

USA Disaster Relief Corps (USADRC)

Rescue Searchlight - Satcom Vehicle

Squad 16 – Headquartered in Lake County, Illinois

Introductory Comments

The purpose of this memorandum is to provide the reader with an overview of Squad 16's capabilities, which are constantly being reviewed and improved. In this regard, if the reader should have any comments, questions, or suggestions on how to improve Squad 16, please contact us as your input is very welcome and greatly appreciated. Emails may be sent to the following: admin@usadrc.us and if you would like to view photos of Squad 16, please go to www.usadrc-squad16.us where 40+ photos can be downloaded.

Squad 16 is headquartered in Lake County, Illinois (which is located 25 miles north of Chicago) and provides mobile emergency communications and disaster relief assistance and education to the public solely in conjunction with federal, state, and local government public safety and emergency management authorities. It is fully funded, and it neither accepts any donations from the public, nor does it charge any fees for the services it provides. Deployments throughout the United States are primarily made pursuant to requests under formal Memorandums of Understanding with applicable governmental agencies. See page 10 for OVERSEAS DEPLOYMENTS and AIRLIFTING SQUAD 16.

Specifications, Systems and Operations Overview

The primary vehicle currently deployed by Squad 16 was built by the Alexis Fire Equipment Company and utilizes an International Trucks Severe Service 7400 4X4 Crew Cab chassis with a DT570 diesel engine, a drive train rated at 80,000 pounds, and a Gross Vehicle Weight Rating of 37,500 pounds. It has a 30kW hydraulic generator and a redundant 12kW diesel generator, which both can operate while driving, which permits Comms Ops while underway approximately 2 miles after initial start-up. Squad 16 produces over 15,000 watts of scene lighting, and with 185 gallons of diesel fuel, it can operate on station for over 16 days without refueling. The vehicle's specialized design and wide front axle permit it to have a turning radius smaller than its overall length of 29' 4". Because it has 10,000+ pounds of equipment mounted under the top of its double-reinforced chassis frame rails, Squad 16 has a relatively low center of gravity of less than 40% of its 12' 9" height (the NFPA maximum allowable is 80%), and it also exceeded the NFPA (National Fire Protection Association) horizontal tilt test of 26.5 degrees.

It has a full array of electrical equipment in its 24+ feet of vertical rack space including: a multi-path telecom IP system with a 1.2 meter VSAT, a 25 watt BUC, 2 Iridiums, 2 Telulars, 1 router, 2 switches, 8 wall phones, 6 wireless VoIP phones, 3 servers, 1 spectrum analyzer, and 3 double conversion Uninterrupted Power Supplies. Radio operations and interoperability are provided by 2 redundant systems (Raytheon ACU-2000 IP, and ClearCom), 40+ radios, 2 repeaters, an 80 position antenna-radio patch panel, and an array of 70+ redundant antennas mounted on the 11' roof, the 30' mast, and the 50' mast. Stability and leveling for SAT acquisitions are provided by

4 hydraulic stabilization jacks. Three air conditioning units with a total of 40,000+ BTUs provide cooling for the stainless steel walk-in Communications Center, which is accessed via an aft door, and can also serve as an emergency cooling center for anyone suffering from heat stress such as civilians, firefighters, rescue teams, and other public safety personnel.

At the request of the Incident Commander, Squad 16 can act as a support vehicle for all-hazards incidents, including serving under the direction of teams conducting Search and Rescue Operations, and Firefighting. Specialized equipment mounted on top of a 50' pneumatic mast includes a primary Rescue Searchlight, which projects usable light approximately 1.5 miles downrange, mounted alongside two long-range day/night (0.07 lux) cameras, which have a detection range of 4 miles, recognition at 2 miles, and identification at 1 mile. For maximizing search coverage areas for victims, the searchlight can also be operated at vehicle speeds up to 10 mph with the mast deployed to a height of 15 feet (subject to local area bridges and roadway conditions). In addition to white visible light, illumination can be provided via an automatic filter wheel in multiple frequencies and colors, including AMBER (550 nanometers) to cut through smoke, RED (680 nanometers) for night vision, and INFRARED (880 nanometers) for those incidents where ground personnel are wearing night vision goggles or a helicopter flight crew requests an infrared illuminated LZ (Landing Zone).

Night operations are also enhanced by two redundant scene lighting systems, which include a 120 VAC 6000 watt light tower mounted on the crew cab roof with a 20' elevation, and four 12 VDC 1500 watt flood lights and three 12 VDC remote controlled crew cab roof searchlights. During both day and night operations with restricted views due to fog or smoke, a Forward Looking Infrared (FLIR) camera provides the Engineer and First Officer with improved visibility of the roadway and allows them to see heat signatures, including, but not limited to, a victim.

At the request of a Search and Rescue Team and under their direction, Squad 16 can be an asset that they might elect to use as an additional resource for their rescue operations. In addition to all of the Communications Systems and the Rescue Searchlight, Squad 16 has a 2,000 pound 3/4" steel plate front bumper assembly that has two receivers for a 10,000 pound (1,000 pound workable load) 120 VAC electric rope rescue AMKUS winch. In addition, the front bumper assembly has a 16,500 pound 12 VDC electric steel cable WARN winch, and two primary tow hooks rated at 30,000 pounds each. Rigging includes four adjustable poles that permit an angle of attack up to approximately 12' above the ground. Tow chains, webbing, extrication tools, and saws can also be utilized with the two winches described above to clear fallen trees or debris that block the roadway. As requested, a live video feed from the forward-facing camera to a secure website can provide a real-time view of both the roadway conditions and the rate of progress for the convoy. Once on station, mast-mounted cameras on both the 30' and 50' masts can provide an overview of the scene and also a view of down-range operations.

The Communications Systems consist of seven core components, which can be operated at two interior locations, and one exterior location on the vehicle, which has 167ru of computer rack space, and three 13,500 BTU 500 CFM air conditioning units for cooling:

1. A 25 Watt 1.2 meter Ku-Band satellite link that connects Squad 16 with the satellite hub that is capable of streaming video at 30 frames per second and, as

- requested, of having a downlink speed of 2 Megabits per second, and an uplink speed of 1 Megabit. Even higher data speeds are possible with a larger “pipe.”
2. A high-performance standards-based IP network that securely connects people and applications residing on, or near Squad 16 to off-site personnel.
 3. A full complement of 25+ rack mounted radio receivers and transceivers, a UHF repeater/duplexer, a VHF repeater/duplexer, 10+ handheld radios, and redundant radio and telephony interoperability systems via the Raytheon ACU-2000 IP, and a 48 port Clear-Com Eclipse Median Digital Matrix.
 4. Telephony links are provided by the 1.2 meter satellite dish, two redundant cellular voice gateways, and an Iridium satellite terminal. These, in turn, provide personnel with dial tone, and with seamless transitions between operational telephony links to the vehicle’s 8 hard-wired VoIP (Voice over Internet Protocol) phones, and its 6 wireless handheld VoIP phones. Further telephony expansion and fax services are immediately available with 8 analog phone jacks.
 5. In addition to voice telephony, personnel can also utilize the two Polycom Video Conferencing Systems.
 6. Situational Awareness and secure streaming video transmission of an incident is accomplished, if requested by the Incident Commander, via the satellite and/or cellular networks, and a 32X32 video matrix, 15 cameras, and 26 monitors.
 7. Personnel are kept informed of broadcast news media coverage and weather alerts via 2 satellite TV receivers, 1 off-air TV antenna, and a weather alert radio system that has nationwide alert coverage and roaming.

Power Systems

Squad 16’s primary generator is a PTO high-capacity hydraulic Harrison generator rated at 30kW that is operational either while on station, or at highway speeds. A secondary Cummins Onan diesel generator rated at 12kW provides redundancy and also a “quiet mode” for rescue operations that require low ambient noise levels. There are three 120 VAC double conversion UPS (Uninterrupted Power Supply) units rated at 2200 VA (1600 watts) each that provide clean sine wave power to all systems, including the rescue searchlight, with approximately 20 minutes of back-up electrical power in the event both the primary 30 kW generator and the secondary 12 kW failed simultaneously. The UPS units also enable all Communication Systems to stay online during seamless transfers between the two generators, and when transferring to shore power.

Squad 16 can utilize shore power via different AC amperage sources that include a total of ten inputs; including one 50 amp 240 VAC input, six 20 amp 120 VAC inputs (one for each of the 3 UPS units, and one for each of the 3 air conditioning units), and three redundant inputs (2 of which are auto-eject) for the three battery conditioners (which augment the 330 amp alternator) for the vehicle’s four 12 VDC chassis batteries and the standby air compressor. In addition to these four chassis batteries, the 12kW diesel generator has its own 12 VDC battery, and there are four Anderson connections onboard Squad 16 (one at each of the four corners) in the event this battery needed charging.

In the event the chassis alternator failed, the above design provides redundancy as Squad 16 would still be operational using these three battery conditioners, which could be powered by

either generator. Because certain radios are more sensitive to the quality of the 12 VDC Power, there are two 180 amp Mean Well Samlex RCP-3000 12 VDC Power Units that have an aggregate total of six 60 amp units that are connected in parallel (further increasing redundancy).

Safe transitions between the vehicle's generators and shore power take place automatically via a change-over relay. In addition, electrical power can be supplied to down-range operations, another vehicle, or a building, via a 200 foot 50 amp 120 VAC twist lock cord reel lighted quad box, one 50 amp 240 VAC receptacle, and nine 120 VAC twist lock receptacles (six 20 amp, and three 15 amp).

Vehicle-Mounted Satellite Terminal

Squad 16 is equipped with a Ku-Band satellite antenna capable of supporting a high-capacity satellite link between the vehicle and a satellite hub facility. This fully-automated antenna is a 1.2 meter MVS-1200 dish manufactured by TracStar Systems, and it is equipped with a 25-Watt WaveStream Solid State Power Amplifier (BUC), and a series 7350 iDirect modem. To monitor signal strength and permit manual satellite acquisitions (for example, while overseas), the vehicle is also equipped with an Agilent N1996A-503 Spectrum Analyzer (maximum frequency 3 GHz).

IP Network

Squad 16 has a high-performance IP network that utilizes Cisco Systems hardware with a Cisco 3825 high performance router at its core. This router is paired with two Cisco 24-port 3560G high-performance Ethernet switches that are both equipped with Power over Ethernet (PoE) to power any device connected to the physical network. The 3825 router serves as the main communications device for the network directing all IP data and telephony traffic. It is also connected to two Telular Gateway devices, which are, in turn, connected to commercial cellular voice via Verizon, and also ATT, for redundancy. The 3825 router is programmed to prefer cellular services, so if a cellular link is available when a VoIP phone is taken off-hook it will be used. Otherwise the call will be completed over the primary 1.2 meter satellite link, or with the Iridium satellite network.

Primary Satellite Link

- This link utilizes an encrypted connection between the vehicle and the iDirect network. This network is pure IP and provides connectivity from the vehicle to the outside world in cases where other network services are not available. The link can be brought up after the vehicle is on station and is stabilized (using the four onboard hydraulic jacks). The entire process of unfurling the 1.2 meter satellite antenna and establishing connectivity with the iDirect service usually takes less than five minutes once Squad 16 is on station.

Verizon EVDO Wireless IP Network

- The vehicle is also equipped with a data terminal to facilitate connections between the on-board IP network and commercial high-speed cellular services. This terminal is connected

from the Cisco 3825 router to Verizon's commercial EVDO broadband service, and it provides the vehicle with fully routed connectivity to the commercial Internet with transmit data rates of approximately 128 kilobits per second, and receive data rates of approximately 400 kilobits per second. Applications using this link can also use Virtual Private Network (VPN) capabilities to connect to secure, or sensitive applications that reside behind firewalls on private networks.

Wireless Network

- The IP network is also able to be extended to users operating in the vicinity of Squad 16 using the 802.11g (2.4 GHz) frequency. This wireless IP network is encrypted using strong commercial methods. The 802.11g wireless access point (WAP) is installed on the top of the 50' mast, and it provides a 'bubble of connectivity' around the vehicle up to approximately 500'.

Onboard Servers

Squad 16 is equipped with three primary onboard redundant servers that are rack-mounted in the Communications Center, and that each has its own dedicated UPS. They are all connected to an NTI KWM switch, which allows the control of each server from multiple locations on the vehicle. In addition, multiple Panasonic Toughbook laptop computers are onboard for personnel in the Crew Cab and Communications Center. All Toughbooks have their own independent EVDO broadband services for additional redundancy, and they are also pre-configured to operate the Cisco IP Network in the event all three of the primary onboard servers failed. Wireless operation via the WAP of the primary Rescue Searchlight's pan tilt platform is accomplished through these Toughbooks, which thereby enables the downrange crew to directly maneuver the Rescue Searchlight from outside of Squad 16 and downrange up to approximately 500'.

Video Reception

The vehicle is able to receive commercial video broadcasts while underway using a stand-alone KVH Ku-Band receive-only gyroscopic antenna. This antenna is equipped to receive two simultaneous commercial DBS broadcasts from DirecTV, and with two DirecTV receivers configured so that personnel can monitor, for example, both CNN and The Weather Channel simultaneously. All video receivers, including one off-air antenna for local TV news broadcasting, are tied into the vehicle's onboard video distribution system, and all audio is fed into the onboard Clear-Com 48 port Eclipse Median Digital Matrix Intercom for redistribution throughout the vehicle and to down-range personnel via their wireless duplex headsets.

Local Video Distribution

The vehicle is equipped with an onboard Leitch/Harris video distribution matrix system (32x32) to distribute video from various sources to any video monitor or broadcast element. All video is switched in a standards-based NTSC (National Television System Committee) format.

The 32 inputs to the video distribution matrix system are the following:

- 5 mast-mounted long-range cameras (three on the 50' mast, and two on the 30' mast)
- 4 exterior cameras (front, left, right, and aft)
- 3 interior vehicle cameras (Crew Cab (2) and Communications Center)
- 2 DirecTV receivers
- 1 off-air television antenna connected to a digital ready receiver
- 1 Digital Video Recorder
- 1 DVD Player
- 2 Polycom Video Conferencing Systems
- 2 down-range cameras plugged into the Communications Center's Input/Output Panel
- 11 spare inputs

The 32 outputs to the video distribution matrix system are the following:

- 8 color 7" monitors (four sets of double rack mounted units) at three work stations
- 4 color 15" monitors - Crew Cab (3), and Compartment L-2 Exterior (1) work stations
- 1 color 17" monitor in the Communications Center's primary work station
- 1 color 7" monitor at the rear bumper Compartment AFT-1
- 9 color 5" monitors – three each in Crew Cab, Communications Center, and L-2
- 1 Nextiva H.264 video encoder for IP video distribution
- 1 NTSC to VGA Switch that provides video to the three primary computer monitors
- 2 Video Outs in the Input/Output Panel in the Communications Center
- 1 RF Modulator in the Input/Output Panel in the Communications Center
- 4 spare outputs

Squad 16 is also equipped with a VGA switch for the distribution of computer-generated images to multiple monitors on the vehicle. One output from the 32x32 video distribution matrix is provided to the VGA switch to allow cross-patching between the two distribution systems.

In addition to the above twelve cameras, operational safety is further enhanced with three other cameras that provide the Engineer with full-time video feeds from the two sides, and the aft view; all of which feed into three 5" dashboard monitors. A FLIR camera also provides a forward view when conditions warrant, and it can be placed on a split screen with a video feed from the Communications Center if mobile operations are being conducted. A separate GPS system has its own dedicated dashboard monitor, and it has a Satellite Radio feed.

Video Broadcast / Re-Broadcast

Squad 16 is equipped with a Nextiva video broadcast encoder. This encoder converts analog (NTSC) video to MPEG-4 over IP using a standard known as H.264. This video can be distributed on the vehicle, or broadcast/multicast to other locations via the Ku-Band satellite link, the cellular data link, or the Panasonic Toughbooks' EVDO services. The quality of this video feed is dependent on the amount of bandwidth allocated to the video. The Nextiva encoder allows the user to control the number of frames per second of the video to match available bandwidth.

Also, the vehicle is pre-wired to accommodate the addition of components to support the reception of COFDM video signals from helicopters. Using the onboard video routing system and the Nextiva encoder, Squad 16 will also be able to serve as a video relay platform for video originated from COFDM broadcast systems on helicopters to the outside world.

Land Mobile Radios

The vehicle is equipped with a full complement of Land Mobile Radios (LMRs) of which 17 are connected to the 48 port Clear-Com Eclipse Median Digital Matrix, which allows such radio frequencies to be keyed by users at any of the four intercom stations on the vehicle. Squad 16 is also equipped with a Raytheon ACU-2000 IP radio interoperability system. This system allows any new radio frequency (not already covered by the vehicle's LMRs) to be included in the interoperability network by simply plugging the radio (which could be a local Fire or Police Department's handheld radio) into the ACU-2000 IP system either directly, or via the Input/Output Panel located in the Communications Center. Two channels from the ACU-2000 IP are connected to the Clear-Com Matrix Intercom to further facilitate complete interoperability.

Voice

Squad 16 relies on a number of elements to complete the voice core. The entire voice system is based on VoIP (Voice over Internet Protocol) utilizing Cisco's Call Manager Express and compression resources on the Cisco 3825 router.

Primary Voice Connections:

- The vehicle has 8 onboard VoIP phones that are hard-wired to the core IP network, and 6 wireless VoIP phones that connect to the same network using 802.11g. Additionally, the Cisco

3825 router has two analog ports connected to the cellular voice gateways (Telular Corporation) with service via Verizon, and ATT. These gateways provide the onboard voice network with two additional cellular voice extensions which are primarily used either when the satellite link cannot be used (i.e. due to high-rise buildings, or terrain), or prior to the establishment of the satellite link such as when the vehicle is underway.

When a user picks up a VoIP phone and goes off-hook, the 3825 router will automatically provide dial tone. If the Ku-Band satellite link is operational, the router will direct the voice traffic out the satellite link. If the satellite link is not available, the router will utilize one of the two cellular voice gateways to complete the call. This is completely transparent to the user.

- In the event no dial tone is automatically provided by either the Ku-Band satellite link, or the two cellular voice gateways, the user can then access, via extension “8” on the phone, the network’s back-up connection that is provided by the onboard primary Iridium satellite terminal.
- A redundant hand-held Iridium satellite phone is also onboard, and it can be operated, as the mission requires, either down-range, or connected to an auxiliary antenna that is located on a telescopic pole adjacent to exterior Compartment L-1, which along with Compartments L-2 and L-3, are all protected by a motorized awning.

Analog Telephone Jacks:

- Squad 16 is also equipped with eight analog telephone jacks with six available at the Input/Output Panel in the Communications Center, and two in exterior Compartment L-3 for use with a fax machine. These jacks are able to accommodate connections to analog telephone handsets, and classified STU/STE encrypted telephones. All voice devices connected to the VoIP core are configured to support the prevailing dial plan established for the vehicle.

Digital Intercom

The vehicle is equipped with a state-of-the-art Clear-Com Eclipse Median Digital Matrix Intercom system. This system is equipped with 48 ports, with further expansion possible, if needed. There are four intercom stations with two in the Communications Center, and one each in the Crew Cab, and Compartment L-2, which is an exterior workstation located under the vehicle’s side awning. The following systems are connected to the Clear-Com’s 48 ports:

- 17 Land Mobile Radios
- 1 Weather Alert Radio
- 1 Radio Scanner
- 2 ports connected to the Raytheon ACU-2000 Radio Interoperability System
- 4 Digital Matrix Intercom Stations (Comms Center [2], Crew Cab, and Compartment L-2)

- 4 CellCom Wireless Intercom Beltpacks
- 2 ports for the four “party-line” CellCom hard-wired Intercom Stations in the Crew Cab
- 3 ports for audio feeds from the two DirecTV receivers, and the one off-air TV antenna
- 5 ports for the five audio mixers (Comms Center, Crew Cab, and three in Compartment L-2)
- 3 ports for the Digital Video Recorder (two for record, and one for playback)
- 2 remote location cameras plugged into the Communications Center’s Input/Output Panel
- 1 DVD Player
- 3 spare ports

The Clear-Com 48 port Matrix supports the establishment of ad hoc voice conferences, which allows any number of onboard radios to be connected seamlessly, and, thereby, provides a redundant interoperability system to the Raytheon ACU-2000 IP. Additionally, the digital intercom makes it possible to key any radio on the vehicle from any of the four intercom positions.

Wireless extensions to the digital matrix intercom system is enabled by utilizing the Clear-Com’s CellCom system, which allows users of the intercom to remain connected to the vehicle at distances up to 150+ yards using wireless belt-packs. The CellCom system is configured with four wireless belt-packs (1.9 GHz), and four hard-wired positions in the Crew Cab. Because the CellCom is a full duplex system, rescue personnel can work freely with both hands as there is no push-to-talk feature commonly found on Land Mobile Radio technology.

Stereo Audio Distribution and Mixers

Squad 16 is equipped with four Stereo Audio Distribution Amplifiers and five Stereo Line Mixers that are connected to five pairs of stereo audio monitors (Communications Center, Crew Cab, Compartment L-2, and the SAT Platform (2 pairs)), and two DirecTV receivers, one off-air TV antenna, one Sony Blu-Ray DVD player, the Clear-Com Matrix, and the two Polycom Video Conferencing Systems.

Weather Station

A Coastal Environmental WEATHERPAK MTR portable Weather Station measures wind speed and direction, air temperature, relative humidity, and barometric pressure. It can be deployed downrange into a hot zone mounted on its battery-powered tripod, or it can be mounted on Squad 16’s front bumper assembly, and because the unit has an internal GPS, corrected wind speed and wind direction are calculated when Squad 16 is underway.

Weather Radio and Time Code

Squad 16 is equipped with a Thunder Eagle weather alert radio system that has nationwide alert coverage and roaming. For the accurate time stamping on all recorded video and servers, a Network Time Protocol (NTP) clock is onboard that is synchronized via the U.S. Department of Defense satellite system.

12 VDC Power for Stranded Vehicles & Emergency Amateur Radio Communications

Because of the possible need to provide 12 VDC power to a stranded vehicle, and to power Emergency Amateur Radio Communications, which can be extremely valuable during disasters, Squad 16 has four 12 VDC Anderson Powerpole connectors with one at each of the four exterior corners of the vehicle. These connections are in addition to all of the other onboard 120 VAC power and communications equipment, which will all be made available, as needed, to members of the Amateur Radio community, including, but not limited to the following organizations:

- The American Radio Relay League (ARRL) National Traffic System (NTS)
- The Amateur Radio Emergency Service (ARES)
- The Radio Amateur Civil Emergency Service (RACES)

These organizations have websites at the following links:

www.arrl.org

www.ares.org

www.usraces.org

Also, so as to further serve the Amateur Radio community, Squad 16 has a total of four Hi-Q HF Radio Antennas onboard, and a total of six HAM radios, including three D-STAR radios.

OVERSEAS DEPLOYMENTS and AIRLIFTING SQUAD 16

As requested by governmental or charitable organizations, Squad 16 and its crew will deploy overseas to assist in humanitarian efforts to assist regions impacted by disasters such as earthquakes, flooding, and famine. Squad 16 can be airlifted from Chicago's O'Hare Airport onboard a Boeing C-17 Globemaster III, which has a loadable height (aft of the wing) of 14.8 feet and 12.3 feet (under the wing), a loadable width of 18 feet, a cargo floor length of 68.2 feet, a ramp capacity of 40,000 pounds, and a payload capacity of 160,000+ pounds.