept, time of start search and predicted intercept point data signals in uplink calculations.
c. In support of Range Safety Mode, ML Control computes missile and predicted intercept point proximity to the Missile Free Zone (MFZ) boundaries and automatic command destruct requirements.
d. Initiates and updates the Header Missile Identification (HMID) algorithm.
e. Selects the SSCWI to support transmission of the uplink message.
f. Determines target data, command point, command destruct, and missile supervisory uplink requirements.
g. Computes ships movement from the firing site, target position, and primary command point uplink data, and converts this uplink data to the Missile Crossrange-Downrange-Up (JRU) reference frame.
h. Determines message priorities for all missiles requiring uplink, at a given time, by the selected SSCWI.
i. Formats SM-2 uplink message data and encodes each word as required by the SSCWI and SM-2 missile.
j. Monitors SSCWI uplink status and determines uplink success/failure status. For uplink failures, ML Control generates and provides to the SSCWI the SMAP uplink test message to determine the SSCWI’s ability to support subsequent uplink transmissions.
k. Provides post-launch data for each missile in flight to WCP.
l. Resets (clears) the missile-in-flight status and deletes the corresponding SMID and missile file upon the completion of missile destruct processing.

Missile Track

68. The Missile Track function establishes, maintains and clears missile files and missile data for up to 20 SM-2 missiles, as controlled by SMID assigned by the MIMO function. The Missile Track function computes estimated missile positional data for use by the Missile Link Control function, and for output to WCP.

SSCWI Control

69. The SSCWI Control function monitors the operation of the two SSCWIs, and in uplink capable configuration, controls each SSCWI for use in support of missile uplink, in support of illuminator control for missile terminal homing requirements, and in support of uplink code testing. The SSCWI Control function includes the following functional and performance requirements:

a. Provides radiation and pre-uplink control requirements to SSCWI for support of missile terminal homing phase, missile uplink transmissions, and uplink code commands.
b. Selects the SSCWI channel to be used for terminal illumination and uplink, as a function of the channel number assignment made at missile initialization.
c. Uses the SSCWI Assignment Order message to control the SSCWI in support of SM-2 engagements. Messages from SMAP to the SSCWI are passed to the WCP, and forwarded to the SSCWI.
d. Monitors SSCWI statuses including Frequency Status, and Radiation Control Status.

System Status

70. The System Status Monitor (SSM) function assesses and reports the operational status of the weapon system to other SMAP functions and to WCP. The SSM function includes the following functions:

a. Assesses and informs other SMAP functions of the operational status of the SM-2 combat system.
b. Monitors interface communications for expected responses to assess specific system availability.
c. Evaluates the operability of the SM-2 navigation system and combat system equipment to conduct SM-2 engagements.

WCP Command/SMAP HMI Support Processing

71. The WCP Command/SMAP HMI Support Processing (WCP/HMI) function processes commands received from WCP, and generates orders based on these commands to other SMAP functions. This function also processes DX commands entered from the SMAP HMI. This function displays various status indications to personnel on the SMAP HMI. The WCP Command/SMAP HMI Support Processing function includes the following functions:

a. Processes Range Safety Mode order and provides to the various SMAP functions for unique Range Safety Mode processing.
b. Processes CWI Home Channel Number assignments and provides to the SSCWI Control function for establishing the primary frequency channel for CAS and STIR SSCWIs.
c. Processes Uplink Code Commands and provides to other SMAP functions for initiation of uplink code testing and SSCWI uplink capability determination.
d. Processes Missile Free Zone data received from WCP and provides computed data to the Missile Link Control function for Range Safety Mode processing to determine Command Destruct requirements.
e. Processes the WCC operator selection for SMAPs entry into Auto Test Maintenance mode, and provides it to the LS Control and MIMO functions for generating an Auto Test Compliance indication, and using a canned missile initialization message during the SM-2 initialization sequence.
f. Processes FCS assignments and GMLS Mk 13 assignment from WCP.

Data Extract

72. The DX function controls the recording of extracted data as ordered at the SMAP HMI. This function requires a PASSWORD prior to initiating the recording of extracted data or copying extracted data files to the RANSID. Extracted data (external input/output data, and interfunctional data), reported status, and operator alerts are used for analysis to ascertain SMAP performance.

Testing / Training

73. When requested by WCP, SMAP will support Auto Test Mode. When SMAP is ready to support Auto Test, SMAP sends an AUTO TEST Compliance status to WCP. While in Auto Test, all SMAP actions and responses, up through missile initialization, are the same as in normal tactical operations, except that no missile file is opened, and SMAP will provide a "canned" initialization message to the GMTR.

74. When Uplink Code Test is initiated by the WCC operator, WCP sends an Uplink Code Command to SMAP. SMAP complies with an Uplink Code Command by generating pre-uplink, uplink, radiate, and frequency test messages for the selected SSCWI. Once initiated, an Uplink Code Test completes in approximately 16 seconds. The WCC operator can also stop the test prior to completion by entering Uplink Code Test again while the test is in progress.

75. During training exercises that use the On Board Training System (OBTS), all SMAP actions and responses are identical to those during normal tactical operations.

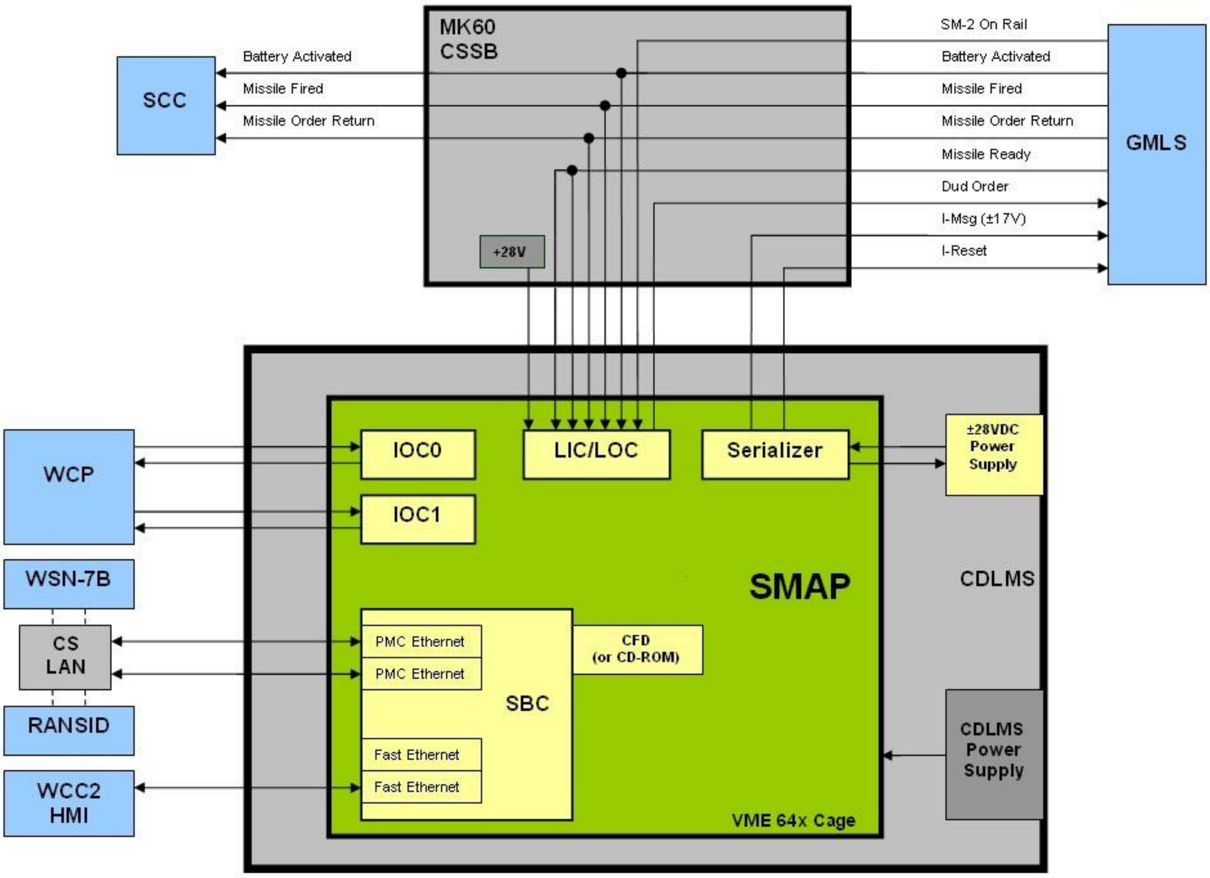

Figure 3-7: SMAP Block Diagram

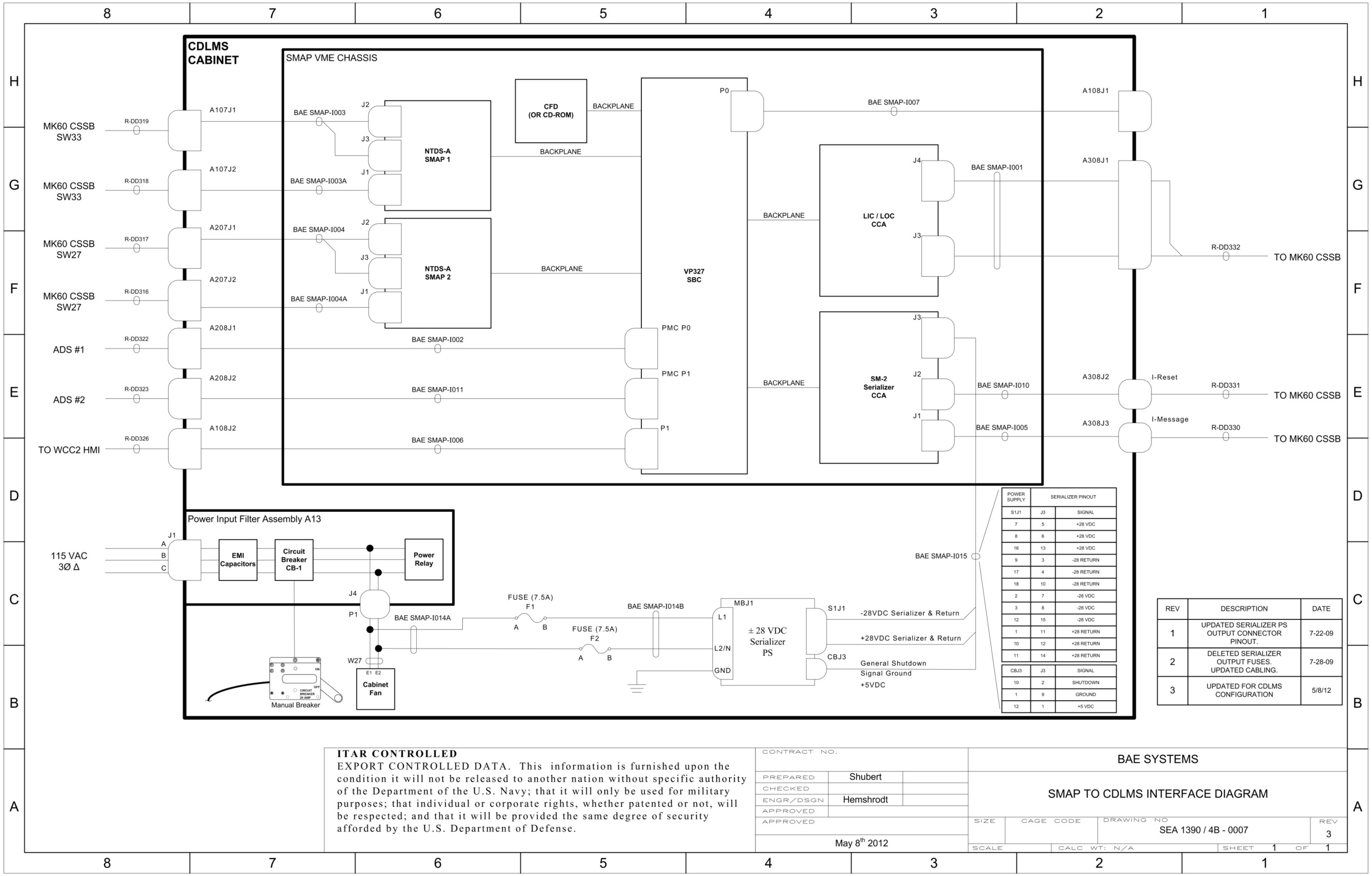

Figure 3-8: SMAP to CDLMS Interface

Blank Page

Chapter 4. HARPOON SHIP COMMAND LAUNCH CONTROL SYSTEM (HSCLCS)

References:

A.	SW261-HT-MMO-020	HARPOON WEAPON SYSTEM AN/SWG-1A
B.	SW265-HT-MM0-010	HSCLCS AN/SWG-1A HCC
C.	SW265-HT-MM0-020	HSCLCS AN/SWG-1A WCIP
D.	SW261-C7-SOM-A10	HARPOON OPERATORS MANUAL FOR FFGs

System Purpose

1. The purpose of the Harpoon Ship Command Launch Control System (HSCLCS), designated SWG-1A, is to provide an all weather, over the horizon, offensive weapon system against surface targets. The HSCLCS uses target data from external sources to produce fire control solutions, missile and launcher orders, and other control status functions required for Harpoon missile firing. The Harpoon missile (configured for "Tartar" launch) is designated RGM-84.

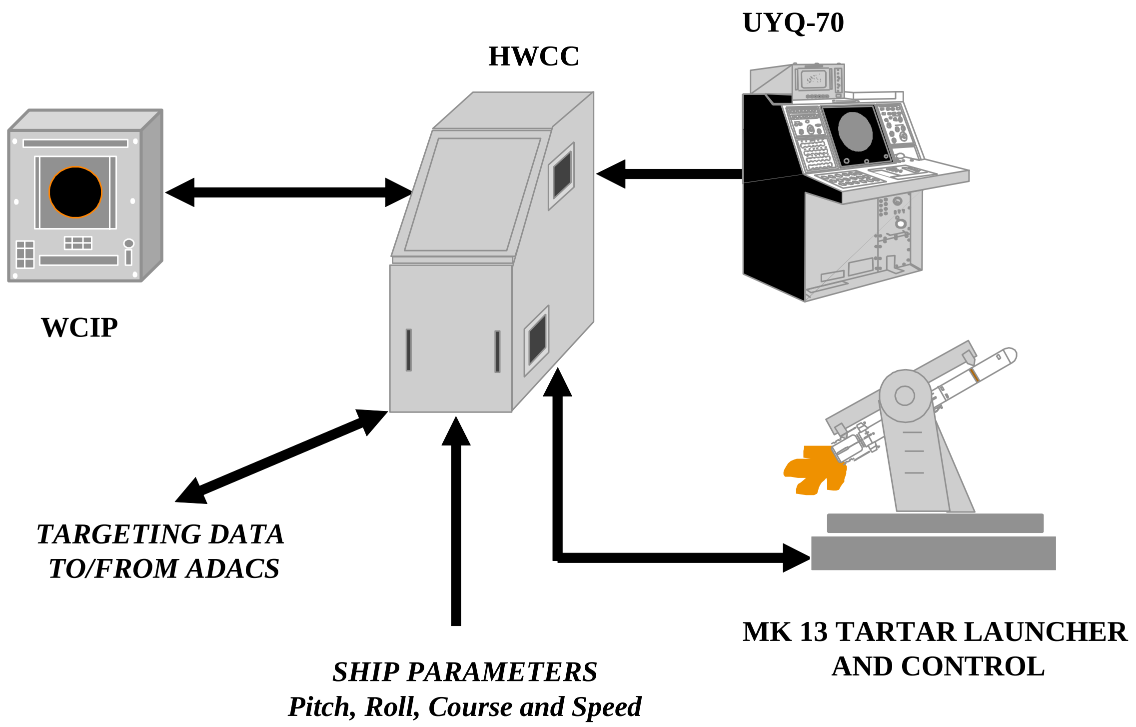

Figure 4-1: Harpoon Weapon System Functional Diagram

Major Equipment and Functions of the HSCLCS

Weapon Control Interface Panel (WCIP)

2. The WCIP is located in the CIC on the immediate right of the FC4-5 Operator and above the CIWS RCP. It acts as the primary user interface for the Harpoon launch system. The WCIP uses a gas plasma PPI display to display target and background shipping data, missile flight plans and system advisories and alerts. The WCIP allows the operator to:

a. manually enter data locally;

b. change flight profiles;

c. enter waypoints;

d. select missile fuse modes;

e. enter and monitor launcher and missile status;

f. select search patterns for the missile seeker; and

g. launch the missile.

Figure 4-2: Harpoon WCIP

Launch Modes

Simultaneous Time on Top (STOT)

3. In this mode, the firing Ship plans for all missiles launched from that Ship to hit the target at the same time. To achieve this, missiles will take separate routes and use different waypoints with the end goal of a simultaneous strike on the target.

Designated Time on Top (DTOT)

4. In this mode, all launched missiles will hit the target at a specified time. This mode is used when co-ordinating strikes with Ships in company.

Ripple Fire

5. In this mode, all selected missiles will be launched in sequence with minimal time between launches.

Selectable Preset Modes of operation:

1. High altitude fly-out range
    a. Missile will cruise at a preset altitude until the predetermined range has been reached.
    b. Range value can be changed by the operator
    c. Ranges Min & Max are limited
2. Pre-search skim altitude
    a. The missile will cruise at a sea skim altitude prior to search.
    b. Operator can select NO PRESEARCH SKIM which will result in a higher cruise altitude.
    c. The system may automatically select NO PRESEARCH SKIM where an immediate seeker turn-on is required.
3. Trajectory waypoints
    a. Used for deceptive manoeuvres or for bypassing background shipping, third parties, land masses and obstructions.
    b. Is also used to achieve STOT and DTOT attacks.
    c. Up to 8 waypoints can be used
4. Search pattern
    a. Fan Search Pattern
        i. The Fan Search Pattern is a fan-shaped search area which the seeker covers by varying the search sweep angle and search range
    b. Rectangular Search Pattern
        i. a corridor-type search pattern with a rectangular search area
    c. Bearing Search Pattern
        i. Is used when the target range is unknown or unreliable
    d. Elliptical Search Pattern
        i. searches an elliptical shaped area which the seeker covers by varying its search sweep angle and search range
    e. The selected search pattern type is displayed under the SRCH PATT header in the RSR Status Area
5. Attack mode

a. Pop Up

b. Sea Skim

Re-Attack

1. In addition to these modes the RMG-84 has a reattack function.

2. The launched missile will reattack if it does not acquire the target or is deceived by countermeasures on the initial pass.

3. This function is only set when the WCIP operator selects it.

Harpoon Weapon Control Console (HWCC).

6. The HWCC is located in RICER. It provides power, data processing, and interface functions for HWS operation. It receives own-ship information, target data that has been entered at the WCIP or remotely from ADACS and, with additional local data entered at the WCIP, can compute a fire control solution on a target utilising up to four harpoon missiles. It monitors the HWS and associated systems equipment status, and issues missile and position orders via the Combat Systems Switchboard (CSSB) to the GMLS Mk 13 launcher. The HWCC is composed of the Data Processing Computer (DPC) and the Data Conversion Unit (DCU).

Figure 4-3: The Harpoon Weapon Control Console

Data Processing Computer (DPC)

7. The DPC is a special purpose digital computer that runs the operational software that is contained wholly on an EPROM, i.e. firmware. RAM is installed, as well as an electrically erasable PROM (EEPROM) which stores missile parameters and configuration, even after power is removed. Since all missile parameters are stored on the EEPROM, if the EEPROM or its circuit card is replaced, all missile parameters including load-out information must be re-entered. The DPC communicates with the WCIP (also referred to as the Graphic Display System -GDS), data extraction computer (if fitted), missile and DCU. The installed program performs the following functions:

a. Track Processing;

b. Engagement Planning;

c. Missile Initialisation;

d. Launcher Stabilisation;

e. Launch Sequencing; and

f. Display Casualty Engagement Processing.

Data Conversion Unit (DCU)

8. The DCU provides signal conditioning and distribution, including conversion to and from synchro format, discrete 5 to 28 V DC conversion (and vice-versa) and synchronisation. The DCU communicates with the WCIP (buttons and indicators), ADACS, synchro devices (ship's parameters, GMLS) and DPC. Data exchange between the DPC and the DCU is conducted over a 16-bit common input/output bus. The DPC controls the timing and the flow of data on the bus. On-line monitoring is performed to validate the transfer hardware with errors resulting in fault codes being displayed at the WCIP.

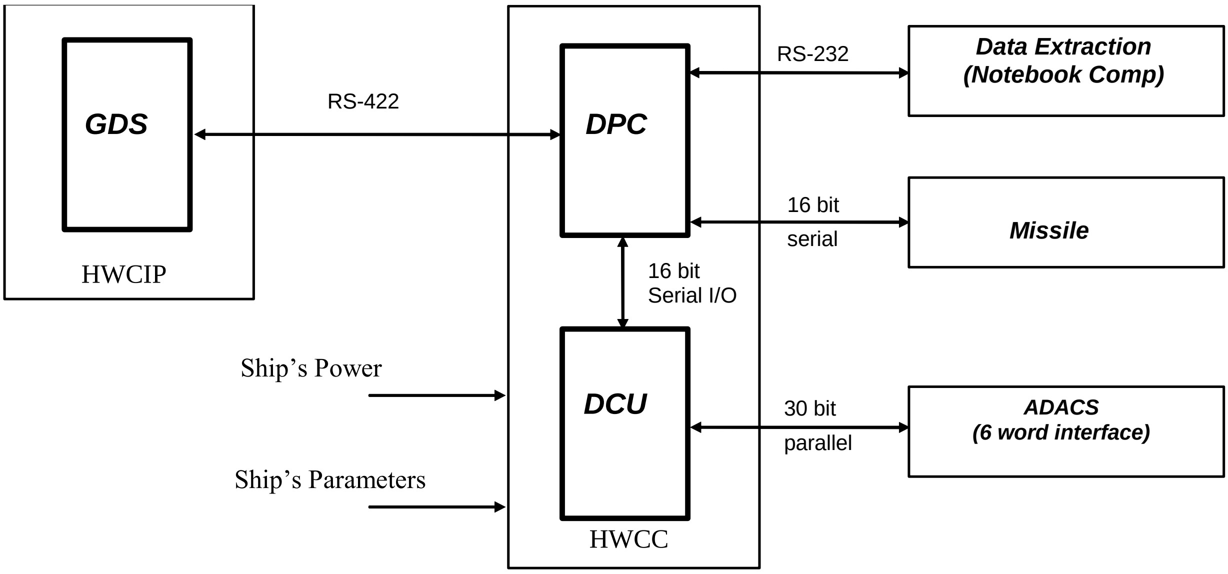

Figure 4-4: HWCC System Interfaces

Combat Systems Switchboard (CSSB)

9. The CSSB provides the central interconnecting point for the HSCLCS as part of the overall combat system. It contains the Action Cut Out (ACO) switches and remotely controlled switches (R2LS) used to allow the HSCLCS to share the launcher with the Mk 92 FCS. CSSB Cabinet C switches 36 and 38, both labelled LS ASSIGN, are used to switch signals between the GMLS Mk 13 and missile, and the FCS, be it Mk 92 or the HSCLCS. On recognition that a Harpoon missile has been loaded to the launcher rail, WCP generates the Harpoon Load Order which causes switches 36 and 38 to rotate to the Harpoon position. Conversely, on notification from the HSCLCS that the engagement is "complete" or broken, the Mk 92 Control Order is generated to rotate switches 36 and 38 back to the Mk 92 position. If required, the Harpoon missile can then be downloaded by WCC operator actions.

Guided Missile Launching System (GMLS Mk13)

10. The GMLS is normally remotely controlled and provides stowage and launcher facilities for Harpoon and Standard missiles. In addition, GMLS provides local and remote control for on-loading, testing, Casualty Firing, jettison, and off-loading of Harpoon missiles. Note that in normal (remote control) operations, GMLS is controlled by Mk 92, which retains control up to the point that a Harpoon missile has been positively identified on the Launcher rail. Thus loading of Harpoon missiles is normally under the control of Mk 92, and/or the WCC Operator.

Guided Missile Training Round (GMTR)

11. The GMTR consists of the Inert Guided Missile Mk 59 and the Guided Missile Simulator Mk 63. The simulator electrically reproduces operational characteristics and functions equivalent to a tactical missile for testing and training purposes. Previously, the GMTR could be *manually* switched between SM-1 and Harpoon simulation modes, using a rotary switch on the simulator body. With the upgrade to SM-2, the GMTRs are now dedicated to either SM-2 or Harpoon/SM-1 and cannot be switched.

12. The Mk84 Block 1-J Harpoon is in service and available in varied configurations to suit:

a. P-3 Orion and FA-18 Hornet in AGM-84-J configuration;

b. Adelaide class Frigate in RGM-84-J (Tartar) configuration;

c. Anzac class Frigates in RGM-84-J (Canister) configuration; and

d. Collins class Submarines in UGM-84-J (Capsule) configuration.

13. The Harpoon inventory is currently undergoing upgrade to the Mk84 Block 2-L variant. This variant provides greater littoral accuracy through the incorporation of GPS technology. The upgraded version is initially limited to Canister variant and will be progressively rolled out to other platforms as they gain the ability to utilise the enhancement.

14. Harpoon is intended to be incorporated on the new Hobart class Air Warfare Destroyer in the Canister configuration.

Major Interfaces

ADACS/DCU

15. External targeting information from the Combat System can be passed to the HSCLCS across this interface. The ADACS/DCU interface consists of an input channel and an output channel, each consisting of data and control lines. The DCU is only equipped with 30 data lines and looses the least significant bits of the 32 lines provided by the ADACS. ADACS initiates all data transfers. Data is transferred in two three word groups. A checksum is included in the last word of the second group. This is used for error checking purposes

at the receive side. Errors in transmission cause a fault code to appear at the WCIP. If ADACS cannot raise the DCU after five consecutive attempts, the alert CANNOT DESIG HARPOON will be displayed at the AWO console.

DPC/WCIP (GDS)

16. Target engagement and missile planning data may be entered via the WCIP for DPC computation of an acceptable fire control solution. Information from external sources (i.e. ADACS) supplied to the DPC also needs to be displayed at the WCIP. The DPC communicates with the WCIP (GDS) through an RS422 serial I/O interface. Should this interface fail, Display Casualty Mode can be selected allowing limited engagements to be carried out.

DPC/Missile

17. All data required to program the missile to execute its flight plan is passed across this interface. The DPC controls data transfer with the missile over serial input and output data lines. The DPC groups data words in blocks for transmission to the missile. Each block consists of a command word followed by a variable number of data words, and a checksum word which is only transmitted if data words are sent. The missile will respond by sending a "good data" word after it has received a data block correctly using timing signal provided by the DPC. If requested by the DPC the missile will respond with a missile status word in lieu of the checksum word.

Blank Page

Chapter 5. MU90/MK 46 Shipborne Torpedo System (STS)

Introduction

1. The entire STS consists of the Torpedo Interface Unit (TIU), Modified MK 32 Torpedo Tubes, Portable Presetter System (PPS), SPS, and Modified Launcher Junction Box.

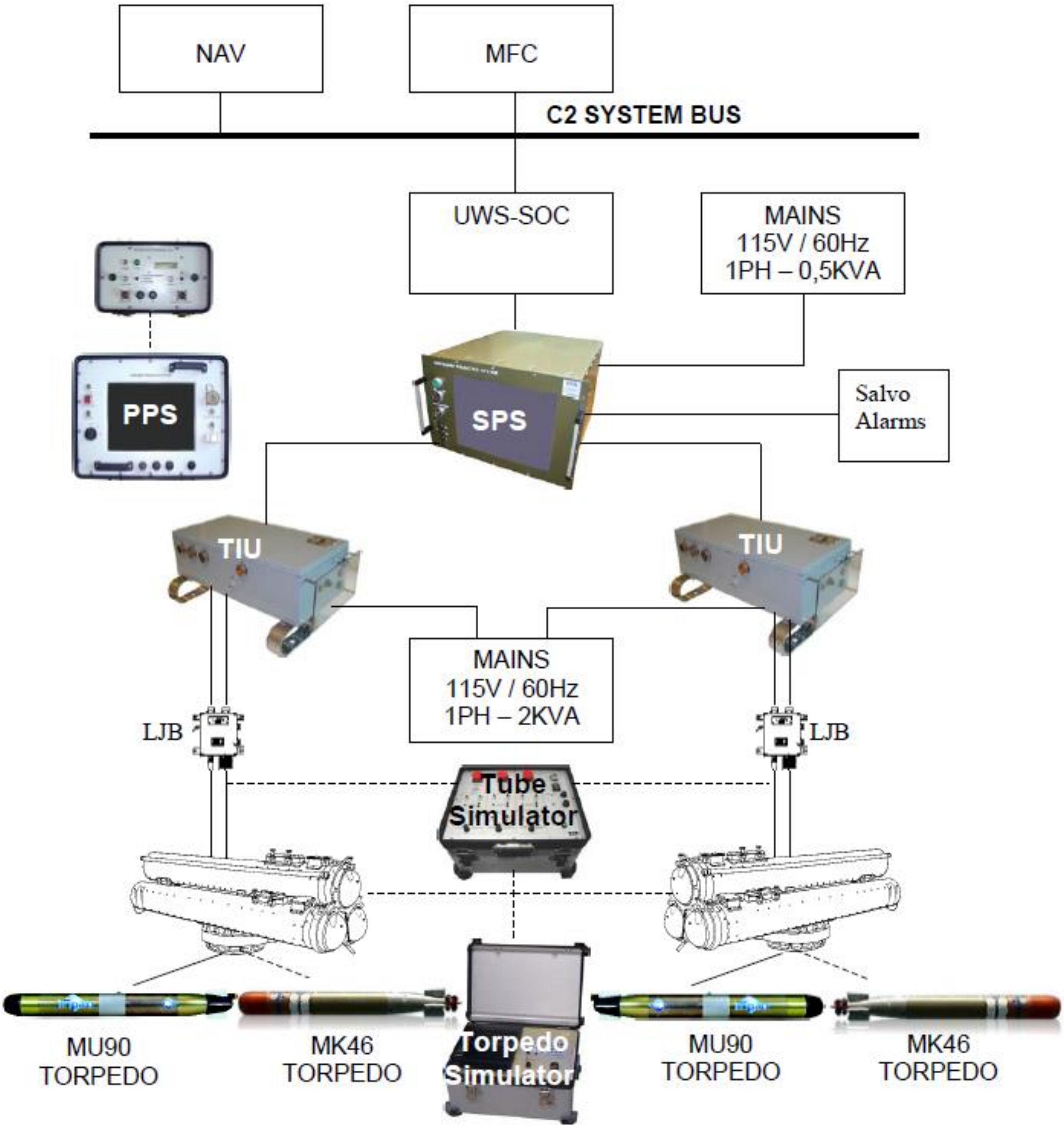

Figure 5-1: FFG STS Block Diagram

Shipborne Presetter System

2. The MU90 SPS is used to control the firing of torpedoes from the modified MK 32 surface vessel torpedo tubes as part of the MU90 Shipborne Torpedo System (STS). This system allows for the firing of the MU90, the new LWT, as well as existing MK 46 LWTs.

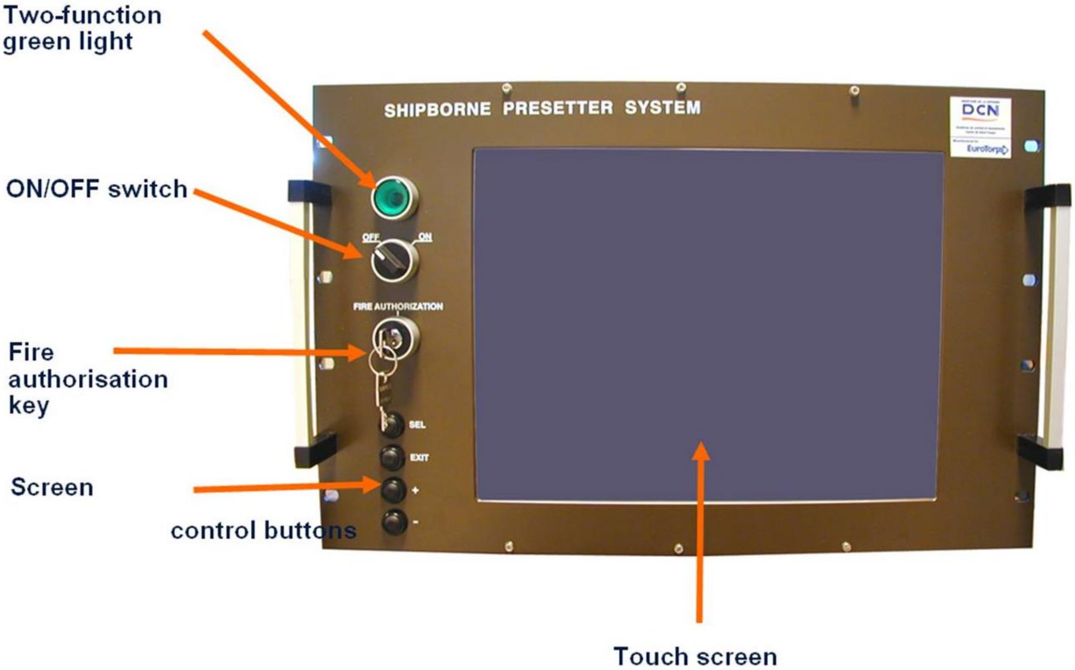

Figure 5-2: SPS Front Panel

3. The SPS is the touch screen man-machine interface to allow for the firing from the Operations Room and replaces the MK 309 Panel. When the SPS is switched on it runs a self-test, if it passes the self-test then the task choice window is displayed. The SPS supports three operating tasks:

a. Operational—In this state the SPS is actually connected to the TIU, LJB, the tubes and torpedoes. This is the mode to launch a torpedo. This is the default task when the SPS is initiated, after a 10-second countdown, or after pushing the appropriate pushbutton on the main menu.

b. Training—In training the TIU, tubes and torpedoes are simulated by the SPS. The training mode allows for five customised training scenarios, which can and should be modified to suit operator's level of experience. The training mode allows for the operator to input in excess of 100 modifications to the already existing training scenarios. The training mode is accessed by password after pushing the appropriate pushbutton on the main menu.

c. Master—This mode allows for the configuration of the system, such things as the types of torpedoes loaded, ship data and TIU labels can be entered. This mode is password protected.

Operational Mode

4. The operator must be in the Operational Mode to fire a weapon. When selected this mode will give the operator access to two windows of operation, supervision and launching.

5. The supervision window, which will be displayed automatically, will show the status of the TIU's, SPS and detailed information on the Torpedoes. The information will be displayed when the appropriate button is selected on the screen.

6. The launching window, which can be selected by pushing the launching button on the top right of the window, will allow the operator to input all data required to fire a torpedo. It will also be the window where the operator commences the launching sequence and launches the weapon.

7. Until the SPS has input from own-ship's navigation system and sonar, all information is to be entered manually. The minimum data required to obtain a firing solution is own-ship's Cse/Speed and target bearing. Once the relevant own-ship and target data is entered, a torpedo is then assigned to the target by selecting the desired torpedo from the Engage sub window. This will then allow the operator to enter the torpedo presets for the MU90 or MK 46 selected.

8. Once the torpedo presets have been entered, selecting the Power Torpedo button, which will commence the Activation Battery sequence, which will inturn allow the presets into the selected torpedo, this commences the firing sequence. To fire the torpedo the Fire Authorisation key is to be inserted into the SPS and turned to the fire position. Once this has been done, the operator can then fire the torpedo by pressing the Fire button for two seconds.

Training mode

9. The Training mode gives access to three windows of operation, supervision and launching which are the same is in the Operational mode, and the training window. The training window allows for the selection of one of five customised training scenarios, which can allow for input of excess of 100 modifications, there is also one default scenario. The customised scenarios can also be changed in this window. Once the appropriate scenario is selected, then the operator can use the supervision and launching windows as they would in Operational mode, however all firings are simulated and there is no communications between the SPS and TIU.

Master mode

10. The Master mode is primarily used to enter the types of torpedoes loaded and in which tubes they are located. In this mode own-ship particulars are also entered. The master mode is password protected.

Torpedo Interface Unit

11. The Master mode is primarily used to enter the types of torpedoes loaded and in which tubes they are located. In this mode own-ship particulars are also entered. The master mode is password protected.

12. Each ship is equipped with a port MK 32 SVTT and a starboard MK 32 SVTT. Each SVTT is associated with one TIU. Both TIUs are intended to ensure the interface between the Modified MK32 tubes, equipped with MU90 or MK46 torpedoes, and the Shipborne Presetter System (SPS).

13. The TIUs carry out the following functions:

a. Preheating of the MU90 torpedoes.

b. Allows the direct connection of the PPS for firing a MU90 torpedo in Emergency mode. In this instance the TIU electronics are not used.

c. For MK46 torpedoes, converts the serial preset data commands from the SPS to the synchro signals supplied to the MK46.

d. Detect the presence of MU90/MK46 torpedoes to be sure that the torpedo present in the tube is the same that is written in the Master mode, to permit the selection by the SPS of a torpedo, and to ensure the preheating 115V.

14. The TIU receives the following commands from the SPS:

a. Power supply on,

b. Barrel selection,

c. Torpedo type selection,

d. Preset data, and,

e. The command to activate the launch barrel solenoid valve.

15. The TIU sends the SPS the results of each step of:

a. Its own self test,

b. The launch barrel status,

c. Information on the type of torpedo resident in each barrel, and

d. The MK46 torpedo squib status.

16. The TIU:

a. Echoes the preset messages sent to the MK46 torpedo,

b. Activates MU90 crossover battery,

c. Activates MK46 Gyro squib,

d. Provides information failure during MK46 presets, and,

e. Provides launch completed (barrel empty) information.

Portable Presetter System (PPS)

17. The PPS allows for firings to be conducted if communications have been lost between the SPS in the Operations Room and the Torpedo Interface Unit. The PPS is connected directly into the TIU and has similar functionality to the SPS. The PPS will only preset MU90 weapons, MK 46 weapons cannot be preset from this device. However the launching of the both weapons will need to be done via the emergency release lever on the MK 32 SVTT.

Figure 5-3: Portable Presetter System