



**COMBAT SAR
AID OR OBSTACLE
TO SAFE RECOVERY?**



**A COMPARISON OF
COMBAT & PEACETIME
SAR TECHNOLOGY**

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COMBAT SAR

AID OR OBSTACLE TO SAFE RECOVERY

INTRODUCTION

1. The proliferation of Combat Search & Rescue (CSAR) systems over recent years has created a view, specially among military operators, that overt, non-CSAR technology is somehow inferior and unsuitable for the demands of military rescue operations. Clearly, in some military scenarios, the use of covert detection and recovery is necessary, indeed, essential; however, in less extreme military and law enforcement scenarios, the use of non-covert civil SAR technology and procedures might not only be appropriate but may also positively enhance a survivor's prospects of early detection and safe recovery.

AIM

2. The aim of this paper is to examine the benefits of civil SAR technology and to compare its operational merits with the capabilities of typical Combat SAR systems.

SAR SATELLITE AIDED TRACKING

3. In the mid-1980's, a multi-national satellite system was deployed which, for the first time, provided a global Search & Rescue (SAR) capability to detect, identify and locate individuals in distress. This SAR Satellite Aided Tracking (SARSAT) system was configured around a new, dedicated frequency (406 MHz) which, unlike the traditional international and NATO distress frequencies, featured a data message which could uniquely identify a transmitting beacon and, moreover, include position co-ordinates derived typically from a GPS receiver. The Techtest Series 500-27 emergency beacon features an integral GPS receiver for this purpose.
4. The current configuration of SARSAT satellites provides near-instantaneous alerting between +/- 80° Latitude from four Geostationary Earth Orbiting Satellites (GEOS), while a constellation of Low Earth Orbiting Satellites (LEOS) provide polar coverage and also facilitate Doppler location by measuring the relative velocity between the orbiting satellite and the rotating Earth beneath. These two constellations of satellites are very much complementary in that the LEOS cover the Polar regions which are not visible

to the GEOS, while the GEOS have much larger instantaneous coverage than the LEOS due to their greater distance from the Earth. Importantly also, the polar orbiting LEOS, despite their limited instantaneous coverage, will eventually pass overhead the scene of an incident. LEO satellites therefore maximize the possibility of detection in difficult terrain. This is particularly important because GEOS elevation reduces with increasing latitude; consequently, at high latitudes a GEOS can be obscured by geographical features as the limit of its coverage is approached.

5. The chief benefit of the SARSAT system lies in its truly global coverage, supported by a fully integrated ground infrastructure which allows appropriate actions to be taken not only to focus rescue efforts in the precise area of an emergency, but also to liaise with the national registration authority (military or civil) to obtain important supplementary information about the aircraft and personnel involved. These characteristics, combined with the provision of identification and location data in the 406 MHz message, bring very significant benefits to satellite-aided rescue operations.

A PEACETIME SAR PERSPECTIVE

6. Civil SAR and, for that matter, non-covert military SAR operations aim to alert all agencies who might be able to assist in an emergency. This may include assets that have only a secondary SAR role. As such, the use of open 'clear' communications and global detection and locating systems is key in ensuring ease of information distribution. For example, a commercial vessel in the locality of an accident or incident could be diverted quickly to the scene, just as a private aircraft operator might be able to assist in the search for survivors. In short, the ability to engage additional, non-assigned resources and assets in the prosecution of peacetime rescue operations improve operational flexibility, mission effectiveness and survival prospects.
7. With the SARSAT satellite system, it is possible for an incident to be detected, identified and located in just a few minutes to within an accuracy of one hundred metres. Furthermore, SARSAT can track multiple transmitting beacons simultaneously, thereby providing a comprehensive information picture to the rescue authorities. Typically, after a helicopter accident at sea, SARSAT data could include the site where the aircraft ditched, marked by a Crash Position Indicator (CPI), and the identity and position of individuals in life-rafts equipped with 406 Personal Locator Beacons. Consequently, rescue craft can be deployed directly to the scene of the incident and to the location of individual survivors. Indeed, equipped with accurate location and identification data, there is no need for the rescue craft to establish line-of-sight communication with the emergency transmitters until the final phase of the mission. Furthermore, it is possible for visual range to be achieved using SARSAT data alone, especially if aided with an on-board 406 decode capability as exemplified by Techtest series 406 avionic homing-decoding systems.

8. Whilst principally a civil system, SARSAT's international, global locating capability also regularly assists military rescue missions. Moreover, the system's rapid detection, identification and locating characteristics positively assist in hostile environments by allowing the rescue craft to remain at low level as it flies direct to the scene of the incident – a tactic that would not be possible in an equivalent CSAR scenario.

COMBAT SAR CHARACTERISTICS

9. Combat SAR operations are mostly conducted covertly with the aim of evading enemy detection and capture. Typical CSAR beacons are therefore normally transponder-activated from airborne interrogators deployed on the search and recovery aircraft. Interrogation replies normally comprise short encrypted data bursts that identify and locate the beacon. In addition, CSAR beacons often feature encrypted speech and integral GPS with navigation / waypoint functions. The absence of any NATO or other allied agreement on a common operating and performance specification for Combat SAR equipment has led to the emergence of many competing CSAR systems that are not interoperable. A typical outcome is that UK forces are forced to use a US CSAR system in any joint military operations. Inevitably, the lack of interoperability between CSAR systems potentially limits participation in combat recovery operations to those forces that, by mutual agreement, have equipped with common CSAR equipment.
10. This exclusivity of participation which characterises CSAR operations clearly has important advantages in a genuinely hostile environment where enemy forces may be equipped with technology capable of intercepting and deciphering emergency distress transmissions. However, the case for implementing a CSAR capability must be weighed against the limitations that this type of operation imposes and the alternative benefits offered by adopting an overt SAR strategy. In addition to the foregoing interoperability issues, there are a number of operational performance constraints that affect CSAR operations, including their confinement to localized (tactical) line-of-sight coverage.
11. **Line-of-Sight Limitations.** Key to the success of airborne CSAR operations is the ability of the search aircraft to interrogate a combat beacon and for the beacon's encrypted response to be received and decoded by the interrogating aircraft. In concept, the success of this process depends on similar factors to those which affect the conduct of traditional airborne SAR operations. First, the interrogating aircraft must be within line-of-sight-range of the transmitting beacon. In practice, this means that at a range of 39 miles, the CSAR aircraft has to be at least 1,000 feet AGL to 'see' a beacon positioned on or close to the ground or sea. At 50 miles range, aircraft height needs to increase to at least 2,000 ft AGL. Such an altitude in a combat scenario would undoubtedly expose the recovery aircraft to considerable risk during the time that interrogations were being transmitted. In addition, it is important to note that an aircraft at an altitude of 10,000 feet and 35 miles

from a transmitting beacon has a relative elevation of only 3.3° , reducing to about 1.7° degrees at 55 miles. At these low elevation angles, line-of-sight coverage is likely to be adversely affected by relatively minor terrain features with the result that detection and tracking may require further increases in altitude or course adjustments and detours, with the attendant risks that this involves, including that of attracting hostile fire.

12. **Tactical Implications.** A further operational constraint imposed by covert search tactics is the limited sphere of operation that a CSAR mission can effectively encompass. With a notional maximum detection range of, say, some 50 miles, a CSAR-equipped aircraft would be capable of searching a maximum instantaneous area of less than 8,000 square miles. Whilst such tactical coverage may be adequate for combat operations over limited areas where the positions of friendly and hostile forces are generally known, clearly the same technology cannot be readily deployed to cover more extensive land areas that might typically be associated with large-scale military action, law enforcement, or national security operations. By contrast, global SARSAT services and compatible 406 MHz emergency beacons deliver near-instant, wide-area identification and locating, unattainable even with the deployment of numerous (and costly) CSAR assets. In sum, not only is SARSAT able continuously to monitor large geographic areas on a continental scale, but its near-instantaneous response time potentially reduces rescue times and therefore minimizes mission risk and improves survival and recovery prospects, even in hostile situations.
13. **System Complexity.** The general complexity of CSAR systems poses additional problems both in terms of their operation and in their routine maintenance and management. In the aftermath of an accident, fundamental errors can easily occur and the added complication of physical injury can impede performance of even the simplest tasks. These human consequences of any aircraft accident demand that all survival equipment be conceptually simple and easy to operate. However, combat SAR equipment tends not only to be relatively heavy and bulky, but it is also significantly more complex than its peacetime SARSAT counterpart. Furthermore, aircrews are not routinely equipped for combat operations; consequently, they are often less familiar with CSAR equipment than with their routine, peacetime training ensemble. This lack of familiarity increases further the risk of operating errors in a Combat SAR scenario.
14. **Ownership & Support.** CSAR equipment also imposes additional ownership costs associated with its acquisition, maintenance and through-life support. To be fully effective, mission-specific encryption data has to be loaded for every operational sortie, and this sensitive information has to be managed and protected as a CSAR system overhead. In turn, this requires suitable security arrangements and procedures to prevent key operational information being compromised. Consequently, the overall cost of ownership of CSAR systems can be significantly greater than that of a civil SARSAT compliant system.

SARSAT VERSUS CSAR.

15. The threat of detection and capture by an adversary has to be assessed in light of the respective capabilities of peacetime and combat SAR technologies. On the one hand, covert CSAR operations, whilst undoubtedly more stealthy, can take a relatively long time to prosecute given the tactical line-of-sight range limitations associated with airborne transponder-based communications, and the limitations in operational area and co-operative participation that inevitably comes from using covert technology of this kind. Moreover, the recovery aircraft's conflicting need to maintain low-level flight to avoid detection and to achieve sufficient altitude to interrogate the survivor's beacon when its location is unknown exposes the operation to further risk. In addition, there is always the possibility of a covert beacon being seized by the enemy and compromised.
16. Alternatively, peacetime SAR services provided by the SARSAT satellite system are extremely well-proven and effective. SARSAT detection, identification and location are globally standardized processes available to nations worldwide. Moreover, SARSAT's ability to detect and locate individuals within only a few minutes can provide a crucial advantage, even in a combat environment, in terms of the time needed to locate and identify an individual and effect recovery, thereby minimizing the risk of capture by the enemy and improving the prospects of survival in extreme environmental conditions. Furthermore, the ability rapidly to detect 406 MHz transmission means that a beacon should not have to transmit for long periods. In this respect, the planned two-way SARSAT link will enable confirmation of detection to the survivor, thereby improving operational stealth where this is needed.

CONCLUSION

17. Conflicts and wars between nations that possess high technology weapons and infrastructure undoubtedly demand similarly comprehensive combat personnel recovery systems and tactics. In these cases, the need for a covert CSAR capability cannot be denied; however, such a capability does not necessarily provide the most appropriate capability for all military rescue scenarios. Indeed, the covert and secure nature of CSAR operations can deprive such operations of important additional intelligence that would normally be available to a non-covert rescue mission. Such systems are also heavily dependent on line-of-sight communication with the rescue platform. This not only limits the effectiveness of combat search operations to relatively small land areas, but also requires the aircraft to risk detection as it interrogates the CSAR beacon. These tactical issues can add significant delay and risk to the recovery operation. Conversely, SARSAT coverage offers global detection, identification and locating which can significantly reduce rescue and recovery times. Moreover, CSAR acquisition and life-cycle costs are significantly higher than those associated with SARSAT

compliant systems, while the complexity of CSAR equipment runs the risk of incorrect operation in the heat of battle. In other words, CSAR missions are, by their very nature, focussed and tightly controlled operations in which mission effectiveness can suffer due to the need for stealth and secrecy.

18. The need for a CSAR capability therefore has to be carefully weighed against the clear advantages of the global SARSAT system with its comprehensive satellite coverage that rapidly detects, identifies and locates emergency 406 MHz transmissions, and its global infrastructure which permits rescue operations to be mounted with minimum delay. Consequently, for certain military or policing operations typically associated with areas of tension and the maintenance of national security, the benefits of adopting a SARSAT emergency rescue policy can significantly outweigh those of an alternative and more costly CSAR solution.
19. In sum, a Combat SAR capability is unlikely to be a panacea for every military or security operation, and its disadvantages should be balanced against the many proven benefits of using global SARSAT services and equipment.

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