The most important thing we build is trust

Airborne DF System for SAR / CSAR
Presentation Overview

Presentation aims to provide:

- An overview of the roles of SAR and CSAR modes in rescue operations
- A description of the rescue system
- A description of the system components
- A description of CSAR operation and missions
- Overview of operator interface to controller
- Installation drawings for DF and Controller
SAR Missions

Search and Rescue (SAR) operations conducted:

- To survivors using swept-tone beacons on standard SAR frequencies of 121.5MHz and 243MHz
  - These beacons only enable AME (L/R homing or DF steer)

- To survivors using beacons on the COSPAS/SARSAT network at 406.025MHz (and now 406.028MHz, 406.031MHz etc.)
  - Enable AME as well as receipt of a data burst that may contain GPS positional information for the survivor

- To victims using conventional transceivers in the V/UHF band
  - These transceivers only enable AME, but AM or FM voice comms can assist in the rescue
CSAR Missions

• Combat Search and Rescue (CSAR) operations conducted:
  
  • When the survivor is in enemy territory
    – If they wish, survivors do not transmit RF energy until requested to do so by the rescue aircraft
    – All RF transactions are short bursts
    – Survivor beacon is coded and only responds if the rescue aircraft sends the correct code

  • CSAR provides several additional facilities to the survivor:
    – Determination of the range from rescuer to survivor
    – Data messaging facilities
    – Voice communications
General characteristics of the Rescue system:

- Provides SAR AME in the 30 to 470MHz band
- Provides SAR message decoding for COSPAS/SARSAT messages
- Provides SAR message decoding for Marine DSC messages
- Provides CSAR line-of-sight (LOS) AME/DME interrogations in the 225MHz to 300MHz band for TAG (Terminal Area Guidance)
- Provides CSAR LOS Data interrogations in the 225MHz to 319.975MHz band for TAC (Terminal Area Communications)
- Provides LOS unsecured half-duplex AM voice communications in the 225MHz to 400MHz band
- Enables mission data-load via USB key
- Operation with CSAR Survivor Beacon types:
  - PRC112B\B1\G Hook (range/bearing & GPS radios)
  - URX3000 (GPS radios)
  - PRC434 (Tadiran; TBC)
- Control panel occupies small instrument panel real-estate
TAG (Terminal Area Guidance)

The airborne system sends a PN sequence to the survivor (downlink interrogation), and if the survivor beacon recognises its unique identifier code, it returns a PN sequence (uplink response) to the aircraft. The V12 system measures the slant-range to the survivor and the DF935 measures the angle of signal arrival and the CH935 controller displays these to the user.

- **Burst Interrogation mode:** Single interrogation burst to survivor (compatible with older CSAR beacons, Tadiran beacon etc.)

- **Continuous Interrogation mode:** The aircraft sends repeated bursts of PN data to the survivor. Typically used when aircraft is in closer proximity to survivor (compatible with older CSAR beacons, Tadiran beacon etc.)
CSAR Missions: Major Operational Modes 2

TAC (Terminal Area Communications)

The airborne system is able to send messages (pre-stored or entered) to the survivor in encrypted form, and receive messages back from the survivor radio displaying these to the user via the CH935 controller.

• **Unsolicited Uplink:** The survivor is able to enter a message into his radio beacon, and send this to the aircraft at any time. For the aircraft to receive the message the system must:
  – The same Frequency as the survivor radio
  – Have the same 6 digit survivor code
  – Have the same 14 digit alphanumeric message encryption key
  – Be within LOS range (or have relay within LOS range)

• **Solicited Uplink:** The aircraft is able to initiate the retrieval of stored messages from the survivor radio. For this to occur, the same 4 conditions as for an unsolicited link are required.

• **Solicited Downlink:** The aircraft is able to send a message to the survivor (typically this is a Rendezvous message). Again, the same 4 conditions are required.
CSAR Missions: General Operation 3

TAC Automatic Message Relay

The airborne system may be set to relay messages between the survivor and another system automatically without the relay displaying the messages. This is used to extend messaging range.

1. PLS ID # 111111 interrogates survival radio ID # 333333
2. PLS ID # 222222 (Relay Mode) receives, stores and rebroadcasts the interrogation (Source ID # 111111, Destination ID # 333333)
3. 112G ID # 333333 receives the interrogation and responds
4. PLS ID # 222222 (Relay Mode) receives, stores and rebroadcasts the interrogation (Source ID # 333333, Destination ID # 111111)
TAC Manual or Automatic Message forwarding

- Allows the user to view and distribute data from the survival radio to another PLS interrogator device.
- Manual forward option requires user interface for each message to be forwarded.
- Auto forward will automatically forward any RF traffic from the survivor to the desired recipient with minimal user interface.

**Additional PLS Aircraft**
The Rescue aircraft will receive the messages from the Forwarding aircraft.

**Forward Mode**
The Survival Radio message is viewed and the user has the option of either Manually Forwarding the message, or elected to Automatically Forward all messages to an additional PLS equipped aircraft.

**Survival Radio**
Survival Radio sends message
Installed Equipment:
1: Required for both SAR and CSAR missions

- Cobham 935-11 Tactical Direction Finder
  - Self-Contained SAR DF system with CSAR capability when Cubic V12 interrogator attached
  - 5 Parallel dedicated SAR receivers, 2 with data decoding
  - 1 Additional receiver operating 30 to 470MHz
  - Sonobuoy, multi-beacon, and On-Top modes
  - Full DSP-Based implementation
    - Software Radio concept
    - Flexible Design

- CH935 Controller (with optional RH150-13 Remote controller)
  - Small Instrument-Panel installation space requirement (optional Remote looks identical)
  - Colour, NVG-compatible display
  - Control of 935-11 and Cubic V12
  - Auto detection of LRU presence to enable SAR or CSAR or both modes
  - Permits connection of USB socket for data load
Installed Equipment:
2: CSAR missions (can be ‘Role-Fit’)

- **Cubic V12 PLS Interrogator**
  - Manufactured by Cubic Corp. USA
  - Interoperability with all U.S. deployed combat survival radios including the PRC-112B/G and PRQ-7 (future)
  - Interoperability with Tadiran beacon in TAG & TAC modes
  - Extended and improved, high quality two-way voice covers entire 225 to 400 MHz UHF Band
  - Makes use of single, separate, antenna for transmission / reception of DME and TAC information
  - System enables ‘Role Fit’ for this LRU

- **PLS Antenna**
  - Cobham type number
  - Passive UHF blade e.g. Cobham 16-1
System Configuration

- DF is interfaced via RS422 control
  - System control and display is via CDU type CH935
  - Remote controller (RH150) is optional fit
  - Interrogator only required for Platforms performing CSAR mission (Role Fit)
  - Facility for Mission Parameter loading via USB
Typical CH935 operating interface 1: START-UP

Start-up

- At switch-on, the CH935 checks whether both a DF and a V12 interrogator are fitted
- If both LRUs are detected, the operator will be presented with a screen similar to the below, to enable him to choose whether he wishes to conduct a SAR or a CSAR mission.
- If the installation includes a USB socket, then at any time, the user may insert a USB key containing the mission and survivor data. If a key is inserted, the CH935 will automatically upload its contents

![Screen shot of CH935 interface showing SAR and CSAR options]
If the user selects SAR mode (up-arrow at start-up), he will be presented with several soft-options including ‘STATUS’; ‘BIT’; ‘SAR_DF’; and ‘SET-UP’.

The typical operational mode would be ‘SAR_DF’, and if selected, the user is presented with a screen similar to the below:

Via this screen, the user can:
- View the signal-present status of all six DF receivers
- View the angular bearing of all receivers, and the digital bearing for the receiver in-focus
- View an indication of the signal strength and bearing quality for the receiver in-focus
- View the Age of the bearing in-focus
- View the frequency of the receiver in-focus
- Change the in-focus receiver and its channel
If the user selects ‘STATUS’, he can then choose PROG and be able to set-up the receivers in the DF. The user will be presented with a screen similar to that shown below.

Via this screen, the user able to:

- Set the frequency of all six DF receivers and their associated Channels
- Set the modulation mode of receivers 0, 1, 2, and 3
- Set the audio status of receivers 0, 1, 2, 3
- Set the squelch status (open, level squelched, noise-squelched) for receivers 0, 1, 2, 3
- Set the bandwidth of receivers 0, 1, 2, 3
- Set whether the receivers are active (on) or not

Viewing the DF SAR Receiver Status

The user can view the status of all DF receivers via the STATUS screen.
Typical CH935 operating interface 4: SELECTION OF CSAR MODE

- If the user selects CSAR mode, he will be presented with several soft-options including ‘Set-Up’; ‘PLS’; BIT; Zeroize (to delete all Keys and ID codes in the V12)
- The typical operational mode would be ‘PLS’ and if selected, the user is presented with a screen similar to the below
- Via this screen, the user can:
  - Select the target CSAR survivor
  - Change the channel for the mission (frequency then displayed)
  - View the signal-present status of all six DF receivers and the V12 interrogator receiver
  - View the bearings from the Tuneable (CSAR) receiver, as well as those from all DF SAR receivers
  - View an indication of the signal strength and bearing quality for the CSAR receiver’s last Reception
  - View the Age of the CSAR bearing
  - Toggle the mode between TAC/TAG
  - Burst-Interrogate the survivor by pressing the ‘EMG’ button and similarly activate Continuous-Interrogate (double-press of ‘EMG’ button)
• The CSAR system requires settings for the V12; for the survivor radios for the mission; and for any potential 3rd-party (for when relay mode is used)

• If ‘Set-Up PLS Interrogator’ is selected, the user is presented with the V12 settings and has the option to view / change:
  - Frequencies in each channel (up to 10 channels)
  - V12 squelch setting (off / normal)
  - V12 audio status (off / on)
  - 6-digit I.D. for the on-board V12
  - Status of Relay mode (on / off)
  - Status of Message Auto Forward (on / off)

• The V12 SW version is also displayed on this screen

• The user is then able to access set-up screens for the ‘Mission’ (Survivor data and any 3rd party ‘RAC’ data)
The CSAR survivor data is usually loaded via USB key, but this data may be viewed / edited via this screen, accessed from the ‘Mission’ soft key.

Parameters associated with each survivor are:

- Survivor 6-digit I.D.
- Survivor 14 digit Encryption Key
- Survivor Call Sign
- Type of Radio in use by the survivor (e.g. PRC112G, URX3000, PRC434G)
- Access messages received from the survivor (can also be accessed at the PLS screen)
When the PLS is used for Manual or Auto FORWARD mode, it is necessary to enter the detail of the 3rd party to/from whom messages will be routed. This data is also loaded via the USB, but:

Selection of ‘RAC Set-Up’ enables the user to:

- Select the specific 3rd party required (1 of 10 possible)
- Set the 6-digit I.D. of the selected 3rd party
- Set a Call-Sign for the selected 3rd party
- Select whether ‘Auto-Forward’ is active for the selected 3rd party (note that the software automatically only permits one of the 3rd parties to have auto-forward selected at a given time)
Two types of data from the survivor can be displayed:
- Text Messages from the survivor
- Situation Reports from the survivor

The last 20 received messages are saved in the controller.

Selection of ‘SVR_Msg’ enables the user to:
- Display the survivor I.D. (Alias name and 6-digit)
- Display of Key used
- Display the Lat / Long / Alt / Time (if available)
- Display the Text message from the Survivor (scrolls when selected)
- Manually forward or reply to the message

Selection of ‘Situation’ enables the user to:
- Display the survivor I.D. (Alias name and 6-digit)
- Display the survivor’s opinion of his status i.r.o. injuries etc
- Display the survivor’s opinion of landing conditions
- Display the time since sit-rep received
- Manually forward or reply to the report
If TAC mode is selected, pressing the ‘EMG’ button will cause the message compilation screen to appear. Via this screen the user is able to:

- Compile Text Messages to send to the selected survivor
- Select the required survivor by means of the survivor index (alias then displayed)
- Use free-text or select from a list of pre-stored messages to send to the survivor, and edit these before sending (up to 10 pre-stored messages loadable from USB)
- Send the message by pressing the ‘EMG’ Button (sent messages can be saved in the canned list)
Installation drawing: DF935-11
Installation drawing: CH935
Installation drawing: V12  (Courtesy Cubic Defence Applications, Inc)
ANY QUESTIONS?
935DF-Series General Features

- Fully Integrated Solution for SAR applications, requires V12 LRU for CSAR
- Contains 6 separate receivers
  - Tunable Covers 30MHz to 470MHz
  - Guard Rx1: 121.5MHz and Aux. (May be tuned 120 to 130MHz)
  - Guard Rx2: 156.8MHz and Aux. (May be tuned 150 to 160MHz)
  - Guard Rx3: 243 MHz and Aux. (May be tuned 240 to 250MHz)
  - Guard Rx4: 156.525 MHz (DSC)
  - Guard Rx5: 406.025 MHz (SARSAT) (Aux channel may be tuned to 407MHz)
- Data Decode facility for Marine DSC Channel
- Data Decode facility for COSPAS / SARSAT Channel
- Can take bearings on 6 receivers simultaneously
- OTPI algorithm
- Sonobuoy mode available
- Multibeacon DF facility for up to 3 SARBE-7-type V/UHF beacons
- Can externally load full DSP code to the DF
- DF forms fully programmable audio matrix for all 6 receivers plus interrogator-audio (if fitted)
Dedicated Controller CH935 General Features

• Based on Proven Chelton TETRA controller
• Colour screen with NVG compatibility
• Full Remote control and display unit available (panel appearance identical to master controller to ease training)
• Keypad for message text entry
• Navigation and soft keys for ease of function selection
• Display of both DF information (in 360 degree or Left-Right formats) and PLS range / message information
• Auto-sense for LRU presence (adapts screen-displays dependant on system LRUs present)
• Facility for connection of USB socket for ease of mission data-loading
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