



# Operating Manual

## MAIPN Van

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## About MAIPN

The Mid-Atlantic IP Network (MAIPN) is an organization established by a group of Amateur Radio operators whose mission is to implement a regional wireless data network consistent with the purposes of the Amateur Radio Service, as stated in the governing FCC regulation, 21 CFR 97:

- Recognition and enhancement of the value of the amateur service to the public as a voluntary noncommercial communication service, particularly with respect to providing emergency communications.
- Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.
- Encouragement and improvement of the amateur service through rules which provide for advancing skills in both the communication and technical phases of the art.
- Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts.

MAIPN is part of a national movement within the Amateur Radio community to employ modern wireless technology in our local and regional Amateur Radio networks. We are particularly interested in the uses of this technology to support local emergency management officials, hospitals, and other public and private organizations that provide disaster response services, although we also provide services that are strictly aimed at Amateur Radio, such as implementing repeater links using broadband technology.

We are taking advantage of a new class of low-cost digital microwave radios that have recently (or not so recently now!) appeared in the marketplace. This equipment was originally intended to be used by commercial providers to deliver wireless internet service to customers who are underserved by existing cable and fiber optic networks. However, we have found that this equipment is ideally suited to provide services that rely on broadband data communications.

One aspect of our approach is that much of the RF equipment we use operates on unlicensed Part 15 frequencies rather than Part 97 (Amateur Radio) frequencies. Not only does this lower the cost of equipment – by taking advantage of economies of scale – but it also provides operational advantages to some of our emcomm “customers,” such as the ability to encrypt sensitive information and the ability to use the system without the need for a licensed control operator at the helm.

So, while we are coming from a well-established Amateur Radio tradition, we are in some cases moving outside the formal boundaries of Amateur Radio while maintaining allegiance to the foundational principles of Amateur Radio.

## Overview of the MAIPN Van

MAIPN operates a communications van to support our mission. The vehicle was originally used for research by a DC-area company, and generously donated to MAIPN when no longer needed. It is equipped with a 48-foot pneumatic mast and a 7 kW generator, among other amenities.

Our design intent for the van was twofold:

- To be used as a mobile test facility to scout out paths for links in our growing microwave network by quickly getting a dish in the air to test signal quality along the path of a planned link, and
- To provide a capability to project broadband connectivity from our network to an arbitrary field location, such as a disaster scene, shelter, or staging area.

We also equipped the van with a complement of HF, VHF, and UHF Amateur Radio gear, enabling its use as a general-purpose mobile emcomm asset.

While a project like this is never truly finished, the van is fully operational and has proven itself in use over a period of several years.

## Vehicle Chassis, Body, and Accommodations

The vehicle is built on a Ford F-450 Super Duty chassis with a 15-foot cutaway box body. Salient vehicle specifications are provided in Appendix A. Although the vehicle is now 20 years old, a mechanic who recently performed an annual safety inspection remarked that the engine looks and performs “as if it was brand new.”

The layout of the van is similar to that of a conventional electronic newsgathering (ENG) van. The design was modified to meet the requirements of the sponsoring research organization.

The van is divided into two compartments, separated by a row of four full-height 19” racks. When facing the racks while standing in the main compartment, the racks are numbered 1 through 4 from left to right.

The main compartment is accessible via a curbside door. There is also a passthrough to the cab. The over-cab portion of the compartment houses three storage compartments.

In addition to the driver and passenger seats in the cab, there is an additional passenger seat in the main compartment which is designed to be occupied while the vehicle is in motion. That seat is mounted in such a way that it can be rotated to face aft when the vehicle is stationary.

Behind the equipment racks is an ample storage area, accessible through the rear door of the vehicle.

## Lighting

The van is equipped with a variety of general and task lighting, both inside and out.

Overhead LED lights in the main compartment may be powered by AC or DC. A switch on the endcap of one of the fixtures is used to choose the power source. When AC power is chosen, a wall switch next to the door controls the overhead lights. When DC power is selected, the INTERIOR LIGHTS switch on the main DC power panel controls them. Each of the overhead light fixtures has a switch to reduce the light output by half to conserve power while operating on battery power.

Small DC-powered task lights are located over each rack. These have individual on-off switches. Collectively, they are controlled by the INTERIOR LIGHTS switch on the main DC power panel.

A DC-powered overhead light is also located in the rear storage compartment. It is controlled by a wall switch next to the door.

DC-powered floodlights are mounted on the roof on both sides of the van as well as the rear, aimed outward and downward to illuminate the area around the van. Another roof-mounted floodlight illuminates the mast, and a fifth floodlight provides general illumination for persons working on the roof at night. These floodlights are individually controlled by switches on the main DC power panel.

[future] A DC-powered pan/tilt spotlight mounted on the roof at the front of the van may be remotely operated using a dashboard-mounted controller.

## Miscellaneous Features

- Drive-on ramps are available in the rear storage compartment to level the van when it is necessary to park on a slope. However, there is a limit to how much slope can be compensated by use of the ramps. Try to select a level parking spot when the van is in use.
- The van is equipped with a set of cable protectors, designed to protect cables from damage when they need to cross a roadway. Their use is straightforward.
- A small exhaust fan is mounted in the curbside wall adjacent to Rack 1 in the rear storage compartment. It is on whenever the battery charger is on. Its purpose is to draw a small volume of fresh outside air into the vehicle. A louvered air vent, located in the streetside wall above and behind the driver seat, provides a source of makeup air when the exhaust fan is operating.

- A carbon monoxide detector is mounted at the front of the main compartment. Press the test button to ensure that it is operating correctly before running either the generator or vehicle engine while the main compartment is occupied.

## AC/DC Power Distribution

### AC Power Distribution

The van is factory-equipped with an AC distribution system. The AC power to the van is switchable between an onboard 7 kW Onan generator and a shore power inlet. A combined AC/DC distribution panel is located in the main compartment. See Figure 1 for a view of the AC section of the panel.



### Shore Power

The shore power inlet is located on the curbside above and behind the rear wheel. The connector is Hubbell p/n CS-6360C, non-NEMA configuration, locking type, 2-pole, 3-wire, rated 50 A at 125 VAC.

In some situations a long extension cord will be needed to reach the shore power receptacle. To minimize voltage drop, use the largest gauge shore power cable available – especially if air conditioning is in use. The van is (or soon will be) equipped with marine grade shore power cables having twist-lock connectors that fit the van’s shore power inlet connector. Use them whenever possible, with an adapter cable at the far end as needed to fit the receptacle you are plugging into.

With the equipment currently installed in the van, the total current draw should never be remotely close to 50 A. In most cases, the van will consume less than 15 A and may be plugged into a standard 120 V, 15 A duplex outlet. Short adapter cables are available to plug into various different outlet configurations that might be encountered in the field. For example, many small generators are equipped with twist-lock receptacles rated for 20 or 30 A, depending on the generator size. If you have an adapter that fits that receptacle, take advantage of it.

Table 1 on the following page lists recommended wire sizes (in AWG) for power cables for a given length and load current, based on voltage drop rather than the ampacity of the wire. The table also shows the reduction in voltage drop obtained by going to the next larger wire size. The recommendations are based on a nominal line voltage of 120 V and a maximum voltage drop of 6 V. Keep in mind that 6 volts corresponds to 5% of the nominal line voltage.

This table is a useful tool any time you need to select an extension cord. Start by selecting the maximum expected load current and cable length in the first two columns. Column C lists the smallest wire gauge that will limit the voltage drop to 5% or less. Columns D and E present the resulting voltage drop. Columns F through G show the improvement to be gained by going to the next larger wire gauge. Keep in mind that there will be additional voltage drop in the van’s internal wiring as well as the source wiring.

For maximum performance, safety, and reliability, if the extension cord is to be used outdoors, we recommend sticking with cords rated for severe duty and having at least 14 AWG conductors. Connectors should be suitable for outdoor use, although it is possible to wrap connections with plastic and elevate them to keep them dry. Also consider the need to strain-relieve connections. Do not tape connectors together. You need to be able to visually inspect the connection to ensure that it is secure.

Table 1 Minimum Recommended Wire Size for AC Power Cables							
Load Current (A)	Cable Length (ft)	Minimum Recommended Wire Size			Next Larger Wire Size		
		Wire Size (AWG)	Voltage Drop (V)	Voltage Drop (%)	Wire Size (AWG)	Voltage Drop (V)	Voltage Drop (%)
10	25	14	1.33	1.1%	12	0.83	0.7%
	50	14	2.65	2.2%	12	1.67	1.4%
	100	14	5.31	4.4%	12	3.33	2.8%
	150	12	5.00	4.2%	10	3.15	2.6%
12	25	14	1.59	1.3%	12	1.00	0.8%
	50	14	3.18	2.7%	12	2.00	1.7%
	100	12	4.00	3.3%	10	2.52	2.1%
	150	12	6.00	5.0%	10	3.78	3.1%
15	25	14	1.99	1.7%	12	1.25	1.0%
	50	14	3.98	3.3%	12	2.50	2.1%
	100	12	5.00	4.2%	10	3.15	2.6%
	150	10	4.72	3.9%	8	2.97	2.5%
20	25	12	1.67	1.4%	10	1.05	0.9%
	50	12	3.33	2.8%	10	2.10	1.7%
	100	10	4.20	3.5%	8	2.64	2.2%
	150	8	3.95	3.3%	6	2.49	2.1%
30	25	10	1.57	1.3%	8	0.99	0.8%
	50	10	3.15	2.6%	8	1.98	1.6%
	100	8	3.95	3.3%	6	2.49	2.1%
	150	6	3.73	3.1%	4	2.34	2.0%
40	25	10	2.10	1.7%	8	1.32	1.1%
	50	10	4.20	3.5%	8	2.64	2.2%
	100	8	5.27	4.4%	6	3.32	2.8%
	150	6	4.97	4.1%	4	3.12	2.6%
50	25	10	2.62	2.2%	8	1.65	1.4%
	50	10	5.24	4.4%	8	3.30	2.7%
	100	6	4.14	3.5%	4	2.60	2.2%
	150	4	3.90	3.3%	2	2.45	2.0%

## Generator

The on-board Onan generator is rated to produce 58.3 A maximum at 120 VAC, single phase. A generator start/stop control is located inside the generator compartment. However, a remote control on the main distribution panel allows the generator to be started and stopped from inside the van, and that is what is normally done. The generator is equipped with microprocessor-controlled self-test features and a manual priming system. There is no manual choke to be concerned with.

The generator draws fuel from the vehicle gas tank. There is a fuel gauge available on the main power panel. Press and hold the test switch for a few seconds to read the fuel level. The intake for the generator is positioned at the  $\frac{1}{4}$  full level of the tank, so the generator will always shut off leaving sufficient fuel to start the vehicle engine and drive a few miles. But keep in mind that when the fuel gauge reaches the  $\frac{1}{4}$ -tank level, you are out of gas as far as the generator is concerned! If the generator won't start, or shuts down unexpectedly, consider low fuel level to be your primary suspect.

Before starting the generator, always press the test switch on the CO detector (mounted on a wall near the main distribution panel) to verify that it is working correctly.

Set the AC source selection switch to off or shore power. In other words, do not start the generator under load. Damage to equipment might result.

Before starting the generator, press STOP/PRIME on the control switch to prime the generator with fuel. Priming may take up to 30 seconds. When priming is completed, the status indicator glows steadily. You might be able to hear the priming pump if there isn't a lot of background noise. It makes a clicking sound.

Once the indicator glows steadily, release the STOP/PRIME switch and press and hold START until the generator starts. There will be a brief pause while the microprocessor performs several system tests. If no problems are detected, the starter will be engaged. The indicator will flash during cranking.

If the microprocessor detects a fault condition, the generator will not start. Any error conditions will be displayed by the status indicator as a series of flashes. Consult the generator's user manual for further information before proceeding.

Allow the generator to run until it stabilizes before setting the AC source selection switch to the generator position.

Stopping the generator under load may cause damage to connected equipment. When it is time to shut off the generator, first use the AC source selection switch to remove the load. Then press and hold the STOP/PRIME switch until the generator has reached full stop.

The generator should receive an oil change after every 150 hours of operation. A high-quality 15W-40 grade oil is recommended. Change the oil more often in hot or dusty environments. Record any oil

changes in the vehicle log. Two quarts are required, assuming the oil filter is replaced. Do not overfill, as this can cause excessive oil consumption.

## DC Power Distribution

The van is equipped with two auxiliary batteries, each rated 12 V, 100 Ah and connected in parallel. The arrangement is unusual in that one battery is located in an external battery compartment behind the passenger door, while the other is located in the base of Rack 4 in the main compartment. The reason that the batteries are in two different locations is to minimize voltage drop in the DC distribution wiring. Voltage drop is a particular concern for communications equipment.

However, this poses a couple of safety concerns. Since the batteries are wired in parallel, both batteries must be disconnected before making any modifications to the DC distribution system. A disconnect located in Rack 4 may be used to separate the two batteries and their associated wiring. Placards are posted in both battery compartments to remind personnel to do this. When removing cables from either battery, always disconnect the two batteries from one another by unplugging the disconnect plug, and remove the negative battery lead from each battery first.

A second concern is that, should one of the batteries develop a shorted cell, a large fault current to flow from the healthy battery to the damaged one. To protect against that eventuality, a high-current fuse is wired between the two batteries. This fuse is physically mounted on the positive terminal of the battery located in rack 4.

Again, because the batteries are wired in parallel, when the time comes to replace one auxiliary battery, both batteries must be replaced with identical batteries in new condition so that they will share the DC load equitably.

There are two DC distribution panels. The main DC distribution panel is located immediately below the AC distribution panel in the front right corner of the main compartment. It contains switches and fuses for the van's DC lighting loads, as well as controls for the battery charger and inverter. There is also a "cigarette lighter" outlet available adjacent to the main DC distribution panel. It is protected by a 10A fuse on the panel, labeled "AUXILIARY POWER."



A secondary DC distribution panel is located in Rack 3. It contains circuit breakers for the communications equipment. The battery switch on this panel only controls DC power to the communications equipment, and the ammeter only shows current drawn by the communications equipment. (Current being drawn from the battery by DC loads connected to the main DC distribution panel is in addition to the current displayed on the ammeter.) The circuit breakers on this panel also function as switches; pull out a circuit breaker button to disconnect its load.



The charger for the auxiliary batteries is located below the main power distribution power panel. It is fully automatic, but it pays to read the manual and check its display each time you turn it on to ensure that it is operating normally. When the van is in storage, with or without shore power, it is important that all DC loads, both the individual switches on the main DC distribution panel and the master battery

switch on the secondary DC panel, are turned off to prevent battery discharge in the event that shore power becomes disconnected. As noted below, also ensure that the inverter is turned off when not in use.

## Inverter

The van is equipped with a 1800-watt sine wave inverter, which is located in the rear compartment. It has its own remote control panel located at the bottom right of the main power panel.

The inverter is wired in line with the AC outlets in Rack 1 only. When the inverter is turned on, it is in standby condition and functions as an uninterruptible power system (UPS) for Rack 1. Switchover to inverter power is automatic in the event that the AC mains power, either from the generator or shore power, is lost.

If you use the inverter, make sure you turn it off when no longer needed so as not to drain the auxiliary battery.

## Pneumatic Mast

The mast can be raised to a height of 50' above ground level. At the top of the mast, there is a Ubiquiti 5.8 GHz data radio with a 650 mm (25") dish antenna mounted on a Yaesu pan/tilt rotator, along with an IP camera whose primary use is as an aid to pointing the dish. The mast also has a UHF-style (SO-239) antenna mount for attaching a mobile triband VHF/UHF antenna. The antenna mount is protected by a rubber cap when no antenna is connected. An adjacent hex nut provides a convenient place to stow the rubber cap when the antenna mount is in use.

There is also a pipe flange into which a 1" pipe can be threaded to support additional equipment. An eyebolt is also provided to which a pulley can be attached to support an HF wire antenna. Three coax cables run from the masthead to the antenna patch panel in Rack 3 inside the van.

The mast has a rated payload capacity of 200 pounds. That far exceeds the weight of equipment we place on the mast. The maximum operating air pressure is 35 PSIG, but with our typical payload, the mast can be raised with half that amount of pressure. However, given the internal volume of the mast, the air source must be able to supply at least 10 SCFM at all times when raising the mast to overcome friction and operate with reasonable speed.

An onboard air compressor is used to raise and lower the mast. The air compressor is piped to a pressure regulator and three-position control valve located just inside the rear door of the van on the left. Raising the handle on the control valve introduces compressed air into the mast, causing it to rise. In the middle position of the control valve, the valve is closed, fixing the mast at its current height. In the lower position, air inside the mast is routed to a bleeder valve to lower the mast at a controlled rate.

There is a ¼-turn draincock located under the body of the van aft of the rear tire on the driver's side. The draincock is piped directly to the air inlet at the base of the mast. The draincock must be closed in order to raise the mast. It must be opened whenever the mast is not in use to allow rainwater and condensate to drain from the mast.

For safety, the van must be within 5° of level when raising the mast more than a few feet. There is a bubble level (aka a *spirit* level) mounted on the rear driver side corner of the vehicle for use in leveling the van. If necessary, you can download a bubble level app on your smartphone to calibrate the van's level.

Before raising the mast, check the air pressure. The gauge on the regulator should read about 15 psi [*need to verify this*] and must never exceed 35 psi under any circumstance.

While raising the mast is a simple process, retracting it is a bit more challenging. If the van is not level, the telescoping mast sections may bind when lowering the mast, leading to an extremely dangerous situation wherein the mast may suddenly collapse into itself if it should become "unstuck" while there is insufficient air pressure to support its weight. Therefore, when lowering the mast, always ensure that personnel are at a safe distance away from the mast and/or paying close attention to its progress. Ensure that the mast starts to come down within a reasonable time period after moving the control valve to the down position. If it doesn't, re-pressurize the mast and try again. If you have a rope attached to the top of the mast, you can gently pull on it to compensate for any tilt or weight imbalance that might be causing the mast to bind – but only if you have sufficient air pressure to prevent a free fall.

Some air pressure has to bleed off in order for the mast to retract, depending on the weight of the payload and other factors. With experience, you will gain a sense of how quickly you should begin to see motion. Also, sections do not always extend or retract in order from bottom to top or vice versa.

Even if the van is level, the mast will often hang briefly when one section has fully retracted before the next section starts to settle. You might observe a slight drop when this happens, but only for a foot or two at most. If the mast hangs in one position for longer than 10 seconds, suspect a binding problem, re-inflate the mast until you see upward motion, and try again.

There are rubber seals between mast sections. If a rubber seal becomes dislodged, repair is needed to minimize water ingress.

The mast sections are heavy, and the joints between sections are pinch points when sections are fully seated. Keep cables and especially, fingers away from the mast while it is retracting. Again, sudden drops are possible.

The mast must be cleaned and lubricated periodically to ensure proper operation. It should also be raised to its full height periodically. Refer to the mast manual for details.

## Radio Equipment

### Radio Complement

The van is equipped with the following radios:

- Dashboard-mounted Icom IC-207 [*need to verify model*] dual-band FM transceiver.
- Alinco DR-135T, DR-235T, and DR-435T single-band FM transceivers for 2 m, 1.25 m, and 709 cm bands.
- Icom IC-718 HF transceiver.
- xxxx DMR transceiver (available but yet to be installed at the location of the “jump seat”).

Here are some things to keep in mind regarding each radio:

#### **IC-207 (dashboard-mounted 2 m radio)**

The dashboard-mounted radio is powered from the vehicle battery and will drain the battery if left on for a long period when the engine is not running. It is hard-wired to a mobile antenna mounted on the driver side front fender.

#### **Alinco Radios**

All three Alinco VHF/UHF radios are connected through a triplexer to a single coaxial cable and intended for use with a triband (2 m /1.25 m /70 cm) antenna. These radios are digital-mode ready via a sound card interface connected to PC 1. The sound card interface is built into a DB-9 connector that can be moved to any of the three Alinco radios.

In the Alinco radios, the front panel mic connector and rear-panel “data” connector are wired essentially in parallel at the input to the modulator circuitry. When using any of the Alinco radios for digital mode operation, it is necessary to disconnect the front panel microphone to avoid inadvertently transmitting microphone audio over the air. Conversely, when using these radios on voice, unplug the sound card interface from the rear-panel data jack to avoid loading down the audio signal from the microphone.

#### **IC-718 HF Radio**

The IC-718 does not currently have an antenna tuner. Use an external antenna tuner (not provided) or an antenna having an SWR of less than 2:1 on the operating frequency.

The IC-718 has been modified for transmit capability on all HF frequencies. All Amateur Radio operators must be reminded to remain within their authorized band limits. Inexperienced operators should be closely supervised to ensure that they do not inadvertently operate outside of the ham bands.

The Icom IC-718 is digital-mode ready via a sound card interface connected to PC 2. However, when using digital modes, it is necessary to disconnect the front panel microphone to avoid inadvertently transmitting microphone audio over the air. Unlike the Alinco radios, it is not necessary to disconnect the sound card interface when using voice modes.

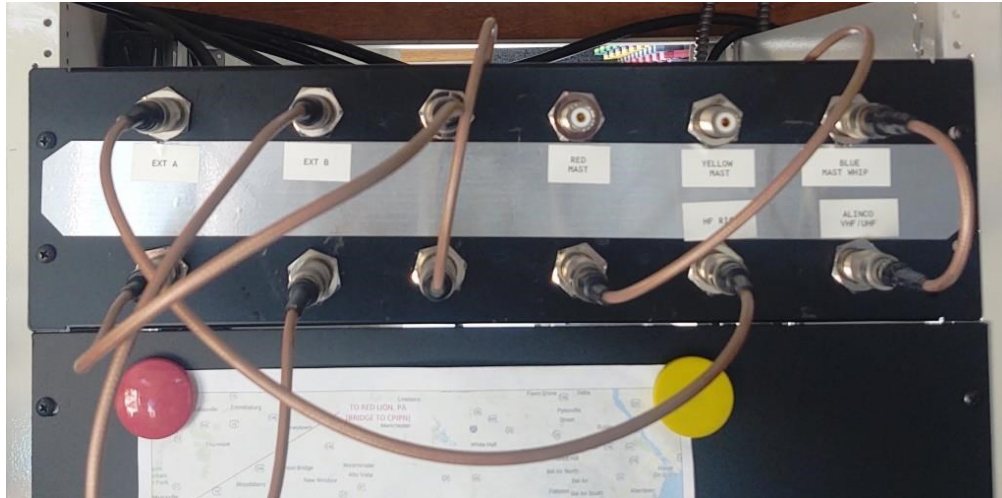
## Input/Output Panel

A panel fitted on the curb side of the van provides the means to pass signal cables between the van's communications gear and external equipment. Bulkhead feedthrough connectors are provided for various commonly used cable types, including coax (UHF-style connectors), CAT-5/6 network cables (RJ45), and telephone cords (RJ11/14/25). There is also a sliding-plate passthrough that is adjustable to accommodate different cables sizes.



## Antenna Patch Panel

There is an antenna patch panel mounted at the top of Rack 3, making it easy to connect any rack-mounted radio to any coaxial feedline coming into the van.



## HF Antennas and Masts

At least two HF antennas are kept in the rear storage area of the van. There is a military-style “tape-measure” dipole that may be adjusted to any length needed for operation on HF through 6 meters. There is also a Tennadyne terminated folded dipole (TFD), Model TD-90SS, that has less than 2:1 SWR from 1.8 through 30 MHz.

For NVIS operation it is customary to erect the terminated folded dipole as an inverted vee, with the center of the antenna suspended from the mast. A halyard (rope and pulley) is used to raise the antenna. For NVIS operation, raising the antenna feedpoint to a height of 20 to 30 feet is sufficient. By elevating the mast well above that height, the ends of the dipole can be tied off in such a way to pull the antenna feedpoint several feet away from the mast, minimizing the mast’s influence on the radiation pattern.

It is also possible to erect an HF antenna at a distance from the van by using the provided sectional mast kit. Refer to the kit’s separate user manual for details.

## PCs

Two Windows PCs normally reside in the van. Both are connected to the van's local area network. PC 1, at the left operating position, is used for digital mode operation on VHF and UHF. PC 2 is used for HF digital mode operation.

PC 1 also has software installed for use in managing the microwave communications equipment.

*[additional details needed]*

## Network Equipment

*Future*

## Roof-Mounted Equipment

*Future*

## Appendix A Vehicle Specifications

DECODED VIN INFORMATION									
1FD	X	E45	3	3	4	H	A27973	Serial #	
Assy plant: Lorain, OH									
Model year: 2004									
Check digit									
Engine: 5.4L SOHC V-8 Gasoline Ford 380 HP									
Line/body/chassis: Econoline E450 DRW/SRW Cutaway									
Restraint system: Light Truck w/ Drv & Pass Side Air Bags									
Manufacturer: Ford (sold as incomplete vehicle)									

Table A1 Powertrain/Chassis

	4.6L Triton V-8	5.4L Triton V-8	6.8L Triton V-10	6.0L Power Stroke Diesel V-8
<b>Engine Type</b>	V-8, iron block, aluminum heads	V-8, iron block, aluminum heads	V-10, iron block, aluminum heads	V-8, iron block and heads
<b>Bore/Stroke</b>	3.55 x 3.54 in	3.55 x 4.16 in	3.55 x 4.16 in	3.74 x 4.13 in
<b>Displacement</b>	281 cu in, 4606 cc	330 cu in, 5409 cc	415 cu in, 6751 cc	363 cu in, 5954 cc
<b>Compression Ratio</b>	9.3:1	9.0:1	9.0:1	18.0:1
<b>Fuel Injection</b>	Sequential multi-port electronic	Sequential multi-port electronic	Sequential multi-port electronic	Hydraulic electronic unit injection (HEUI) direct injection
<b>Valvetrain</b>	SOHC, 2 valves per cylinder	SOHC, 2 valves per cylinder	SOHC, 2 valves per cylinder	OHV, 4 valves per cylinder
<b>Horsepower</b>	225 hp @ 4800 rpm	255 hp @ 4500 rpm	305 hp @ 4250 rpm	235 hp @ 3300 rpm
<b>Torque</b>	286 lb-ft @ 3500 rpm	350 lb-ft @ 2500 rpm	420 lb-ft @ 3250 rpm	440 lb-ft @ 3750 rpm
<b>Oil Capacity</b>	6.0 qt	6.0 qt	6.0 qt	14.0 qt
<b>Coolant Capacity</b>	23.8 qt	27.8 qt	29.4 qt	

<b>Transmission Type</b>	4-speed automatic overdrive	4-speed automatic overdrive	4-speed automatic overdrive	4-speed automatic overdrive	5-speed automatic overdrive
<b>Gear Ratios</b>					
I	2.84:1	2.84:1	2.71:1	2.71:1	3.09:1
II	1.55:1	1.55:1	1.54:1	1.54:1	2.20:1
III	1.00:1	1.00:1	1.00:1	1.00:1	1.54:1
IV	0.70:1	0.70:1	0.70:1	0.70:1	1.00:1
V	–	–	–	–	0.71:1
<b>Available axle ratios</b>	3.55:1, 3.73:1, 4.10:1, 4.56:1				
<b>SUSPENSION</b>					
<b>Front</b>	<b>Independent twin I-beam, coil springs, shock absorbers and stabilizer bar</b>				
<b>Rear</b>	<b>Non-independent live axle, leaf springs and shock absorbers</b>				
<b>STEERING</b>					
<b>Type</b>	<b>Power recirculating ball</b>				
<b>Overall Ratio</b>	<b>17.0:1</b>				
<b>Turning circle, curb-to-curb</b>	<b>see Dimensions and Capacities</b>				
<b>BRAKES</b>					
<b>Front</b>	<b>13.0-in vented disc (12.8-in vented disc on E-150)</b>				
<b>Rear</b>	<b>12.8-in vented disc (13.1-in vented disc on E-150, 12.9-in vented disc on E-450)</b>				
<b>Assist type</b>	<b>vacuum (gas engines) hydro-boost, (diesel) ABS</b>				
<b>WHEELS AND TIRES</b>					
<b>Base wheel and tire</b>	<b>16-in steel, P235/70R16</b>				
<b>Largest tires available</b>	<b>LT245/75R16</b>				

Table A2 Dimensions and Capacities

Body Style	E-350 SD DRW	E-350 SD DRW	E-350 SD DRW	E-350 SD DRW	E-450 SD DRW	E-450 SD DRW*
<b>EXTERIOR (inches)</b>						
Wheelbase	158.0	158.0	176.0	176.0	158.0	<b>176.0</b>
Overall length	258.2	258.2	258.2	258.2	258.2	<b>258.2</b>
Overall height	–	–	–	–	–	–
Overall width	–	–	–	–	–	–
Track width, front	69.4	69.4	69.4	69.4	69.4	<b>69.4</b>
Track width, rear	73.2	73.2	73.2	73.2	73.2	<b>73.2</b>
<b>INTERIOR (inches, except as noted)</b>						
Seating capacity	2	2	2	2	2	<b>2</b>
Headroom (Front)	42.5	42.5	42.5	42.5	42.5	<b>42.5</b>
Legroom (Front)	40	40	40	40	40	<b>40</b>
Hip Room (Front)	65.6	65.6	65.6	65.6	65.6	<b>65.6</b>
Shoulder Room (Front)	68.4	68.4	68.4	68.4	68.4	<b>68.4</b>
Fuel capacity (gal)	37.0	37.0	37.0	37.0	55.0	<b>55.0</b>
Turning circle, curb-to-curb (ft)	54.1	54.1	59.9	59.9	54.1	<b>59.9</b>
<b>Base curb weight</b>	4325	4325	4361	4361	4373	<b>4568</b>
<b>Maximum GVWR</b>	10,000	11,000	10,000	11,000	14,050	<b>14,050</b>

\* E-450 SD: Econoline 450 Super-Duty Series DRW: Dual rear wheels

## Appendix B Checklists

A number of checklists are provided on the following pages. They are intended to be used as guidelines. Circumstances might require deviations from these checklists, but they provide a quick reference to best practice.

## B1. Takeoff Checklist

Use this checklist before moving the van for any purpose.

### **ROOF**

1. Mast fully down.
2. Antennas removed from masthead.
3. Connector covers installed.
4. Dish facing down. Top to front of van if driving in rain or snow.
5. Rooftop antenna mast removed.
6. All loose materials removed.

### **BACK OF VAN**

1. All loose materials stowed/secured.
2. Mast control in center position.
3. Lights off.

### **OPS CENTER**

1. Radios off.
2. Computers off.
3. Battery switch on console off.
4. Chairs secured.
5. All loose materials stowed/secured.
6. Overhead storage bins closed and latched.
7. All load center switches off on except interior lights.
8. Main switch off.
9. Generator off.
10. Lights off when exiting van.

### **EXTERIOR OF VAN**

1. Shore power cord disconnected and stowed.
2. Side I/O panel connections removed and stowed.
3. Battery and I/O panels locked.
4. Side door locked.
5. Steps stowed.
6. Generator panel locked.
7. Wheel chocks and traffic cones stowed.
8. Lock back door.
9. Walk all the way around van checking high, low, under.

## B2. Parking Checklist

Use this checklist when you arrive at a deployment site.

1. Engine off. (Engine may be run for brief periods, but should not be left running indefinitely while main compartment is occupied. Ensure carbon monoxide detector is working before running engine when vehicle is stationary.)
2. Vehicle lights and dashboard radio off. (Radio may be left on for a brief period if needed for communications, but will drain vehicle battery if left on for an extended period.)
3. Parking brake set.
4. Wheels chocked.
5. Orient dish upright to shed rain or snow (if precipitation is a possibility).

These are minimal steps to be taken whenever the van is parked.

### B3. Storage Checklist

Use this checklist when the van will be parked and left unattended for more than a few hours.

1. Vehicle lights and dashboard radio off.
2. Parking brake set.
3. Wheels chocked.
4. Orient dish upright to shed rain.
5. AC power selector switch set to off.
6. All DC circuit breakers on main power panel off.
7. Battery switch on secondary DC power panel (in Rack 3) off.
8. All doors locked.
9. **Keys stowed in lockbox.**

If shore power is available and needed:

1. Connect shore power.
2. Set AC power selector switch to SHORE POWER.
3. Battery charger on.
4. Turn power on to racks 1 and 2 if needed.
5. Rack 3 battery switch on (to charge laptops and power network equipment).
6. (Winter only) Radiator on, powered, thermostat set to 50°.

A loss of shore power when the vehicle is unattended will eventually result in draining the auxiliary battery. While it might be appropriate to leave the van unattended overnight while charging the batteries and/or performing software updates on the PCs, it should not be left in this state indefinitely.

## Mast Checklist

Use this checklist as a guideline when deploying or retracting the pneumatic mast.

## Generator Checklist

Use this checklist when starting and stopping the generator.

### Starting:

1. Test the carbon monoxide detector to verify that it is working.
2. Verify that there is sufficient fuel to run the generator, keeping in mind that the generator will not run when there is less than a quarter-tank of fuel in the tank.
3. Ensure that the AC power selector switch is not set to generator power. (It can be in either the off or shore power position.)
4. Prime the generator with fuel by holding down the start/stop rocker switch in the STOP/PRIME position for up to 30 seconds. The status light should come on and stay on while the priming pump is running. It stops when priming is complete. We have found that 10 seconds is usually sufficient. If it is quiet, you may be able to hear the pump clicking from inside the van.
5. Press and hold the start/stop switch until the generator starts. There is a short delay before the starter motor starts cranking while the generator's control microprocessor makes some readiness tests.
6. Allow the generator to stabilize before placing the AC power selector switch in the GENERATOR position.
7. If the generator fails to start, the status indicator will flash. Count the flashes, as the number of flashes indicates an error code. Refer to the generator manual for the meaning.

### Stopping:

1. **IMPORTANT:** Remove the load from the generator by moving the AC power selector switch to any position except GENERATOR.
2. Press and hold the start/stop switch until the generator comes to a complete stop.

## Appendix C List of Ancillary Equipment Available in Van

Item Description	Location	Notes
<i>[future]</i>		