GUARDRAIL COMMON SENSOR (GR/CS)
PROGRAM SUMMARY
and
SYSTEM DESCRIPTION

Final
Revision 0.6

15 April 1994

Prepared for
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Prepared for the Guardrail Program Office by Modern Technologies Inc.
under contract number: DAAB07-91-D-J268, Task Order 8038-005

FORWARD

Army force structure in the new world political environment, joint precision targeting requirements, and adapting to new threats and coping with the accelerated technology revolution are the drivers of today's GUARDRAIL pre-planned technology insertion program.

Today's rapidly changing world situation, ever evolving threats, and the rate of technology advances that quickly cause hardware to become obsolete are critical issues in the Guardrail Common Sensor Systems 1 and 2 program. The Guardrail mission has been extended to support a wide range of conflicts and training scenarios required for CONUS/OCONUS bases and split base rapid deployment operations. The ability to support the commander with offensive intelligence from a stand-off platform, with a unique view of the battlefield from up to three platforms, and to precisely locate a wide range of conventional and exotic targets with Product Improvement Programs (PIP's) are the 1990's Guardrail program objective.

It has been shown that the way to avoid obsolescence does not rest on attempting to put technological progress on hold or by standardizing on specific hardware but rather by employing industry accepted standards that are open to all. These standards must include fiber optic bus structures, software language with development standards, operating systems and standard interface protocol. Modern EW systems are heavily processing/software oriented. Much of the adaptability required for solving the EW operational problems are truly software dependent. Modern Guardrail system functions are mostly software based and could use a variety of workstations and processors to perform these software functions so long as they abide by the established standards and have sufficient power and interfaces to support the requirement.

Much of the system special processing and unique equipment in Guardrail, such as the data link/sensors/signal processing, are being developed by co-contractors or were developed independent of Guardrail. These components find their way into the system via the system's Programmable Adapter Modules (PAM's) which also employ standards and are able to adapt any non-standard interfaces to the system.

Use of open standard architecture is the best way to overcome the exponentially rising technology advances that otherwise also carry obsolescence as its downside.

The new Guardrail system with distributed architecture employs extensive bus structures based on standards that allow the Guardrail capability to grow and evolve to handle changing environments. It is also adaptable to various other platforms and to system sizing. This modern architecture is also its insurance that the inevitable hardware obsolescence will not prevent the system's most expensive element, namely its software, from continuing to operate in the system even if hardware components may require substitution because of obsolescence. Further, it will more readily allow new capabilities from third party sources to be integrated into the system.

Guardrail has a heritage of successful programs that have met the signal intelligence challenge over 20 years.

Guardrail was the first remotely controlled airborne COMINT system with ground based processing and reporting capabilities. The original Guardrail objective to collect signal intelligence from a stand-off range and to support near real time reporting of critical intelligence to the field commander has not changed. Initially, the Guardrail collection and location measurements were mainly for identifying activity, obtaining approximate location, associating nets and performing situational analysis on collected voice data. This objective has consistently been executed very successfully. Although the DF performance has significantly improved over the years, and has proven very effective for finding and tracking enemy tactical forces, the direction of arrival (DOA) DF principle does not permit sufficient accuracy to support lethal targeting. However, recent GR/CS program product improvements have incorporated the time difference of arrival (TDOA) and differential dopler (DD) location measurement principle that does have the target location accuracy to support tasking required for Quick Fire targeting.

The increased timeliness of acquiring targeting accuracy Signal Intelligence, along with the integration of the one channel LRIP CTT, and the two and three channel CTT's with their multi protocols, enables Guardrail to quickly relay reports to Tactical Analysis Centers (TAC's) and field commanders. The CTT/H-R "receive only terminal" provides the capability for dissemination of collateral tactical reports directly to the shooter in time to use it to the greatest advantage. This requirement for precision accuracy and quick delivery of reports has been a very high priority in the recent and on-going Guardrail product improvement programs.

The current Guardrail technology insertion program provides the precision targeting and has the product dissemination to tactical commanders so that tactical consumers can make rapid use of pre-processed responses to their tasking relative to formulation of battle plans. These enhancements insure that the system will be effective against the evolving threats in today's changing political climate and will support the Army's joint Quick fire targeting requirement. Response to tasking inputs supports the field commander in developing the battle plan and provides fresh intelligence updates that assists him in adjusting that plan as events develop.

This Guardrail Common Sensor Program Summary and System Description Document is structured to provide a historical background and to develop an understanding of system capabilities, technical features and operational deployment considerations for those needing a general overview (and) at a top level it includes specific information on the Guardrail family of pre-planned product improvement programs.

The document provides a progressive summary of the product improvements, an outline of system level specifications and an overview of system characteristics, some insight into operation and deployment. It covers each of the currently fielded and planned Guardrail systems.

The document has been reviewed by the various project engineers for technical content and by the Program office to insure that it clearly achieves its stated objectives.

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1.1 On-going Preplanned Product Improvement Program Overview

The current pre-planned product improvement program will soon allow the Guardrail Common Sensor system to adapt to various signal environments and to re-allocate sensors and processing resources to match the requirements of varying phases of a mission. For example, the new unified architecture will have the necessary flexibility to program its on-board sensor suite for different mixes of conventional and exotic signals. It will be capable of re-allocating payload assets from primarily collecting signal data to sorting of tactical data as the mission progresses in response to tasking from the system operators. Additionally, system deployment flexibility will enable the system to adapt to the ever changing international political scene.

1.1.1 Program Evolution via Technology Insertion Programs

The Guardrail family of systems have successfully provided the Army with an airborne battlefield signal surveillance capability for more than twenty years. A series of seven generations of technology insertion product improvement programs have provided major capability enhancements in a cost effective, timely manner. Guardrail has grown from a manually controlled remote Communications Intelligence (COMINT) intercept system whose capability was to collect tactical voice communications in order to provide timely tactical reporting, to today's Guardrail SIGINT targeting systems that rapidly acquires and accurately locates SIGINT threats including radar and weapons systems command and control signals.

1.1.2 Traditional Guardrail Developmental Approach

Since the early 1970's, the Guardrail programs, first with QRC prototypes, then with fully supported PIP's, have provided the Army with a fixed wing, airborne COMINT capability. Timely fielding of modern assets has been achieved by applying low to moderate risk, current technology to satisfy the evolving EW requirements. Figure 1.1.2-1 illustrates past and projected threats and how Guardrail capabilities have kept pace. Each system has improved on the capabilities and architecture of its predecessor. This approach has proven to be an extremely effective method of increasing overall system effectiveness against the ever changing threats and has helped to moderate procurement and life cycle costs. Figure 1.1.2-2 shows the evolutionary timeline for the GR family of systems, the flow of some of the critical technologies that have been transferred to Guardrail from other programs, and the utilization of technology from IR&D/Commercial-off-the-shelf (COTS).

1.1.3 Guardrail System overview

A typical AN/USD-9 Special Purpose Signal Detection (Guardrail) system has four major subsystems: the ground based Integrated Processing Facility (IPF), the Airborne Relay Facility (ARF), the Auxiliary Ground Equipment (AGE) and Commanders Tactical Terminal CTT pictured in figure 1.1.3-1. It also has certain associated support equipment which includes maintenance facilities, storage vans and a power distribution system. A typical Guardrail mission as shown in Figure 1.1.3-2 is tethered to one, two or three special mission equipped aircraft deployed in stand-off flight tracks that are within line of sight to the targeted area of interest. The system mission is to collect and locate and to analyze the collected SIGINT signal threats in response to higher level tasking. The system relays tactical intelligence reports to its users.

The ground based Integrated Processing Facility (IPF) subsystem provides command/control; the airborne sensor platforms collect the threat data; the Auxiliary Ground Equipment (AGE) supports the ARF equipment; and tactical reporting terminals support the direct relay of reports to the tactical commander.

The IPF has computational systems and operator stations that process collected intelligence and prepare it for dissemination to field commanders via the Commander's Tactical Terminal (CTT) or land lines. The IPF has connectivity to other external networks that interface to the intelligence community.

The Guardrail airborne platform consists of a special electronic mission (SEMA) aircraft and its payload, the AN/ARW-83(V) Airborne Relay Facility (ARF). The SEMA aircraft are derivations from the RU21 and RC12 Beech military utility aircraft. The airframe includes navigation, avionics and survivability equipment. The mission payload is commonly called the "Airborne Relay Facility" (ARF) subsystem. The ARF has sensor subsystems consisting of antenna arrays, DF and intercept equipment, micro processors for processing/control, and data Link communications equipment. A key part of the payload capability is its direction finding (DF)/time difference of arrival (TDOA) emitter location equipment.

Ground support for the payload mission sensors/link communications is provided by a mobile AGE step van.

The CTT related (TRIXS GPF) equipment is integrated into the IPF. Its relay equipment is installed in the ARF and its GSE is located in the AGE and in the maintenance van. Normally, Commander's Tactical Terminals (CTT's) are located at designated intelligence centers and tactical operations centers.

The currently deployed Guardrail systems are assigned between 6 to 12 Mission aircraft. The number of platforms is determined by the aircraft maintenance cycles and the number of on-line platforms required to support system operational availability. Nine to twelve is the derived number of aircraft required in modern system to assure "surge capability" coverage. The specified number of platforms is based on a mix of two and three aircraft missions.
(Note: High accuracy targeting missions generally require three aircraft sorties.)

1.1.4 Mission Capability Growth

Figure 1.1.4-1 shows plan view of the Guardrail operational concept overlaid on a typical battlefield area. Guardrail threats are signals with tactical significance that fall within a Corps area of interest (AOI) (or) signals that have tactical value in a special operations scenario. Earlier Guardrail systems focused on VHF/UHF tactical single channel voice and multi-channel COMINT signals. Figure 1.1.4-2 provides some insight into the typical tactical signal environment that Guardrail is required to operate in. Mission scenarios have traditionally required operators to search out assigned COMINT activity, identify the collected intercepts, gist the content and determine the location of the high value targets (HVT's) in response to tasking from Corps Intelligence centers. Traffic analysts would associate the collected battlefield COMINT data and formulate tactical reports (TACREPS). After a review and approval of the reports, the intelligence reports were sent via the Commander's Tactical Terminal (CTT) digital communications channel or given to a communications center in the form of hard copy or paper tape COMINT TACREP's.

Traditionally, Mission Managers have planned a mission using system initialization procedures and operational frequency band assignments prior to the mission to effectively support tasking. System initialization parameters and operator assignments can be modified during the mission. Computer files that store the situation data base (SDB) are used to analyze the data collected by operators. Traffic analysts get their data from the operator Gist's or recorded audio data. Location analysts use DF files to create geographic target location data and to fill-in "emitter location fields" in the tactical reports. The (TACREPS) after review by a mission manager, are released by the Tactical Operator via the CTT and via the operational communications channels.

Recently, TRIXS, TIBS, and TRAP/TADIXS-B nets supported by the Three Channel CTT illustrated in figure 1.1.4-3, have become the new priority interfaces for ingesting external intelligence into Guardrail, TRIXS being the disseminating relay for Guardrail SIGINT reports. Modern Guardrail Workstations provide three dimensional map overlays that support the operator in conversion of graphics and text data to a message format that is acceptable to the net protocol's. The current direct tactical dissemination concept includes sending the Guardrail intelligence reports to tactical user's via the CTT field terminal or to the mobile CTT/H-R "receive only" terminals. Fig 1.4-4 illustrates current thinking as to how connectivity will be incorporated for rapid battlefield dissemination to Quick Fire and TOC's.

Pre-planned integration of the Advanced Quick Look (AQL) technology has added ELINT collection, EOB processing, ELINT DF and ELINT TDOA to GR/CS. Communications frequency coverage is being extended with Lowband and microwave intercept. More automated signal search, acquisition and recognition features have provided significant added flexibility and operator efficiency to the signal collection process. Near first syllable detection via priority audio monitor (PAM)/priority audio recording (PAR) has made it possible to assure the intercept and automatic DF of identified threats. This enhancement has also provided the ability to prioritize search and acquisition only in defined areas of interest.

Guardrail Operational Concept

Figure 1.1.4-1

Signal Threat Environment

Figure 1.1.4-2

Tactical Intelligence Dissemination Concept

Figure 1.1.4-3

Evolving Fire Support Architecture in Support of Deep Strike

Figure 1.1.4-4

1.1.4 Mission Capability Growth(Cont)

Another important Guardrail technology insertion is the Communications High-Accuracy Airborne Location System (CHAALS) that has provided a TDOA/DD COMINT precision target location capability on Guardrail Common Sensor systems.

The new GR/CS System 1 has distributed ground processing that employs open standards. This advancement has provided vastly increased IPF processing power, new deployment flexibility with 2, 3 or 4 IPF vans and plenty of software processing capacity for future growth.

System 2, which is currently under development, will extend the distributed processing to the on-board assets using a "unified SIGINT architecture" that adds real time programmability/and shared asset modularity to the payload. The on-board "unified" collection/DF/signal processing is an N Channel system. This "technology transfer" handles exotic signals and complements the Guardrail IPF Universal Workstations currently being employed in System 1. This distributed, unified Advanced Tactical SIGINT Architecture (ATSA), provides a task driven SIGINT capability that can rapidly respond to current and evolving tactical signal environments by querying the airborne data base (or) via a manual mode. It is this architectural advance that is the heart of the most current Guardrail PIP. State of the art, serial, wide band fiber optic "Data Flow" buses move the collected signals around the system using a precise time code for synchronization and recall. The unified ARF architecture uses a standard Fiber Distributed Data Interface (FDDI) network to manage and control the on-board distributed processing equipment interfaces serial digitized signal data to the new generation onboard Guardrail Dual Data Link (GDDL) which communicates with the ground based Modular Interoperable Surface Terminal (MIST) which has dual X and Ku band capabilities in each of its trackers.

Flexible sizing of the IPF is part of the System 1 and 2 upgrades. The ability to deploy 2, 3 or 4 IPF vans and with the flight line support autonomy provided by the payload's new built-in, on-board ARF flight line check-out, it will enable quicker world wide system deployment. Use of a satellite relay for quick deployment of the airborne platforms with respect to the IPF's and its associated home base life support facilities, further adds to the system employment flexibility that is required for diverse, rapid deployments that are likely to occur in today's unstable world politics.

1.2 Historical Overview

1.2.1 Early Guardrail systems

In the 1971 time frame, NSA desired to demonstrate the value of an airborne remote COMINT system. Doing a QRC "stand-off Guardrail airborne signal collection/surveillance system" was a natural extension of the remote COMINT ground based systems that were used in the Vietnam war. A "paper study and laboratory fly-off" test showed that proven pre-selection digital receiver designs used in Vietnam along with the Explorer COMINT remoting would operate most effectively in the dense European signal environment. NSA and

1.2.1 Early Guardrail systems (Cont)

ESL believed that these technologies could be deployed in an airborne system in less than five months, just in time for the '71 REFORGER exercises.

1.2.1.1 Guardrail I

In the spring of 1971, NSA with guidance from its director Admiral Gayler, initiated the QRC procurement of the first Guardrail system. This large, complex system was delivered on schedule, in time to be installed at an old Nike Missile site at Gruenstadt, West Germany where it remotely supported the '71 REFORGER exercise. Its three mission configured aircraft were ferried to the Ramstien AF Base. The '71 REFORGER exercises proved to be the ideal environment for evaluation of this new concept for airborne reconnaissance.

The initial Guardrail (Crosstalk was the cover-name), had both airborne and ground mobile remote sensors. As shown in figure 1.2.1-1, it employed three 40 foot trailers to house the air-conditioned ground command/control and the 18 collection/analyst operator stations. The collection operators tuned in signals, monitored their tactical content and gisted or tape recorded the intercepted signals. The analyst would enter critical data into tactical reports which were relayed directly to the field commander and to the Tactical Operations Centers (TOC's).

Guardrail's COMINT intercept platforms provided an obvious advantage being highly mobile with an expanded view of the battlefield. The system provided COMINT data while operating safely west of the Rhine using stand-off flight tracks.

1.2.1.2 Guardrail II

An important operational need, not provided by Guardrail I, was the ability to locate the position of enemy communications. Conveniently, ESL Inc was performing flight test demonstrations for the Army Security Agency (ASA) on an IR&D developed, patented, simple, electronic direction finding system in the late '71 and early '72 time frame. ESL felt that a remote version of this DF system could be manufactured and integrated in time for the '72 REFORGER exercises. The Guardrail II product improvement program was authorized in April of 1972. Guardrail II was to use as much of the initial Guardrail system as practical. Once again, the delivery schedule was five months.

Integration of airborne DF required an inertial navigation system. The solution here, was to use the residual "Left Jab" RU21-E model aircraft that had already integrated the ASN-86 INS and add antenna foot prints required for the Guardrail DF array. Figure 1.2.1.2-1 shows the initial DF configured Guardrail aircraft.

The original Guardrail I microwave link required moderate upgrades to support DF link requirements. The air-to-air relays and TCT relay were upgraded from VHF to UHF for less interference. Digital protocol was added to the TCT to allow for a direct computer interface of emitter location DF data into reports and for keyboard free text inputs to the TACREP's.

Initial Guardrail DF Aircraft

Figure 1.2.1.2-1

1.2.1.2 Guardrail II (Cont)

A computer system and mission peculiar software were required to support DF commands, DF calculations and reporting. The computer map/hard copy capability provided overlay of lines of bearing (LOB's) on map coordinates. The computer also provided spheroid earth curvature calculations required to formulate target locations based on DF line of position (LOP) measurements.

The system was now able to perform instant direction finding against acquired targets with a simple key stroke. Figure 1.2.1.2-2 shows the GR-II operator stations. An Auxiliary Ground Equipment (AGE) facility was configured in a Ford Econoline van for basic flight line checkout of prime mission electronics.

Although the first two Guardrails were prototype systems, they met all their critical operational objectives. Formal documentation had to catch up later. However, the European Theater now had an airborne COMINT system that demonstrated the force multiplying factor that was to become part of the US/NATO defense strategy. A permanent Guardrail in Europe could provide peacetime data on a daily basis; it could efficiently monitor military build-ups, track crisis development, be used to discover new threats, and be operationally ready for any hostilities that might come along.

1.2.1.3 Guardrail IIA

Initially, the intent was not to field the QRC Guardrail II system as a permanent operational system due to a lack of logistic support. Only a very limited "push package" of spares were available at that time. Additional spares and minor enhancements were incorporated under a GR-IIA PIP. Guardrail IIA remained as a USAREUR theater asset until GR-V would arrive some six years later. It participated in all subsequent REFORGER exercises. The forces that had the Guardrail system had the advantage on the battlefield. The advantage was that the tactical commander now had critical intercepted COMINT data that reached beyond the forward line of troops (FLOT). That data was effectively used by the commanders to help formulate, implement and adjust their battle plan.

1.2.1.4 GR-IV

The Pacific Theater also required a Guardrail capability. Beginning in 1973, a low budget, twelve month NSA program provided that capability as the GR-IV system. It employed an improved version of the ARC-176 UHF communications data links and a new generation, lighter weight, broader coverage R812 VHF receiver. System coverage and basic system capabilities were basically the same as the GR II, except that GR-IV used a UHF link exclusively vs a mix of S-Band/UHF links.

The computer system and the software for GR-IV, with some adaptations and improvements, was derived from Guardrail II. GR-IV also had a more sophisticated set of auxiliary ground equipment (AGE) that was installed in a step van for self contained flight line maintenance as illustrated in figure 1.2.1.4-1. This expanded AGE concept proved very valuable for efficient pre-mission tests as did the improved GR-IV IPF self test features.

Guardrail IV Flight Line Support

Figure 1.2.1.4-1

1.2.1.4 GR-IV (Cont)

Due to budget constraints, only four sets of payloads were delivered with GR-IV along with six modified RU21-E aircraft. The system performed very effectively in the Korean US 8th Army environment and enjoyed a reputation for system availability near 100%. It operated in Korea until the system was retired in 1979 when it was replaced by the new GR-V system.

The GR-IV system was designed, built and tested on schedule (and) on budget. The formal Technical Manuals for both GR-IV and GR-II were prepared and delivered as part of the Hardman Program along with additional spares in 1974. ASA took the responsibility for supporting the fielded systems and maintained a small contingent of contractor Field Service Representatives. The factory was to be the depot for mission peculiar equipment, while SAAD and other military depots supported mil standard items.

1.2.1.5 Early Guardrail Program Performance

Each of the early Guardrail systems achieved its programmatic and operational requirements as to schedule, budget and operational performance. The early three Guardrail systems were procured by NSA as QRC programs and were designated as theater level assets which led to a long term requirement for Guardrail as an Army Corps level asset.

1.2.2 GR-V History

The GR-V program objective was to supply supportable Guardrails to the Army Corps Military Intelligence Battalions on the shortest schedule practical. These systems would undergo user evaluation test programs in the real field environment, performed by the troops that would be using the system in the years to come. Using this approach, systems could be delivered in a fraction of a normal full development cycle. An important fringe benefit would be reduced costs and avoidance of the all too common problem that plagued many an EW system, that of obsolescence occurring before the system could be fielded.

The Guardrail V program was conceived and placed on contract in the early FY'76 time frame. GR-V was to be an economical, second generation technology insertion system. It would be produced as a low density production system while the Army was waiting for the CEFLY Lancer system to be developed and fielded.

The GR-V program office was to be under PM SEMA control. The contracts office and technical oversight were transitioned from NSA to CECOM at Ft Monmouth, NJ. and AVSCOM had technical responsibility for certifying the aircraft.

Like previous Guardrail programs, ESL would be the prime contractor and Beech would be the aircraft modification subcontractor. Unlike previous contracts, the GR-V program had formal data requirements that included logistic engineering, a qualification test program, a formal integrated system test program, a parts program, a Mil std 45208 QA program, a government QA representative, mil std manuals including dash 10 dash 13 and dash 23 TM's, RPSTLs, formal software documentation and provisioning. ESL provided a formal one time training program on each system for the mission equipment and BAC provided airframe training.

1.2.2 GR-V History (Cont)

The GR-V system was type classified as a Limited production urgent (LP-U) system. The system was nomenclatured as the AN/USD-9 Special Purpose Detecting System. The GR-V system was designed and documented so it could be maintained by Army 33-S personnel with GR-V specialty training.

The overall GR-V program required 24 aircraft. These were derived from the various versions of existing RU21 aircraft including the RU21-E, A, D and the G utility aircraft. Each of the aircraft were modified to the GR-V specific RU21-H configuration shown in figure 1.2.2-1. These aircraft would be outfitted with wing tip pods that replaced many of the individual antennas and had provisions for the ALQ-44 and ALQ-36 radar warning equipment, had low reflective paint, and the were equipped XM-130 chaff and flare dispensers. Lighter, smaller DF equipment helped make room for the heavy UHF link and RF antenna multiplexing equipment that was required in order to connect multiple communications transceivers and on-board radios to the same antenna.

The GR-V system employed three 40 ft sea-land type trailers to house the IPF illustrated in figure 1.2.2-2. The inside of the Intercept/DF van is shown in figure 1.2.2-3. The vans were modified with operator stations and sealed for EMI integrity. The IPF was designed to be transported in C-141 or C-5A type aircraft. A new computer system with vastly increased memory and processing capability was introduced. The capability for direct transfer of DF file LOP data into a

tactical report was also introduced. Computer assisted diagnostics and link frequency algorithms were some of the refinements that went into the GR-V system software. More streamlined DF calibration and built-in automated DF accuracy test software was added. Superior DF performance was available from this 2nd generation DF system that used two channels for successful DF against SSB and other intermittent signals.

The initial GR-V system was delivered in 28 months, on schedule and was successfully fielded to replace the prototype GR-II at Gruenstadt. ESL and the US Government developing agency, with the cooperation of the gaining command performed an evaluation test program prior to final hand-off to the 7th Corps. Two additional systems were delivered to Korea and CONUS in one year intervals. Both the GR-II and GR-IV system were retired at this point. The older GR systems had been heavily used, and did not have equal performance to the new GR-V system.

The Guardrail V system met all criterion for a successful program as to budget, schedule and its operational capabilities. A spares push package and stock fund spares were delivered with the GR-V system to support system readiness.

Although the GR-V system was still largely a manual system from a mission operational standpoint, it has proven to be a very capable, reliable system that has lived up to full expectations and generally exceeded all its performance specifications. The fourth GR-V system was diverted to support the Improved Guardrail V program, hence was not completed or fielded and the last three RU21-H aircraft were canceled.

1.2.3 IGR-V History

A requirement that was placed on the Improved Guardrail V (IGR-V) program was to transition to a pressurized aircraft for higher altitude missions. It also desperately needed increased INS reliability. The ASN-86 INS had proved to be the weak link in system availability. Navigation was key to the DF capability and was needed to insure that the aircraft would not drift across the boarder into enemy territory during peace time missions.

Another "requirement driver" for IGR-V was the integration of the Interoperable Data Link (IDL) in support of inter service interoperability. The interoperable link originated as a wide band microwave link designed by Sperry Univac for the Air Force. The link had been upgraded over the years and had a number of applications with the armed services. For example, a Ku band version of this link was the basis for the CEFLY Lancer link. Guardrail product improvements to the link that established interoperability included dual Ku/X band tracker operation, error encoding, bulk encryption, a wider band uplink, dual airborne antennas and enhanced link diagnostics. The IDL provided vastly increased Guardrail link capacity and added anti-jam features. The introduction of the IDL also moved the link interference outside the band of COMINT signals which would significantly alleviate EMC problems.

The IGR-V program got underway late '81 with a contract for two systems destined for V Corps and VII Corps.

One of the Guardrail challenges was the high density airborne signal environment. The availability of newly developed technology for managing the collected signal environment called for implementation of pre-planned product improvements that included the Fast DF that was jointly developed by ESL and the USAF and the ESL developed Signal Classification and Recognition (SCARS) equipment. The SCARS equipment was developed by ESL under its IR&D program. These available technologies allowed auto search, auto DF, area of interest (AOI) screening and an order of magnitude increase in DF through-put with greater emitter location accuracy.

Interoperability with the Air Force was an OSD/NSA mandated objective for IGR-V. Achieving this requirement was greatly facilitated by using the common data link and a common Fast DF technology.

The pressurized IGR-V RC12-D aircraft was derived from the RC12 utility aircraft by militarizing the avionics and cockpit and by integrating the Carousel IV-E INS. The C-IV-E is a the high accuracy version of the Delco inertial navigation system commonly used on the C141 and KC-135 aircraft. The C-IV-E is a militarized version of a proven, reliable commercial navigation system. ESL contracted with BAC for the installation of the data link antennas and mission antenna arrays. Certification and qualification testing of the RC12-D was part of the IGR-V program.

1.2.3 IGR-V History (Cont);

Four vans were used to provide the IPF with some 23 operator stations that were equipped with color graphics terminals. Frequency coverage of the DF system was expanded, and a significant upgrade in software was provided to make all the positions capable of doing any authorized computer related responsibility. A greater degree of signal collection automation was made possible by the integration of Fast DF and SCARS subsystems. A more sophisticated message file was added for interactive report generation. These DF and signal processing upgrades made IGR-V a more powerful system than its GR-V predecessor. IGR-V was truly a significant product improvement over the GR-V system.

Like pervious Guardrail programs, IGR-V achieved its schedule and budget and performed in excess of nearly all of its specifications. The pressurized aircraft, the IDL and Fast DF were particularly successful. Interoperability was tested during system integration and field tested later in Germany. Highly successful deployments and field tests were performed at the 5th Corps 205th MI Battalion in Wiesbaden in Oct. '84 and at the 7th Corps 330th MI Battalion in Stuttgart the spring of '85. Both systems were successfully deployed during Desert Storm.

Guardrail/Common Sensor is a 7th generation Guardrail product improvement program. The major requirements for this P3I program included integration of the Advanced Quick Look (AQL) ELINT system and the Communications High Accuracy Airborne Locations System (CHAALS). The objective was an integrated SIGINT capability that would permit the retirement of the aging Mohawk aircraft with its Quick Look II ELINT system. The Guardrail/Common Sensor system would provide full SIGINT on a single platform and would add targeting accuracy. Although the development of AQL and CHAALS were on-going programs under separate contracts, the GR/CS program actually got underway 1st quarter FY '85.

Other GR/CS upgrades included receiver pooling, digital intercom and digital temporary storage recording (DTSR), a greater aircraft payload capacity in order to carry the added subsystems, and the larger ELINT pods. Integration of the highly accurate Global Positioning System (GPS) equipment into the airborne navigation system was needed to support the TDOA capability. The RC12-K with its larger PT-67A engine would become the new Guardrail/Common Sensor aircraft.

Due to schedule considerations, six D model aircraft were modified to a RC12-H configuration for Guardrail/Common Sensor system 3. System 3 was fielded in Korea to replace the aging GR-V system which was in need of refurbishment and the 60's vintage RU21-H's were not going to last much longer with the mission work load being flown in that theater. This meant that although System 3 had been tested with EDM AQL and CHAALS units, it was fielded without these subsystems.

1.2.4 GR/CS Systems 3 & 4 Background (Cont);

Another upgrade to the Guardrail/Common Sensor system was the inclusion of 4 mission computers rather than 1 computer to handle the COMINT, AQL and CHAALS loading and to provide a back-up computer. Two of the four computers would be to support the AQL and CHAALS ground processing, while the fourth would back-up any failure of the Main System Computer (MSC) or backup the ELINT computer. This feature added a lot of reliability to the system by eliminating some single point failures.

The AQL program started in 1984 and underwent ED testing in 1985. The ED models were integrated and tested on the System 3 and 4 aircraft at ESL. The flight test program proved the AQL equipment to be accurate and it provided timely ELINT reports. This application of ELINT on a multi platform system with combined SIGINT capability was considered successful. Production AQL units built by ESCO were integrated on system 4 in the 1992 time frame.

The CHAALS development program began back in 1972 as a joint Army/Air Force initiative. IBM developed the coherent processing and emitter location capability while ESL developed the equalized Time Difference of Arrival (TDOA) receiver. Initial programs in the 1970's were the Emitter Location System (ELS) and the Mini ELS. This led to an 1980 flight test of the Coherent Emitter Location Test bed (CELT). CHAALS is a productized outgrowth of these programs. A Global Positioning System (GPS) was integrated into GR/CS to achieve the required navigation accuracy for TDOA/DD measurements. Also, a third data link was necessary to support three aircraft missions that are required for the CHAALS TDOA/DD operations.

New pods that could support both COMINT and ELINT simultaneously were developed for the Guardrail/Common Sensor platform along with a flight test and certification program.

Guardrail/Common Sensor System 3 was deployed to the Republic of Korea Oct. 1988 on schedule. Guardrail/Common Sensor System 4 deployment was delayed till the Spring of 1991 so that production AQL and CHAALS units could be integrated and tested prior to fielding to the V Corps 1st MI Airborne Exploitation Battalion at Wiesbaden to replace the original IGR-V.

Several QRC enhancements were checked out in Guardrail/Common Sensor system 4 prior to fielding, then fully integrated in the field later in the year. These QRC upgrades added capabilities that were shown to be operational shortcomings in the Iraq conflict in early '91. These included Lowband intercept, Upward frequency extension with programmed multi-channel demodulation, Special Radio Exploitation (SRE), a Proforma capability and integration of a TIBS interface. Although not fully integrated into the Main System Computer (MSC) software, these PC based QRC software upgrades provided an important increased capability that might well be needed for any re-deployment to support insurgence or special operations around the world.

Another key post fielding QRC upgrade to GR/CS system 4 was the Smart File Cabinet/FasTrack "smart mapping workstation". This PIP employed two Sparc SUN workstation terminals and successfully re-used and expanded, a very large

set of existing graphics software. It included ESL developed IR&D software for terrain mapping/mission planning as well as geographic data

bases developed by the US Government that were necessary to support this important system enhancement. Eventually, TIBS was interfaced to these workstations to provide the system with external multi-sensor data.

Some minor impacts to the GR/CS System 4 schedule and fielding were experienced along the way due to the large amount of GFE. Integration of CHAALS and AQL presented some challenges, but the operational goals of the program were achieved. Some field modifications to the GFE ELINT software was required and some CHAALS support software for mission monitoring were deemed to be necessary post fielding upgrades.

1.2.4 GR/CS Systems 3 & 4 Background (Cont);

The Guardrail/Common Sensor System 4 was delivered with eight platforms. The ninth platform and its payload was held back to support flight certification for the RC12-N model aircraft with its new multi function display (MFD) that enhances the cockpit MMI; and was also needed to support various "System 1" next generation product improvements.

The ever increasing advancements in computer technology have compressed the cycles of hardware obsolescence to a couple of years. Processing power increases by an order of magnitude with each generation, performance per $ increases even more rapidly. With this extra processing power, signal processing, data sorting, very wide band fiber optic buses, embedded training and all sorts of capabilities are now available to the Guardrail system.

International standards are coming on line to control and define computer interfaces. These standards along with software languages that include development standards, now make software reusability a reality. Since it is no longer practical to control the future availability of particular computer hardware, nor would one want to limit system capabilities and speed by doing that, it becomes apparent that a different approach to avoiding obsolescence is required.

ESL, under IR&D, and on other joint programs, such as the advanced SIGINT Fireworks program, put forth two initiatives to resolve that dilemma. The first, was the application of a real time tactical system processing architecture that was based on use of international standards and use of the seven layer, Ada protocol. The second technology advancement was the Advanced Tactical SIGINT Architecture (ATSA) initiative that employs a "unified architecture" that is bus oriented and employs all Ada software in a shared asset payload. In this manner, the architecture and the software standards become the basis for the system, not the vintage of computer hardware. As new computer and bus technology comes along, so does the method of adapting to the established standards. As new languages come along, they will also be required to be compatible with Ada "objects".

1.2.5 GR/CS System 1 (Hybrid system) and GR/CS System 2 (Objective System) Background Overview (Cont);

The new airborne distributed unified architecture shifts away from the traditional philosophy of integration of dedicated hardware subsystems with typically non-reusable software that is very difficult to upgrade and that is usually not compatible to new generation computers. Rather ATSA uses shared assets and established standards to define all interfaces, hence becomes an open system architecture that can accept capabilities from anyone who follows the rules.

As Shown in figure 1.2.5-1, distributed, unified architecture is the driver for the current Guardrail System Technology Insertion Program. Onboard assets have bus structures that are bridged to the ground facilities bus via the data link and are synchronized so that signal data can be re-constructed whenever tasking requires it. This figure illustrates the types of assets that reside onboard the platforms, how the wide area networks connect all elements of the system, shows the assets that are normally located on the ground and lists the various standards that are employed to achieve this revolutionary approach to a SIGINT system architecture.

System 1 provides the distributed processing IPF that is also downward compatible with older Guardrail payloads and the Air Force system. System 1's payloads are identical to the GR/CS System 4 except it has extended coverage, lighter weight intercept receivers and has an improved interference reduction system that is required by agile on-board avionics radios and the TRIXS Relay. The System 1 program started in September '91.

System 2, on the other hand, focuses on a new on-board architecture designed to deal with the evolving signal environment and at the same time further reduces weight. Use of common modules and Ada software from an on-going development program, formed the basis for the new "Unified" Guardrail payload architecture. The system 2 payload is designed around a wide band signal fiber optic "Data Flow" bus, an FDDI bus and a synchronization fiber bus. This technology had been already designed and laboratory tested. Shared general purpose processors are being used to perform signal processing and on-board data base management. These modules use established standards (or) are participating in establishing standards where they do not yet exist. The newest generation of the Interoperable Data Link, CHALS-X and AQL ELINT are being employed in the system as are wide band, multi-channel tuners and active antennas. Although ELINT equipment is not initially unified, it is moving toward that goal by integrating airborne ELINT processing into the common, distributed processors. This phase II portion of the program started early calendar year '92, with major follow-up ECP's.

Other planned upgrades include embedded training, advanced smart map sensor management support, automated multi level security reporting, expanded proforma exploitation and integration of the three channel CTT with its multiple interfaces and protocols. These protocols include compatibility with TRIXS, TIBS, TRAP/TADIXS-B It potentially can communicate via Satcom nets.

1.3 Program schedule

This section provides an overview of the preliminary Guardrail enhancement schedule. The on-going and planned programs focus on the Guardrail objectives for supporting current and future Corps level Army SIGINT requirements. Events like the retirement (or transfer to National Guard) of the GR-V systems, IOC deployments, planned field retrofits and retrofitting of major enhancements like drop-on microwave receiver, Automated Proforma, CHAALS supervisor console, Auto Multi-channel Reporting with upgraded accreditation, Mission Management Enhancements, ASE upgrades, CHAALS/ELINT on-board processing, embedded training, expanded interoperability, mmw, direct satellite relay and onboard ELINT processing enhancements are projected in a timeline schedule. Full implementation of some of these capabilities is dependent on availability of production funding. A high level programmatic schedule is depicted in figure 1.3-1.

A chart showing the flow of program technology initiatives that are drivers for the current distributed processing Guardrail Common Sensor System 1 IPF and the full-up distributed, unified architecture being employed Guardrail Common Sensor System 2 is illustrated in figure 1.3-2.

Figure 1.2.5-1

Guardrail Distributed Architecture With
SIGINT Wide Area Network

Figure 1.2.5-1

2.0 System Description

2.1 System capability matrix

Table 2.1-1 tabulates most of the top level capabilities of GR-V, IGR-V and the GR/CS family of systems. This summary of characteristics and capabilities starts at the system level then shows payload, aircraft and ground processing subsystem comparisons.

By using available technologies, the Guardrail capabilities have evolved with each product improvement program to better handle the changing threats and improve the system's capability to work effectively in the difficult tactical signal environments.

These capabilities will be explained in further detail in the subsequent subsections of section 2. Many of the capabilities that are future planned enhancements and not yet in the program. There are others that are only best knowledge projections.

2.2 GR-V Description and capabilities ;

The AN/USD-9 Special Purpose Signal Detection Guardrail V System is designed to support the tactical commander's at the Corps level and below with near real time communications intelligence. Traditionally, the system served a secondary mission to collect intelligence under the peace time tasking (PARPRO) missions. This product improvement program used available 1970's technology to produce a reliable, effective system in about two years. The system computer processing capability is mainframe oriented, its operation is primarily manual and the threats are COMINT single channel voice and multi-channel. The system has a 3 van IPF, 6 ARF's and an AGE step van.

It employs 1, 2 or 3 remote airborne payloads in stand-off flight tracks to intercept and locate emitters of interest. Remotely controlled VHF/UHF intercept receivers are used to search out tactical threats. VHF DF locates ground based and airborne communication emitters.

GR-V uses mission configured GR-V RU21-H platform. The three van IPF supports the mission operation with operator workstations and with a computerized signal data base. GR-V is self contained in that it has a full complement of STE and TMDE installed in AN/ASM-189 shelters and has auxiliary vans for spares and transportation of accessories such as the communications antennas used at the IPF. Figure 2.2-1 shows the GR-V system components and an overall illustration of the system level interfaces.

2.2.1 GR-V Description and Capabilities Summary

An unclassified version of the Guardrail V system level capabilities and performance characteristics at the system level are tabulated in Table 2.2.1-1.

Table 2.1-1

Capability Matrix

Capability/Mission Enhancements	GR-V	IGR-V	GR/CS Sys #3	GR/CS Sys #4	GR/CS Sys #1	GR/CS Sys #2	Notes
Universal Workstations	No	No	No	No	Yes	Yes	
Distributed Processing	No	No	No	No	Yes*	Yes	*Has gnd LAN/Workstations
Ada (as dominate language)	No	No	No	No	Yes	Yes	
Scalable configuration	No	No	No	No	Yes*	Yes*	*2,3 or 4 van deployment
Digital terrain mapping	No	No	Yes	Yes	Yes	Yes	
Smart Map/Sensor Mgt	No	No	Yes	Yes	Yes	Yes	
SIGINT overlay	No	No	No	Opt	Opt	Opt	
COMINT	Yes	Yes	Yes	Yes	Yes	Yes	
ELINT	No	No	No	Yes	Yes	Yes	
Receiver pooling	No	No	Yes	Yes	Yes	Yes	
Fast DF/SCARS	No	Yes	Yes	Yes	Yes	Yes*	*Embedded in ATSA
Unified A/B Architecture	No	No	No	No	Opt*	Yes	*Retrofitable
On-board ELINT processing	No	No	No	No	No	Opt	
High resolution DF	No	No	No	Yes	Yes	Yes	
Special signals	No	Yes	Yes	Yes	Yes	Yes	
Number of IPF vans	3	4	4	4	2,3,4	2,3,4	
Number of operators	19	23	26	26	25	25	
Platforms/mission	1,2,3	1,2	1,2	1,2,3	1,2,3	1,2,3	
Platforms, total aircraft	6	6	6	9	12	12	
Reporting	TCT	ICTT	ICTT	CTT*	CTT	CTT-h	*Retrofit
Collateral reporting	No	No	No	Yes*	Yes*	Yes*	*"Air gap" Manual
Interoperablity	No	Yes	Yes	Yes	Yes	Yes	
Wideband Microwave link	No	Yes	Yes	Yes	Yes	Yes*	Multi Role Data Link
Separated deployment opt	Yes	No	No	No	Yes	Yes*	*Satellite relay (P3I)
Data Distr System/MLS	No	No	No	Opt*	Yes	Yes	*Retrofit
Programmable payload	No	No	No	No	No*	Yes	*Requires Retrofit
Gateway bridge	No	No	No	No	No*	Yes	*Requires Retrofit
Distr on-board processing	No	No	No	No	No*	Yes	*Requires Retrofit
Receivers per mission	12	28	28	42	42	30*	30 set-on plus 24 WB
Receivers per A/C (Max)	6	14	14	14	14	10*	*10 set-on plus 8 WB
Expanded band rcvrs	No	No	No	Yes*	Yes	Yes	*QRC expansion
Basic full COMINT coverage	Yes*	Yes	Yes	Yes	Yes	Yes	*Except DF
Extended upward coverage	No	No	No	Yes*	Yes*	Yes*	*Intercept only
Extended downward coverage	No	No	No	Yes*	Yes	Opt	*Intercept only
LPI	No	No	No	Opt	Opt	Yes	
FDDM	Yes	Yes	Yes	Yes*	Yes*	Yes*	*On-board and gnd
PCM/TDM	No	No	No	No	No	Opt	
Proforma	No	Yes	Yes	Yes	Yes	Yes	
SRE	No	No	No	Yes	Opt	Opt	
Signal recigizer on-board	No	No	No	No	Opt	Yes	
DOA DF (multi chan vs 2 chan)	2	2	2	2	2	6	
DF extended coverage, down	No	No	No	No	yes	Opt*	
DF extended coverage, up	No	No	No	no	Opt	Yes	
TDOA (ELINT & COMINT)	No	No	No	Yes	Yes	Yes	

Table 2.1-1
Capability Matrix (Con't)

Enhancements	GR-V	IGR-V	GR/CS Sys #3	GR/CS Sys #4	GR/CS Sys #1	GR/CS Sys #2	Notes
ELINT, basic	No	No	No	Yes	Yes	Yes	
ELINT drop-on rcvr	No	No	No	No	No*	Opt	*Requires Unified arch
ELINT, Embedded	No	No	No	No	No*	Opt	*Requires Unified arch
ELINT, on-board proc	No	No	No	No	Opt	Opt	
Link, air to gnd	UHF	IDL	IDL	IDL	IDL	GDDL	
Link, air to air	Yes	No	No	No	No	Opt	
Message transponder	TCT	ICTT	ICTT	CTT*	CTT	CTT	*Retrofit
Satellite remoting	Yes	No	No	No	Yes	Opt	
Flight Line Support	AGE	AGE	AGE	AGE	AGE	Blt-in*	*Built-in Go, No-go + AGE

2.2.2 GR-V IPF

The GR-V Surveillance Information Processing Center AN/TSQ-105(V) (IPF) is installed in three sea-land type transportable operator vans. Figure 1.2.2-2 is a photo of the IPF with its antennas. Within the IPF, are the mission operators, the main system computer (MSC)/special processors which provides the control, processing functions, message formatting capabilities. Supporting functions include links/communications/test functions. All together there are 20 operator terminals in the IPF and normally up to 19 operators. The IPF is configured with passage ways, egress, security, and support equipment. Figure 2.2.2.-1 shows a plan view of the IPF operator vans.

Figure 2.2.2-2 is a functional diagram of the GR-V IPF.

2.2.2.1 Analyst Van

Van 1 has eight operator positions. Two are DF Analysts with graphics terminals. They have access to the system intercom and TCT voice communications. They are the senior analysts and have responsibility for the GR-V intelligence product and mission planning.

The DF Location analysts work the DF files created by the Intercept/DF operators. They contain collected DF LOB's and the location of intercepted threats. The location analysts can also create their own files using collected data from other DF data files. They use both computer maps, and transparency overlays on wall maps to establish battlefield situations and targets. The lat-long or UTM coordinates with a EEP confidence major-minor axis data is used in the formation of TACREPS. This data can be transferred into the report using the computer.

The three Traffic Analysts that are configured with recorder playback, time code readers, a computer terminal and intercommunication and audio distribution equipment. Three alpha-numeric computer terminals support the Traffic Analysts in doing text type analysis on voice information. Inputs to the Traffic analysts come via manual gisting, location data from the Location analysts and from reel-to-reel recorders. The responsibility of the Traffic analysts is to reduce the collected data to TACREP message traffic as quickly as possible in preparation for transmission to the tactical commander and other intelligence consumers. The fourth alpha-numeric position is the Tactical Communications Operator (TCO). This position actually sends the computerized TACREPS via the TCT after they are reviewed and released by the Mission Managers. The TCO position has the TCT access, a printer for journalizing the release reports and the paper punch machine. Released reports are also logged in the MSC.

The IPF power distribution/line filtering also reside in van 1. Wall maps and mission area information are available to the mission personnel in van 1 and other vans. Van 1 is the main entrance to the GR-V IPF and the center for intelligence product output activity.

GR-V System Concept

Figure 2.2-1

Table 2.2.1-1
GR-V System Specifications

Duration	4 hours (ISO day at sea level)
Altitude	22 K feet
Range LOS/link range limitations	
Operator positions	
Intercept/DF	12
Intercept supervisors	2
Mission Mgrs.	2
Location analysts	2
Traffic analysts	4
Test operator	1
Computer operator	1
Dissemination	
TACREPS	TCT text messages (UHF)
Voice coordination	TCT voice comms
External	KY-26 Klieglite interface
Paper tape	TTY compatible
Other	Manual MGC-38 ops comm
Link range	170 KM
Link band width	78 kB per link X 2 links per platform
Link capacity	4 voice, 1 each 1.5 kB telemetry per link
Total Links per system	4
Command	5 kB serial
Intercept receivers (per A/C)	
VHF	5
UHF	1
Modulations	AM, FM, SSB, CW
Bandwidths	8, 20, 50, 120 K Hz
Control	Remoted RCU
Multi channel	FDDM, 12 channel (select any 3 per A/C)
Recording	Reel to-reel (2 voice ch, comment & time code)
DF Through-put	30 per minute
DF control	Automatic tune, single key stroke cmd
DF coverage	VHF
DF files	Based on frequency, and time.
Contains	
	ID, operator #, modulation & BW,
lat/long or UTM location and CEP	parameters
Computer	PE 8-32, 32 bit mainframe
Accuracy	(Classified)
Sensitivity	(Classified)
Mission stand-off	Line of sight
Mission range	(Classified) function of LOS/sensitivity
Aircraft	RU-21H
Navigation	ASN-86 with TACAN update
Re-deployment	4 hour tear-down
	8 hour set-up
Transport	C-5A, C-141, ship or improved highway

GR-V IPF Layout

Figure 2.2.2-1

2.2.2.2 Communications/Computer Van

Van 2 has the link, the communications, the encryptors, the main system computer (MSC), the MSC printer, a hard copy graphics copier, and the test support and mission flight coordination functions. This equipment is shown in figure 2.2.2.2.-1. Van 2 also has four of the 12 Intercept/DF Operator stations (except these four positions do not have SDU's). Links and communications use AN/ARC-164 UHF transceivers except for the down link. The down link employs the ARC-176 multi-channel UHF communications set. ARC-176 receivers and Demux's receive and demodulate encrypted signals from the ARF. The down link signals are distributed to all the other positions via the Audio Distribution System. DF and Intercept Commands are formulated in the computer and RCU's. This serial data command and control data is transmitted to the ARF's by the Command ARC-164 UHF radio. KG-30 series key generator encryptors are used to secure the data links/command and control. KY-58's are used for voice and TCT communications. Van 2 has two terminals that support the test operator. These are used along with link monitoring equipment and other test support equipment to insure the proper system operation and to communicate with the pilot. Functions of the test operator position include:

- Mission initialization
- IPF self test/pre-mission loop around tests
- Mission launch and mission monitoring of airborne and IPF health
- VOW communications
- Changing of mission configuration and ARF designator
- Keying, zeroizing and storing of encryptors
- Monitoring of the MSC
- Mission shut-down and logging of any problems

The self test capability in the GR-V IPF generally employs common mission equipment interconnected via special equipment using manual and computer controlled tests. Some units such as the RCU have built-in diagnostic self tests.

2.2.2.3 Operator Van;

Van 3 is generally designated as the Operator van. A photo of the van 3 operator positions is shown in figure 2.2.2.3-1. It has a total of ten positions which include two Operator Supervisors with Alpha-numeric terminals. The Operator Supervisors also operate the system intercom and play a strong role in minute by minute mission coordination/operator tasking and assist the Intercept/DF operators in understanding the events as they unfold. The remaining 8 positions are Intercept/DF operators. Each has access to a payload receiver, SDU and DF equipment via their RCU and the computer terminal. Figure 2.2.2.3-2 is a photograph of the Intercept/DF position. The Intercept/DF operator has access to a recorder, intercom/signal distribution and a time code generator. Positions 4 and 8 have access to an on-board multi-channel Special Purpose Demultiplxer (SPD) capability. The responsibility of the Intercept/DF operators is to search out the threats assigned to them and work any other incidental signal of value in their bands and to do rapid identification, DF, gisting and recording operations.

Communications/Computer Position

Figure 2.2.2.2-1

2.2.2.3 Operator Van (Cont);

When adequate data is collected the mission mangers/supervisors are informed and the DF files are passed via the MSC. The operator supervisors may also listen in and the location analysts can monitor the DF files as they develop (and) request further follow-up data from the Intercept/DF operator on the task. Recorded and hand written information is passed to the Traffic Analysts.

Other support equipment in van 3 included the calibration DF test synthesizer and DF test transmitter, Signal Distribution unit, and external interfaces used for extended system operation and special operations.

Each of the IPF vans has its climate control. Dual air-conditions provide cooling and heat for the equipment the operator personnel. Lighting, emergency exits, alarms, rifle racks etc are part of the IPF equipment.

The IPF has several communications and test antennas that must be installed such as to minimize interference and adjusted to a height provide the coverage in the assigned mission area. The lay out of the IPF is defined in section 2.2.6. Line of sight to the mission platforms is essential for mission operation. The IPF operator van site must be level with-in the tolerances of the leveling jacks that are part of the undercarriages. The installation site must be level within approximately plus/minus one foot over a 50X50 foot area. Security lights are provided as are generators for mission power. The GR-V IPF can operate from 60 Hz commercial power or conditioned 50 Hz or from 95 kW generators. A 10 kW generator is sufficient for auxiliary (mission-down) power.

System installation, life support and manning of the GR-V IPF is covered in the system technical manual.

2.2.3 GR-V ARFs;

The Radio Receiving Sets AN/ARW-83(V3) commonly called the Airborne Relay Facility (ARF) include the GR-V sensors that collect signals and perform DF's against targets of interest and supporting equipment. Figure 2.2.3-1 is a photograph of the GR-V aircraft and its payload installation. Figure 2.2.3-2 is box level functional diagram of the GR-V ARF. The GR-V ARF mission electronics are installed in Guardrail V designated RU21-H aircraft. The RU21-H has wing tip pod DF antennas, VHF and UHF blade antennas, cabling to support their interface to the mission electronics, mission power and a cockpit enunciator that interfaces to the pilot and provides warning lights and the mission active control. The modifications also include cockpit modernization and the ASN-86 inertial navigation system. The mission racks fasten directly to seat rails. Figure 2.2.3-3 illustrates the cabin mounted racks and their interfaces to the airframe. There are three ARF racks as shown figure 2.2.3-3. This diagram shows the location and name of each of the rack mounted units.

There is an antenna control unit and conformal antennas in the pod. The direction finding antenna arrays are configured to provide unambiguous direction finding, collection sensitivity and minimization of cross-interference.

Intercept/DF Operator Position

Figure 2.2.2.3-2

2.2.3 GR-V ARFs (Con't);

The ARF LRU's are typically ATR chassis that have been qualified for airborne applications. Very few of these units came directly from the previous Guardrails however the receivers are common to Trailblazer, and the DF equipment is similar to Trailblazer, the

Air Force and other similar systems. The link is an upgraded version of the GR-IV UHF link. ARF equipment is grouped into link/communications equipment, DF equipment, intercept equipment, TCT relay, power control/distribution, and VOW comm's. The units within each of these subsystems are shown in table 2.2.3-3. Supporting equipment such as the aircraft mounted antennas, VOW encryptor and antenna control/cables that are installed as part of the airframe. Mission specific cable assemblies are used to interface the ARF electronics and the aircraft. The DF cabling is phase sensitive and is phase matched at the factory to the tolerances required. This process make the airframe less sensitive to changes in line replaceable units.

2.2.4 Aircraft

The GR-V RU21-H aircraft is derived from the RU21-G Army utility aircraft or other older mission aircraft such as the RU21-E, A or D airframes. The GR-V RU21-H is upgraded with high flotation landing gear for a 10,200 gross max. weight limit. The aircraft is certified with wing extensions/pods and the other mission airframe modifications. Two 200 amp generators and extra 400 Hz inverters support the mission electronics and avionics. Twenty one of the GR-V RU21-H aircraft exist. Figure 2.2.4-1 shows the aircraft and its antenna configuration. The location and function of each appendage is also shown.

The mission enunciator panel located on the aircraft instrument panel has the Mission Active switch and indicator lights to warn the pilot of mission faults such as over temperature, loss of link synchronization and processor lock-up. The ARF Status panel located on the mission racks behind the co-pilot that shows more detailed mission parameters and has the ARF (1, 2 or 3) designator control. As with other GR systems, the crews responsibility is only to fly the aircraft and to monitor the health of the mission equipment. (Most of the ARF parameters are also monitored remotely, but only the crew can activate or re-cycle the mission equipment.)

2.2.5 GR-V AGE;

Flight line support for the GR-V payloads is provided by the AN/ARM-163(V)3, commonly called the AGE. The AGE electronics is mounted in a step van that has auxiliary power and is fully mobile. It has all the controls, link interfaces and displays necessary to command the intercept and DF subsystems, to monitor their return signals and to do loop around link tests required to assure a successful mission. The AGE is also a diagnostic tool for trouble shooting the ARF electronics. The AGE is linked up to the ARF but can also be connected directly with cables. Test signals are likewise radiated, but can be connected for more precise routine maintenance testing.

Figure 2.2.3-1

GR-V Aircraft and Payload

Figure 2.2.3-1

2.2.6 Tactical Commanders Terminal (TCT);

The An/TSC-87 Tactical Commander's Terminal receives relayed message data from the GR-V IPF via the ARF. These reports are printed out by the TCT for use of the tactical commander. The TCT also has half duplex voice communications used for coordination and re-tasking of the system. KY-58 encryptors are used to secure the TCT links. Figure 2.2.6-1 is a photograph of the TCT field terminal.

2.2.7 GR-V Satellite Remote Relay;

The GR-V system has available a Transportable Relay Facility (TRF) that enables relay of the system links via a TSC-93 earth terminal through the DSCS III communications satellite. It also has a hill top repeater to extend the range from the platform to the transportable relay facility (TRF). Figure 2.2.7-1 is a operational diagram of the GR-V satellite relay. The IPF requires an earth terminal and an interface subsystem installation to operate in the relay mode. All GR-V subsystem nets i.e. data links 1-4, command, VOW, TCT are multiplexed and fiber optically linked to the earth terminals at the remote site and IPF location. Interface hardware installed in the system allows GR-V to operate in either the local or remote mode. The TRF is installed in an S-280 shelter with mobilizes. The entire remote subsystem is transportable in a C-130 aircraft and TRF including the hill-top relay equipment is helicopter lift able. Two of the GR-V systems have satellite relay capability.

2.2.8 Interference Mitigation;

A critical parameter in the GR-V system is its communications frequency allocation requirements. Avionics transceivers operate in the VHF and UHF bands as does the mission sensors and the mission communications links. Up to five mission transceivers connect to a single communications antenna. Although some of the communications links only transmit intermittently, there is great potential for interference.

The intercept subsystem has a high dynamic range RF distribution unit and notch filters to help protect it from on-board interference. Special filters and RF multiplexers in the avionics and the mission equipment are used to reduce splatter and to protect the radios from potential adverse RFI/EMC affects. These include a tracking filter in the pilots UHF radio, notch filters in the avionics and the RF multiplexers in the UHF link antenna path.

In addition to these hardware interference protection devices, further precautions are required. GR-V frequency allocation management, which is an off-line computer program, suggests and validates the selection of mission communications frequencies for command, returned data links and TCT comms. The notch filters are tunable and are switched in when needed. The UHF mux's track the attached transmitter or receiver. The procedures and the limits prescribed must be carefully adhered to in order to avoid direct interference or interference from products generated between either airborne or ground communications. Spacing and orientation of antennas on the ground with its filtering protects the IPF site. Interference between GR-V and other adjacent facilities must also be considered.

Tactical Commanders Terminal

Figure 2.2.6-1

2.2.8 Interference Mitigation (Con't);

On-board the platform the problem is much more critical because of its close proximity to the antennas, and there are strict requirements for aircraft safety. Further, the mission intercept and DF sensors must share the same physical space and frequency bands. The system is effective when the design parameters and standard operational procedures are adhered to, however interference mitigation is a critical system requirement to maximize performance.

2..2.9 GR-V Employment;

Guardrail V is a CONUS based COMINT system that is part of the Army worldwide EW forces. It provides airborne, stand-off collection and location of tactical communications signals. Re-deployment requires advance preparations or at least an advanced party to consider the best location and to insure that line of site to the planned mission flight tracks has been properly considered. The system requires approximately a 200 ft by 200 ft area for the IPF and a landing strip within range of the planned mission flight tracks.

2.2.9.1 Site Preparation and IPF Installation;

Figure 2.2.9-1 illustrates the site layout and spacing of the communications antennas. The overall planning is included in the system manual.

Items to support such a move include camouflage, spares, consumables such as tapes, disks and rations, water, fuel, ammo etc.

Mission initialization sets up the parameters that are standard for a mission or are peculiar to the mission or to the theater of operation. These procedures include bringing the computer up, entering the IPF location, entering maps of the new mission area, crypto keying, setting up the communications frequencies, determining of areas of interest, establishing search scenarios, and entry of applicable archived a-priori data etc.

IPF pre-mission test is part of initialization unless is was already done (this is particularly important if the system has been fully shut down or moved.)

Numerous details are involved for mission implementation. These include personnel briefings, scheduling, flight operations planning, coordinating and establishing of mission flight track profiles, defining of mission objectives/tasking, identification of threats, etc. A correct understanding of the mission area and its terrain along with the priorities for optimization of system performance, is essential to planning system initialization and setting up flight orbits that will insure target field of view (FOV).

A specific procedure defined in the system technical manual must be followed during mission shut down in order to summarize the mission data, store it in archives or retain it as a-priori data for the next mission. It is also important to insure an orderly shut down of the application software. At the close of each mission attention should be given to any problems that may have occurred during the mission. Debriefing of operator and maintenance personnel is part of the mission shut down procedure. Normally the computer equipment and climate control system will be left running for the next mission. Off-line analysis work and training normally occurs between missions.

2.3 IGRV Description and Capabilities;

As shown in figure 2.3-1, the IGR-V mission concept is similar to GR-V. The AN/USD-9(A) Special Purpose Signal Detection System commonly called the Improved Guardrail V (or) IGR-V, is a fifth generation Guardrail system that employs updated data link, DF, and search and acquisition technology. Major product improvements implemented in IGR-V with respect to GR-V are:

- o Pressurized RC12-D aircraft with upgraded cockpit, power systems, ASE, mission antenna arrays and 14,200 gross weight. Includes certification of airframe/qualification testing.
- o High reliability Carousel IV-E inertial navigation system.
- o Integration of the Interoperable Data Link (IDL). Includes PIP's to IGDL, AIDL and GSE that resulted in a common Army/Air Force micro wave data link operating in Ku Band and with dual band tracker upgrades.
- o Army/AF Common Fast Direction Finding (FDF). Increased through-put and expanded frequency coverage to include full VHF/UHF. Includes on-board LOB processing and ground location processing.
- o Auto search via signal classification and recognition system (SCARS). Includes Directed search, general search, signal recognition/classification and area of interest screening. Also triggers automatic DF.
- o Improved primary field of view emitter location accuracy, via improved antenna aperture.
- o Up-graded main system computer (MSC) with color graphic operator displays, message files, joint service report generation and self test and computer diagnostics to support the new technology insertions.
- o Next generation of VHF/UHF receivers
- o Biological/chemical protection for operator vans
- o Improved reporting capability with the dual channel ICTT field communications terminal and message prioritization. (The ICTT interface unit in the IPF is downward compatible with the TCT field terminals and the TCT airborne relay.)

The Improved Guardrail-V system employs the new generation Concurrent 3252 main frame computer with expanded semi conductor memory and multi disk drives and re-uses as much GR-V software as practical. The color terminals use digital color graphics techniques vs. the GR-V "memory scope" type display for graphics so that all terminals are compatible and any or all computer functions can be allocated to an operator and can be supported from any operator position. The computational speed increased an order of magnitude as did memory capacity. Array processors using 68000 chips were added to both the airborne system and the ground equipment for high speed processing of the collected FDF AOI and SCARS signal activity/recognition data.

Table 2.3-1 provides a tabulation of the IGR-V system level specifications.

Table 2.3-1

IGR-V System Specifications

Duration	5.5 hours
Altitude	30 K feet
Range	LOS/link range limitations
Operator positions	
Intercept/DF	12
Intercept supervisors	2
Mission Mgrs.	2
Location analysts	2
Traffic analysts	4
Test operator	1
IGDL operator	1
Dissemination	
TACREPS	ICTT (Via IDL/UHF relay)
Voice coordination	ICTT voice (Via IDL/UHF relay)
External comms	TRI TAC, Auto DIN
Paper tape	TTY compatible
Other	Manual MGC-38 ops comm
Micro wave link	IDL (One Ku band, one dual Ku/X tracker)
Link range	240 km (Max)
Up-Link data rates	200 KB command (multi channel) with anti jam capabilities
Down-Link Data rates	10.7 MB down link (multi channel) 8 ea. 1.152 MB plus 4 ea. 50 KB plus a spare 800 KB channel
Link Voice channels	16 embedded in one 1.152 MB down-link channel (Interoperable)
ICTT link channel	50 KB (duplex)
Link nav back-up	Range/angle tracking
Mission control	Command 20 KB serial; DF/SCARS 20 KB
Intercept receivers	VHF/UHF Up to 14
Modulations	AM, FM, SSB, CW
Bandwidths	8, 20, 50, 150 K Hz
Multi channel	12 channel (select any 3 from each A/C)
DF Through-put	Coarse: 20 per second Fine: 5 per second
DF control	Automatic/single key stroke
DF coverage	VHF/UHF
DF files	Based on frequency, and time (ID, operator, modulation & BW, lat/long or UTM and CEP) parameters are stored in disks
Special signals	Proforma and IEWP
Accuracy	(Classified)
Sensitivity	(Classified)
Receiver Control	Remoted RCU/Directed Search
Mission stand-off	Line of sight
Mission aircraft	RC-12D
Re-deployment	4 hour tear-down 8 hour set-up
Transport	C-5A, C-141, ship or improved highway
IPF Ambient temp	-40 to +120 deg F
ARF Inside Ambient	-5 to 131 deg F

2.3 IGRV Description and Capabilities (Con't);

IGR-V has approximately an order of magnitude increased DF throughput and computer capacity. Its ability to search out targets of interest and automatically locate them is a key upgrade. Use of the Interoperable data link and the common fast DF system provides interopability with an Air Force system. The ability to get higher altitudes and a longer range data link gives the system greater coverage and the pilots no longer need to wear oxygen masks during the mission.

Figure 2.3-2 is a functional block diagram of the IGR-V system.

2.3.1 IGRV IPF;

The IGR-V Surveillance Information Processing Center AN/TSQ-105(V)4 (IPF) is installed in tempest/NBC sea-land type transportable operator vans. The IGR-V IPF employs a four van complex with a total of 23 operator stations. The shelters have positive pressure, entry vestibule, filtration of air and alarm systems for NBC protection. In addition to the operator vans, IPF subsystem includes the power distribution vans, the IGDL Trackers, the maintenance support van and test antennas/backup VOW antenna. Figure 2.3.1-1 is a functional diagram of the IGR-V IPF. Figure 2.3.1-2 is a pictorial drawing of the IPF site. Figure 2.3.1-3 is plan view of the IPF operator vans. Figure 2.3.1-4 shows the physical van configuration. The side view in this figure shows the NBC filter system and the entry vestibule.

Van 1 has 8 positions.

- Two Mission Managers with large screen 21" terminals and access to internal and external ICTT voice communications.
- Two Location Analysts with access to the ICTT and voice channels the same as the Mission Managers.
- Four Traffic Analysts with 13" terminals, recorders for playback and access to comms. One of the Traffic Analysts is the tactical operator and has the ICTT interface and printer for a record of message transmissions.

The van 1 likewise has tactical area maps, ICTT printer for logging message traffic, and control of the TACREP message interface at one of the traffic analyst positions. Van 1 also has the power distribution and the MSC printer.

Van 2 has the Main System Computer (MSC), the IEWP, and work space/expansion space for operator positions.

Van 3 has the communications facility with the test operator and four of the 12 Intercept/DF Operators. The IDL, VOW, ICTT comms and the system monitoring equipment reside in this van. Encryptors, Auxiliary comms, and mission initiation/diagnostics are part of van 3. The test operator's responsibilities are:

- Power-up/pre-mission test and initialization of computer system.
- Start-up and readiness test of the IGDL (initialization and loop around test).
- Manage the interactive test of the various hardware equipment in the IPF and do VOW, ICTT, data multiplexing loop-around tests.
- Communicate with the flight crew and monitor mission flight data.

IGR-V IPF Interior Layout
Figure 2.3.1-3

2.3.1 IGR-V IPF (Cont);

Van 4 is the operator van. There are 8 Intercept Operators and two Supervisors in this van. The operators have the following equipment to support the collection, file generation and emitter location responsibilities:

- Computer terminal- Supports tasking assignments; creation of a file to enter data; signal identification, provides key stroke DF control; manages stored collected DF data that includes auto storage of parameters such as frequency, modulation and band width; and other on-line functions.
- RCU for controlling the on-board intercept receivers.
- SDU for monitoring the spectrum in the region of tuning.
- Time code for mission time and recorder synchronization.
- Data distribution/Intercom headset and controls.
- Reel-to-reel recorder with dual signal recording, comments and time.

The van 4 equipment includes two Operator Supervisors positions with computer terminals, system connectivity etc. These positions also have the Signal Distribution/ Intercommunications consoles which are controlled by the supervisors. The supervisors also have RCU's and recorders. The DF test synthesizer/transmitter resides in van 4 along with some of the data demultiplexing, multi-channel frequency division demultiplexing (FDDM) equipment and Proforma equipment.

2.3.2 IGRV ARF;

The Radio Receiving Sets AN/ARW-83(V)5 commonly called the Airborne Relay Facility (ARF) provide the IGR-V airborne sensors that collect signals and perform DF's against targets of interest. The IGR-V ARF mission electronics are installed in the Improved Guardrail V designated RU12-D aircraft. The RU12-D has wing tip pod DF antennas, VHF and UHF blade antennas, fore/aft IADL dish antennas, cabling to support their interface to the mission electronics, cockpit modernization, mission power/cockpit enunciator and mission active control and the C-IV-E inertial navigation system. The two mission racks fasten directly to seat rails. Figure 2.3.2-1 illustrates the ARF components, gives their names and shows their interfaces to the airframe. The antenna arrays are configured to provide unambiguous direction finding, good collection sensitivity, link communications and are configured for the minimization of cross-interference.

Figure 2.3.2-2 is a simplified functional diagram of the IGR-V payload.

The primary mission of the ARF is the sensor for the IGR-V system. Sensors include the intercept equipment and the DF equipment. The ARF has provisions for 14 each R-2089 intercept receivers. Other intercept equipment includes the antenna notch filter, RF Distribution, SDU Remote and SCARS 0 and SCARS 1/2 down converter.

The FDF equipment includes the RF Processor, R-2077 DF receiver, and the airborne DPU. These remotely controlled equipment's operate in concert to collect signal and obtain lines of bearing to the emitters of interest.

2.3.2 IGR-V ARF (Cont);

Supporting equipment includes the communications and power system. IADL equipment has an executive processor, R/T, TWTA, wave guide/antennas and KG-45 COMSEC. Multiplexing equipment includes the Command Demux and the Data Mux. The ICTT relay is TCT compatible and includes 2 ARC-164 transceivers and RF filtering. A airborne power supply, power distribution and a ARF status panel are provided to control and monitor the mission equipment. An enunciator/control panel is located in front of the co-pilot to activate the mission, monitor warning lights and control the IADL TWTA/antennas.

2.3.3 RC12-D Aircraft;

The IGR-V RC12-D special electronic mission aircraft is a modified version of an RC12 utility aircraft. This pressurized dual seat aircraft is powered by two UACL PT 6A41 turbo prop engines rated at 850 SHP with Hartzell 3 blade, constant speed propellers as pictured in figure 2.3.3-1. The high accuracy version of the Delco Carousel IV-E inertial navigation system is integrated into this near all weather aircraft. Antennas include "RU21-H like" wing tip pods, plus a tail boom blade, dual microwave link antennas, and a UHF array. Avionics are updated with systems like the Sierra TACAN DME for INS position updates, AP-106 auto pilot, ARC-186 radio, RT- 1167 (ARC-164) UHF radio, APN-215 color weather radar and an ASE suite including the AN/APR-39, AN/APR-44 and the M-130 chaff and flare dispenser. The gross max capacity of the RC12-D is 14,000 lbs. Figure 2.3.3-2 shows the aircraft configuration and defines the location and usage of its avionics and mission antennas. The platform has reserve for future growth and is able to exceed 25,000 ft altitude.

2.3.4 IGRV AGE Subsystem;

Flight line support for the IGR-V payloads is provided by the AN/ARM-163(V)4 commonly called the AGE. The AN/ARM-163 Auxiliary Ground Equipment provides complete flight line maintenance and test for the ARF mission electronics. The AGE physical configuration is shown in figure 2.3.4-1. It does loop around test of the communications and link equipment. Radiated signals and commands are used to test the on-board Intercept and DF equipment and software. The AGE uses a mini computer to formulate tests and record test results.

The AGE is installed in a 1 ton step van with auxiliary power for flight line operation. Direct routing of test signals via cable and test panel is provided as an alternate method of test when it is desirable not to radiate signals or when more exacting levels are required. The AGE is also capable of self test/diagnostics which verifies the AGE equipment prior to preflight operations. Figure 2.3.4-2 is a functional diagram of the IGR-V AGE.

2.3.5 Interoperable Data Link

The Interoperable data link was developed by the Air Force and improved by the Army for use on the IGR-V system. IGR-V uses two IGDL Trackers shown in figure 2.3.5-1 for dual aircraft operation. The Trackers have 6 ft tracking dishes and house the TWTA amplifier, receiver and have built-in alignment and test support features.

Three racks of equipment in the IPF contain the modulating/demodulating, encoders, encryption, and computer control/diagnostic equipment. Each link requires one rack of equipment and the third rack supports built in test and control functions.

The IDL interfaces to the mission multiplexers, demultiplexers and to the MSC. The data link provides back-up location updates to the INS.

Airborne IDL (IADL) equipment interfaces to the on-board mission Data Multiplexers and Command Demultiplexers, and to the airframe fore-aft antennas and to other IDL control interfaces that are installed by the airframe company. Power up and back-up antenna controls are located on the instrument panel. Automatic switching between the dual link antennas are tied to the navigation/IDL Executive processor to give fore-aft coverage. The tail antenna gives about 210 degrees of coverage and the nose gives plus minus 90 degrees coverage. The link operates in the Ku band well outside the mission collection frequency band and has about 70 watts of down link power.

The link ground support equipment (GSE) is located in the AGE is a subset of the equipment in the IPF and ARF. It has both self test and loop around tests to initialize and check out the ARF IADL link.

Figure 2.3.5-2 is an interface diagram of the ground based IDL equipment.

2.3.6 Improved Tactical Commanders Terminal (ICTT);

The AN/TSC-116 remote communications terminal supports the reception of dual relayed IGR-V tactical reports and has half duplex voice communications. Each ICTT is equipped to receive secure teletype messages from two sources at a time. One relay might be the local Guardrail and the other may by from a neighboring Corps Guardrail or the Air Force. These TACREP messages are buffered into the ICTT field terminal, checked for priority and printed out or buffered into a host computer. Figure 2.3.6-1 is a drawing of the ICTT field terminal installation and its interfaces.

The ICTT also has half duplex voice communications for tasking and chatter with other commanders. Since the ICTT is relayed from the IPF through the ARF, it has a range that extends well beyond the normal line of sight. The ICTT has an antenna and encryption equipment. It is mounted in carrying cases to protect it while in transit. Power is provided by the host unit.

Radios in the ICTT are ARC-164's and are secured by KY-58 encryptors.

ICTT Application

Figure 2.3.6-1

2.3.6 Improved Tactical Commanders Terminal (ICTT) (Con't);

Figure 2.3.6-2 is a functional diagram of the AN/TSC 116 ICTT Terminal equipment. The ICTT has three modes: The TCT compatible 300 baud mode, the mid rate 1 K baud rate and a 2K baud rate. Figure 2.3.6-2 also illustrates how the IPF and ARF reporting interfaces and how reporting interop works.

The IPF ICTT message equipment is also downward compatible with the older AN/TSQ-87 TCT field terminal.

2.3.7 IGRV Employment;

Improved Guardrail V is a CONUS based COMINT system that is part of the Army worldwide EW forces. It provides airborne, stand-off collection and location of tactical communications signals. Re-deployment of IGR-V needs to have advance preparations or at least an advanced party to consider the best location and to insure that line of site to the planned mission flight tracks has been properly considered. Although the system has organic support, it requires an IPF installation area with tracker line of sight to the flight tracks and a landing strip within range of the planned mission flight tracks.

2.3.7.1 Site Preporation and IPF Installation;

A pre-planned order of entry to the new site will be necessary to insure proper set-up. The order of march for convoy should be based on the order of entry if possible. The actual order of arrival may be driven by considerations that will vary from sited to site. The Suggested order is IPF vans 1, 2, 3, 4, trackers, power distribution system, maintenance 189 van, 190 van and Aux. van.

Figure 2.3.7.1-1 illustrates the site layout and dimensions. The overall planning is included in the system manual TM 11-5865-243-10.

Items to support such a move include tractors, the NBC protection filters, camouflage, spares, consumables such as tapes etc and rations, water, fuel, ammo etc.

2.3.7.2 ARF/AGE Checkout Proceedures;

Proper check out procedures assures that the mission electronics are properly installed in the aircraft, the aircraft is powered up, INS is aligned and the mission electronics is activated. There are certain safety precautions such as microwave radiation perimeter/protection of personnel etc. The crypto equipment is installed and keyed to either the test code or the code to be used on the mission, if the mission is to follow the checkout.

The AGE, after successful self test, is locked up to the mission data link. Loop around tests demonstrate that the link is operating correctly. The on-board intercept equipment is commanded to specific test scenarios. A low level radiated signal from the AGE is received and the response of the mission intercept is monitored in the AGE. Like wise, the DF system is commanded and its response to its own test signal is monitored within the AGE. If the mission equipment is operating correctly and the platform is properly identified as an "ARF 1" or "ARF 2" and the communication/link frequencies are properly set-up the platform is declared mission ready. Abbreviated tests may be used for quick turn around or more extensive diagnostics may be used if there is trouble with the mission equipment.

ICTT Link Interface
Figure 2.3.6-2

2.3.7.3 Mission Inialization;

Mission initialization sets up the parameters that are standard for a mission, or are peculiar to the mission or to the locality. These include bringing the computer up, entering the IPF location, crypto keying, setting of communications frequencies, entering up to 16 areas of interest, establishing search scenarios, and entry of applicable archived a-priori data etc.

IPF pre-mission test is part of initialization if that has not been previously done (this is particularly important if the system has been fully shut down.)

2.3.7.4 Mission Deployment;

Numerous details are involved for mission implementation. These include entering the IPF coordinates into the computer, tracker locations/bore sighting, entering mission maps into the computer, and reviewing mission tasking, personnel briefings, mission scheduling, flight operations, coordinating and establishing of mission flight track profiles, defining of mission objectives/tasking, identification of targeted threats, etc. A correct understanding of the mission area and its terrain, insuring link LOS, along with the priorities for optimization of system performance, is essential to planning of system initialization and location of flight orbits that will insure target field of view (FOV).

2.3.7.5 Operator Responsibilities;

Mission Manager
Establish mission goals and personnel tasking. Normally performed by a 98 C.

COMINT Supervisor
The COMINT supervisor positions are normally manned by senior 98 Gs who have system experience and intercept experience. Their task is to help individual operators and maintain the proper environmental coverage. They verify that operators are not needlessly overlapping and aid in passing signals to operators who may be more experienced with certain types.

COMINT Intercept/DF Operator
The intercept positions are manned primarily by 98 G's and somewhat by 98 Ds. These operators are responsible for identifying emitters, DF'ing recording and transcribing the audio or using other equipment to perform signal analysis.

Traffic Analyst
The traffic analyst position is manned by a 98 C who is responsible for sorting through the situation analysis data and generating the various report types which end users require.

Location Analyst

The location analyst function is performed by an 98 C who has the responsibility to analyze the transcripted and DF data from the intercept/DF operators to determine the target area laydown and movement of units.

2.3.7.5 Operator Responsibilities (Cont);

Tactical Communications Operator
The TCO is a 98 C who is responsible for helping generate reports and is also normally the final check for validity and security for outgoing reports. This position is then responsible for selecting the outgoing message path and transmitting the message.

Civilian Support Personnel
In addition to assigned military personnel, most sites are supported by civilian personnel who are specially trained to help maintain equipment and provide support to the unit operations. Examples of these contractor technical representatives (CTRs) are BASI support personnel who maintain the aircraft, contractor personnel who support the data link and government/contractor personnel who help to perform training on the prime mission electronics.

2.3.7.6 Flight Tracks;

2.3.7.6.1 Flight Tracks For Single aircraft;

The system can operate effectively with only one aircraft. Of course, there will be no instant DOA triangulation capability with a single aircraft. The flight track should simply be the baseline from waypoint to waypoint in as straight a line as possible. This will provide for maximum coverage of the area of interest. It is also possible to fly a "dog-leg" track , taking care that the center turn is under 45 degrees to avoid a blind area in the center of the track. The dog-leg track will allow for slightly enhanced coverage of the center mission area, but the straight line leg for longer baseline is preferred. With a single aircraft there is also more flexibility in the track distance and flight operation since there are no turns to coordinate and the track can extend as far along the signal of interest front as desired.

2.3.7.6.2 Flight tracks For Dual Aircrft;

Normally, two aircraft are used on a mission. In this case, "canted" legs as shown in figure 2.3.7.6-1 is best, as it will provide best coverage of the central area while allowing running optimum DOA fixes. If a longer baseline is required, the aircraft should fly canted legs spread apart by about 50 to 75 km.

2.3.7.7 Missiion Shutdown;

A specific procedure as defined in the system technical manual, must be followed during mission shut down in order to safely summarize the mission data, store it in archives, or retain it in files as a-priori data for the next mission. To avoid loss of data it is important to insure an orderly shut down of the computer and data link. Debriefing of operator and maintenance personnel is part of the mission shut down procedure. Proper attention should be given to record any problems that may have occurred during the mission. The conclusion of a day's mission activity should be followed up immediately with maintenance required to resolve any problems that might have occurred during the mission. Normally the computer equipment and climate control system will be left running for the next mission. Normally operator training and off-line analysis work occurs between missions.

2.4 GR/CS System 3 and GR/CS System 4 Description and Capabilities;

The AN/USD-9(B) Special Purpose Signal Detection System commonly called the Guardrail Common Sensor System (or) GR/CS is a combined COMINT-ELINT or "SIGINT" system. Guardrail Common Sensor is a product improvement to the IGR-V system. This section therefore will define the upgrades and design changes with respect to the capabilities of IGR-V and provide top level GR/CS system definition and specifications. System 4 major enhancements include the following:

o Integration of CHAALS for COMINT high accuracy TDOA/DD COMINT emitter location which provides support to COMINT targeting operations
o AQL for ELINT collection/emitter location/target processing and ELINT TDOA
o Receiver pooling for flexible allocation of intercept assets
o Digital temporary storage recording (DTSR) and a digital audio bus for audio recording and audio distribution support to the operator positions
o SIGINT related software upgrades for combined for processing of combined COMINT/ELINT missions and for TDOA operator tasking.
o Integration of GPS for highly accurate navigation updates
o Re-engine, modified RC12-K aircraft with PT-67A engines, increased payload capacity/take-off climb margin required for SIGINT mission capacity. Includes new SIGINT wing tip pods.
o Integration of third IDL for three platform ELINT and TDOA COMINT missions

A number of upgrades related to these fundamental enhancements are also a necessary part of the GR/CS program. For example GR/CS employs four main frame computers Vs one computer in IGR-V, with integrated software interfaces that are required between COMINT, ELINT and CHAALS. These computers and several new special processors support the new SIGINT capabilities and precision time difference of arrival (TDOA) emitter location capabilities and provide the required additional processing power and storage to manage the approximate additional 500K lines of code entailed in GR/CS.

Two different airframes were used for systems 3 and 4. The RC12-H used on system 3 is a derivative of the RC12-D that is used for IGR-V. The reason for this variation hinged on the fact that the RC12-K could not be made available in the delivery time frame. The RC12-H has the appearance of the RC12-K including the new pods, but has the smaller PT-6A-41 engines and a 15,000 lb gross max weight limit.

The RC12-K GR/CS System 4 aircraft has larger engines and beefed up wings and additional empennage modifications for stabilization and a 16,000 lb gross max capacity that is capable of carrying the added CHAALS and AQL sensors.

The technology for many of the system upgrades such as Temporary Digital Storage Recording (DTSR), GPS hardware, AQL and CHAALS came from other programs. For example, the DTSR came from an Air Force program. This upgrade allows the operators to efficiently record and play back audio signals. The recorded signal data is stored on magnetic disks for instant recall. Signals can be designated for automatic recording and the operator can do play back while recording is still in progress.

2.4 GR/CS System 3 and GR/CS System 4 Description and Capabilities (Cont);

With this capability the operator can do a computer search for recorded signals based on time, frequency, or operator position etc. Recording automatically takes place when a directed search intercept occurs, if that is desired. An audio bus for Intercommunication and Signal Distribution and a receiver pooling capability were added as part of the signal handling upgrade to better support the SCARS signal acquisition automation. One of the many system software upgrades incorporates connectivity for allowing in-coming messages into the system computerized message data base.

Guardrail Common Sensor systems 3 and 4 are part of the same product improvement program but differ in the amount of hardware deployed and the fielded capabilities. Although System 3 was tested with a full complement of hardware, it was delivered without AQL and CHAALS and their assigned mainframe computers. The RC12-H airframes were the available aircraft at the time of integration but did not have the capacity for the full mission nor were production AQL and CHAALS units available at the time, therefore GR/CS System 3 was deployed with only six platforms and with no CHAALS targeting capability or ELINT capability installed.

Figure 2.4-1 shows the GR/CS System physical configurations. The subsystem differences between System 3 and System 4 are:

1. System 3 IPF does not have the CHAALS or AQL subsystems or their maintenance facilities.
2. System 3 IPF does not have the third data link that is required to support CHAALS three aircraft missions.
3. The System 3 IPF has two main frames and CPO for two additional computers and other AQL/CHAALS specific equipment.
4. The System 3 payloads have full provisions but only IGR-V equipment installed
5. The System 3 AGE has provisions but lacks the extra AQL/CHAALS ground support equipment
6. System 3 has six RC12-H platforms Vs nine each RC12-K's used on system 4

System level specifications for GR/CS System 3 and GR/CS System 4 are outlined in Table 2.4-1.

High level system interfaces are shown in figure 2.4-2. The System 4 composition is shown in Figure 2.4-3 with its IPF, AGE and the ARF's which are mounted in the airborne platform.

In addition to the above defined basic System 4 specified upgrades, a group of QRC enhancements were added to system 4 late in the program. These include microwave intercept and downward frequency intercept extensions, special signal receiver capability, expanded multi channel, Proforma enhancements and Smart File Cabinet/FasTrack smart map capability.

2.4.1 Guardrail Common Sensor IPF;

The GR/CS Surveillance Information Processing Center AN/TSQ-105(V)5 (IPF) is installed in four Tempest/chemical-biological protected sea-land type transportable operator vans. Refer to figure 2.4-1 for a pictorial illustration of the System 4 IPF subsystem configuration. A functional block diagram of the IPF subsystem is shown in figure 2.4.1-1.

Table 2.4-1
GR/CS Systems 3 and 4 Specifications

Duration	
System 3	4.9 hours
System 4	4.8 hours
Altitude	30 K feet
IPF to payload range	LOS/link range limitations
Operator positions	
Intercept/DF	12
Intercept supervisors	2
Mission Mgrs.	2
Location analysts	2
Traffic analysts	4
Test operator	1
IGDL operator	1
ELINT positions	3 (CPO/terminals on system 3)
Digital Audio System	
DTSR	48 channels of record/playback
Audio Bus	32 stations of intercom/distr.
Storage capacity	Approximately 80 hrs
High accuracy location	CHAALS TDOA/DD (CPO on system 3) AQL TDOA (CPO on system 3)
Dissemination and Comms	
TACREPS (Sys 3)	ICTT (Via IDL/ARC-164 UHF relay)
Voice coordination	ICTT voice (Via IDL/UHF relay)
External (Std)	TRI TAC, Auto DIN
TACREPS Sys 4)	CTT LRIP with TDMA relay
External (Sys 4 Retrofit)	DDS (TRI TAC, Auto DIN, GENSER, MSE, STU III
Other (Sys 4)	TIBS (receive)
Link range	240 KM
Up-Link data rates	200 KB command (multi channel) with anti jam capabilities,
Down-Link Data rates	10.7 MB down link (multi channel) 8 ea. 1.152 MB plus 4 ea. 50 KB plus a spare 800 KB channel Link Voice channels 16 embedded in one 1.152 MB down-link channel (Interoperable)
CTT link (duplex)	50 KB (Interoperable)
Primary Nav update	GPS
Back-up nav Update	Link range/angle tracking and TAC AN
Mission control	Intercept Command 20 KB serial, DF/SCARS 20 KB

	CHAALS 20 KB
	AQL 20 KB
ELINT	(See Table 2.6.1-1)
Intercept receivers	VHF/UHF (Up to 14 receivers)
Modulations	AM, FM, SSB, CW, FDM
Bandwidths	8, 20, 50, 150 K Hz
Pooling	Assets allocated from IPF
DF Through-put	Coarse: 20 per second
	Fine: 5 per second

Table 2.4-1 (cont)
GR/CS Systems 3 and 4 Specifications

DF control	Automatic/manual single key stroke
DF coverage	VHF/UHF
Receiver Control	Remoted RCU/Directed Search
DF files	Based on frequency, and time (ID, operator, modulation & BW, lat/long and UTM, CEP) parameters are stored in disk Accuracy (Classified)
Sensitivity	(Classified)
Mission stand-off	(Classified)
Mission aircraft	RC-12K
Re-deployment	4 hour tear-down 8 hour set-up
Transport	C-5A, C-141, shipboard or improved highway
IPF ambient temp	-40 to +120 degrees F
ARF inside ambient	-5 to + 131 degrees F

2.4.1 Guardrail Common Sensor IPF (Con't);

The Guardrail Common Sensor IPF provides the control, data processing for "IGR-V COMINT", CHAALS and AQL capabilities and message preparation for distribution via the CTT and TRI-TAC and the retrofitted DDS land line communications interfaces. The Guardrail Common Sensor IPF has provisions for 27 operators. Figure 2.4.1-2 shows the IPF interior layout.

Van 1 has 8 positions.

- Two Mission Managers with large screen terminal and comms.
- Two Location Analysts with the same access to the CTT and voice data as the Mission Managers.
- Four Traffic Analysts with terminals, recorders for playback and CTT access.

GR/CS System Composition

Figure 2.4-3

IPF Interior Layout
Figure 2.4.1-2

2.4.1 Guardrail Common Sensor IPF (Con't);

The Guardrail Common Sensor IPF provides the control, data processing for "IGR-V COMINT", CHAALS and AQL capabilities and message preparation for distribution via the CTT and TRI-TAC and the retrofitted DDS land line communications interfaces. The Guardrail Common Sensor IPF has provisions for 27 operators. Figure 2.4.1-2 shows the IPF interior layout.

2.4.1.1 Analyst Van;

Van 1 has 8 positions.

- Two Mission Managers with large screen terminal and comms.
- Two Location Analysts with the same access to the CTT and voice data as the Mission Managers.
- Four Traffic Analysts with terminals, recorders for playback and CTT access.

As shown as part of Figure 2.4.1-2, the Analyst Van (Van 1) provides environmental control, electrical and operational support for mission operation positions normally configured to support Traffic Analysts, Mission Managers and Location Analysts. One of the Traffic Analyst position serves as the Traffic Control Operator (TCO). The van also contains the prime power distribution rack with power panels for AC power circuit breakers, power filtering and power monitoring indicators for all four IPF vans. Interior and exterior lighting control circuit breakers for all vans are also contained in the van 1 power rack. A hard copy capability and the MSC laser printer are also located in van 1.

Each of the three Traffic Analyst (TA) positions contain a 13 inch color graphics display terminal and keyboard entry device. TA personnel are responsible for accessing a catalog of situation database entries, and identification and a message generation capability, that through the use of message masks, allows the analyst to manually transcribe data and target location information into tactical and special message formats for release to various field users. One, two or all three of the TA positions can be optionally re configured for ELINT operation as mission tasking and other circumstances dictate. This switching is performed from the computer operator position and is normally set-up during premission activities if required.

Two Mission Manager (MM) positions are also located in van 1 of the IPF. Each of these positions contains a 19 inch, high resolution, color-graphics display terminal and companion keyboard similar to that found at the other operator positions. The MM is the top-level operational overseer responsible for the mission planning and tasking of the system as dictated by the outstanding general and detailed tasking requests of tactical intelligence consumers. The MM controls message database and emitter location information; establishes general search lists and monitors them by means of mission histograms; and activates, edits and deactivates these search lists to the current mission tactical situation.

The hardware found at the Location Analyst positions includes the same 19 inch, color graphics, display terminal and keyboard, as the Mission Manager positions. The location Analysts are responsible for reviewing, editing and merging current DF files utilizing zone definition and analysis techniques. Upon completion of the review process, this information may then be passed into the situational database for report generation and display.

2.4.1.1 Analyst Van (Con't);

The Traffic Control Operator (TCO) designated TA position is equipped with the same hardware terminal items as the TA positions. The TCO ensures that all out-going messages are properly formatted and do not violate the classification levels of the link over which they are being passes. The TCO also determines the means of message transmission, (CTT, TRI-TAC, or other means as appropriate), ensures that transmittal is accomplished, and controls all direct communication links relayed through the ARF's to the remote CTTs. The TCO position can optionally function as a TA position if required.

2.4.1.2 Computer Van

Van 2 has the Main System Computer's (MSC's), IEWP, and terminals for three ELINT operator stations. A full complement of computers would include one MSC for COMINT, one for AQL processing, one for CHAALS location processing, and a spare to back-up a failure in the MSC or CHAALS.

The computer Van (Van 2), shown as part of Figure 2.4.1-2, provides environmental, electrical and operational support for four Perkin-Elmer 3252 computers. The van also provides the support elements for two ELINT Operators/Analysts, one ELINT Supervisor, one Computer Operator position, interface equipment and the TDOA/DD location and high-speed signal processors. The three ELINT positions are configured with the same display terminal, keyboard, and operator audio interface assembly as that found at the COMINT operator positions; however, the ELINT positions do not have a Receiver Control Unit (RCU), Spectrum Display Unit SDU() or audio recording capability. A voice communications control panel is installed at each position to allow direct message generation, CTT comms and reporting in support of mission specific ELINT tactical requirements. The ELINT Supervisor's position can also be assigned with software functions required for mission planning, report preparation, and for data edit and review.

The Computer Operator position is provided in support of the mainframe computer segment. This position is equipped with the 13 inch graphics display and keyboard input terminal found at the COMINT and ELINT Operator positions. Although the Computer Operator position is normally unmanned during a GR/CS mission, it is utilized to perform pre-mission initialization of the mainframe computer processors; conduct the switching of system peripherals; and run computer diagnostics, as required.

2.4.1.3 Communications Van;

Van 3 is the communications facility with the mission test operator and four Intercept/DF Operators. This van is basically configured like IGR-V except it has a extra rack of IDL equipment third IGDL link, a three link Status Unit, a third Data Demux and a set of DTSR equipment. The IDL, VOW, CTT comms and the system monitoring equipment reside in this van. Encryptors, Aux. comms, and mission initiation/diagnostics are part of van 3.

The Communications Van (Van 3), as shown as part of Figure 2.4.1-2, contains the GIDL equipment, and IDL operator, the Test Operator, Collection Operator positions 9 through 12, the ground digital processor, SCAR 1 and SCAR 2 processors and UHF communications equipment.

2.4.1.3 Communications Van (Cont);

The Test Operator position is supplied with two 13 inch graphics display and keyboard input terminals – one serving as the IDL console to monitor data link status and control, and the other serving as the IPF test operator console for the performance of system BIT and diagnostics testing. This position is manned by a 33R.

The test operator's responsibilities are:

- Power-up/pre-mission test and initialization of computer system.
- Start-up and readiness test of the IGDL (initialization and loop around test).
- Manage the interactive test of the various hardware equipment in the IPF and do VOW, CTT, data multiplexing loop-around tests.

The Collection Operator positions have an RCU which permits the operator to control the respective airborne COMINT receivers. The RCU has a manual, step, scan, and stored frequency tuning modes. The Van 3 operators have an SDU to monitor the signal environment in the vicinity of the tuned frequency. They are supported by Digital Temporary Storage Recorder (DTSR) and signal distribution/ intercommunications system. The system can handle two audio channels from up to 2 remote receivers. The Collection Operator positions also contain the Ramtek 6212, high resolution, color-graphics display terminal along with an accompanying keyboard.

2.4.1.4 Operators Van;

Van 4 is the operator van. The Operator Van (Van 4), shown at the top of Figure 2.4.1-2, contains Collection Operator positions 1 through 8, and two Collection Supervisor positions. Each of these positions are configured identically to the Collection Operator positions located in Van 3, with the exception that the two Collection Supervisor positions that are located in van 4 monitor the overall activities of the Collection Operators, and perform emitter location analysis as they oversee the Intercept/DF operator activities.

The operators have basically the same computer equipment and similar software as the IGR-V to support the COMINT collection, the DF file generation and other Intercept/DF responsibilities. A major difference between IGR-V and the GR/CS system is its DTSR with automatic record, digital playback and the pooled receiver assets to support automatic signal acquisition Vs manual acquisition and manually operated reel-to-reel recorders. GR/CS also has the audio digital bus and a digital intercom system for internal voice communications and signal distribution and significant software upgrade to support the new capabilities. The Mission Supervisors are in charge of operating the intercom and signal distribution equipment similar to their responsibilities in IGR-V.

2.4.2 Interoperable Data Link;

The Interoperable Data Link (IDL) system used for GRCS is similar to IGR-V. It consists of the Interoperable Airborne Data Link (IADL) group; the Ground Support Equipment (GSE) group; and three trackers (channels) of Interoperable Ground Data Link (IGDL). The IADL consists of equipment contained within the RC-12K aircraft and provides the capability to receive commands from, and transmit data to, the companion IGDL or GSE. The GSE group is comprised of all of the IDL equipment associated with the Auxiliary Ground Equipment (AGE) van.

2.4.2 Interoperable Data Link (Cont);

The IGDL constitutes all of the data link equipment contained within, or supporting the IPF to include four racks of equipment; the cable pallets; and three remote tracker/trailers.

Three tracking microwave dish antennas, mounted on separate M390 trailers (Refer back to Figure 2.3.5-1), provide the wide band data transmission and encrypted communications links between the IPF and the airborne platforms. The data links transmit the commands to control and initialize the equipment in the ARFs, as well as provide the means for all collected COMINT and ELINT LOP's, ELINT target data, TDOA/DD sensor data, SCARS data, and intercepted audio signals to be returned to the IPF for processing by the operators and the traffic analysts. DF, ELINT and CHAALS precision location data are processed and correlated on the ground and displayed to the collection/DF operators for real-time analysis and reporting of both COMINT and ELINT information. The data links also provide voice order wire communications to the

ARFs. Real-time tactical reporting is accomplished via the CTT and area communications. VHF, UHF, ground data and voice communications facilities are also included for auxiliary communications, voice order wire backup, and system calibration purposes. Other support equipment includes two power distribution/generator trailers, a maintenance van, and a storage van. The IGDL group is operated and controlled through the Test Operator position located in IPF van 3.

2.4.3 Guardrail Common Sensor ARF;

The Radio Receiving Sets AN/ARW-83(V)6 commonly called the Airborne Relay Facility (ARF) functions as a remotely controlled airborne collection sensor and consists of the airborne portions of the IGR common equipment, AQL and CHAALS subsystems mounted in the SEMA aircraft.

2.4.3.1 The ARF Prime Mission Equipment (PME);

The GR/CS ARF is nomenclature as the AN/ARW-83(V)6. The ARF collects communications and non-communications data, does precision emitter location, provides fast DF, and transmits the information to the IPF in real time via the Interoperable Data Link (IDL) for processing. The ARF also include a two-way CTT relay to and from the tactical field commanders. The IGR-V type DF equipment contained in GR/CS ARF's consists of specifically arranged DF antenna pairs with a radio frequency (RF) processor, and ADPU and a DF receiver. Also included are elements of the automatic Signal Classification and Recognition System (SCARS). All receiver commands and data are transmitted via the IDL.

Physically, the Guardrail Common Sensor ARF pallets include the IGR-V capabilities, and uses similarly configured racks. Some of its units are re-arranged to accommodate the new CHAALS and AQL equipment. An airframe mounted GPS has been added, newly designed SIGINT wing tip pods contain the AQL front end as well as COMINT DF antennas. Newly installed CHAALS antennas have been added to the fuselage.

Figure 2.4.3-1 shows the Guardrail Common Sensor ARF assets including the retrofitted CTT relay and their installation in the ARF mission racks. Figure 2.4.3-2 is a functional block diagram of the GR/CS ARF mission electronics.

ARF Assets

Figure 2.4.3-1

ARF Functional Block Diagram
Figure 2.4.3-2

2.4.3.1 The ARF Prime Mission Equipment (PME) (Cont);

It shows the functions and interfaces between the COMINT, ELINT, CHAALS, navigation and the link/CTT relay. Several QRC enhancements have been added to System 4. These include a microwave receiver, two low band receivers, an onboard multi-channel FDDM capability, Proforma and a special signal collection capability (see section 2.4.7).

The GR/CS payload differs from the IGR-V in that it has significantly expanded hardware with the CHAALS Receiver and Processor units that interface to the link and navigation equipment. It also has some 25 AQL units. A dual set of AQL antennas each consisting of multiple linear arrays, receivers, pre-amps, processor and supporting equipment are in each pod. The AQL Processor and its power supply/interface are in the cabin area. Pooling and other enhancements do not affect the COMINT functionality and these are downward compatible with IGR-V. The CTT relay shown in the figures is the LRIP version which is a field retrofit for the ICTT relay.

2.4.3.2 GR/CS Aircraft;

There are two versions of the GR/CS aircraft. The RC12-H version is an IGR-V RC12-D with GR/CS type pods, tailets and antenna hard points. It is used only on System 3. The RC12-K is the fully upgraded GR/CS platform.

System 4 employs the RC-12K Special Electronic Reconnaissance Aircraft. The RC-12K turboprop aircraft (as seen in Figure 2.4.3.2-1), is intended for special
electronic missions and replaces the RC-12D aircraft used in IGRV. The RC-12K is a twin engine, fixed wing, pressurized cabin Beechcraft. Seating accommodations are provided for a crew of two during normal mission configuration. For ferry flight, a third seat will be added for the crew chief. Dual side-by-side flight controls and instruments are provided. The landing gear is retractable tricycle with dual main wheels and steerable noise gear. The aircraft is powered by two United Aircraft Canada Limited (UACL) PT-67A engines that are flat-rated at 1200 SHP and equipped with two Harzell four-blade, constant-speed, automatic-full-feathering, reversing propellers.

2.4.4 Guardrail Common Sensor AGE;

The Guardrail Common Sensor AGE bears a strong resemblance to the IGR-V AGE except it is longer and has CHAALS and AQL flight line GSE installed.

The AN/ARM-163(V)5, (as seen in Figure 2.4.4-1), more commonly referred to as the Auxiliary Ground Equipment (AGE) van, provides flight line preflight and test facilities for the ARF mission equipment, including IGRV, AQL, CHAALS, IDL, and the CTT subsystems. A functional block diagram of the AGE is shown in figure 2.4.4-2. The purpose of the AGE is to simulate the IPF functions to the extent necessary to test the ARF receiving, communication, DF, and TC relay equipment. These tests are accomplished by the generation, transmission, reception, and analysis of command data and DOA DF signals. Additional equipment is installed in the AGE to support TDOA/DD and ELINT preflight tests. All command and output data for maintenance purposes are coupled through the GR/CS aircraft antenna systems or hardwire bypass. Control of the AGE test process is automatic with only minimal operator intervention required.

RC-12K Aircraft
Figure 2.4.3.2-1

AN/ARM-163(V)5 AGE Van
Figure 2.4.4-1

2.4.5 Support Equipment.

Includes three maintenance facilities, (the Airfield Maintenance Facility the IGR type equipment, the IPF maintenance facility and the AQL/CHAALS maintenance van), and a power distribution system.

2.4.5.1. AN/ARM-185B Airfield Maintenance Facility.

The AN/ARM-185B Airfield Maintenance Facility is a semi-trailer-mounted shop containing special and general purpose test equipment and maintenance facilities. The shop will be used to fault-isolate and repair defective airborne mission equipment at the airfield primarily by the removal and replacement of failed circuit cards, modules, and chassis-mounted parts.

2.4.5.2 AN/GMS-271B IPF Maintenance Facility.

The AN/GSM-271B IPF Maintenance Facility is a semi-trailer-mounted shop containing special and general purpose test equipment, maintenance facilities, and spare modules/piece parts. The shop is used to fault-isolate and repair defective IPF equipment at the operational site primarily by removal and replacement of failed circuit cards, modules, and chassis-mounted parts.

2.4.5.3 AN/GSM-624 AQL/CHAALS Maintenance Van.

The AN/GSM-624 AQL/CHAALS maintenance van is a semi-trailer mounted electronic shop which provides an off-the-flight line maintenance facility for direct support of the Advanced QUICKLOOK and Communications High Accuracy Airborne Location System airborne subsystems, and for the AQL Mission Test Equipment.

2.4.5.4 Power Distribution System

The AN/MJQ-44 Power Plant (commonly called the Power Distribution System) consists of two generator trailers with power distribution and conditioning equipment. This subsystem provides power for the IPF and maintenance support equipment. The power distribution can provide all the essential system power (with back-up in case of a generator failure) or it can use local commercial power. The Power Distribution System was depicted in the system configuration diagram, figure 2.4-1.

2.4.6 Used With Equipment

2.4.6.1 The Commanders Tactical Terminal (CTT).

The CTT is a transportable communications terminal designed to provide a reliable, joint service, interoperable, tactical airborne network. The system will disseminate intelligence data collected by the Army GR/CS and the Air Force Tactical Reconnaissance System (TRS) Ground Processing Facilities (GPFs) to Tactical Commanders along with other mobile tactical consumers.

Relationship of the CTT to GR/CS is considered "used-with" equipment--in that it is separately assigned to the using unit.

2.4.6.1 The Commanders Tactical Terminal (CTT) (Cont).

The CTT system consists of a communications processor subsystem located within the IPF; the relay equipment located within the airborne platforms; and manned, ground-based, portable communications terminals that support consumers in the field. Both secure data and secure voice nets are provided on the UHF band by the CTT system. The system is normally used for the receipt of formatted messages from the IPF, but a provision for interactive use also allows for it's receipt at the IPF. Voice communications between the IPF, remote CTT terminals, and an interoperable ground system over a UHF half-duplex, push-to-talk, secure voice channel via ARF relay is also provided by this equipment.

The retrofit LRIP CTT-H is being installed into System 4 along with the DDS system. The LRIP CTT-H supports up to 100 field terminals. (Refer to section 2.5.5 for a description of the LRIP CTT capability).

2.4.6.2 Remote Relay System (RRS) (Future)

Such a capability would be similar to the GR-V satellite relay with respect to use of a Transportable Relay Facility with-in line of sight to the airborne platforms but would be designed to operate with the interoperable data link as defined in paragraph 2.5.6. AQL and CHAALS operation would be optional through the relay.

2.4.7 QRC Enhancement Add-ons

In addition to the above defined equipment, there is a suite of QRC enhancements in GR/CS System 4, most of which resides in van 4. These include the PC based controls for microwave intercept and the operator interface for low band intercept. Proforma and SRE reside in van 2. An additional microwave intercept position is part of van 3. Figure 2.4.7-1 illustrates these add-on upgrades. The Smart File Cabinet/FasTrack smart map positions not shown in this figure, reside in van 1 where they replace the two location analysts. They provide additional mission management support with digital map overlays, mission planning tools and with order of battle analysis.

2.4.8 Guardrail Common Sensor Employment

Guardrail common Sensor is part of the Army worldwide EW forces and provides airborne, stand-off collection and location of tactical SIGINT signals. Re-deployment of GR/CS needs to have advance preparations or at least an advanced party to consider the best location and to insure that line of site to the planned mission flight tracks has been properly considered. Although the system has the organic support that is needed for flight operations, it requires a landing strip within range of the planned orbits. It also requires an IPF location that is within line of sight of the planned mission flight tracks.

2.4.8.1 Site Preparation and Installation

A pre-planned order of entry to the new site will be necessary to insure proper set-up. The order of march for convoy should be based on the order of entry if possible. The actual order of arrival may be driven by considerations that will vary from sited to site. The Suggested order is IPF vans 1, 2, 3 and 4, trackers, power distribution system, maintenance 189 van, 190 van and Aux. van.

System 4 QRC Add-on's

Figure 2.4.7-1

2.4.8.1 Site Preparation and Installation (Cont);

Figure 2.4.8.1-1 illustrates the GR/CS system site layout and functional interfaces when the system is deployed. There should be four GPS satellites in view of the flight tracks for optimum navigation accuracy. The flight tracks must be in line of sight to the IPF. Overall planning is included in chapters one and two of the system TM. This section provides an overview of employment of the system including some of the operator responsibilities and mission flight track considerations. Figure 2.4.8.1-2 is a plan view of the GR/CS site showing a dimensional layout of the IPF system component.

Items to support such a move include tractors, the Power Distribution trailers, the installation of NBC protection filters, camouflage, spares, consumables such as tapes etc and rations, water, generator fuel, ammo etc.

2.4.8.1.1 ARF/AGE Checkout Procedures

Proper check out procedures assure that the mission electronics are properly installed in the aircraft. Pre-mission checkout procedures require that the aircraft be powered up, the encryptors be correctly keyed, the INS be aligned and the mission electronics be activated. There are certain safety precautions such as microwave radiation perimeter/protection of personnel etc. The classified crypto equipment is installed and keyed to either the test code or the code to be used on the mission, if mission launch is to follow the checkout. Tests include IDL verification, CTT relay check-out, CHAALS tests, AQL parameter loading and checkout, and DF and intercept verifications

The preflight procedures are carried out in the following manner: The AGE, after successful self test, is syncronized to the payload data link. Loop around tests demonstrate that the link is operating correctly. The on-board intercept equipment is commanded to specific test scenarios. A low level radiated signal from the AGE is received and the response of the mission intercept is monitored in the AGE. Like wise the DF system is commanded and its response to its own test signal is monitored within the AGE. AQL and CHAALS test pages is called up and its specified procedures are followed as defined by the software using the AGE computer and GSE built into the AGE. If the mission equipment is operating correctly and the platform is properly identified as an ARF one or ARF two and the communication/link frequencies are properly set-up and the platform is declared mission ready. Abbreviated prefight tests may be used for quick turn around or more extensive diagnostics may be used if there is trouble with the mission equipment.

2.4.8.1.2 Mission Initialization;

Mission initialization sets up the parameters that are standard for all missions and those that are peculiar to the theater of operation. These include bringing up the main sytem computer (MSC), entering the IPF location, crypto keying, setting of communications frequencies, set up of areas of interest, search scenarios, and entry of archived a-priori data etc.

IPF pre-mission test is part of initialization if that had not been previously done (this is particularly important if the system has been fully shut down).

2.4.8.1.3 Mission Planning;

Numerous details are involved for mission implementation. These include personnel briefings, scheduling, flight operations, coordinating and establishing of mission flight track profiles, defining of mission objectives/tasking, identification of threats, etc. Based on the configuration of the mission area, the terrain and the mission objectives, flight tracks are established as part of mission planning.

2.4.8.1.4 Operator Responsibilities and System Tasking;

The following is outline of the various operator responsibilities:

Mission Manager
Establish mission goals and personnel tasking. Normally performed by a 98 C.

COMINT Supervisor
The COMINT supervisor positions are normally manned by senior 98 Gs who have system experience and intercept experience. Their task is to help individual operators and maintain the proper environmental coverage. They verify that operators are not needlessly overlapping and aid in passing signals to operators who may be more experienced with certain types.

COMINT Intercept Operator
The intercept positions are manned primarily by 98 Gs and somewhat by 98 Ds. These operators are responsible for identifying emitters, recording and transcribing the audio or using other equipment to perform signal analysis.

ELINT Supervisor
The ELINT supervisor is normally a senior 98 J but could also be a 98 C who is trained in ELINT system operations. This persons job is to direct the other ELINT operators and coordinate the ELINT collection with the COMINT supervisors based on the mission tasking. The ELINT supervisor is also normally trained to generate ELINT specific reports to be transmitted out of the system.

ELINT Operator
The ELINT operator is responsible for directing the collection and data reduction of the collected ELINT data. This position is staffed by 98 J's. Once the data is collected, it is then passed to the ELINT supervisor for further analysis and battlefield evaluation.

Traffic Analyst
The traffic analyst position is manned by a 98 C who is responsible for sorting through the situation analysis data and generating the various report types which the intelligence users require.

Location Analyst

The location analyst function is performed by an 98 C who has the responsibility to analyze the transcripted and DF data from the COMINT operators and the ELINT data from the ELINT operators to determine the target area laydown and movement of units.

Tactical Communications Operator
The TCO is a 98 C who is responsible for helping generate reports and is also normally the final check for validity and security for outgoing reports. This position is then responsible for selecting the outgoing message path and transmitting the message.

Civilian Support Personnel
Most sites are supported by civilian personnel who are specially trained to maintain the system and provide support to the unit operations. Examples of these contractor technical representatives (CTRs) are BASI support personnel who maintain the aircraft, link contractor personnel who support the data link and US government/prime contractor personnel who help perform training on the mission electronics of the ARF, IPF, and AGE.

2.4.8.2 Operational Concept;

The GR/CS System can be used in a several ways due to its flexible design. System operations are broken into two major mode groupings; support modes and mission modes. The specific capabilities at any specific time are dependent on the mode of operation.

Each mission scenario utilizes a unique configuration of system resources and assets, resulting in a specific initialization that is set-up to best achieve mission goals.

2.4.8.2.1 Guardrail Garrison Standard Operations;

This configuration is the standard operating configuration for Guardrail/Common Sensor System. In this scenario, the system relies on standard garrison support such as power, base housing, maintenance facilities, and hangers which are properly equipped to handle day-to-day operations and maintenance. The IPF and the aircraft could be collocated at the same facility but could also be split between two physically separated facilities.

This scenario provides the full set of system capabilities for the mission operations. This includes all manual and automated search, collection, location, and reporting functions. This scenario utilizes either two or three aircraft for a mission. Figure 2.4.8.2.1-1 shows the mission configuration for this scenario.

2.4.8.2.2 Guardrail Garrison Single Aircraft

The single aircraft configuration provides the mission planners with a means of performing environmental surveys without utilizing full equipment sets. This configuration might be used prior to a standard mission as an aid to environment search or during times where either hardware or personnel assets were not available for a full system mission.

This scenario provides for access to most of the system capabilities. The primary exception is that in the single aircraft configuration, cannot do either COMINT nor ELINT precision locations. Figure 2.4.8.2.2-1 shows the configuration for the this scenario.

Guardrail Garrison Tethered Standard Operations Scenario

Figure 2.4.8.2.1-1

Guardrail Garrison Tethered Single Aircraft Scenario

Figure 2.4.8.2.2-1

2.4.8.3 Standard Flight Information

System performance is strongly affected by the way the sensor aircraft are flown. Aircraft altitude, track, and attitude are very important. So are the relative spacing and headings of the sensor aircraft with respect to each other, the IPF, and the emitters of interest. To effectively execute mission goals, the mission planners need to have a basic understanding of the flight factors which influence mission operations, signal acquisition and location capabilities.

2.4.8.3.1 Flight Tracks;

General Information

The flight tracks are the paths of the aircraft plotted on a map. These tracks are set up before a mission. Each aircraft flies back and forth along its individual track during the mission as the sensors collect data. As general guidelines for multi-platform missions, the aircraft need to be flown so that:

- o At least two, and preferably three, sensor aircraft can "see" each target at the same time. This is an absolute necessity for the highest accuracy available from either of the two TDOA emitter location capabilities, and is essential for good DF location measurements.
- o The spacing between aircraft is sufficient to ensure that the relative signal data collected by the individual aircraft is influenced by the target position. If the aircraft are too close, they will collect essentially the same data and neither the DF nor TDOA systems will accurately locate the target. In general, the location systems will perform well when the targets are in a range between 1/2 and 3 times the spread between the outside sensor aircraft.
- o The above conditions are sufficient for basic intercept/DF location/ELINT performance. A third condition must be observed to ensure adequate COMINT precision locations. When three aircraft are up, and all three must simultaneously "see" the same target, the COMINT TDOA needs no further flight restrictions. However, if only two aircraft are up, or if only two of three see the signal at exactly the same time (a frequent situation), the COMINT TDOA uses a differential Doppler (DD) mode that requires that the flight tracks be staggered or tilted (see Figure 2.4.8.3-1).

When defining flight tracks, the following must be considered:

- o Geographic obstructions. Trees at close range and mountains at any range can block the data link.
- o Altitude and range. Altitude and range are closely linked. The longer the distance from the trackers, the higher the altitude must be flown. This is due to the curvature of the earth and the fact that if you fly out far enough you will eventually fly over the horizon and out of the line of sight for the data link. Refer to system TM for the Track Range Vs Aircraft Altitude.
- o Angle of depression. The angle of the aircraft in relation to the emitter of interest must not be so steep as to defeat the system's ability to DF upon it. This is not generally a problem unless targets of interest are less than 50 KM from the aircraft.
- o Distance of aircraft from each other. The aircraft must fly in relation to each other such that both aircraft can DF in the area of interest (AOI).

The flight tracks should be designed to provide, to the maximum extent possible, the optimum direction finding geometry. The ability to accomplish this optimum geometry is affected most notably by the location of threat weapon systems, political boundaries, and in peacetime, civilian aviation. When performing DF operations, the required angular relationships between each of the individual GR/CS aircraft must be maintained to ensure optimum DF accuracy. The length of the flight tracks for the GR/CS aircraft should be uniform so that a constant DF baseline can be maintained. A distance of between 50 and 80 nautical miles for each of the GR/CS aircraft tracks would not be unusual.

The following three figures are suggested track configurations which can be used. The three types of tracks shown are not the only possibilities; they are chosen only as initial guidelines. The "3/4 Baseline U" track is preferable to the "135 degree" track for triple ARF operation.

3/4 Baseline U Triad Tracks

Figure 2.4.8.3-1A

135 Degree Triad Tracks

Figure 2.4.8.3-1B

155 Degree Dyad Tracks
Figure 2.4.8.3-1C

2.4.8.3.2 Flight Tracks for a Single Aircraft

The system can operate effectively with only one aircraft. Of course, there will be no TDOA capability for either comms or non-comms signals with a single aircraft. With a single aircraft there is also more flexibility in the track distance and flight operation since there are no turns to coordinate and the track can extend as far along the signal of interest front as desired.

2.4.8.3.3 Flight Tracks for Two Aircraft

In some cases only two of the three aircraft are used on a mission. In this case, use of the two "canted" legs as shown in figure 2.6.8.3.3-1C is best, as it will provide best coverage of the central area while allowing progressive fixes with the TDOA system. If a longer baseline is required and only two aircraft are available, the two should fly the canted legs spread apart by 50 to 75 km as in the three-aircraft extended profile without the center aircraft.

The system requires special flight tracks whenever calibration is performed. Both the ELINT and COMINT arrays may require calibration when major aircraft modification is performed or antenna work is performed which affects the mounting or orientation of the arrays. The ELINT system requires calibration, known as "panel bias", any time that certain maintenance or installation of an antenna panel is performed. The COMINT system also may require occasional partial or complete re calibration. The depression angle for calibration is less than 5 degrees and uses circular, flat turn flight tracks.

Care must be taken while conducting the circular, flat turns. The aircraft should not be allowed to bank more than 5 degrees at any time. A bank exceeding this value will cause data to be discarded and may interrupt the calibration cycle. This then causes additional flight time for calibration collection.

Selection of the GR/CS aircraft altitude is critical to the intercept and DF results desired. The altitude flown by the GR/CS aircraft is a function of the following interrelated factors. Consideration of all of these factors is required to optimize the GR/CS collection mission:

1. Location of Target Emitter(s) from Flight Tracks. This is the most important factor. If the target emitter is close to the aircraft flight tracks it should have <5 deg depression angle, and terrain located between the aircraft and the emitter impedes the aircraft's line-of-sight (LOS) to the target transmitter, the altitude of the aircraft should be increased to reduce or eliminate this shadow effect.

2. Air Traffic Control (ATC). ATC can take several forms. In peace time the Federal Aviation Administration (FAA) or its host

country equivalent will impose certain restrictions on the altitude to be flown. It is critical that the operations section of the GR/CS unit work closely with the ATC authorities to ensure expedited and priority handling of their aircraft to facilitate the maximum effectiveness of the collection mission. During times of hostilities the altitude of the GR/CS aircraft will be assigned by the Corps Airspace Management Element (CAME), a component of the Corps G-3 operations section.

2.4.8.3.5 Altitude Selection (Cont);

The aircraft flown by the Aerial Exploitation Battalion are most likely the only aircraft organic to the Corps which will fly above the airspace coordination altitude. Therefore, it is imperative that the operations section of the GR/CS company coordinate with the CAME, to ensure their inclusion on the Air Tasking Order (ATO). In addition, the establishment of Restricted Operating Zones (ROZs) will be required to ensure that protected airspace is provided for the establishment of the desired flight tracks.

3. Weather. The RC-12K aircraft used by the GR/CS system has both temperature and altitude limitations. During certain seasons the aircraft will be limited in the maximum altitude it can fly due to the outside air temperature. Also the flight of the aircraft in certain icing conditions as well as turbulence of certain intensities will also affect DF operations. The aircraft will be altitude limited in either case.

4. Signal environment. Although the concept of "the higher the altitude the farther the reception " may seem to be the best all around approach, the aircraft altitude must be carefully selected in concert with the attributes of the targeted transmitter. For example, if a targeted transmitter is of low power and relatively close to the aircraft you may not actually be able to receive it's signal due to the over riding affect of the increased signal environment from higher power transmissions received at the higher altitude. This is a result of the increase in the density of the signal environment at the higher altitude.

2.4.8.3.6 Attaining Altitude;

Launching of the GR/CS aircraft should be coordinated with the mission manager prior to the aircraft becoming airborne. This will assist the data link operator in establishing the required data exchange between the aircraft and the Integrated Processing Facility (IPF). The aircraft should launch as close to the front of the takeoff "window" as possible. A close takeoff sequence will help achieve the maximum amount of "on-station" time for all three aircraft. All three aircraft should climb to their designated mission flight tracks (or) achieve line of sight to the target area as soon as practical. This early arrival at its assigned orbit altitude or arrival within LOS to the targeted threats, will assist in maximizing the collection effort by allowing the operators in the IPF to start their intercept and DF tasks prior to the aircraft reaching their flight tracks. In addition, an expedited climb to mission altitude will allow the GR/CS aircraft to reduce their fuel consumption sooner, thereby extending the mission time.

Special care must be taken not to overlook emitters with narrow beams close to the collector when at high altitude. It is possible for an emitter oriented toward ground targets and with narrow beam characteristics, such as ground surveillance radar's (GSRs), to pass below a high altitude track without intercept.

2.4.8.3.7 Synchronization and Turns;

Normal coordinated turns will roll the aircraft more than 5-10 degree limit, hence the COMINT and ELINT DF sets will turn off. (See section 2.4.8.3.12 for specifics). Flat turns preclude this "turn-off" period, but they are difficult to perform, are time and space consuming. It is best to fly straight and level back and forth along the tracks with short radius coordinated turns at each end to minimize DF shut down time. In order to keep the aircraft from bunching up (i.e., getting to close to each), one aircraft should be designated as the "master" aircraft. The crew in that aircraft is responsible for the synchronization of the other aircraft so that they maintain approximately the

2.4.8.3.7 Synchronization and Turns (Con't);

same spacing between them. This is absolutely essential for the COMINT TDOA in its differential Doppler mode. In this case, the apparent differences in received target frequency caused by aircraft motion are used to calculate target position. A requirement is that the aircraft be "chasing" each other, not flying towards or away from each other.

2.4.8.3.8 Data Link Considerations;

The data link is essential to consistent operation of the system. Care must be taken in flight planning to ensure that data link contact will be maintained. This is especially critical if using the extended base line flight tracks which extend the aircraft ranges to the extremes of line-of-site. A brief interruption in the data link continuity is operating is acceptable, though in a normally intense signal environment, the acceptable interruption may be only a very few seconds.

2.4.8.3.9 Navigation System Operations;

The system can operate in a number of navigation modes which affect navigation accuracy and timing accuracy of the mission equipment. The navigation is extremely important to the accuracy of the location measurements and calculations performed. The primary navigation mode is using GPS. This is followed in decreasing order of accuracy by data link navigation update mode, TACAN navigation mode, and internal navigation mode.

2.4.8.3.10 GPS To Backup Switching;

The normal navigation mode is GPS. In the event that there is either a failure or if insufficient satellite reception is available, a backup Nav Update mode must be used. To switch to backup navigation, a command will be sent from the IPF. This will be performed on all aircraft simultaneously in order to maintain the time synchronization required for system operations. To switch to backup navigation mode, the mission manager must first communicate with the pilot. The pilot then switches navigation modes on the pilot control panel. The first backup is the data link backup mode. TACAN is the second backup mode.

2.4.8.3.11 Ground Speed and Direction;

A constant ground speed is desirable for DF operations of the GR/CS aircraft. Because of the arrival sequence of the aircraft, several adjustments will be required to establish and maintain their relative positions. Normally a cruise airspeed of between 125 - 140 knots indicated is considered normal. As the mission progresses, the reduced weight caused by fuel burnoff will require a reduction of throttle power to maintain the same ground speed. The establishment and maintenance of constant ground speed and baselines is essential to optimizing the GR/CS collection mission.

2.4.8.3.12 Roll and Pitch Limitations;

Software limitations have been placed in the ELINT processing software to stop scan on the system if the roll of the aircraft exceeds 7 degrees bank. The COMINT processing software will continue to process data but will flag data showing over 5 degrees bank as having roll errors and will discard data with 10 degrees or greater bank.

2.4.8.4 Scan Plan Definition

Scan plans define a specific frequency range and equipment utilization for mission operations. In the case of ELINT processing, the scan plan defines the specific signals of interest and bands of interest which the operator sets and then uploads. The COMINT processing system uses both frequency and specific operations types to determine the optimum use of the search and intercept assets

2.4.8.5 Security Accreditation

Assuming that the DDS has been retrofitted into the system, physical and message security provide a C-2 level of accreditation. This limited accreditation is designed into the IPF message interfaces using log-on/logout procedures and override timer and a trusted I/O. The Security Data Processor (SDS) hardware and software is used as the trusted interface with its CRC checksum, a reliable review function, labeling and marking, Jounalization, miss routing detection, null password, and audit trail capabilities. These features and requirements are described in the SAR report.

2.5 GR/CS System 1;

The system nomenclatured as the AN/USD-9(C) Special Purpose Signal Detection System is commonly called the "Guardrail Common Sensor System 1". The major system enhancement is the IPF distributed processing. The System 1 IPF uses a Fiber Distributed Data Interface (FDDI) open architecture, local area network (LAN) based on a fiber optic, dual, counter-rotating token ring. Universal Workstations that are identical for all operator stations have been incorporated. It has an integrated approach to SIGINT ground processing. Ada is used for all new software. The System 1 IPF is an important step toward a reconfigurable, flexible approach to SIGINT.

Guardrail Common Sensor System 1 is a product improvement to the fielded GR/CS systems and has all the functionality of the initial GR/CS systems in addition to its unique new features. The features and capabilities of System 1 are described in this document at a summary level with emphasis on the System 1 capability upgrades and its modern architecture. System 1 is the first phase toward the "objective" System 2 that will have distributed processing both in the IPF and the airborne payload. System 1 provides the foundation for this objective with new distributed architecture in the IPF and AGE. The System 1 IPF is designed so as to be easily retrofitable to the System 2 configuration.

Major enhancements to System 1 include the following:

- o SUN based Universal SIGINT Workstations in the IPF using the FDDI fiber optic local area network (LAN) with file servers and programmable adapter modules (PAM's) to interface the IGDL and special processors to the LAN. Interconnections between units and between vans are via FDDI fiber optics to the maximum extent practical. This improvement allows for future growth, greatly reduces system wiring and enhances TEMPEST and EMI performance.
- o The IPF is designed for flexible sizing of the ground processing so that a system could be deployed with 2, 3 or 4 IPF vans. The design interfaces power to each van separately to facilitate van independence.
- o Implements Audio Management System (AMS) with improved manipulation capabilities and a digital audio bus using a real time FDDI LAN as the audio bus and employs the workstations/Audio PAM as the audio processors. Audio storage uses an optical disk for record storage and recall of collected signals to any operator position
- o All of the new SIGINT related software upgrades are in Ada and reside in the workstations and PAM's to the extent practical.
- o Expands frequency coverage with the integration of Lowband DF/Intercept/search
- o Integrates a new comms Data Distribution System interface (DDS)
- o Modified RC12-N aircraft has increased gross max weight capacity

- o Implements readily available, lighter weight receivers in the ARF
- o Flight line AGE uses PAM's and a new computer
- o AGE upgraded with air-conditioning and with diesel power
- o Performs an accreditation study and implements physical security provisions
- o The IPF is to be growable and readily adaptable to the new System 2 requirements
- o Re-uses software from GR/CS as economics dictate and applies workstation based MMI software/architecture
- o Integrates CTT (SI-Hi) in the IPF/ARF/AGE and integrates the interference canceller in the ARF
- o Provides an upgraded power distribution system
- o Provides Multi level reproting with man-in-the-loop oversight

The RC12-N is the GR/CS System 1 aircraft. Aircraft enhancements provide antenna provisions for low band antenna provisions and a 16,200 lb gross max capacity.

Some of the enhancements were developed on other programs. For example, DDS is similar to the ASAS communications control set. Other NDI System 1 enhancements include Lowband integration, airborne FDDM and Smart File Cabinet/FasTrack. Lowband is an EDM intercept/DF subsystem that is being deployed on System 1 and fills the Guardrail operational need for low band search, collection and DF, and provides a sky wave/co-channel capability to make airborne collection practical in a real world environment.

Guardrail Common Sensor System 1 has an ARF payload rack configuration that is similar to GR/CS systems 3 and 4 in that it employs similar COMINT equipment, the IADL, AQL and CHAALS. The LRIP CTT relay is new and it has new WJ-8604 intercept receivers, and has Lowband DF/intercept provisions.

Figure 2.5-1 a System 1 physical configuration with its major components. Its operational concept and the planned enhancements are shown in this artists drawing. System level specifications for GR/CS System 1 are outlined in table 2.5-1.

System 1 Specifications
Table 2.5-1

Duration	4.4 hours
Altitude	30 K feet
Range	LOS/link range limitations
Operator positions	Universal Workstations
	27 Sparc based terminals
System bus/van interface	FDDI IEEE 802.5
Software development	IAW ISO/OSI standards
Servers	UNIX, Concurrent
PAM's	UNIX, Concurrent, adaptive

programmable processors

Main System Computer	Micro 5 (3 ea.)
Language	
Workstation/PAM	Ada
MSC	Ada and FORTRAN
Operating system	
Workstation	UNIX Sys 5
MSC	OS/32 rev 8.3
Graphic	Motif X windows/OSF
High accuracy location	CHAALS COMINT TDOA/DD AQL ELINT TDOA
Non-communications (ELINT)	AQL (See Table 2.6.1-1)
Audio Management System	
Record channels	96
Playback channels	48
Capacity	162 hours
Audio Bus	FDDI LAN based (Dedicated real time LAN)
Dissemination	DDS (TRI TAC, Auto DIN, MSE, STU III) and TRIXS IPF master station/CTT
Multi level security	Collateral/SCI
Link range	LOS up to 240 KM
Up-Link data rates	200 KB command (multi channel) with anti jam capabilities,
Down-Link Data rates	10.7 MB down link (multi channel) 8 ea. 1.152 MB plus 4 ea. 50 KB plus a spare 800 KB channel Link
Voice channels	16 embedded in one 1.152 MB down-link channel (Interoperable)
CTT link (duplex)	50 KB (Interoperable)
Primary Nav update	GPS
Back-up Nav update	Link DME tracking and TACAN
Mission control	Intercept Command 20 KB serial, DF/SCARS 20 KB CHAALS 20 KB AQL 20 KB
Intercept receivers	VHF/UHF/P-Band (plus Lowband extension) Up to 14 slots (14 deployed per A/C)
Modulations	AM, FM, SSB, CW, FDM
Bandwidths	8, 20, 50, 150, 500 K Hz
Receiver Control	Remoted soft control Search/manual RCU
Spectrum Display	Soft display of 0.5 or 1 MHz
Pooling	Assets allocated via IPF control
Multi-channel	FDDM, 120 channels (select any 12) Activity search Recognition Up-down flag Six down-link channels

DF Through-put (COMINT)	Coarse: 20 per second Fine: 5 per second
DF control	Automatic/single key stroke
DF coverage	Classified
DF files (COMINT)	Based on frequency, operator # and time (Contains ID, operator, modulation & BW, lat/long and UTM, CEP and audio log) Parameters are stored in disk
Accuracy (SIGINT)(Classified)	
Sensitivity (SIGINT)	(Classified)
Mission stand-off	LOS
Mission aircraft	RC-12N
IPF ambient range	-40 to +131 degrees F
ARF inside ambient	-5 to +131 degrees F
Re-deployment	4 hour tear-down 8 hour set-up
Transport	C-130, C-141 with K-Loader; (or) C-5A, shipboard or improved highway

System 1 Configuration

Figure 2.5-1

High level system interfaces are shown in figure 2.5-2 System 1 block diagram. System 1's composition is shown in Figure 2.5-3. The system is organized into three subsystems which are the AN/TSQ-176 IPF with three IGDL Trackers that are part of the AN/UPQ-3B microwave link, AN/ARF-83(V)7 ARF payloads and the AN/ARM-163(V)6 AGE which provides flight line support equipment. There are a number of used with equipment's including eight RC12-N aircraft, AN/TSC-125 CTT, the AN/MJQ-44 Power Plant, Maintenance/Storage facilities etc as shown in figure 2.5-4 definition diagram.

The System 1's operational configuration differs from System 4 in that it can operate with as few as two IPF vans at a time Vs all four. This allows greater deployment mobility and flexible system sizing. The internal configuration of the System 1 is vastly different than other GR/CS systems. Standard "re configurable" workstations make this practical and the workstations allow software to replace most of the formerly unique IPF hardware. System 1 employs a lot of NDI and ruggedized COTS equipment such as the workstations, MSC, LAN, servers and PAM's. Where economics dictate, System 1 re-uses GR/CS software extensively.

System 1 has multiple functions that are distributed among its several major subsystems and its functional segments. These functions are treed and numbered in figure 2.5-5 as a functional/segment breakdown.

2.5.1 System 1 Distributed Processing;

The GR/CS Surveillance Information Processing Facility AN/TSQ-176(V) (IPF) is installed in four Tempest/chemical-biological protected, C-130 transportable operator vans. Figure 2.5.1-1 Illustrates the IPF subsystem composition and its physical configuration. The functions contained in each van are listed in that diagram.

The Guardrail Common Sensor System 1 IPF provides the command and control function for COMINT, CHALS-X, AQL and Lowband capabilities and does ground system data processing. It provides message preparation and distribution of reports as well as DDS/CTT communications interfaces. Figure 2.5.1-2 is an abbreviated block diagram of the IPF that illustrates the various interfaces to the other parts of the system. It shows the various external connections to land lines etc. It also illustrates the various man-machine interfaces (MMI's). The Data Link PAM's provide buffering I/O data to the link interfaces. Other PAM's do interfacing and provide processing for the communications and the DDS to the LAN.

The Guardrail Common Sensor IPF has provisions for 27 operators. Each operator has a color graphics windowed display/keyboard, with intercom/signal distribution computer control and headsets for audio signals, digital temporary storage access and access to "soft" RCU/SDU capabilities as assigned. Audio reel to reel transfer recording and time code are available at two of the operator stations.

The ambient temperature environment of the IPF has been upgraded to handle temperatures from -40 to +131 degrees F. Other physical improvements include de-humidification, improved biological chemical operations, individual power to each van, non-interuptable power, and a built- in security system.

System 1 Block Diagram

Figure 2.5-2

Figure 2.5-3

System Composition

Figure 2.5-3

Figure 2.5.1-1

IPF subsystem composition

Figure 2.5.1-1

IPF Subsystem Interface Diagram

Figure 2.5.1-2

2.5.1.1 Open Architecture

The ground segment consists of four primary subsystems. The subsystems are functional equipment groupings which have different functions in the IPF. The groupings are: The IPF Platform, Communications, IPF Information Distribution, and IPF Control and Processing subsystems. Figure 2.5.1.1-1 provides a high level architectural diagram of the IPF ground segment that illustrates the functional association of each of these subsystem and the equipment elements contained in each subsystem.

Figure 2.5.1.1-1 Ground Segment Architectural Diagram

The IPF Platform Subsystem consists of the physical vans, racks, cabling, climate control, power distribution, lighting/security equipment and biological/chemical protection. It also provides the various life support, safety and HUMINT accommodations. The Platform Subsystem physically supports the IPF mission electronics.

The Communications Subsystem consists of all equipment utilized for data link transmissions to and from the airborne segments, communications self test, reporting and external net connectivity.

The Information Distribution Subsystem shown in the center of this diagram provides the FDDI fiber optic networks with its standard protocol that allows information to be passed from one node to the next within the system. This subsystem includes all servers, local area networks, and programmable adapter modules that interface the FDDI LAN to with non-FDDI standard or mission peculiar devices.

The Control and Processing Subsystem consists of all of the elements which provide for executing the mission functions including the Universal Workstations.

The IPF ground segment provides the command, control, and analysis capability for the Guardrail system. The system operators utilize the ground equipment to remotely control the payload on the airborne segment.

Figure 2.5.1.1-2 is a simplified block diagram of the IPF. This diagram further illustrates its distributed open architecture. The IPF units are clustered around the system's FDDI LAN's. The Universal Workstations are shown as one function in the diagram but are physically and functionally distributed throughout the IPF vans and are in a standard configuration that supports all MMI requirements.

2.5.1.2 Language/Operating System;

The IPF reuses significant System 4 MSC software as foundation and has OS/32 revision 8.3 OS and employs Ada for new applications. The FDDI replaces the RS-232 interfaces to the operator terminals and other IPF equipment.

2.5.1.3 Main System Computers;

Three Micro 5 computers support the re-hosted software. One acts as the MSC with location files and message data base. The second is the ELINT system computer and the third supports CHAALS as the Navigation Processor computer. In the event of a MSC failure, the CHAALS computer can be re-configured to take over the COMINT MSC function. Each of the main frame computers has reserve to handle up to 256 I/O's and has two 600 M Byte disks and 105 mega bytes of RAM.

2.5.1.4 Operators Workstations;

Workstations are SUN SPARC compatible with nineteen inch monitor with 1280 X 1024 pixels for high resolution, color graphics with a minimum of 16 distinct colors. A graphics co-processor is used to accelerate screen re-draw. Expandable memory will support the system's most memory intensive operation and leaves room for capability growth. Example of display functions are the control/display of intercept and DF data, map feature analysis, terrain and elevation map display/analysis, digital map data base etc. Windowed displays allow for simultaneous display of operator functions, messages, digital maps, audio system monitoring, spectrum display, etc.

IPF Simplified Block Diagram

Figure 2.5.1.1-2

All operator positions are equipped with "Universal SIGINT Workstations" for standardization and for maximum flexibility. Each workstation is re-configurable to do any system function. Soft RCU's and SDU's are accessible to any position that are assigned to perform intercept/DF operation if so authorized.

2.5.1.5 Audio Storage;

Audio storage and routing is integrated into the audio management server, operator work stations. It has 48 playback channels and 96 record channels with up to 162 hours of recording capacity. Features include auto turn-on, gap suppression, cataloging of intercepts, sorting through previously recorded data and transfer to long term storage. Signal threshold settings are available and data can be transferred to a reel to reel analog recorder for transfer compatibility. Audio storage and audio distribution/intercommunications is carried on the real time FDDI LAN and is controlled by individual operators and is played back at the workstations.

2.5.1.6 Data Distribution System/Reporting;

The DDS provides the external message interfaces and security processing for reporting and Tactical Reconnaissance Intelligence Exchange (TRIXS). Dual CTT's are part of the DDS and are provided to handle Si High and collateral reports separately. The CTT's are interfaced to the message data base and communications security processors in the loop for data security.

Message formats are automated and can be disseminated over any of several communications networks that are connected to the DDS. These include TRI-TAC/Auto Din, STU III, TIBS and GENSER. The CTT (TRIXS) interface supports TIBS, TRIXS, TRAP/TADIXS protocols. Free text or Tactical Report messages can also be received or sent via the DDS using TRI-TAC, AUTO DIN and other operational networks.

2.5.1.7 Special Signal Processor (Proforma);

The system employs the EPR-107C which is a PC workstation installed to process special narrow band digitized signals. The proforma operator works and interprets intercepts the processed data. The input is from an operator's radio or from the receiver pool. Up to two special Signal Processing (SSP) recognizers/classifiers can be tasked to identify and process formatted weapon's signal and other proforma data. Receivers are seized from the receiver pool to support the SSP tasking or it can monitor the operators channel. Wide band SSP recognizers are planned for on-board processing. Recognized channels will alert the operator to engage the IPF SSP for further processing.

2.5.1.8 Smart File Cabinet/FasTrack Mission Management Tools;

These tools support efficient identification of battlefield nodes and has available to it the mission data base and terrain/features maps to allow interactive planning and analysis. It also supports threat association and report generation. Its Smart File Cabinet software provides powerful data base search. Fastrack mapping software provides rapid overlay of collected data and has the agility required to support rapid, timely reporting of requested targets. It is also a valuable tool for mission planning that includes terrain perspective required for intelligent planning of flight tracks that assures that the platforms have a clear field of view coverage of planned target areas.

2.5.1.9 IPF Vans;

Normally four IPF vans are employed along with three trackers plus Power Distribution trailers and auxiliary/maintenance facilities at the IPF site. The vans are called Operator Vans, Computer Van and Communications Van. Vans (#1 and #2) are operator vans with workstations and distributed processing. Vans 1 and 2 are alike and each provides a group of nine re-configurable operator positions. Van (#3) is the Communications van. It has six workstations and the Main System Computers. Van (#4) is the Communications van. It has one re configurable workstation, the data link operator position, Data Distribution System with its operator, and the CHAALS Processors. Its workstation is normally used to manage the technical/test functions of the system. The IPF enclosures disconnect from their undercarriage and can be loaded into C-130 cargo aircraft using a K-Loader. The support equipment can also be transported via C-130.

System 1 vans 3 and 4 can be deployed as a subset of the IPF for a reduced size, easily deployable ground capability. Additional vans can deploy as a follow-up to the re-deployment to provide more system capacity.

Although the System 1 IPF is quite revolutionary compared to earlier IPF's, it is downward compatible with the IGR and GR/CS platforms.

2.5.2 System 1 ARF;

The ARF consists of mission equipment installed in an RC12-N aircraft and operates within line of sight to the IPF. The ARF mission sensors search out and collect SIGINT signals, provide DOA measurements and emitter location data, and does ELINT DF and ELINT signal processing. The ARF has link communications, a CTT relay and VOW communications. The system can operate beyond line of sight with with respect to the IPF when the optional Transportable (satellite) Relay Facility (TRF) is installed. As shown in figure 2.5.2-1, the System 1 ARF mostly uses the same components as GR/CS System 4 including CHAALS, AQL, IDL, COMINT intercept/Fast DF, SCARS, and communications with the following exceptions:

System 1 ARF employs a reduced weight, broader coverage WJ 8604 receiver, has the CTT LRIP relay and has a new Interference Canceller System (ICS). The CTT relay and ICS are the same as the retrofits planned for System 4. The new receivers have greater frequency coverage and broader bandwidth at a lessor cost and weight. The interference cancellers are required to protect intercept, COMINT TDOA, certain bands of DF against agile avionics radios and the CTT relay. Racks are common to the fielded Sysem 4 payload except for the EDM Lowband provisions. The ARF rack layout is shown in figure 2.5.2-2. Location of the racks within the platform is illustrated in figure 2.5.2-3.

Figure 2,5.2-4 is a functional diagram of the System 1 ARF. Each of the airborne subsystems are broken out in this diagram. Note that the rack provisions allow for the integration of the EDM Lowband system payload. Three System 1 platforms have the Lowband search, intercept and DF capability fully integrated. The other platforms have provisions for Lowband. Lowband interfaces to the link include a 20 KB command channel and downlink data on the spare 800 KB channel. Since the EDM Lowband is an 8 channel system it has 8 DF antennas and an intercept antenna.

Figure 2.5.2-1

System 1 ARF Composition

Figure 2.5.2-1

2.5.3 Aircraft;

The System 1 aircraft has been re-designated as the RC12-N with Lowband antenna provisions and has been re-certified with a Multi-function Display (MFD)/Electronic Flight Instrument System (EFIS)/1553 bus, with upgraded avionics radios, ASE expansion provisions and frequency extension provisions. The aircraft has had qualification testing and re-certification with these avionics and surface changes. The RC-12N is one of the first DOD aircraft to have the "glass cockpit" and an integrated ASE suite. The RC-12N aircraft is certified for a 16,200 pound gross weight. Figures 2.5.3-1 and 2 are drawings of the aircraft and its antenna arrays.

2.5.4 System 1 AGE;

The System 1 AGE is manned, mobile vehicle that contains automated tests and other test equipment for pre-mission start-up of the ARF electronics. Its test capabilities interactively controls and monitors various ARF functions. System 1's AGE employs a HP-9000-360 computer to control and monitor the ARF premission tests. The AGE is co-located with the ARF. Figure 2.5.4-1 is an AGE abbreviated block diagram and figure 2.5.4-2 shows the AGE van configuration.

2.5.5 System 1 LRIP CTT;

The CTT is a time division multiple access (TDMA) type communication system that connects the Guardrail IPF to the tactical commander via the ARF using TRIXS compatible protocol. The link between the IPF and ARF is a 50K Bps channel in the IDL. The relay from the ARF to the CTT field terminal is a UHF FM channel with a single frequency mode and an agile AJ mode. The CTT relay receives in the lower part of the UHF band and transmits is in the upper half. The purpose of the CTT is to transmit and receive formatted reports and voice messages. The IPF becomes a master station in the TRIXS net. There are two CTT master terminals in the IPF. One is for SI High messages and provides both data and voice channels. The other is for collateral message generation and is only allowed to do formatted report (e.g. no voice transmissions).

The IPF mounted LRIP CTT has six units: Red/black Processor, Operator's terminal, Security Data processor (SDS), SDS terminal, SDS printer, Receiver/Transmitter Unit (RRT) and its antenna for external RF transmissions.

The CTT field terminal is illustrated in figure 2.5.5-1. These are some of the same units employed at the IPF, except SDS equipment are not included in the field terminal. The field terminal provide secure, two way tactical messages and voice communications. It allows the tactical commanders to obtain combat tactical intelligence generated by system 1 and provides the IPF with tasking updates and feedback from the field commander.

The IPF can drive up to 100 CTT field terminals on up to 5 nets. When the data flow is properly managed and reviewed for release, the IPF can transmit either collateral or SI-High CTT messages. However, voice comms are restricted over the collateral channel.

System 1 ARF Rack Layout

Figure 2.5.2-2

Figure 2.5.2-3

System 1 ARF Installation

Figure 2.5.2-3

Figure 2.5.2-4

ARF Functional Block Diagram

Figure 2.5.2-4

RC-12 N Aircraft

Figures 2.5.3-1

System 1 Antenna Arrays

Figures 2.5.3-2

AGE Van

Figure 2.5.4-1

AGE Block Diagram

Figure 2.5.4-2

2.5.6 System 1 Satellite Remote Relay;

In addition to its direct tethered mode, System 1 has a capability for split base operational mode where the IPF is connected to a Remoted operational site via a DSCS satellite. (This configuration is illustrated in figure 2.5.6-1.)

The equipment for satellite remoting of System 1 is being provided by the USG and the system prime contractor as an optional capability. A Transportable Relay Facility (TRF) is located within line of sight to the ARF. The TRF relays commands and data to and from the IPF via a satellite terminal and the DSCS III satellite. The system capability is reduced in this mode is limited to SIGINT collection and DF with optional ELINT. This limitation relates to limited satellite band width.

2.5.7 Support concept;

System support modes consist of deployment, mission, maintenance, and training. Deployment, maintenance, and training support insures system readiness. Deployment requires take down and set up, loading, transporting and some site selection/preparation. Deployments may be used for training or may involve a tactical environment . The site layout is similar to System 4.

Refer to the system TM's for specific maintenance requirements. Maintenance support is defined in the Material Fielding Plan and the System, Subsystem and LRU Technical Manuals. Training requirements are defined in the T&M plan.

2.5.8 System Operational Employment/Operational Concept;

The GR/CS System 1 can be used in a variety of ways due to its flexible design. The ground system is scale able for easy transportability in a tactical environment and is flexible in configuration and use.

System operations are broken into two major mode groupings; support modes and mission mode. The specific capabilities are dependent on the mode of operation, the type of tasking, the environment of operation, and the mission scenario.

Specific functions available to system operator personnel are driven by the operational setup and system initialization. Setup is tailored to the mission objectives. Mission tasking is contained within the message which is received from the Corps TCAE and is used to generate a mission definition. Tasking takes into account the environment (peacetime [garrison or training exercise]) or tactical [deployed]), and the specific operational scenario such as normal, interop, sat relay, etc. Tasking may involve a move of the ground or airborne segment or specific mission goals to define the mission scenario. Each scenario will force a different plan, different initialization process, and result in a different set of functions and capabilities.

CTT Field Terminal

Figure 2.5.5-1

System 1 Satellite Relay

Figure 2.5.6-1

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2.5.8.1 Operator Responsibilities and System Tasking;

Mission Manager
Establish mission goals and personnel tasking. Normally performed by a 98 C.

COMINT Supervisor
The COMINT supervisor positions are normally manned by senior 98 Gs who have system experience and intercept experience. Their task is to help individual operators and maintain the proper environmental coverage. They verify that operators are not needlessly overlapping and aid in passing signals to operators who may be more experienced with certain types.

COMINT Intercept Operator
The intercept positions are manned primarily by 98 Gs and somewhat by 98 Ds. These operators are responsible for identifying emitters, recording and transcribing the audio or using other equipment to perform signal analysis.

ELINT Supervisor
The ELINT supervisor is normally a senior 98 J but could also be a 98 C who is trained in ELINT system operations. This persons job is to direct the other ELINT operators and coordinate the ELINT collection with the COMINT supervisors based on the mission tasking. The ELINT supervisor is also normally trained to generate ELINT specific reports to be transmitted out of the system.

ELINT Operator
The ELINT operator is responsible for directing the collection and data reduction of the collected ELINT data. This position is staffed by 98 Js. Once the data is collected, it is then passed to the ELINT supervisor for further analysis and battlefield evaluation.

Traffic Analyst
The traffic analyst position is manned by a 98 C who is responsible for sorting through the situation analysis data and generating the various report types which end users require.

Location Analyst

The location analyst function is performed by an 98 C who has the responsibility to analyze the transcripted and DF data from the COMINT operators and the ELINT data from the ELINT operators to determine the target area laydown and movement of units.

Tactical Communications Operator

The TCO is a 98 C who is responsible for helping generate reports and is also normally the final check for validity and security for outgoing reports. This position is then responsible for selecting the outgoing message path and transmitting the message.

Civilian Support Personnel

Most sites are supported by civilian personnel who are specially trained to help maintain the system and provide support to the unit operations. Examples of these contractor technical representatives (CTRs) are BASI support personnel who maintain the aircraft, Paramax personnel who support the data link and ESL personnel who help perform training on the mission electronics of the ARF, IPF, and MMV.

2.5.8.2 System Operational Scenarios

GR/CS System 1 operations are defined by the assignments to operators and software functional allocation, resulting in a specific set of functions available to each operator, in order to meet various mission goals.

A description of different scenarios and their uses is provided in the following sections for mission planning purposes.

2.5.8.2.1 Guardrail Garrison Tethered Standard Operations

This standard configuration is the standard operating configuration for Guardrail/Common Sensor System 1. In this scenario, the system relies on standard garrison support such as power, base housing, maintenance facilities, and hangers which are properly equipped to handle day-to-day operations and maintenance. In this configuration, the IPF and the aircraft could be collocated at the same facility but could also be split between two physically separated facilities.

This scenario provides the full set of system capabilities for the mission operations personnel to use. Capabilities include all manual and automated search, collection, location, and reporting functions.

This scenario utilizes either two or three (standard) aircraft for a mission. Figure 2.5.8.2.1-1 shows the mission configuration for this scenario.

Figure 2.5.8.2.1-1 Guardrail Garrison Tethered Standard Operations Scenario

2.5.8.2.2 Guardrail Garrison Tethered Single Aircraft

The single aircraft configuration provides the mission planners with a means of performing environmental surveys without utilizing full equipment sets. This configuration could be used prior to a standard mission as an aid to tasking or during times where either hardware or personnel assets were not available for a full system mission.

This scenario provides for access to most of the system capabilities. The primary exception is that in the single aircraft configuration, neither COMINT nor ELINT TDOA is available. Figure 2.5.8.2.2-1 shows the configuration for the GGTSA scenario.

Guardrail Garrison Tethered Single Aircraft Scenario
Figure 2.5.8.2.2-1

2.5.8.2.3 Quick Deployment Tactical Tethered Operations

This scenario would be used to support a quick deployment of the system to an alternate location in support of tactical operations. This scenario (and the next) assume that a minimal set of IPF and ARF equipment is moved in support of operations. While there are several related configurations, the basic configuration involves two IPF vans, six to nine aircraft, and a minimum contingent of support equipment. Figure 2.5.8.2.3-1 shows the quick deployment mission scenario.

In this configuration, the IPF is working in its scaled down configuration, involving primarily vans 3 and 4 only (although depending on fielding, vans 2 and 1 could also be added). This two van configuration of the IPF provides for six standard operator positions, and a position that supports communications, test and the data link. Both the test operator position and the communications operator position could be utilized as standard operator or analyst positions if desired. In this configuration, all standard functions are available to the mission manager, however, data collection quantity would be reduced.
This configuration can utilize one to three data links but the normal configuration would be with three. To support the IPF in this scenario, local power or the power group of the support segment would have to be provided.

Quick Deployment Tactical Tethered Operations Scenario
Figure 2.5.8.2.3-1

This scenario utilizes the GR/CS System 1 IPF as the ground control segment but utilizes an Air Force payload as the airborne segment. The specific airborne payload is the RS-6b payload in backup mode operations. Figure 2.5.8.2.4-1 shows the interoperable scenario. Refer to table 2.5.8.1.5-1 which shows the interoperability between the systems.

This scenario is a single aircraft scenario which provides for manual intercept and manual DF capability. This system configuration is used to provide access to targets which would be normally outside of the operational area of the Guardrail aircraft or when the ARF platforms are not up.

Air Force Interop Tethered Operations Scenario
Figure 2.5.8.2.4-1

2.5.8.2.5 Army Tethered Interoperable Operations;

This is a set of related scenarios which utilize versions of payloads. The IPF can control several versions of payloads to varying degrees as shown in table 2.5.8.2.5-1.

Table 2.5.8.2.5-1
GR/CS System 1 Ground Segment Interoperability

CAPABILITY	**PAYLOAD TYPE**				
	GR/CS 1	**GR/CS 4**	**GR/CS 3**	**IGRV**	**Air Force**
Comms Intercept	_	_	_	_	_
COMINT manual DF	_	_	_	_	_
ELINT DF	_	_			
DS		_	_	_	
Energy Detect	_	_	_	_	
	_	_	_	_	
PAM	_	_	_	_	
PAR	_	_	_	_	
Auto DF	_	_	_	_	
IEWP	_	_	_	_	
GS (w/o SCAR)					
CHAALS	_	_			
AOI	_	_	_	_	
CTT	_	_			_
Frequency Extension	_				
FDDM	_	_			
Ground Special Signals	_	_			

2.5.8.3 Standard Flight Information

System performance is strongly affected by the way the sensor aircraft are flown. Aircraft altitude, track, and attitude are very important. So are the relative spacings and headings of the sensor aircraft with respect to each other, the IPF, and the emitters of interest. To effectively execute mission goals, the mission planners need to have a basic understanding of the flight factors which influence mission operations, signal acquisition and location capabilities.

2.5.8.3.1 Flight Tracks;

General Information
The flight tracks are the paths of the aircraft plotted on a map. These tracks are set up before a mission. Each aircraft flies back and forth along its individual track during the mission as the sensors collect data. As general guidelines for multi-platform missions, the aircraft need to be flown so that:

o At least two, and preferably three, sensor aircraft can "see" each target at the same time. This is an absolute necessity for the highest accuracy available from either of the two TDOA emitter location capabilities, and is essential for good DF location.

o The spacing between aircraft is sufficient to ensure that the relative signal data collected by the individual aircraft is influenced by the target position. If the aircraft are too close, they will collect essentially the same data and neither the DF nor TDOA systems will accurately locate the target. In general, the location systems will perform well when the targets are in a range between 1/2 and 3 times the spread between the outside sensor aircraft.

o The above conditions are sufficient for basic intercept/DF location/ELINT performance. A third condition must be observed to ensure adequate COMINT TDOA operation. When three aircraft are up, and all three can simultaneously "see" the same target, the COMINT TDOA needs no further flight restrictions. However, if only two aircraft are up, or if only two of three see the signal at exactly the same time (a frequent situation), the COMINT TDOA uses a differential Doppler (DD) mode that requires that the flight tracks be staggered or tilted (see Figure 2.5.8.3-1A,B,C).

When defining flight tracks, the following must be considered:

o Geographic obstructions. Trees at close range and mountains at any range can block the data link.

o Altitude and range. Altitude and range are closely linked. The longer the distance from the trackers, the higher the altitude must be flown. This is due to the curvature of the earth and the fact that if you fly out far enough you will eventually fly over the horizon and out of the line of sight for the data link. Refer to the system TM.

o Angle of depression. The angle of the aircraft in relation to the emitter of interest must not be so steep as to defeat the system's ability to DF upon it. That is, targets of interest must not be right below the aircraft.

o Distance of aircraft from each other. The aircraft must fly in relation to each other such that both aircraft can DF in the area of interest (AOI).

The flight tracks should be designed to provide, to the maximum extent possible, the optimum direction finding geometry. The ability to accomplish this optimum geometry is affected most notably by the location of threat weapon systems, political boundaries, and in peacetime, civilian aviation restrictions. If a set of standard tracks are to be established, the overall target area orientation must be considered. When performing DF operations, the required angular relationships between each of the individual GR/CS aircraft must be maintained to ensure optimum DF accuracy. The length of the flight tracks for the GR/CS aircraft should be uniform so that a constant DF baseline can be maintained. A distance of between 50 and 80 nautical miles for each of the GR/CS aircraft tracks would not be unusual. While it is not always possible for the mission tracks to be of the same length, it should, nevertheless, be considered a goal.

The following three figures (figures 2.5.8.3-1 A,B,C) are suggested track configurations which can be used. The three types of tracks shown are not the only possibilities; they are chosen only as initial guidelines. The "3/4 Baseline U" track is preferable to the "135 degree" track for triple ARF operation.

2.5.8.3.2 Flight Tracks for a Single Aircraft

The system can operate effectively with only one aircraft. Of course, there will be no TDOA capability for either COMINT or ELINT signals with a single aircraft. The flight track should simply be the baseline from waypoint to way point in as straight a line as possible. This will provide for maximum coverage of the area of interest. It is also possible to fly a "dog-leg" track, taking care that the center turn is under 45 degrees to avoid a blind area in the center of the track.

3/4 Baseline U Triad Tracks
Figure 2.5.8.3-1A

135 Degree Triad Tracks.
Figure 2.5.8.3-1B

155 Degree Dyad Tracks
Figure 2.5.8.3-1C

2.5.8.33 Flight Tracks For Two Aircraft;

In some cases only two of the three aircraft are used on a mission. In this case, use of the two "canted" legs as shown in figure 2.5.8.3.3-1C is best, as it will provide best coverage of the central area while allowing progrssive fixes with the TDOA system. If a longer baseline is required and only two aircraft are available, the two should fly the canted legs spread apart by 50 to 75 km as in the three-aircraft extended profile without the center aircraft.

2.5.8.3.4 Calibration Tracks;

The system requires special flight tracks when calibration is required. Both the ELINT and COMINT arrays may require calibration when major aircraft modification is performed or antenna work is performed which affects the mounting or orientation of the arrays.

The COMINT system also may require occasional partial or complete re calibration. While this is not normal, if aircraft structural changes occur due to repair or if major antenna damage results in significant antenna work, calibration must at least be checked. The normal process to maintain performance of the system is to periodically perform a verification flight and process and analyze the data to assess current calibration integrity. The calibration and verification process is discussed in the maintenance section of the system TM.

2.5.8.3.5 Altitude Selection;

Selection of the GR/CS aircraft altitude is critical to the intercept and DF results desired. The altitude flown by the GR/CS aircraft is a function of the following interrelated factors. Consideration of all of these factors is required to optimize the GR/CS collection mission:

1. Location of Target Emitter(s) from Flight Tracks. This is the most important factor. If the target emitter is close to the aircraft flight tracks, and terrain located between the aircraft and the emitter impedes the aircraft's line-of-sight (LOS) to the

target transmitter, the altitude of the aircraft should be increased to reduce or eliminate this shadow effect. Increasing the altitude of the aircraft must also take into account the effect of LOS depression-angle error on the accuracy of direction finding (DF) operations. Generally a depression angle of 5 degrees or less is desirable.

2. Air Traffic Control (ATC). ATC can take several forms. In peace time the Federal Aviation Administration (FAA) or its host country equivalent will impose certain restrictions on the altitude to be flown. It is critical that the operations section of the GR/CS unit work closely with the ATC authorities to ensure expedited and priority handling of their aircraft to facilitate the maximum effectiveness of the collection mission. During times of hostilities the altitude of the GR/CS aircraft will be assigned by the Corps Airspace Management Element (CAME), a component of the Corps G-3 operations section. The aircraft flown by the Aerial Exploitation Battalion are most likely the only aircraft organic to the Corps which will fly above the airspace coordination altitude. Therefore, it is imperative that the operations section of the GR/CS company coordinate with the CAME, to ensure their inclusion on the Air Tasking Order (ATO). In addition, the establishment of Restricted Operating Zones (ROZs) will be required to ensure that protected airspace is provided for the establishment of the desired flight tracks.

3. Weather. The RC-12N aircraft used by the GR/CS System 1 has both temperature and altitude limitations. During certain seasons the aircraft will be limited in the maximum altitude it can fly due to the outside air temperature. Also the flight of the aircraft in certain icing conditions as well as turbulence of certain intensities will also affect DF operations. The aircraft will be altitude limited in either case.

4. Signal environment. Although the concept of "the higher the altitude the farther the reception " may seem to be the best all around approach, the aircraft altitude must be carefully selected in concert with the attributes of the targeted transmitter. For example, if a targeted transmitter is of low power and relatively close to the aircraft you may not actually be able to receive it's signal due to the increase of higher power transmissions received at the higher altitude. This is a result of the increase in the density of the signal environment at the higher altitude.

2.5.8.3.6 Attaining Altitude;

Launching of the GR/CS aircraft must be coordinated with the mission manager prior to the aircraft becoming airborne. This will assist the data link operator in establishing the required data exchange between the aircraft and the Integrated Processing Facility (IPF). All aircraft should launch as close to the front of the takeoff "window" as possible. A close takeoff sequence will help achieve the maximum amount of "on-station" time for all three aircraft. All three aircraft should climb as rapidly as practical to their mission altitude. This climb to mission altitude will assist in maximizing the collection effort by allowing the operators in the IPF to start their intercept and DF tasks prior to the aircraft reaching their flight tracks. In addition, an expedited climb to mission altitude will allow the GR/CS aircraft to reduce their fuel consumption sooner.

2.5.8.3.7 Synchronization and Turns;

Normal coordinated turns will roll the aircraft more than 5-10 degrees, and the COMINT and ELINT DF sets will turn off. (Refer to section 2.4.8.12 for more details). Flat turns preclude this "turn-off" period, but they are difficult to perform, are time and space consuming. It is best to fly straight and level back and forth along the tracks with short radius coordinated turns at each end to minimize DF shut down time. A requirement is that the aircraft be "chasing" each other, not flying towards or away from each other.

2.5.8.3.8 Data Link Considerations;

Without the data link the aircraft can neither receive commands nor send data back to the IPF. Periodic drop-outs due to atmospheric or geographic interference might cause a slight degradation of performance; although this is annoying it is not catastrophic to the system.

2.5.8.3.9 Navigation System Operations;

The system can operate in a number of navigation modes which affect navigation accuracy and timing accuracy of the mission equipment. The primary navigation mode is the GPS. This is followed in decreasing order of accuracy by data link navigation update mode, TACAN navigation mode, and internal navigation mode.

2.5.8.3.10 Ground Speed and Direction

A constant ground speed is desirable for DF operations of the GR/CS aircraft. Normally a cruise airspeed of between 125 - 140 knots indicated is considered normal. As the mission progresses, the reduced weight caused by fuel burnoff will require a reduction of throttle power to maintain the same ground speed. The establishment and maintenance of constant ground speed and baselines is essential to optimizing the GR/CS collection mission.

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2.5.8.4 Scan Plan Definition

Scan plans define a specific frequency range and equipment utilization for mission operations. In the case of ELINT processing, the scan plan defines the specific signals of interest and bands of interest which the operator sets and then uploads. The COMINT processing system uses both frequency and specific operations types to determine the optimum use of assets

2.5.8.5 Security Accreditation

Physical and message security provide a C-2 level of accreditation. This limited accreditation is designed into the IPF interfaces using log-on/logout procedures and override timer and a trusted I/O. The Security Data Processor (SDS) hardware and software is used as the trusted interface with its CRC checksum, a reliable review function, labeling and marking, Jounalization, miss-routing detection, null password, and audit trail capabilities. Greater detail on these features and requirements are described in SAR report 71-189504.

2.6 GR/CS Objective System Description (System 2);

Guardrail Common Sensor System 2 is nomenclatured as the AN/USD-9(V)D Special Purpose Detection System. Figure 2.6-1 illustrates the System configuration and its major components as they are configured in the standard direct tether operational mode. System 2 is a Corps asset that collects and accurately locates SIGINT signals in real time and disseminates high value, target accuracy, intelligence in near real time. The system is designed to provide vital information on the targeted area of interest for mission scenarios that cover: 1) peace time reconnaissance search and collection operations (PRSCO)/training missions and 2) battlefield tactical operations in various levels of conflicts.

Major capability enhancements to the System 2 payloads expand the signal set capability and adds important mission flexibility to the system with its new "Unified Architecture". The new ARF architecture assists in the efficient acquisition, location, signal processing and expedites situational analysis of signals of interest. The IPF operators can now obtain information from the ARF via task oriented queries, by using predetermined signal environment filters or by manual operation.

GR/CS System 2 Functional Diagram
Figure 2.6-1

System 2 is capable of operating against a large set of signals as indicated in figure 2.6-2 which indicates its multiple band antennas and supports modern modulation types over a wide range of COMINT and ELINT frequency bands. Baseline System 2 mission assets provide the operators with the resources to acquire, identify and copy a combination of conventional signals and exotic signals. Automated and manual analysis of collected data allows a more rapid response to tasking from tactical consumers. The pre-processed collected data is used to turn raw intercepts into usable intelligence reports which are disseminated over a variety of communications nets. Table 2.6-1 shows the types of products, the interface, users/classification level and application.

Table 2,6-1

GR/CS System Products

PRODUCT	INTERFACE	USER	CLASSIF	APPLICATION
formatted character oriented – Klieglight – TACREP – TACELINT – Critic	landline comms & CTT airborne relay	national fusion centers & aviation fire support	SCI & collateral	INTEL EOB, targeting, warning
voice reports	CTT airborne relay	aviation special ops	collateral	cross FLOT ops
bit oriented broadcast (TADIL type)	Satcom (TIBS), CTT/H airborne relay	air defense & aviation fire support	collateral	targeting, warning
recorded signals with operator comments	tapes/discs	national field station	SCI	data exploitation, voice exploitation, training

Antenna Band Coverage

Figure 2.6-2

2.6.1 System Enhancements

The System 2 IPF is based on the System 1 IPF distributed architecture. Changes to the ground system are therefore limited to those related to new system requirements that ripple into the IPF design. Major architectural changes are primarily to the ARF and AGE. All System 1 functionality is retained and the following enhancements are added:

- CMC Architecture. The airborne Unified architecture is a technology transfer which uses state of the are technology that includes MCM techniques, RISC processors, and fiber optic buses. These are all interfaced into a unified system to provide a flexible system that has allocable processing to the various priority functions performed in payload, including conventional signals and LPI capabilities. This a shared asset approach to signal collection and distributed on-board signal processing.

- New generation CHALS-X COMINT TDOA system. CHALS-X features modern VME based ground processing and expandable on-board processing. It has provisions for future air to air operation that will result in a significantly reduced CHALS-X link data rate which is needed for a daisy chained air-to-air link and a future direct satellite relay.

- Enhanced AQL ELINT uses a common CMC architecture type airborne processor and a single panel antenna array for reduced weight. It includes antenna provisions for a drop-on receiver that will support WB dwell-scan operation over an expanded frequency band. Has planned future expansion that will provide expanded on-board processing that supports reduced link bandwidth needed for direct satellite relay.

- New generation interoperable Multi-Role Data Link (MRDL). Includes ground based Modular Interoperable Surface Terminal (MIST), the portable GSE in the MMV , and the airborne Guardrail Dual Data Link (GDDL). The GDDL is a dual channel Ku band version of the X band MIDL. The GDDL has provisions for air-to-air link-up between platforms concurrent with air-to-ground operation. A major improvement in the MRDL is its variable serial data rate at its I/O.

- Set-on receivers. Automatic on-board search and hand off to intercept receivers is enhanced to support several new signal acquisition scan plans.

- Wide Band Multi-element DF. A six channel DF system has replaced the older two channel switched baseline system. The system uses six wide band tuners that are routed through Digitizer, FFT's and signal processors using a fiber optic network. The wide band front-end is required to support LPI processing. Automatic search rates are increased by a factor of 1000.

- Low Probability of Intercept (LPI). System 2 is able to acquire, track, locate and copy LPI transmissions. It can simultaneously locate LPI and conventional emitters. One platform is seized for copy when multi-search and DF functions are in progress.

- Identification processing. The identification processing has been transferred from the IPF to the payload. This results in a factor of 3 increase in capacity and supports reduced link bandwidths required for the planned future satellite relay.

- PAM/Workstation/processing upgrades. IPF Link PAM's are upgraded to support the bulk serial MRDL interface and provide the system communications control. An airborne data link PAM is added to support the airborne link interface. Additional workstation software changes are incorporated to support the new CHALS-X and LPI.

- Upgrade the RC12-N to the RC12-P. New pods with a single panel ELINT array and Drop-on Receiver antenna provisions are added. Incorporates the unified architecture racks, cables and fiber optics provisions and provides weight reductions.

- Onboard preflight checkout. The CMC architecture and the new generation MRDL and CHALS-X have self test and fault indicators. The on-board bus structures support end to end test of system functions and interface to monitoring panel that displays system health and failure modes during preflight check-out. This new feature allows autonomy for quick deployments and expedites premission testing.

These enhancements are defined in greater detail in the various sections throughout section 2.6 of this document. Table 2.6.1-1 provides a list of high level System 2 specifications. The main difference between System 2 capabilities and System 1 capabilities resides in the sensor capabilities, its programmability and the new signal search and scan plans.

Table 2.6.1-1

Duration	4.5 hours
Altitude	30 K feet
Range LOS/link range limitations	
Operator positions	Universal Workstations 27 Sparc based terminals
System bus/van interface	FDDI IEEE 802.5
Software development	IAW ISO/OSI standards
Servers	UNIX, Sparc based
PAM's	UNIX, Sparc based adaptive programmable processors
MSC	Micro 5 (3 ea.)
Language	
Workstations/PAM	Ada
MSC	Ada and FORTRAN
Operating system	
Workstation	UNIX Sys 5
MSC	OS/32 rev 8.3
Graphic	Motif X windows/OSF
High accuracy location	CHALS-X TDOA (VME based) AQL TDOA
Audio Management System	
Record channels	96
Playback channels	48
Capacity	162 hours
Audio Bus	FDDI LAN based
Dissemination	DDS (TRI TAC, Auto DIN, MSE, STU III, TIBS, GENSER)
Protocols	TRIXS, TADIL/TRAP, TIBS
CTT terminal	Three Channel
Multi level security	Message interface collateral/SCI
Data Link	Multi Role Data Link
Link range	240 KM
Up-Link data rates	170 KB command (multi channel) with anti jam capabilities, (Variable rate serial rates)
Down-Link Data rates	9.216 MB down link (Serial channel) with programmable rates
Downward compatible mode	8 ea. 1.152 MB plus 4 ea. 50 KB plus a spare 800 KB channel Link Voice channels Programmable own-link channel (Interoperable)
CTT link (duplex)	50 KB (Interoperable)
Primary Nav update	GPS
Back-up Nav update	Link range/angle tracking and TAC AN
Mission control (programmable)	Intercept Command , DF/SCARS, CHALS-X, AQL

System 2 Specifications (continued)
Table 2.6.1-1

ELINT prime features	Auto detect system with classifier, emitter ID & location measurement; has manual search & analysis augmentation
ELINT coverage	Left/right, linear array antennas
ELINT search strategy	Threat library, auto adapt to signal envir
ELINT Thru-put	Classified
ELINT DF accuracy	Classified
PRI/PW/TOI accuracy	Classified
ELINT DF	TDOA/DOA
Intrapulse	FMOP/PMOP
Onboard data base	Activity log/EPL/EOB
ELINT frequency range	Classified
ELINT target processing	Single/multiple aircraft DOA, TDOA location (Auto/manual, ground based)
ELINT receiver group	True monopulse, fast scan super-het
COMINT Intercept receivers	VHF/UHF/P-Band (expandable) Digital NB receivers (Up to N) Set-on receivers (Up to 10)
Modulations	AM, FM, SSB, CW, FDM
Bandwidths	8, 20, 50, 150, 500 K Hz
Signals	Conventional, special and LPI
Pooling	Assets allocated by data mgr software
DF System	6 channel, wide band
Multi-channel (programmable)	FDDM, 120 channels (select any 12) Activity search Recognition Up-down flag Up to 12 down-link channels
DF Through-put (COMINT)	Coarse: X per second Fine: Y per second
DF control	Automatic/single key stroke
DF coverage	Classified
DF files (COMINT)	Based on ID, frequency, and time (Contains ID, operator, modulation & BW, lat/long and UTM, CEP, audio tag) Parameters are stored in disk Accuracy (Classified)
Sensitivity	(Classified)
Mission stand-off	LOS
Mission range	240 km
Receiver Control	Remoted soft control Search
Spectrum Display	Soft display of spectrum
IPF ambient range	-40 to +131 degrees F
ARF inside ambient	-5 to +131 degrees F
Aircraft	RC-12P
Re-deployment	4 hour tear-down 8 hour set-up
Transport	C-130, C-141 with K-Loader; (or) C-5A, shipboard or improved highway

2.6.2 System 2 Architecture Overview

The GR/CS System 2 is composed of a set of SIGINT sensors and a shared modular processing package which resides in the airborne segment. It has a System 1 like IPF that provides the ground based command, control, and processing segment which resides in a set of transportable IPF shelters. A support segment provides various storage, maintenance, and support facilities.
The sensor package consists of COMINT and ELINT antenna and receiving systems with powerful back-end processing capabilities.

The system remote and local data buses are bridged together in a way that is transparent to system operation. This architecture efficiently provides system functions that include manual and automatic signal acquisition, SIGINT signal intercept monitoring and signal recording, emitter location and targeting, signals processing and analysis, system control and mission planning, and intelligence reporting capabilities. The system is physically defined as three segments (Ground, Airborne and Support).

The Airborne Segment is the remote sensor that is linked to the Ground Segment. Both the ground and airborne segments interface with GPS satellites to provide precision time tags and location information for the collection and processing of signals. During a standard mission, system operators perform the functions of signal activity monitoring and system control, signal acquisition, collection, location processing, signal processing, data analysis, and reporting within the Ground Segment. The system supports multiple reporting links such as the CTT which relays TACREPS, TACELINT reports, voice comms and has the protocol for TIBS, TRIXS and TRAP/TADIXS-B. MSE, Autodin, secure phone and secure fax capabilities are also part of the dissemination capabilities.

2.6.2.1 Ground Segment Architecture;

The ground segment consists of four primary subsystems. The subsystems are functional equipment groupings which have different functions but similar levels of hierarchy. The IPF Platform, Communications, IPF Information Distribution, and IPF Control and Processing subsystems. Figure 2.6.2.1-1 provides a high level diagram of the ground segment architecture that illustrates the breakdown of it functional subsystems.

The IPF Platform Subsystem consists of the physical vans, racks, cabling, climate control, power distribution, lighting/security equipment and biological/chemical protection. It also provides the various life support, safety and HUMINT accommodations. The Platform Subsystem physically supports the IPF mission electronics.

The Communications Subsystem consists of all equipment utilized for data link transmissions to and from the airborne segments, communications self test, reporting and external net connectivity.

The Information Distribution Subsystem shown in the center of this diagram provides the FDDI fiber optic networks with its standard protocol that allows information to be passed from one node to the next within the system. This subsystem includes all servers, local area networks, and programmable adapter modules that interface the FDDI LAN to with non-FDDI standard or mission peculiar devices.

The Control and Processing Subsystem consists of all of the elements which provide for executing the mission functions including the Universal Workstations.

Ground Segment Architectural Diagram
Figure 2.6.2.1-1

The ground segment provides the command, control, and analysis capability to the system. The system operators utilize the ground equipment to remotely control the payload on the airborne segment. All operator positions are equipped with "Universal SIGINT Workstations" for standardization and for maximum system flexibility. The operators interact with the windowed workstation terminals to perform mission tasking of the payload and are able to view and interpret results and analyze the intelligence preparatory to it dissemination.

2.6.2.2 Airborne Segment Advanced Tactical SIGINT Achitecture;

The GR/CS System 2 airborne segment consists of the aircraft and payload combination. The RC12-P aircraft is the airborne platform for System 2. There are a number of interoperable airborne subsystems which are employed in the System 2 payload. The system currently consists of nine airborne platforms. The ARF is composed of seven functionally oriented hardware subsystems which are groups of system elements. The identified subsystems are: Collection Subsystem, SIGINT Distribution Subsystem, SIGINT Processing Subsystem, SIGINT Receiving, Support Subsystem, Communications Subsystem, and the Platform. Figure 2.6.2.2-1 provides a high level diagram of the airborne segment architecture.

Figure 2.6.2.2-2 illustrates the advanced tactical SIGINT unified segment architectural infrastructure used to interface distributed ARF modules. There are three separate fiber optic buses on-board the ARF mission electronics. The FDDI LAN interfaces the control functions and handles moderate bandwidth signals such as audio and link PAM interfaces. A wide band "Data Flow" bus carries wide band digitized signals such as digitized tuner pre-detection outputs. This net routes signals to all destinations via a fiber optic matrix switch arrangement. It connects signals to the FFT, digital receiver/demodulator, signal activity detection/measurement, signal processors and other wide band processors and operates with a 0.5 G Hz clock. The third fiber optic bus provides the synchronization for the on-board equipment. Figure 2.6.2.2-3 shows the Common Module Carrier (CMC) chassis that holds the common Line Replaceable Modules (LRM's) that perform the Unified ARF mission sensor processing functions. Included in these functions are signal distribution, the SIGINT processing element and communications element.

As in the ground segment, the airborne segment is broken down with the "platform subsystem" identified as the physical aircraft structure, racks, cabling, power distribution, and cooling equipment. The pilot's avionics group is considered part of the platform subsystem. The antenna arrays are installed and certified as part of the airframe but are defined as part of the payload electronics.

The payload front-end is called the collection subsystem and consists of the COMINT, ELINT and future drop-on elements. These are active and passive antenna arrays and related hardware.

The SIGINT Distribution Subsystem has the COMINT RF equipment that interfaces the antennas to the COMINT receiving elements. This equipment amplifies and switches RF to designated wide band and set-on receivers.

The SIGINT Receiver Subsystem has the CHALS, set-on receivers, COMINT wide band tuners and the ELINT receivers. The output of these elements are either digital or analog pre detection or base band signals.

Airborne Segment Architectural Diagram
Figure 2.6.2.2-1

SIGINT Processing works with digitized signals and generally takes place in shared common carrier chassis. The CHALS-X digitized signal is processed in its processor chassis.

The ARF Support Subsystem is identified as the local area network FDDI bus and servers/onboard mass storage. It also has the touch panel that is used for an onboard end to end testing control and display.

The Communications Subsystem has all the on-board link, CTT relay, voice comms, navigation and interference reduction equipment.

Figure 2.6.2.2-2

ATSA architecture

Figure 2.6.2.2-2

Figure 2.6.2.2-3

Common Module Carrier (CMC)

Figure 2.6.2.2-3

2.6.2.3 Support Segment Architecture;

The support segment includes various pieces of support equipment which are part of the system and aid the mission by supplying flight line maintenance support, storage, maintenance, and power functions. The support segment is split into equipment groupings to support ground segment and flight line operations.

2.6.3 System 2 Definition;

System 2 employs the latest technology, using military and industrial standards to produce a modern, growable EW system whose object is to be fully responsive to the requirement to deal with modern signal modulations and at the same time be sufficiently flexible and adaptable so as to be insulated against obsolescence. The AN/USD-9(V)D is a tactical SIGINT (combined COMINT and ELINT) system designed to translate the signal environment into combat information. The system employs programmable remote airborne sensors to assist in the intercept, identification, classification and location of selected signals. Processed reports are sent to tactical commanders in near real time.

System composition is defined in figure 2.6.3-1. The objective number of platforms is twelve. Figure 2.6.3-2 is a system decomposition diagram that defines how functional and physical elements are identified. Note that system 2 has vastly enhanced capabilities and a new architecture that is designed for growth and adaptivity. To better track this new architecture, a slightly different approach to nomenclature structure has been employed to document and define the system subsystems and functional segments.

System 2 is made up of three major subsystems and a number of "Used With" equipment's. Figure 2.6.3-3 defines the system. This diagram also shows the nomenclatures and part numbers of the main components. The system may also be divided into major mission functions such as planning, controlling, tasking, collecting, processing, analyzing, reporting and support. Since there are many functional Segments in the system, figure 2.6.3-4 is extremely informative in understanding what these functions are, where they reside and these sub-functions relate to the system major Segment. Figure 2.6.3-5 is a system block diagram showing the subsystems and the system "used with" functions.

Figure 2.6.3-1

System 2 Composition

Figure 2.6.3-1

System 2 Simplified Block Diagram

Figure 2.6.3-5

2.6.3.1 IPF Segment

The System 2 IPF is nomenclatured as the AN/TSQ-176(V)2 Surveillance Information Processing Center. The system operators and IPF support segments are co-located with the IPF. Figure 2.6.3.1-1 is a drawing that illustrates a typical system operational configuration where all equipment's are deployed. An actual site may have less equipment, depending on the mission objectives.

Figure 2.6.3.1-2 shows the IPF vans and outlines their functions and operator stations in each van. The interior layout of the four IPF vans is shown in figure 2.6.3.1-3. Note that vans 3 and 4 have the communications and MSC's. Vans 1 and 2 are operator expansion vans.

As previously indicated, physically and electrically the System 2 IPF Closely tracks System 1 IPF. Like System 1, it has NBC protection, flexible sizing of the IPF, three trackers, Universal Workstations, etc. As the IPF block diagram in figure 2.6.3.1-4 shows, the difference lies in the new MIST link I/O format, the CHALS-X processor, new LPI MMI and the software to support the differences in the new generation CHALS-X, data link and the new System 2 payload capabilities.

2.6.3.2 ARF Segment;

The System 2 ARF designated as the AN/ARW-83(V)8 has a revolutionary architecture that is task driven and has an expanded sensor capability. It can operate in a 1, 2 or 3 platform mode. The basic deployment is the standard direct tether mode. The system is designed to be expanded to include a air-to-air daisy chain mode and eventually a direct satellite relay mode. The multi-platform modes provide instant emitter location and a broad area coverage at stand-off ranges.

Figure 2.6.3.2-1 shows the ARF components. Figure 2.6.3.2-2 shows the flow of this architecture and the segments that make up the equipment's that are installed in the RC12-P platform. These are broken down into several functional Segments: COMINT collection element; the SIGINT Distribution subsystem; SIGINT Receivers; SIGINT Processing; ARF Support which includes the LAN, servers, bridge and touch panel; and ARF communications that includes the CTT and the Data Link. Figure 2.6.3.2-2 is a functional block diagram of the CMC portion of the ARF payload.

Figures 2.6.3.2-3, 4 and 5 show a simplified block diagram of the ARF electronics and the integration of the modified AQL and the new CHALS-X into the payload.

System Operational Configuration

Figure 2.6.3.1-1

IPF Composition

Figure 2.6.3.1-2

IPF Interior Layout

Figure 2.6.3.1-3

Figure 2.6.3.1-4

IPF Block Diagram

Figure 2.6.3.1-4

Figure 2.6.3.2-1

ARF Composition

Figure 2.6.3.2-1

Payload Unified Diagram
Figure 2.6.3.2-2

System 2 ARF Block Diagram

Figure 2.6.3.2-3

ELINT Integration Diagram

Figures 2.6.3.2-4

CHALS-X Integration Diagram

Figures 2.6.3.2-5

2.6.3.3 MMV Segment/Support Segment;

The System 2 Support Segment has two elements: 1) Preflight checkout, and 2) extended diagnostics/PME maintenance. System 2 uses on-board self test that consists of software that is embedded in the mission equipment. This is major change with respect to the approach used on previous systems were an AGE van was used to do interactive checkout and diagnostics. Extended diagnostics and testing that goes beyond Go, No-go checkout and its remove and replace instructions that are built into the ARF, employs a mobile maintenance van (MMV) installed in a shelter. The MMV supports LRU repairs and ARF maintenance problems which cannot unambiguously determined with the built-in test routine. Figure 2.6.3.3-1 illustrates the MMV functions. The MMV test equipment is controlled by the Workstation as shown in the MMV simplified block diagram figure 2.6.3.3-2. The System 2 AN/ARM-163(V)7 has computer controlled resources to stimulate test and measure results. Like the IPF, it has an FDDI LAN that interfaces to a Sun Workstation. Physically, the MMV is installed in an S-280 type shelter.

2.6.3.4 Three Channel CTT Segment;

The CTT/H three channel equipment is interoperable with three different network protocols. These networks include: TRIXS, TIBS and TRAP-TADIXS-B. The CTT/H-R is a receive only unit that is intended for use as a collateral consumer terminal.

These capabilities are covered in more detail in the Commander's Tactical Terminal (CTT) Program Summary and Potential Applications for Tactical Intelligence Dissemination dated 1 August 1993. The three channel CTT is nomenclatured as the Command System Tactical Communications Terminal AN/USC-55. The receive only 3 channel CTT is nomenclatured as the Command System, Tactical Radio Receiver An/USR-6 communications terminal. Figure 2.6.3.4-1 shows the CTT components. Figure 2.6.3.4-2 is a drawing of the CTT field installation.

The CTT configuration in the IPF is called the Tactical Reconnaissance Intelligence Exchange (TRIXS) system and has channels assigned for collateral and SI messages. The normal routing of transmissions is via the data link to the ARF then the message is relayed to the CTT field terminal. The field commander can also communicate back to the IPF.

The field terminal has six units. These include the antenna, RTT, the Red-black processor, the CRT control. The CTT is designed to handle various message protocols that are used for direct radio transmissions and satellite communications in tactical scenarios.

Figure 2.6.3.3-1

MMV Functions

Figure 2.6.3.3-1

Figure 2.6.3.3-2

MMV Block Diagram

Figure 2.6.3.3-2

CTT Three Channel Equipment
Figure 2.6.3.4-1

CTT Field Terminal
Figure 2.6.3.4-2

2.6.3.5 Aircraft;

The RC12-P System 2 aircraft is an upgraded version of the RC12-K and RC12-N GR/CS aircraft. It has a more streamlined, has a lighter wing tip pod that provides an additional extended frequency coverage antenna, a single panel ELINT antenna array and a DF antenna array. A more weight efficient method of mounting the ARF electronics has been devised. This mounting arrangement takes away some of the weight overhead. It also accommodates the replacement of wires with light weight serial fiber optic cables. The aircraft is designed to handle the System 2 Unified Payload and the GDDL. Active antennas are used in the lower bands to enhance sensitivity. The towel bar antennas have been removed and every attempt has been made to reduce drag and weight. In addition to the EFIS/ASC shared "Glass Cockpit" interface, a serial shared control has been added. Enhanced ASE provisions are also installed.

2.6.3.6 Multi Role Data Link;

The Multi Role Data Link (MRDL) is the Guardrail version of the Common Data Link (CDL). The MRDL replaces the IDL. This interoperable link is the new generation data link is used in System 2 and could be retrofitted into System 1. It has three elements: the airborne Guardrail Dual Data Link (GDDL), the IPF based Modular Interoperable Surface Terminal (MIST), and the Portable Ground Support Equipment (PGSE) that resides in the MMV.

The MIST can operate either in Ku band or X-band and has WB or NB modes. The Guardrail version of the MIST has three trackers and is designed for three platform operation. It has embedded KG-68 encryption. A fiber optic signal interface allows the trackers to be remoted up to 1500 ft from the IPF. This assumes that there is a remote power source to operate the tracker electronics. Five hundred feet of fiber optic cable is supplied along with up to 100 ft of power cable. Physically the MIST appears like the IDL trackers used on other Guardrails.

The GDDL is a Ku band version of the MIDL with a number of additional features which include:

- Ability to operate in an air-to-air mode simultaneously with the normal ground tethered mode.

- Ability to switch between antennas to not only maintain line of sight to the MIST, but also to track the moving air-to-air relay platform.

- Has interfaces to the GPS/INS for back-up of 1088 ft or better CEP.

- Has a programmable bulk serial I/O mode (Rates are selectable up to 170 Kb command
rates and 9.216 Mb encrypted down link data rates.

In addition to the IDL like dual tracking airborne antennas, the GDDL has a dual reverse RF Amplifier for transmitting return data and relaying commands simultaneously. It also contains a Dual Airborne Modem Assembly (DAMA) that provides encoding, modulation, the receiving functions, control functions and has embedded encryption.

When fully implemented, the GDDL will be capable of daisy chaining the System 2 platforms. The platform nearest to the IPF can then communicate directly to the MIST (or) potentially can interface to a satellite terminal on-board the platform to provide Direct Airborne Satellite Relay (DASR) operation.

The GDDL is capable of self test that provides a Go, No-go test of the on-board data link. The GDDL interfaces to the Navigation System for pointing and for back-up DME position updates to the system.

The PGSE is packaged in two suitcase like enclosures. When installed in the MMV with its workstation, or hooked up to a Grid terminal, and has external power/GDDL connections, it performs GDDL test and diagnostics. A Spectrum analyzer is needed for the more detailed diagnostics.

Figures 2.6.3.6-1 and 2 illustrate the MRDL in the standard direct tether mode and the optional air-to-air relay mission configuration.
The Link PAM in the IPF interfaces to the MIST I/O and controls the command format. The GDDL likewise interfaces to the ARF Bridge PAM which allocates the data content and distributes the command data. When implemented, it would also buffer the relay data.

2.6.4 Accreditation

Physical and message security provide a C-2 level of accreditation. This limited accreditation is designed into the IPF interfaces using log-on/logout procedures and override timer and a trusted I/O. The Security Data Processor (SDS) hardware and software is used as the trusted interface with its CRC checksum, a reliable review function, labeling and marking, Jounalization, miss-routing detection, null password, and audit trail capabilities. These features and requirements are similar to those described in the System 1 SAR report.

2.6.5 Embedded Training

Embedded training pertains to operator proficiency training and simulated maintenance training tools. The workstation architecture employed in the modern IPF is ideally suited to this application. Although there is New Equipment Training (NET) courses designed for the new system, it has been shown that on-the-job training is the primary source of operator and maintenance proficiency optimization in a tactical system.

The system currently provides a simulator that generates TDOA and DOA DF data in response to General and Directed search and manual DF requests. It allows emitters to be defined by the operator, lets the operator practice location analysis and allows association of DF data with simulated audio. This is very useful in refreshing operators skills in DF collection, location analysis, situation analysis and report commands.

Future upgrades will add mission relevant scenarios so that the mission managers can set up complex mission objectives with simulated realist tactical situations including emitter nets. The operator staff then can participate actively in carrying out simulated missions that more realistically reflect the real world target environment. These future upgrades to "embedded training" will provide low cost mission operator training with the realism that will prepare the operator for the pressures and rigors encountered in battlefield operations and in live field training exercises.

MRDL in Standard Tethered Mode

Figures 2.6.3.6-1

MRDL in Optional Air-to-Air Relay Mode
Figure 2.6.3.6-2

MRDL in Optional Air-to-Air Relay Mode
Figure 2.6.3.6-2

The existing built-in system diagnostics are applicable to maintenance training, however with some additional software, simulated failures and practice corrective actions can be readily added to allow support personnel to maintain their repair skills at a readiness level.

2.6.6 Sensor Management PIPs;

The objective of the sensor management enhancements has been to increase intelligence through-put in response to specific tasking with improved timeliness of critical reports. It has also become a key mission planning tool. Initial threat association improvements are focused on obtaining real time alerts as the battlefield situation develops and ultimately greater automation that will allow more efficient correlation and validation of multi-sensor data. The workstation windowed display is the sensor management operator interface.

The Smart File Cabinet/Sybase Data Manger which provides access to the system data base and the FasTrack smart map capability which provides situational graphics and threat association, are key elements that were used for upgrading sensor management tools. Many of these tools are currently being evaluated on Systems 3 & 4 in the field and new features are continually being added.

Initial capabilities provide access to an extensive digital map data base that supports target area feature analysis and has terrain elevation data that is used during mission planning and during the mission to assure a field of view of the area of interest. The mission managers also use the map data base to interactively overlay collected data onto natural terrain features and man made features such as roads, bridges, junctions, installations, towns etc.

Battlefield nodes are tied together by association of voice nets, LPI nets, multi channel nets and special signal activity. Exploitation of digital signals supports the operators with additional intelligence normally associated with nodes of battlefield operations and command posts. Initially, access to the mission sensor data base and some event triggers provide activity alerts. These support migration of data necessary for specific node analysis. Using terrain and battlefield maps, the mission manager is involved in the planning of flight tracks, altitude for clear field of view, establishes search lists both during planning and as the mission develops so as to insure that there is a good fit with initialization/pre-correlation displays for sensor management implementation that will best support the mission objectives and tasking requirements.

Further automation is being looked at as method of speeding up the process. A key consideration in development of these tools, is not only current utility, but that the architecture being implemented fits in with continued growth to insure that tools can be easily added to assure that intelligence gaps can be quickly identified so that mission resources can be best focused on the mission objective. This includes efficiently controlling task driven resources on-board the platform and ability to monitor and correlate results of computer controlled search and automatic emitter location. The result is that time lag between events and reporting will continue to shortened. Continued improvement in the use of the SIGINT data base and growth to more efficiently use other available data to correlate EOB and validate target data that potentially can go directly to Quick Fire over the collateral CTT net is a potential, foreseeable threat correlation/sensor management capability.

Current tools being used for sensor management include the terrain maps, geo-sort, upgraded search functions with tailored scan plans, and more sophisticated text transfer that allows the mission manager to be more efficient in making use of the system's vast collection capabilities as the mission operator responds to critical intelligence requirements in a complex battlefield environment.

The objective continues be, to use the enhanced "task driven SIGINT system" to support the operator in obtaining requested data in real time so that the mission manager can accurately assess collected data on his windowed workstation using his "sensor management tools" and report it in time to use it as a targeting input for battle plan execution (including collateral TAC ELINT reports and collateral reports on SIGINT nodes), using the expanded Guardrail dissemination network interfaces and the three channel CTT.

2.6.7 Support concept;

System support modes consist of deployment, mission, maintenance, and training. Deployment, maintenance, and training support insures system readiness. It involves getting the system to its operational site, making sure it works, and making sure the maintenance personnel know how to test and repair it and that the operator personnel know how to use it properly. Deployment requires take down and set up, loading, transporting and some site selection/preparation. Deployments may be used for training or may involve a tactical environment.

The system has a three level maintenance support concept: First, Organizational which involves identification of faults and removal and replacement of LRU's and minor repairs where boxes or line replaceable modules are not spared, or where the fault is with wiring or a hard mounted component. Second, Direct which handles any on-site box repair and routine maintenance including aircraft maintenance. And third, Depot Support which includes factory repairs, government depots and certain COTS equipment's that are non-field repairable. There is a plan to combine the first two levels.

Refer to the system TM's for specifics. Maintenance support is defined in the Fielding Plan and the System, Subsystem and LRU Technical Manuals. Training requirements are defined in the T&M plan.

System 2 airborne segment contains embedded pre-flight go, no-go test functions which performs complete end to end readiness testing. System 2 also generally supports fault isolation to the LRM/CCA/module for the COMINT equipment, CHALS-X, the ELINT processor and the data link to the chassis level.

The support concept is illustrated in figures 2.6.7-1 and 2.6.7-2.

Support Segment Functional Diagram
Figure 2.6.7-1

Support Segment Configuration Diagram
Figure 2.6.7-2

2.6 8 System Employment/Operational Concept

The GR/CS System 2 can be used in a variety of ways due to its flexible design. The payload can be configured to optimize collection on specific signal types, can perform acquisition and location functions without ground control, is self-testing for pre-mission readiness, and is fail-soft for reliable operation. The ground system is scale able for easy transportability in a tactical environment and is flexible in configuration and use.

System operations are broken into two major mode groupings; support modes and mission mode. The specific capabilities used or tasks performed by mission personnel at any specific time are dependent on the mode of operation, the type of tasking, the environment of operation, and the mission scenario.

To understand system operations, the primary functions are organized in a hierarchical two dimensional structure. The levels of the hierarchy are:

Level 1 - Fielded System Operations (phase). This is the phase the system is in once it is delivered to the users for mission operations. This is the phase the remainder of the hierarchy supports. Other phases of a system include concept definition, design & development, test, and decommission.

Level 2 - System Modes (mutually exclusive for an element). Modes define conditions of planning and operation of the system which are mutually exclusive for particular system elements. Different system elements can be in different modes at different times. There are two mode groupings as stated previously; support and mission. Support modes are those which contribute to the system performing the mission and require planning and training but are not directly involved in mission operations. The support modes are transport, maintenance, and mission training. The fourth system mode is mission. Mission mode contains all of the operational functionality of the system.

Level 3 - System States (mutually exclusive for an element). States are time phased operations for the system. There are four defined states for each system mode.

Level 4 - State Functions (concurrent operations). Functions are the activities which occur at the heart of any state. Each state consists of multiple functions which can be performed. However, the specific functions available to operations personnel at any point are dependent on the mission tasking, goals, and scenario. In mission mode during the operation state, functions include acquisition, collection, data processing, etc.

Level 5 - Functional Capabilities. Capabilities are subgroups of functions and provide the next level of specification. For example, under the acquisition function, capabilities are defined as manual, automatic, and visual.

Level 6 - Capability Threads. Threads are the lowest level of functional definition at the system level and define specific types of mission operations. A thread is defined as all actions from a trigger to a product. As an example, a manual DF thread would be described as 1) operator pushes DF button 2) command generated in workstation 3) message passed over LAN to DFP 4) DFP queues message and passes to aircraft 5) message is passed into airborne manual queue and then parsed into a sequence of events for the RFD and tuner 6) incoming RF is digitized, narrow banded, measured on 6 simultaneous channels 7) LOB calculations are performed 8) response message sent to data link and back to IPF 9) DFP gets response and returns to operator workstation 10) LOB is displayed on operator display. Threads will be described from the operators perspective as part of this document but only to a level required for understanding of the system operations.

Level 7 - Thread Definitions. This level of operational hierarchy is quite involved hence will not be included in any detail this document but the definitions are included here for informational purposes. This level is used to define the breakdown of threads into component sub threads for each portion of the operation. This level of definition can be as high as IPF to ARF or as low as a process happening totally within a single processing element.

As has been stated, the specific functions available to system personnel at any point in time is driven by another group of characteristics which define the operational setup for a specific mission. The mission definition is defined by a tasking hierarchy which defines a third dimension to the system functional definitions. Tasking is contained within the message which is received from the Corps TCAE and used to generate a mission definition. Tasking takes into account the environment (peacetime [garrison or training exercise]) or tactical [deployed]), and the specific operational scenario such as normal, interop, sat relay, etc. Tasking may involve a move of the ground or airborne segment or specific mission goals to define the mission scenario. Each scenario will force a different plan, different initialization process, and result in a different set of functions, capabilities, and threads. The tasking hierarchy for GR/CS System 2 is:

Level 1 - Tasking

Level 2 - Environment

Level 3 - Scenario

2.6.8.1 Operator Responsibilities and System Tasking

Mission Manager

Establish mission goals and personnel tasking. Normally performed by a 98 C.

COMINT Supervisor

The COMINT supervisor positions are normally manned by senior 98 Gs who have system experience and intercept experience. Their task is to help individual operators and maintain the proper environmental coverage. They verify that operators are not needlessly overlapping and aid in passing signals to operators who may be more experienced with certain types.

COMINT Intercept Operator

The intercept positions are manned primarily by 98 Gs and somewhat by 98 Ds. These operators are responsible for identifying emitters, recording and transcribing the audio or using other equipment to perform signal analysis.

ELINT Supervisor

The ELINT supervisor is normally a senior 98 J but could also be a 98 C who is trained in ELINT system operations. This persons job is to direct the other ELINT operators and coordinate the ELINT collection with the COMINT supervisors based on the mission tasking. The ELINT supervisor is also normally trained to generate ELINT specific reports to be transmitted out of the system.

ELINT Operator

The ELINT operator is responsible for directing the collection and data reduction of the collected ELINT data. This position is staffed by 98 Js. Once the data is collected, it is then passed to the ELINT supervisor for further analysis and battlefield evaluation.

Traffic Analyst

The traffic analyst position is manned by a 98 C who is responsible for sorting through the situation analysis data and generating the various report types which end users require.

Location Analyst

The location analyst function is performed by an 98 C who has the responsibility to analyze the transcripted and DF data from the COMINT operators and the ELINT data from the ELINT operators to determine the target area laydown and movement of units.

Tactical Communications Operator

The TCO is a 98 C who is responsible for helping generate reports and is also normally the final check for validity and security for outgoing reports. This position is then responsible for selecting the outgoing message path and transmitting the message.

Civilian Support Personnel

Most sites are supported by civilian personnel who are specially trained to help maintain the system and to support the unit operations. Examples of these contractor technical representatives (CTRs) are BASI support personnel who maintain the aircraft, Paramax personnel who support the data link and ESL personnel who help perform training on the mission electronics of the ARF, IPF, and MMV.

2.6.8.2 System Operational Scenarios

GR/CS System 2 operations are defined by seven operational scenarios. Each scenario utilizes a unique configuration of system resources and assets, resulting in a specific set of functions available to the operator, in order to meet various mission goals.

A description of each scenario and its uses is provided in the following sections. The eight definitions are provided as the primary guidelines for system utilization. This is not to imply that other combinations of system assets are not possible. However, these system deployment definitions outline here provide a broad spectrum of capability for mission planning purposes and are illustrated in diagrams in the following sections.

2.6.8.2.1 Guardrail Garrison Tethered Standard Operations

The standard, tethered configuration is the normal three aircraft operating configuration for Guardrail/Common Sensor System 2. In this scenario, the system relies on standard garrison support such as power, base housing, maintenance facilities, and hangers which are properly equipped to handle day-to-day operations and maintenance. In this configuration, the IPF and the aircraft could be collocated at the same facility but could also be split between two physically separated facilities.

This scenario provides the full set of system capabilities for the mission operations personnel to use. This includes all manual and automated search, collection, location, and reporting functions.

This scenario utilizes either two or three (standard) aircraft for a mission. Figure 2.6.8.2.1-1 shows the mission configuration for this scenario.

2.6.8.2.2 Guardrail Garrison Tethered Single Aircraft (GGTSA)

The single aircraft configuration provides the mission planners with a means of performing environmental surveys without utilizing full equipment sets. This configuration could be used prior to a standard mission as an aid to tasking or during times where either hardware or personnel assets were not available for a full system mission.

This scenario provides for access to most of the system capabilities. The primary exception is that in the single aircraft configuration, neither COMINT nor ELINT TDOA is available. Figure 2.6.8.2.2-1 shows the configuration for the GGTSA scenario.

Guardrail Garrison Tethered Standard

Operations Scenario

2.6.8.2.1-1

Guardrail Tethered Single Aircraft Scenario
Figure 2.6.8.2.2-1

This scenario would be used to support a quick deployment of the system to an alternate location in support of tactical operations. This scenario (and the next) assume that a minimal set of IPF and ARF equipment is moved in support of operations. While there are several related configurations, the basic configuration involves two IPF vans, six aircraft, and a minimum contingent of support equipment. Figure 2.6.8.2.3 shows the quick deployment mission scenario.

In this configuration, the IPF is working in its scaled down configuration, involving primarily vans 3 and 4 only (although depending on fielding, vans 2 and 1 could also be added). This two van configuration of the IPF provides for six standard operator positions, a communications operator, a test operator and a link operator. Both the test operator position and the communications operator position could be utilized as standard operator or analyst positions if desired. In this configuration, all standard

functions are available to the mission manager, however, data collection quantity would be reduced.
This configuration can utilize one to three data links but the normal configuration would be with three.

To support the IPF in this scenario, the power group of the support segment would have to be provided.

At the flight line, no auxiliary vans are required. All preflight testing would be done on board the aircraft.

Quick Deployment Tactical Tethered Operations Scenario
Figure 2.6.8.2.3-1

2.6.8.2.4 Quick Deployment Tactical Unteathered Operations;

This untethered scenario utilizes a minimum system configuration with a primary goal of collecting data outside the normal flight area covered by the current system location. This configuration allows for an environmental sweep of potential areas for relocation or to support a short duration operation outside of the current tactical boundary. Figure 2.6.8.2.4-1 shows the untethered mission scenario.

The untethered mode will utilize a single aircraft. Preflight on the aircraft proceeds as normal. After preflight is complete, the aircraft is launched and establishes communications with the IPF.

The test operator performs the standard series of quick BIT checks on the payload in order to assure proper operations. The mission manager then uploads an automatic scan plan data filter windows to the payload processor.

The aircraft then flies out of data link range to the target area and sets up in a standard collection racetrack. The pilots would fly this track for a TBD duration, collecting requested data which is automatically stored on board.

The aircraft would then fly back into the standard link range of the IPF to a predefined re acquisition point. Once the data link has been reestablished, the mission manager or mission analyst could then perform various queries on the airborne data base to retrieve data on emitters and nets. No audio data is available.

Quick Deployment Tactical Untethered Operations Scenario
Figure 2.6.8.2.4-1

This scenario utilizes the GR/CS System 2 IPF as the ground control segment but utilizes an Air Force payload as the airborne segment. The specific airborne payload is the RS-6b payload in backup mode operations. Figure 2.6.8.2.5-1 shows the Air Force interop scenario while table 2.6.8.2.6-1 shows the interoperability between the systems.

This scenario is a single aircraft scenario which provides for manual intercept and manual DF capability. This system configuration is used to provide access to targets which would be normally outside of the operational area of the System 2 aircraft.

Air Force Interop Tethered Operations Scenario
Figure 2.6.8.2.5-1

2.6.8.1.6 Army Tethered Interoperable Operations;

This is a set of related scenarios which utilize older versions of the Guardrail payload. The System 2 IPF can control these payloads to varying degrees as shown in table 2.6.8.2.6-1. This mode of operation would be used to provide system coverage while the primary system 2 aircraft were being moved to an alternate location.

2.6.8.2.7 Extended Teathered Range Air-to-Air (Future);

This scenario allows for operations outside of the normal operational area of GR/CS System 2 with full capability. In this mode, three aircraft are utilized, one as a tethered relay/collector, one as an air-to-air relay/collector, and one as a prime collector. Figure 2.6.8.2.7-1 shows the EXTRAA scenario.

In this scenario, preflight operations are performed as normal. Once the aircraft are launched, they proceed to the flight area. Once there, the tethered relay collector aircraft establishes a link with the IPF. With the aid of the pilots, this aircraft then establishes the air-to-air link with the second aircraft. Once this link is established, the second and third aircraft link up in a similar manner.

At this point, all normal system functionality is available. This scenario functions like the standard multi-aircraft tethered scenarios with the exception that a large majority of the processing is now done on board rather than in the IPF to reduce data link traffic. There are also some operational considerations as to the number of available audio channels.

Table 2.6.8.2.6-1
GR/CS System 2 Ground Segment Interoperability

CAPABILITY	**PAYLOAD TYPE**				
	GR/CS 1	**GR/CS 4**	**GR/CS 3**	**IGRV**	**Air Force**
Comms Intercept	_	_	_	_	_
COMINT manual DF	_	_	_	_	_
ELINT DF	_	_			
Directed Search					
Energy Detect	_	_	_	_	
Geoscreen	_	_	_	_	
PAM	_	_	_	_	
PAR	_	_	_	_	
Auto DF	_	_	_	_	
IEWP	_	_	_	_	
GS (w/o SCAR)					
CHAALS	_	_			
AOI	_	_	_	_	
CTT	_	_			_
Frequency Extension	_				
FDDM	_	_			

Ground Special Signals	–				

Extended Range Tethered Air-to-Air Relay Scenario

Figure 2.6.8.2.7-1

2.6.8.2.8 Direct Air-to-Satellite Relay (DASR) (future)

This scenario is functionally the same for the aircraft as the Extended Range scenario, however, the IPF relay would be through the last relay aircraft direct to a satellite rather than through a tethered data link to the ground. Figure 2.6.8.2.8-1 shows the DASR scenario.

Direct Air-to-Satellite Relay Scenario
Figure 2.6.8.2.8-1

2.6.8.3 Standard Flight Tracks;

System performance is strongly affected by the way the sensor aircraft are flown. Aircraft altitude, track, and attitude are very important. So are the relative spacings and headings of the sensor aircraft with respect to each other, the IPF, and the emitters of interest. To effectively execute mission goals, the mission planners need to have a basic understanding of the flight factors which influence mission operations, signal acquisition and location capabilities.

2.6.8.3.1 Flight Tracks;

General Information
The flight tracks are the paths of the aircraft plotted on a map. These tracks are set up before a mission. Each aircraft flies back and forth along its individual track during the mission as the sensors collect data. As general guidelines for multi-platform missions, the aircraft need to be flown so that:

o At least two, and preferably three, sensor aircraft can "see" each target at the same time. This is an absolute necessity for the highest accuracy available from either of the two TDOA emitter location capabilities, and is essential for good DF location.

o The spacing between aircraft is sufficient to ensure that the relative signal data collected by the individual aircraft is influenced by the target position. If the aircraft are too close, they will collect essentially the same data and neither the DF nor TDOA systems will accurately locate the target. In general, the location systems will perform well when the targets are in a range between 1/2 and 3 times the spread between the outside sensor aircraft.

o The above conditions are sufficient for basic intercept/DF location/ELINT performance. A third condition must be observed to ensure adequate COMINT TDOA operation. When three aircraft are up, and all three can simultaneously "see" the same target, the COMINT TDOA needs no further flight restrictions. However, if only two aircraft are up, or if only two of three see the signal at exactly the same time (a frequent situation), the COMINT TDOA uses a differential Doppler (DD) mode that requires that the flight tracks be staggered or tilted (see Figure 2.6.8.3-1).

When defining flight tracks, the following must be considered:

o Geographic obstructions. Trees at close range and mountains at any range can block the data link.

o Altitude and range. Altitude and range are closely linked. The longer the distance from the trackers, the higher the altitude must be flown. This is due to the curvature of the earth and the fact that if you fly out far enough you will eventually fly over the horizon and out of the line of sight for the data link. Refer to TM 11-5865-273-12, Figure 2-2, Track Range vs. Aircraft Altitude.

o Angle of depression. The angle of the aircraft in relation to the emitter of interest must not be so steep as to defeat the system's ability to DF upon it. That is, targets of interest must not be right below the aircraft.

o Distance of aircraft from each other. The aircraft must fly in relation to each other such that both aircraft can DF in the area of interest (AOI).

The flight tracks should be designed to provide, to the maximum extent possible, the optimum direction finding geometry. The ability to accomplish this optimum geometry is affected most notably by the location of threat weapon systems, political boundaries, and in peacetime, civilian aviation. If a set of standard tracks are to be established, the overall target area orientation must be considered. When performing DF operations, the required angular relationships between each of the individual GR/CS aircraft must be maintained to ensure optimum DF accuracy. The length of the flight tracks for the GR/CS aircraft should be uniform so that a constant DF baseline can be maintained. A length of between 50 and 80 nautical miles for each of the GR/CS aircraft tracks would not be unusual. While it is not always possible for the mission tracks to be of the same length, it should, nevertheless, be considered a goal.

The following three figures (figures 2.6.8.3-1A,B,C) are suggested track configurations which can be used. The three types of tracks shown are not the only possibilities; they are chosen only as initial guidelines. The "3/4 Baseline U" track is preferable to the "135 degree" track for triple ARF operation.

3/4 Baseline U Triad Tracks

Figure 2.6.8.3-1A

135 Degree Triad Tracks.
Figure 2.6.8.3-1B

155 Degree Dyad Tracks
Figure 2.6.8.3-1C

The system can operate effectively with only one aircraft. There will be no TDOA capability for either comms or non-comms signals with a single aircraft. The flight track should simply be the baseline from waypoint to way point in as straight a line as possible. This will provide for maximum coverage of the area of interest. It is also possible to fly a "dog-leg" track , taking care that the center turn is under 45 degrees to avoid a blind area in the center of the track. The dog-leg track will allow for slightly enhanced coverage of the center mission area, but the straight line leg for longer baseline is preferred. With a single aircraft there is also more flexibility in the track distance and flight operation since there are no turns to coordinate and the track can extend as far along the signal of interest front as desired. Single aircraft track considerations should be kept in mind for the untethered operations scenario of the system.

2.6.8.3.3 Flight Tracks for Two Aircraft;

In some cases only two of the three aircraft are used on a mission. In this case, use of the two "canted" legs as shown in figure 2.6.8.3.3-1C is best, as it will provide best coverage of the central area while allowing running fixes with the TDOA system. If a longer baseline is required and only two aircraft are available, the two should fly the canted legs spread apart by 50 to 75 km as in the three-aircraft extended profile without the center aircraft.

2.6.8.3.4 Calibration Tracks;

The system requires special flight tracks when calibration is required. Both the ELINT and COMINT arrays will require calibration when major aircraft modification is performed or antenna work is performed which affects the mounting or orientation of the arrays.

The ELINT system requires calibration, known as "panel bias", any time that certain maintenance or installation of an antenna panel is performed. A minimum of two consecutive turns in each direction on the circular path will comprise a complete panel bias flight.

The COMINT system also may require occasional partial or complete re calibration. If aircraft structural changes occur due to repair or if major antenna damage results in significant antenna work, calibration must at least be checked. The COMINT arrays require that the calibration be done at two depression angles, forcing the selection of flight tracks. The primary depression angle for calibration is two degrees and the secondary angle is seven degrees.

The normal process to maintain performance of the system is to periodically perform a calibration verification flight and process and analyze the data to validated calibration integrity. The calibration and verification process is discussed in the maintenance section of the system TM. In setting up calibration areas, at least three areas must be located; one for the ELINT panel bias against a known emitter set, one for primary calibration for the COMINT arrays, and one for the secondary depression angle for the COMINT arrays.

2.6.8.3.5 Altitude Selection;

Selection of the GR/CS aircraft altitude is critical to the intercept and DF results desired. The altitude flown by the GR/CS aircraft is a function of the following interrelated factors. Consideration of all of these factors is required to optimize the GR/CS collection mission:

1. Location of Target Emitter(s) from Flight Tracks. This is the most important factor. If the target emitter is close to the aircraft flight tracks, and terrain located between the aircraft and the emitter impedes the aircraft's line-of-sight (LOS) to the target transmitter, the altitude of the aircraft should be increased to reduce or eliminate this shadow effect. Increasing the altitude of the aircraft must also take into account the effect of LOS depression-angle error on the accuracy of direction finding (DF) operations. Generally a depression angle of 5 degrees or less is desirable.

2. Air Traffic Control (ATC). ATC can take several forms. In peace time the Federal Aviation Administration (FAA) or its host country equivalent will impose certain restrictions on the altitude to be flown. It is critical that the operations section of the GR/CS unit work closely with the ATC authorities to ensure expedited and priority handling of their aircraft to facilitate the maximum effectiveness of the collection mission. During times of hostilities the altitude of the GR/CS aircraft will be assigned by the Corps Airspace Management Element (CAME), a component of the Corps G-3 operations section. The aircraft flown by the Aerial Exploitation Battalion are most likely the only aircraft organic to the Corps which will fly above the airspace coordination altitude. Therefore, it is imperative that the operations section of the GR/CS company coordinate with the CAME, to ensure their inclusion on the Air Tasking Order (ATO). In addition, the establishment of Restricted Operating Zones (ROZs) will be required to ensure that protected airspace is provided for the establishment of the desired flight tracks.

3. Weather. The RC-12P aircraft used by the GR/CS system has weather, temperature and altitude limitations. During certain seasons the aircraft will be limited in the maximum altitude it can fly due to the outside air temperature. Also the flight of the aircraft in certain icing conditions as well as turbulence of certain intensities will also affect the performance of DF

operations. In any case the aircraft will be limited to its ceiling altitude.

4. Signal environment. Although the concept of "the higher the altitude the farther the reception " may seem to be the best all around approach, the aircraft altitude must be carefully selected in concert with the attributes of the targeted transmitter. For example, if a targeted transmitter is of low power and relatively close to the aircraft you may not actually be able to receive it's signal due to the increase of higher power transmissions received at the higher altitude. This is a result of the increase in the density of the signal environment at the higher altitude.

2.6.8.3.6 Attaining Altitude;

Launching of the GR/CS aircraft must be coordinated with the mission manager prior to the aircraft becoming airborne. This will assist the data link operator in establishing the required data exchange between the aircraft and the Integrated Processing Facility (IPF). The aircraft should launch as close to the front of the takeoff "window" as possible. The second and third aircraft should try to take off as soon after the preceding as possible. This close takeoff sequence will help achieve the maximum amount of "on-station" time for all three aircraft. Additionally, all three aircraft should climb as rapidly as practical to their mission altitude. This climb to mission altitude will assist in maximizing the collection effort by allowing the operators in the IPF to start their intercept and DF tasks prior to the aircraft reaching their flight tracks. In addition, an expedited climb to mission altitude will allow the GR/CS aircraft to reduce their fuel consumption sooner, thereby extending the mission time.
Special care must be taken not to overlook emitters with narrow beams close to the collector when at high altitude. It is possible for an emitter oriented toward ground targets and with narrow beam characteristics, such as ground surveillance radar's (GSRs), to pass below a high altitude track without intercept.

2.6.8.3.7 Altitude and Attitude;

Both the COMINT and ELINT DF sets are calibrated for distant targets which are not much below the sensor aircraft horizon. Close-in targets which "look-up" at the aircraft don't affect the DF antenna arrays in the same way as distant targets, and the DF doesn't work properly.

The ELINT also has two narrow blind sectors, one off the nose and one off the tail of the aircraft. These blind spots don't ordinarily cause a problem. The ELINT system covers about 260 degrees around the aircraft.

The combination of pitch/roll and look-down (depression) angle to the target should not exceed approximately 15 degrees. The ELINT set will shut off whenever pitch or roll exceeds 7 degrees. While the value for the COMINT set can be set as part of system initialization, a maximum setting of 5 degrees is recommended. This leaves about 10 degrees for look-down angle. (See section 2.6.8.3.12 for more details).

2.6.8.3.8 Synchronization and Turns;

It is best to fly straight and level back and forth along the tracks with short radius coordinated turns at each end to minimize DF shut down time. A requirement is that the aircraft be "chasing" each other, not flying towards or away from each other.

2.6.8.3.9 Data Link Considerations;

Without the data link the aircraft can neither receive commands nor send data back to the IPF. Periodic drop-outs due to atmospheric or geographic interference might cause a slight degradation of performance; although this is annoying it is not catastrophic to the system. During the interruption, some data will be buffered. Then the data will be passed via data link when it is re-established. This type of acceptable interruption includes antenna switching times on the aircraft and brief interruptions due to small obstacles between the tracker and the aircraft.

Upload and initialization of the payload with parameters and mission data files is required. A solid link is required prior attempting to start the payload operations. If it is interrupted, then the entire upload must be repeated for that aircraft.

2.6.8.3.10 Navigation System Operations;

The system can operate in a number of navigation modes which affect navigation accuracy and timing accuracy of the mission equipment. The navigation and timing accuracy of the system is extremely important to the accuracy of the location measurements and calculations performed.
The primary navigation mode is using GPS. This is followed in decreasing order of accuracy by data link navigation update mode, TACAN navigation mode, and internal navigation mode.

2.6.8.3.11 Ground Speed and Direction;

A constant ground speed is desirable for DF operations of the GR/CS aircraft. Each of the aircraft must be traveling in the same basic direction to maintain the required constant DF baseline. Since the GR/CS aircraft departed the airfield at different times, and the individual flight tracks are at different distances from the departure point, it is probable that the aircraft will arrive at the start of their respective flight tracks at different times. As each aircraft arrives at its flight track, it will slow to its mission cruise speed and establish itself on track.

Due to several factors (track length, weather, relative wind, etc.) different airspeeds may need to be flown by each aircraft to maintain a constant ground speed. Normally a cruise airspeed of between 125 - 140 knots indicated is considered normal. As the mission progresses, the reduced weight caused by fuel burnoff will require a reduction of throttle power to maintain the same ground speed. Ground speed monitoring should allow for the synchronous turns required and for a reasonable baseline for each aircraft involved in the mission. Care must be taken to avoid reducing ground speed to the point that any aircraft will exceed the pitch limitations. If airspeed on any aircraft is reduced to the point that a 7 degree nose-up attitude results, the data collection may stop and data will be discarded on that particular aircraft.

2.6.8.3.12 Roll and Pitch Limitations;

Software limitations have been placed in the ELINT processing software to stop scan on the system if the roll of the aircraft exceeds 7 degrees bank or if the pitch of the aircraft exceeds 7 degrees. The COMINT processing software will continue to process data but will flag data showing over 5 degrees bank as having roll errors and will discard data with 10 degrees or greater bank.

2.6.8.4 Scan Plan Definition;

Scan plans define a specific frequency range and equipment utilization for mission operations. In the case of ELINT processing, the scan plan defines the specific signals of interest and bands of interest which the operator sets and then uploads. The COMINT processing system uses both frequency and specific operations types to determine the assets.

The selection of a scan plan is dependent on the expected density of the signal environment which the mission manager expects to encounter and the types of comms signals expected. There are five scan plans which the mission manager can choose from to optimize comms mission performance. Selection of scan plans can be performed on a payload-by-payload basis but must be done with an understanding of the operational constraints imposed by the selections.

2.6.8.4.1 Scan Plan 1: Combined;

Scan plan 1 is the default scan plan for system operations. This scan plan provides a balanced search plan for the automatic search assets, allowing for optimum performance in a combined conventional and LPI comms environment. This scan plan allows for operations in a combined environment consisting of X conventional nets and Y LPI nets with the LPI emitters ranging from W to Z.

This scan plan provides for the generation of conventional comms search and DF results for bands 2-4 with a revisit rate of A.

The scan plan provides for the generation of LPI comms results for a 60 MHz band, located anywhere in the band 2 or 3 range with a revisit rate of B.
When this scan plan is used, there is also the ability to obtain search results in the band 5 range on comms signals without DF.
This scan plan also provides for visual search inputs for the narrow band conventional receiver assets.

2.6.8.4.2 Scan Plan 2: LPI;

Scan plan 2 provides for optimized performance in an LPI environment. In this mode, the payload resources are dedicated to the task of search and DF on LPI signals. This scan plan allows for operation in an LPI environment.
When this scan plan is selected, while the narrow band conventional receivers are available for manual intercept operations, there are no resources available for performing conventional comms non-DF search nor are there resources available to provide PAN/SD data generation.

2.6.8.4.3 Scan Plan 3: Conventional;

This scan plan is selected to optimize operations against conventional signals. This scan plan would be utilized if the tasking definition showed either the absence of LPI emitters or if the LPI environment is light and not of primary mission interest. Using this scan plan allows for best results in a conventional environment. The use of this scan plan also configures the system for non-DF search in band 5 and PAN/SD support for the narrow band conventional receivers.

2.6.8.4.4 Scan Plan 4: Full-band LPI Copy;

Scan plan 4 is selected to provide for the capability to track and copy LPI type signals. This scan plan provides for up to four copy channels in a moderate LPI environment. Fewer copy channels are available in denser environments since some resources must be utilized to provide additional tracking information. This scan plan would be selected for one aircraft only. The other single or two aircraft are required to be configured for scan plan 1 or 3 since they provide additional tracking information to the copy platform.

2.6.8.4.5 Scan Plan 5: Sub-band LPI copy;

Scan plan 5 is similar to 4 except it is targeted at environments in which LPI transmissions of interest are limited to the sub band frequency range.

3.0 Pre-planned Capability Growth;

3.1. System 1 P3I Upgrades;

Several of the operational upgrades described in this section are product improvements that generally relate to lessons learned from the System 4 QRC upgrades. These planned upgrades may well be integrated into System 1 at the time of initial fielding, or can be readily field retrofitted. Depending on funding levels, the Auto Multi-level reporting and accreditation upgrades could turn out to be longer term preplanned enhancements that will flow from the System 2 design. Several of the latter upgrades described in this section should be expedited because they are critical to required operating capabilities. A cost efficient version of these can be part of System 1 and are generally a subset of the more advanced System 2 implementation. These are important building blocks that relate to near term requirements for rapid deployment and near real time reporting of targeting data, and will provide operational experience that will show how to best obtain optimum capability in the evolving tactical environment.

3.1.1 Airborne Auto Frequency Division Demultiplxer (FDDM);

The System 1 basic design has an FDDM capability that is located on the ground. This FDDM enhancement adds an identical airborne signal processor that demodulates the multi-channel signal prior to downlink transmission, hence is not limited by link bandwidth. By simply locating the FDDM on-board the platform it significantly expands the capability of the system with respect to modern multi-channel threats. This is a proven approach that is similar to the prototype QRC FDDM installed on GR/CS System 4. Additional enhancements involved in the System 1 implementation are related to more elegant interfacing of the airborne equipment to the link and a significant enhancement to the System 1 MMI integration with respect to the stand-alone System 4 QRC prototype approach, e.g. the FDDM operator MMI and the programming of the remote FDDM control will be integrated into the operator's Universal Workstation rather than requiring a stand alone PC.

Hardware includes a programmable, NDI Frequency Division Demultiplxer (FDDM) unit with channel activity monitoring that tracks channel activity within the intercepted base band. It accepts basebands up to 1 MHz wide and can simultaneously demodulate any 12 channels from a signal containing up to 120 channels of data. The demodulated channels sent down the data link may be monitored and recorded by the ground based Audio Management system.

Remote controlled functionality of the airborne FDDM includes:
- Manual control of twelve channels of demodulation
- Operator may define an auto or manual scan scenario
- Operator may do both direct frequency tuning or channel tuning
- Operator may select pre-dwell timing or post loss timing
- Operator can start or suspend auto scans and pick up where he left off
- The signal threshold is adjustable as is scan limits and spectrum inversion
- Controls and MMI will include: Gain control, BIT initialization, and programming of search activity. The operator has a display of channel activity and programmed status on his workstation screen.

3.1.2 Narrow Band/Wide Band Proforma;

The Proforma upgrade integrates the EPR-107C special signal processor (SSP) into the IPF. The SSP is a PC based, classified capability that connects into the signal path via the Audio Management system. Signals that are routed to the SSP can come from a operator assigned receiver; or from a specified receiver that is assigned as part of the system search capability when the signal is recognized by SCAR; or an intercept receiver can be seized from the receiver pool when a manually recognized signal has been identified for processing. There will be two EPR-107's in the IPF located in two separate vans. This capability with its specified weapons systems signal analysis and its ability to process other digital signals, will be similar to other GR installations except its tasking and output will transfer into the system data base to support a more integrated data correlation.

3.1.3 CHAALS Supervisor Console;

The CHAALS Supervisory Console (CSC), supports the management of the CHAALS subsystem. The CSC will reside in a PC based processor placed in the signal path between the IGDL and the CHAALS location processor. This is a productized version of the CSC that was integrated and tested as part of the System 4 QRC upgrades. The CSC display will show a spectrum plot, CHAALS received signal vs. time plot and a polar plot. Since aircraft location and flight tracks are rather critical as to optimum CHAALS operation, the CHAALS console allows extra technical insight as to exactly what is going-on internal to the CHAALS system as it is being tasked by the mission operators. It also provides information as to the "CHAALS location measurement" quality and can show the status of on-going CHAALS processing as well as the navigation processing status. It gives some important insight into the CHAALS signal environment within its receiver pass band which is considered to be important technical data that a mission manager can use to optimize the system employment as a targeting asset. The CSC processor, the CSC software and its display are GFE.

3.1.4 Auto Multi-level Reporting;

This enhancement is a retrofit to System 1 and is based on the System 2 "Auto Multi-level Reporting" design. Its capability will be identical to System 2 once the System 1 retrofit has been fully implemented. (See section 3.3).

3.1.5 Accreditation Upgrade;

This enhancement provides some "internal real-time operational software" security safeguards that avoids accidental security violations and supports security management, and enhances the existing C-2 level MLS provisions. Currently the design has a two level message capability and its accreditation requires a man-in-the-loop message release. The system design also has the necessary physical provisions required for accreditation.

There will be a longer term, future major preplanned accreditation software retrofit to System 1 that is based on the System 2 design and its planned enhancements that will allow more automated Quickfire reporting. This Phase II System I capability will be identical to System 2 once the System 1 retrofit has been implemented. (See section 3.3).

3.1.6 Mission Management Enhancements;

Currently, an interim FasTrack/Smart File Cabinet version is planned for the IOC system. With this on-going enhancement, System 1 is getting Sensor Management tools like those described for System 2 in section 2.6.6 above but with more limited scan plans, fewer available sensors and without on-board tasking until the System 1 retrofit is in place. On-going improvements that insure more effective use of the ground mission data base are part of the phase I System 1 mission management enhancements. This includes upgraded situational analysis that employs digital mapping and overlay graphics and basic mission planning tools. Sensor Correlation tools will be added to System 1 as part of this enhancement, in the future as funding permits.

This is an important capability enhancement since it relates to speeding up the system back-end processing and has a direct bearing on the timeliness with which targeting data can be disseminated to the awaiting intelligence consumer in response to mission tasking.

3.1.7 ASE Suite Upgrade;

Provisions for adding the ALQ-136, ALQ-156 and ALQ-162 to the airframe have been engineered and functionally tested so that the kits could be installed on production aircraft. The ASE hardware upgrade involves cable and antenna "A kits", and electronics ASE "B kits". These subsystems are in addition to the existing ALQ-39, M-130 and IR Stacks/IR paint.

The ASE enhancement is focused on the requirement to provide an ASE system integration that will insure optimal operational effectiveness in the mission environment. This includes efficient use of the EFIS/ASE soft display for integrated cockpit control of the overall ASE suite; providing a Prime Mission Equipment interference management that insures compatibility with the primary mission objectives including blanking/software driven filtering of ASE generated interference; and generating the Standard Operating Procedures (SOP's) that will provide "programmed" ASE system effectiveness against potential missile threats. The cost and weight and the drag count of the full set of ASE equipment is significant, therefore, the methods for operational use and the guidelines as to when to carry this added equipment is an important part of the Guardrail system O&O concept as it relates to this upgrade that provides of the full set of upgraded ASE equipment.

Chamber testing and range testing including operational effectiveness testing will establish standard operating procedures for the expanded ASE application on this particular aircraft in its specified stand-off flight tracks.

3.1.8 CHAALS/ELINT Remote Operation;

This upgrade will allow the CHAALS to operate using the System 1 Ground Transportable Satellite Relay (GTSR). Satellite bandwidth limitations normally do not allow the digitized CHAALS signals to be returned to the IPF. However, with some minor modifications to the CHAALS software for time delays and with a significantly greater satellite bandwidth allocation, this important capability can be added. A possible alternate approach would be the installation of CHAALS processing in the GTSR, (or) to simply wait till the new generation CHALS-X is retrofitted into System 1 IAW section 3.2.2 of this document.

The addition of ELINT to System 1 remoting is much simpler than the CHAALS modification and can potentially be accomplished within the allocated satellite bandwidth. It involves choking the ELINT data flow in the beginning of the mission or simply dedicating the mission to ELINT for a short time till the amount of new ELINT data subsides. There are also some software modifications required to implement this remote relay enhancement.

3.2 System 1 Potential Retrofits;

The preplanned system 1 enhancements defined in this section are software and hardware retrofits from the System 2 design hence are generally longer term upgrades.

3.2.1 Three Channel CTT retrofit;

This enhancement is a retrofit to System 1 that provides simultaneous TRIXS, TRAP/TADIXS and TIBS network interfaces. It can work within the security levels appropriate to each of these net protocols and can support the CTT airborne relay and the SAT COM nets as well as any of the compatible land line nets. This operational enhancement includes a one way collateral channel to Quickfire via the CTT/H-R. The Three Channel CTT implementation is based on the System 2 basic design. It replaces the LRIP two channel CTT currently employed in System 1. This capability will be identical to System 2 and is dependent upon the planned System 2 advanced accreditation (See section 3.3).

3.2.2 Unified Architecture/LPI Payload Retrofit;

This enhancement is a retrofit to System 1 and will employ the full-up System 2 distributed architecture design. The Unified SIGINT payload architecture which includes CHALS-X LRU's, AQL with its single panel antenna arrays (and) the to-be developed ELINT on-board processing, the new generation MRDL interoperable link and the drop-on receiver are all anticipated equipment to be included in this retrofit program. This unified airborne enhancement will replace the older payload architecture with the new generation System 2 equipment.

Necessary IPF retrofits that are required to accept the new generation CHALS-X ground processing equipment and the MIST data link LRU's and related software installations are also part of the overall System 1 retrofit. The System 1 payload capability including allocable conventional/LPI sensors, multiple channel DF and task driven on-board processing/sensor data base will become identical to System 2 when this retrofit is installed (See section 2.6 and section 3.3 of this document for configuration and capability details).

3.2.3 Single Panel Pod Retrofit/Weight Reduction;

This enhancement is a future retrofit to System 1 and is based on the System 2 design. As a weight/cost reduction design modification, it employs a single ELINT array on each wing tip rather than a dual panel system and eliminates associated front-end equipment and switching. This retrofit will not take place until its aircraft are upgraded to the RC-12P configuration and is only compatible with the upgraded System 2 AQL ELINT system with its single panel antenna configuration. When this upgrade is installed, its capability is anticipated to be identical to System 2 (See section 3.3).

3.2.4 Embedded Training;

These upgrades will add some mission relevant scenarios to System 1 so that the mission managers can set up a variety of complex mission objectives that will include simulated, realistic tactical situations including emitter nets, and will ultimately show exotic modulations/identities/net reconstruction and will show some simulated outputs from various recognition's and signal exploitation elements. Using these simulated operational scenarios, the operator staff will increase their proficiency by participating actively in performing simulated missions that to the degree practical, realistically reflect the real world target environment. These embedded training upgrades will provide a low cost, on-going mission operator training program with the realism needed to prepare the operator for the operational rigors commonly encountered in battlefield operations and will prepare the operators for live field training exercises.

Embedded training is the best means of maintaining operational readiness that does not require the expense and wear and tear of excessive flight time. Further, it provides a simulated signal environment that may not be available in a "peace-time day-to-day garrisoned" area of operation. Therefore, Embedded Training can provide operational simulation needed for training that can not be easily simulated otherwise (or) may not even be legally radiated in some areas.

Simulated maintenance training software that provides instruction, has simulated system faults and provides "AI type diagnostic" promptings will be added as funding permits. There are several levels of sophistication that can be added as part of the Maintenance Proficiency Training. However, in any case, doing this training within the system using its own Operator Workstation terminals to practice diagnostics has many advantages for both simulated and hands-on maintenance training and at the same time substantially reduces travel and subsistence costs. Performing such training can be readily worked into the off-hours availability of the system and insures that all personnel are properly trained. It should be noted that much of this Maintenance Proficiency Training can also be performed on Workstations located away from the system.

3.2.5 Interoperability Enhancements;

The current System 1 IPF will interoperate with GR/CS systems 3 and 4 or IGR-V platforms or with a mix of Guardrail and RS-6b platforms. Its interoperability is limited to the functions that are compatible between systems. (See System 1 Interoperability Table 2.5.8.2.5-1). For example, IGR-V intercept, search and COMINT DF are compatible, however IGR-V has the ICTT relay rather than the CTT LRIP relay, hence, its CTT is not compatible, nor does IGR-V have AQL or CHAALS. The intercept and DF functions are the only mission features that are RS-6b compatible. Until it undergoes retrofit, the System 1 IPF will not be interoperable with the System 2 payloads with their unified architecture. These limitations relate to the new generation on-board System 2 features such as its on-board data base, its multiple channel front-end/LPI capability, AQL enhancements, the CHALS-X on-board processing, and the GDDL link with it serial I/O data feature.

3.2.6 Direct Airborne Satellite Relay;

This enhancement is required to achieve direct aircraft to satellite remote relay operations rather than requiring the current System 1 GTSR deployment that must be located at a field site within line of sight to the mission platforms. This advanced System 1 retrofit is based on the planned System 2 Direct Airborne Satellite Relay (DASR) design and requires that the air-to-air link software, the airborne CHALS-X processing software and that an on-board satellite terminal be installed in one or more of the System 1 aircraft. Its capability will be identical to System 2 (See section 3.3).

3.2.7 Drop-on Receiver;

System 1 has partial provisions for ELINT expansion. For example, it is capable of accepting a wide band microwave capability similar to the System 4 QRC installation. With the installation of this upgrade, the control of the microwave receiver can be coordinated with the ELINT subsystem to handle dwell-scan requirements but not the ELINT TDOA channel as is currently planned when retrofitted to the System 2 configuration.

The basic phase I drop-on receiver upgrades will provide the following enhancements to system 1:
- More than an order of magnitude increase in COMINT band coverage
- Up to a 10 MHz IF bandwidth with Pulse/AM/FM demodulation
- Directional side looking antennas
- Integrated microwave receiver control including programmed search/scan
- Operational software and an on-board IF signal interface to the FDDM unit as defined in section 3.1.1 above, will provide a wide band, multi channel capability and will support 120 channel FDM emitters in the microwave bands in addition to the basic bands 2 and 3.

When the System 1 payload is retrofitted to the System 2 configuration, a full fledged Drop-on Receiver capability with its COMINT expansion and its ELINT dwell/TDOA sensitivity enhancements would be part of that future retrofit. (See section 3.3)

3.2.8 ELINT On-board Enhancements;

This enhancement is required to perform target processing on-board the aircraft and is part of the planned System 1 retrofit that will implement the System 2 ELINT On-board Processing design. This capability will support DASR and will be identical to that planned for System 2 (See section 3.3).

3.3 System 2 P3I Enhancements;

These System 2 operational enhancements take advantage of many of the upgraded designs from System 1 and will benefit from the operational experience gained from the System 4 QRC upgrades and early System 1 operational experience. In addition to upgrades from System 1 such as ASE expansion, there a number of advanced, preplanned System 2 capabilities that will run in parallel with the System 2 development program, or that will be potential future field retrofits to System 2 first, then latter will be implemented on System 1 as a follow-up retrofit. The Direct Airborne Satellite Relay (DASR), Drop-on SIGINT Receiver (DOSR), and the ATSA based Band One capabilities are examples of high priority, longer term System 2 enhancements.

3.3.1 ASE Expansion;

This enhancement will be the same as the System 1 ASE enhancement, (or) alternatively it may be integrated first on System 2 then retrofitted to System 1.

3.3.2 Accreditation Upgrade;

Working with DIA and making full use of the established Security Accreditation Working Group (SAWG), the system will be upgraded from the current C-2 level to include an automated information system (AIS). This enhancement will extend the system to a higher level accreditation than is now in place and will support certain SAR requirements. The main effort here is to achieve security interfaces that will permit direct automatic release of less than SCI level data via the system reporting channels when this function is so authorized by the operator.

It will provide a "Security Features Users Guide" and a "Trusted Facility Manual" that will reflect the proper use of the system multi-level security reporting capabilities and that will specify the system design features and any security procedures required for the use of the software that supports the AIS approvals that are the primary objective of this effort.

3.3.3 Drop-on Receiver;

The Drop-on SIGINT receiver enhancement complements and supplements the ELINT capability and will support microwave COMINT. This microwave subsystem will consist of a high sensitivity set-on receiver channel with precision pulse measurement capability. It will improve the systems probability of intercept for ELINT TDOA and provide a new ELINT analysis capability for wideband and modern ELINT modulations. Control will be accessible to the ELINT operator to perform dwell/radar scan monitoring.

ELINT analysis of such parameters as pulse patterns, scan characteristics analysis and intrapulse modulation measurements will be an added capability without interfering with normal ELINT operation or degrading the probability of intercept during normal search. Graphic displays of frequency, pulse, time and amplitude relationships will be provided with appropriate filters for pulse width, pulse frequency and PRI are part of the planned operational aids. Specific Emitter Identification (SEI) is also an objective.

Enhanced COMINT capability will be focused on multi-channel FDDM, TDM and PCM type signals. It will provide an order of magnitude increase in frequency coverage, signal search with extended collection/manual analysis against signal parameters and events.

Antennas for the Drop-on Receiver are provisioned in the RC-12P pods. COTS receiving equipment with a maximum IF band width up to 500 MHz (30 MHz typical) will be used were practical. A 5 dB to

20 dB sensitivity improvement is being sought. The GPX will be used to support signal processing. Size, weight and power are critical issues in the trade-offs. The MMI will be seamlessly integrated into the existing ELINT and COMINT workstation software.

3.3.4 ATSA Embedded Band 1 Receiver/DF;

This embedded N channel approach to Band 1 will employ the ATSA fiber optic switch matrix, the GPX processors and messaging/control protocols that are currently part of the System 2 payload design and active antennas for maximum sensitivity. The object is have minimum impact on the System 2 architecture and operating MMI. This enhancement will entail the addition of Band 1 tuners and RF distribution. Planned capabilities will include:

- LPI search, track, DF and copy
- Multi-channel DF
- Cochannel interference reduction for conventional signals
- Wide band directed and general search
- Panoramic and spectral operator displays
- Integrated Band one MMI

An important objective of this multi-channel approach is to provide LPI emitter tracking, Band 1 scan plans and alarm modes, signal identification and a wide band DF capability for conventional and exotic signals. Rejection of sky wave, multiple co-channel LOP reporting and audio beam forming processing with the ability to sort fixes in a dense environment are high priorities in this future enhancement.

Off-the-shelf NDI equipment and existing on-board GPX CMC based processors will be used for receiving and processing the signals. Some System 1 RF distribution designs can be used and several of the Band one tuner elements are common with Band 2 and 3 channel elements. Its MMI including use of the System 2 dynamic falling raster display and back end data base query, Pan displays, mission area of interest screening, geolocation algorithms based on System 1 and use of potential enhancements for sorting of signals in a noisy environment will be installed in the IPF.

3.3.5 Air-to-Air Linkup ;

The GDDL is designed to handle forward and reverse communications, that is, it can receive commands and transmit data per normal operation, and at the same time, re-transmit commands and receive data on its reverse channel. The forward antenna would handle one channel and the rear antenna would handle the other.

Implementation of the air-to-air link supports the Direct Airborne Satellite Relay (DASR) and the extended tethered mode.

Integration involves two main areas: First, control software is required in the GDDL to track between two moving platforms and to select the correct antenna for the flight pattern at any moment in time. This includes antenna switching and any necessary bandwidth and frequency management that is required to avoid interference and to insure the integrity of the link. It also involves acquisition and re-acquisition of the air-to-air link. Second, the data flow must be properly addressed and routed so that received relay information can be processed in the receiving payload (or) simply merged into the outgoing data stream and passed through to the next aircraft, to the satellite or directly to the IPF.

There is no direct impact on the ground system except it must work with preprocessed data as opposed to standard raw data normally sent down the link. This enhancement is closely related to the on-board CHALS-X section 3.3.6 and the DASR section 3.3.10.

3.3.6 On-board CHALS-X Processing;

On-board CHALS-X processing moves correlation of the CHALS-X signals from the IPF to the payload. In the direct tethered modes, all digitized CHALS-X signals are sent to the IPF where they are correlated and processed with navigation to provide emitter location. This requires significant link bandwidth from each platform but is more convenient to process and re-process as required. The DASR implementation has severe limitations as to available satellite bandwidth. This limitation is also integral to the ability to employ a high power micro wave transmitter on-board the aircraft. This limitation relates to weight, antenna size, electromagnetic compatibility, antenna size etc. By preprocessing and correlating the CHALS-X on the platform the TDOA bandwidth and accompanying power is reduced by more than an order of magnitude.

The CHALS-X hardware is designed to perform correlation of its signal with a digitized signal from another platform so that it can be passed on, then re-correlated with another signal on the next platform. Software and integration is required to implement this mode of operation and to make the ground CHALS-X equipment work with the resulting data stream. Navigation processing and location processing remains in the IPF.

3.3.7 ELINT On-board Processing;

This enhancement to AQL reduces uplink and down-link loading that permits remote satellite relay operation and moves the ELINT correlation and location processing from the IPF to the platform.

ELINT on-board processing takes full advantage of the existing high capacity GPX processing that is part of the baseline ELINT configuration. The plan is to port the multi-aircraft location and time difference of arrival capabilities from the ground to the platform. Placing target correlation on-board reduces data flow by greater than an order of magnitude, preparatory to DASR operation.

These changes will significantly impact the operator MMI and are related to the upgrades in 3.3.8.

ELINT on-board processing also supports on-board tasking and signal analysis that can lead to direct collateral transmission of TAC ELINT reports.

3.3.8 ELINT Ground Processing upgrade;

The ELINT Ground Processing upgrade improves analysis and sorting capabilities that include ability to better handle jitter, stagger and complex emitter identification. It includes enhanced scan and PRI analysis. This is a software enhancement that will upgrade the ELINT signal processing algorithms to operate in the universal workstations in a distributed environment. The specifics will be defined as part of a study.

Currently the ELINT processing thread resides in the ground ELINT System Computer (ESC). Now that the system normally employs three platforms, large amounts of ELINT data flows from the ELINT sensors to the IPF. With this increased data flow, the ESC limits throughput and reduces the probability of intercept during overload periods. With the vastly increased processing power that is available in the Universal Workstations and servers, this problem can be mitigated by using distributed processing techniques being employed in other parts of the system.

New available threat association algorithms along with modern windowed MMI, the implementation of distributed ELINT processing can be leveraged to substantially enhance the system's capability for sorting threats, efficiently presenting results to the operator and supervisor, and can more effectively deal with expanded, modern ELINT signal environments. Transition to the new threat association models provides the following benefits:

- Automatic identification
- Automatic geolocation (including unknown emitters)
- Multi-mode processing
- Relational interfacing
- Multi-aircraft correlation processing
- On-line EWIR data base
- EWIR query
- DMA maps
- Playback analysis
- Data base generation
- TIBS interface/correlation

The study will demonstrate the applicability of the planned technology transfer. Operation against a recorded AQL signal data base has already been demonstrated. On-site system operators will evaluate the study demonstration software for utility. Implementation would include transitioning the demonstration software into the system. This enhancement would make use of the Smart File Cabinet and smart map sensor management graphics.

3.3.9 Auto Multi-level Reporting;

An objective of this enhancement is to reduce latency of intelligence data exported from the system. The system has passwords, journalization, auditing, CRC checks and various protections against the contamination of collateral data with higher classification data, as information is merged and to prevent other violations, however the final review is a man-in-the-loop which slows the process of getting information in and out of the system. This enhancement will employ the advanced mission management tools defined in section 3.3.15 and an enhanced Security Data System that will either automate release or allow advanced approval for release of selected formatted/filtered reports.

3.3.10 Direct Airborne Satellite Relay;

The Direct Airborne Satellite Relay (DASR) capability will allow world-wide deployment of Guardrail/Common Sensor System 2 without the need for transporting the IPF and associated ground support equipment. This direct aircraft to satellite relay provides a quick reaction capability not currently possible when the aircraft are tethered to the IPF by the Guardrail Dual Data Link (GDDL). With the DASR enhancement, the aircraft payloads will be remotely controlled by the IPF through a DSCS III satellite channel. The current tethered mode generally requires the aircraft to fly at maximum flight profile altitudes in order to maintain line-of sight with the IPF ground station. The maximum distance is nominally 250 km. It is very desirable that operational deployments operate at various altitude profiles and with a varying number of aircraft. The direct satellite relay allows the aircraft to operate at variety of altitudes to optimize target geometry without affecting line of sight to the ground station.

Three flight profile limitations are anticipated when operating in the full DASR deployment scenario. The limitations are: The distance between aircraft be less than 150 km; altitudes between aircraft should not exceed 5,000 ft; and the satellite relay configured aircraft must be at the end of the daisy chain. Each ARF has a reversible data link called the Guardrail Dual Data Link (GDDL). The "relay aircraft" will have a microwave relay link that uses a steerable antenna mounted on the top of the aircraft fuselage that communicates with the satellite. The GDDL will use the antennas located in the lower nose and tail area to communicate with next aircraft in the chain.

Operational implementation is driven by the required mission geometry, the range with respect to the supporting airfield, and the coverage required which relates to the number of aircraft required to adequately cover the mission area. The satellite relay aircraft will have a lesser set of sensor equipment because of power and weight required to support the airborne satellite communications terminal. That aircraft, however, will be able to provide limited SIGINT mission coverage by itself for periods when light activity is expected. Figure 3.3.10-1 depicts a typical deployment scenario.

The three-aircraft mission configuration shown in this figure shows the planned satellite-remote operating configuration for Guardrail/Common Sensor System 2. In this scenario, the mission aircraft relies on garrison support such as power, housing, maintenance facilities, and hangars that are properly equipped to handle day-to-day operations and maintenance of the deployed aircraft, crew and support personnel. The payloads have built-in pre-mission test for Go, No-go checkout of the ARF equipment. For extended deployments, the MMV and spare modules should be deployed to the remote airfield site.

A modest DSCS bandwidth (_1.5 mB) is required for the satellite communications channel. Aircraft to satellite geometry suited to the mission area is also required. An earth station at the IPF interfaces the satellite link to the IPF ground station and serves to manage the relay communications power levels, monitors link integrity, initializes the satellite link and insures that geometry's are correct for successful mission operation.

The DASR configured aircraft is tethered to the DSCS satellite and also supports the GDDL. The DASR aircraft consolidates return data gathered from the aircraft-to-aircraft links and performs any necessary processing of raw data. The final correlation of TDOA and consolidation of the down link data takes place in the master DASR platform. The DASR aircraft transmits the limited band width signal through the DSCS III satellite to the IPF.

Figure 3.3.10-1 DASR Aircraft Deployment Configuration

In the direct satellite configuration, the ground segment can be remoted large distances from the target environment. Up to two satellite hops are possible to further extend the range. Air-to-air daisy chain operational deployments are defined in section 2.6.8.2.7 and 2.6.8.2.8.

3.3.11 Interoperability Enhancements;

This enhancement is equivalent to that described in section 3.2.5 except it will only be compatible with the CHALS-X processing and the Three Channel CTT. The Multi-role Data Link and the on-board CTT relay are to be downward compatible with the IDL and LRIP CTT.

3.3.12 ARF Roundout;

An additional three payloads are required to roundout the mission equipment to support the defined surge capability. This would provide prime mission equipment in nine of the twelve aircraft.

Retrofit of the System 1 platforms would require nine System 2 type payloads and an upgrade of the RC12-N aircraft to the RC12-P configuration (See section 3.2.2). These roundout programs are a function of available funding, but are important to the capabilities and readiness of the Corps MI Airborne Exploitation Battalions.

3.3.13 Automated Proforma Upgrade;

Automatic routing of signals that have been recognized as candidates for SSP processing as result of their directed search frequency or by the signal classifier, will expedite the exploitation of this class of signals. Part of the automation will probably include entering the results into the mission data bases.

3.3.14 CHALS-X LPI Tasking;

This enhancement would allow CHALS-X to be tasked to do precision location of LPI signals. This will allow TDOA location accuracy of short duration exotic signals as well as conventional signals. Its capability and the methodology of achieving this objective is yet to be defined.

3.3.15 Sensor Management/Quickfire;

The Sensor Management/ Quickfire (SM/QF) enhancement provide the mission manager with additional primary analysis and mission planning tools needed for a highly coordinated mission planning process. It includes search control, data analysis, and reporting functions. This enhancement also focuses on "software translating" of high level mission tasking to internal sensor management in order to provide enhanced situational awareness as it supports the development of a detailed picture of the target environment. It helps the mission manger develop search, collection, processing and reporting strategies that will satisfy the tasking requirements. This enhancement will be a combination of government furnished and contractor furnished software. Implementation of this extension is related to the Accreditation Upgrade in 3.3.2.

This new mission management capability will provide automatic Quickfire report generation that will send out high-value targets when those reports have been given operator authority for release. Features like ELINT scan tables, and advanced COMINT Directed and General search and software initiated tasking in response to high level mission tasking are part of the Sensor Management/Quickfire enhancement. Figure 3.3.15-1 illustrates the software tools and information flow that will automate sensor management and Quickfire reporting.

The current baseline System Sensor Management supports the finding and reporting of high value targets, but is largely manual in setting up the search, geo-screening, establishing ELINT emitter recognition files and tactical site files. As part of the automatic sensor management enhancement, additional threat association/sensor management is planned as an extension of the System 2 baseline capability. A key feature of this enhancement is direct, immediate collateral reporting of target data to Quickfire. Ultimate contents of that report will include radar's, radio types, call signs and locations of high value targets.

An Object-Oriented Mission Planner (OOMP) will be implemented to allow the operator to specify the mission objectives at a higher level than is currently possible. A windowed display will allow the operator to select mission objectives that fit the profile of the tasking. This tool will be configured such that profiles can easily be added or deleted. Some parameters would be search lists that fit certain weapons systems, or pre-defined echelon types and selection of the exploitation that would be necessary to fit the doctrine applying to those threats. Alerts that coincide with activities, movements etc will also contribute to the automation and speed of getting accurate data quickly to the users. The Unified Search Controller (USC) will support the automatic and manual creation of search lists, merging of lists, checking of lists for redundancy and insures that lists can be satisfied by the sensor capability.

Sensor Management/Quickfire Software Tools

Figure 3.3.15-1