ORDER

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Alaskan Region

AL 6520.2A

October 26, 1998

SUBJ: Maintenance Concept for Self-Sustained Outlets (SSO)

1. **PURPOSE.** This order prescribes the Alaskan Region maintenance concept for self-sustained outlets (SSO) within the region.

2. **DISTRIBUTION.** This supplement is distributed to the branch level in the Airway Facilities Division and to all Airway Facilities Division field offices and facilities.

3. **CANCELATION.** Order AL 6520.2, dated November 30, 1987, is canceled.

4. **BACKGROUND.** The Alaskan Region SSOs are regionally procured and designed single-frequency, air-ground communications outlets. They are placed at sites that are not served by commercial power and telephone utilities. Power provided by expendable batteries often with solar recharging capability. Communication is provided by a dedicated radio link to the controlling Air Traffic facility.

5. **FUNCTION.** This type of facility was established for the express purpose of providing air-ground communications between air traffic control specialists and pilots in remote, uncovered areas. This allows the delivery of en route clearance and acknowledgement of instrument flight rules, cancellations, or departure/landing times. As a secondary function, it ma be used for advisory purposes whenever the aircraft is below coverage of the primary air-ground frequency.

6. **DESCRIPTION.** An SSO facility consists of a shelter, a suitcase radio package which contains a UHF repeater or UHF link/repeater and a VHF air-ground radio, a battery power supply and other alternative energy sources, and antennas the remote location. There may also be a solar power system for recharging batteries at high site locations. The base statio consists of a shelter, main and hot-standby link equipment, link antenna, and a maintenance panel.

7. **FACILITY TYPE.** An air-ground facility which does not meet the description of Order 6580.5, Maintenance of Remote Communications Facilities (RCF) shall be entered into the Facilities, Services, and Equipment Profile (FSEP) as Self-Sustained Outlet (SSO).

8. **FACILITY RESTORATION.** The base level of restoration of an SSO shall be A1 as defined in Order 6030.31E, Restoration of Operational Facilities, unless a different level is justified.

9. **PERIODIC MAINTENANCE.** Electronic periodic maintenance will be accomplished on an annual basis except in the case of helicopter access only sites. These shall only be visited for optimization at times of reported problems, and site optimization visits should otherwise coincide with/before anticipated battery failure (approximately 2 year intervals) and occur as scheduled during good weather times of the year.

a. Inspect the batteries in the heater and radio battery banks. Battery replacement should be scheduled during the summer. This will minimize exposure of personnel to extreme hazards present during the winter months.

b. When the SSO radio communications link terminal (RCLT) equipment is located in FAA-owned facilities and collocated with equipment requiring periodic maintenance, preventive maintenance of the RCLT will be performed.

c. Appendix 1 to this Order addresses the requirements of the newer generation Mark III SSO utilizing Daniels Electronics, LTD, radio equipment. This document was approved for use in the Alaskan Region by Configuration Control Decision (CCD) F18295 dated 1/16/96. Standards and tolerances for the equipment shall be as indicated in appendix A, or in Order 6580.5 as applicable.

d. Scheduling and documentation of maintenance activities shall be noted in the Simplified Automated Logging (SAL) system for the facility.

e. Environmental periodic maintenance will consist of a visual inspection of the remote facility each time the technician visits the facility. The inspection will include, as a minimum, the following:

(1) Check to see the shelter is free of water or snow.

(2) Perform an overall visual inspection of the shelter's exterior tie-down points and exterior walls.

(3) Examine antennas and transmission lines and other ancillary equipment to verify mechanical security.

(4) Check battery voltages and check solar-charging equipment for proper operation.

(5) Check propane fuel level at sites with thermoelectric generators.

(6) Perform OSHA safety inspections.

10. CERTIFICATION. On scheduled site visits SSO type facilities will be certified by the ATSS performing equipment checks. A "SSO certified" entry will be placed in the appropriate maintenance log with facility identification indicated. Service certification will be accomplished in accordance with the appropriate Control Facility Handbook.

11. CORRECTIVE MAINTENANCE. In Outage situations, the inoperative radio ~~suitcase package should~~ be exchanged for the functional spare and the failed unit repaired. Restoration procedures will be in accordance with appropriate handbooks, directives, and Regional policy letters.

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FOREWORD

In 1994, the Mark III Self Sustaining Outlet (SSO) was developed by the Electronics Section, Airway Facilities Division, of the Alaskan Region FAA. SSOs have been used by the Alaskan Region since the 1960s to provide VHF air-ground radio communications from Flight Service Stations. By locating radio outlets on mountain tops, FAA is able to cover a large service volume, and sometimes cover mountain passes that could not be reached by conventional Remote Controlled Outlets (RCOs).

The Mark III SSO represents an advance over its predecessor, the Mark II. The Mark III minimizes the number of maintenance trips made to the SSO site by using solar power and ruggedized reliable radio equipment.

This instruction book is intended to be used both as a maintenance guide and as an engineering guide for the establishment of working SSOs.

1. GENERAL INFORMATION AND REQUIREMENTS

1.1 Introduction. - This instruction book provides installation, checkout, operation, engineering, a maintenance information for the Mark III SSO (Self Sustained Outlet). The Mark III SSO system is distributed among three sites: the high site, the base station and the control point.

a) The high site components comprise a high site shelter, air-ground and link radios, antennas, an RF equipment case, batteries, solar panels, and DC power regulator.

b) The base station components comprise a link radio, and antenna, an RF body panel, a duplexer, a leased line and circuit control equipment.

c) The control point, typically an Automated Flight Service Station (AFSS), interfaces an Integrated Communications Switching System (ICSS), via a four-wire leased circuit, to the base station.

Table 1-1 lists the site locations, unit designations, and nomenclature of all major components of the Mark III SSO. The unit relationships are shown in figure 1-1

LOCATION	DESIGNATION	DESCRIPTION
High site	Unit 0	High site shelter
	Unit 1	RF equipment case
	Unit 1A	Radio repeater
	Unit 1A	Duplexer
	Unit 1C	RF body panel
	Unit 2	DC power regulator
	BATT 1	Left battery string
	BATT 2	Right battery string
	Unit 3A	Solar array 1 junction box
	Unit 4A	Solar array 2 junction box
	Unit 3B	Solar array 1
	Unit 4B	Solar array 2
Base	Unit 5A	Radio link
	Unit 5B	Duplexer
	Unit 5C	RF body panel
	Unit 5D	Control shelf
Control		Circuit control equipment

Table 1-1. Mark III SSO Unit nomenclature.

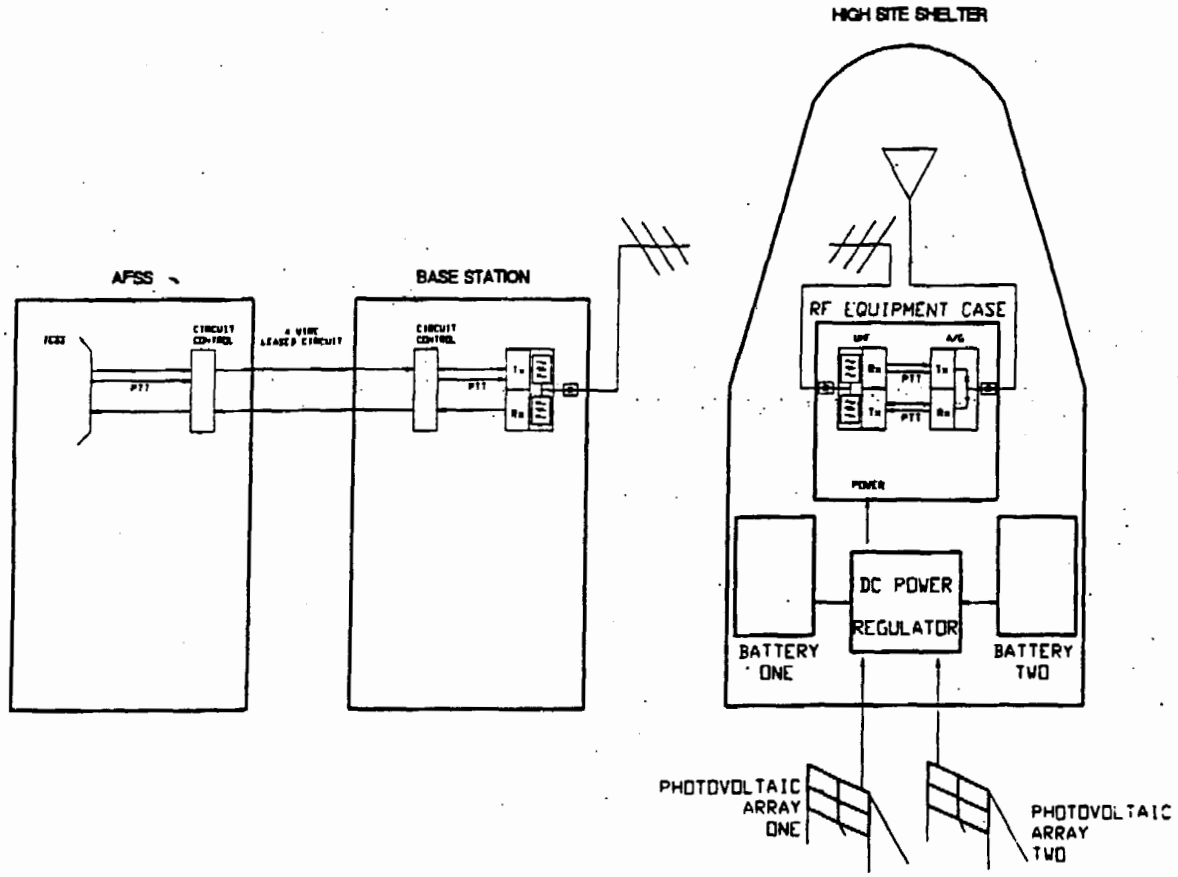

Figure 1-1. Mark III SSO block diagram.

1.2 EQUIPMENT DESCRIPTION

1.2.1 Purpose. - The purpose of the Mark III SSO is to provide VHF air-ground communication between aircraft pilots and Flight Service Specialists at an Automated Flight Station. The purpose of the equipment at the sites is described below. Refer to figure 1-1 for the relationships among equipment components.

1.2.1.1 High Site. - The high site equipment, typically located on a mountain top, provides VHF radio communications to and from aircraft and communicates those conversations to the base station.

1.2.1.2 Base station. - The base station is typically located at the base of the mountain where line-of-sight visibility to the high site and common carrier telecommunications are available. The base station communicates with the high site via a UHF radio link and to the control station via a 4-wire leased or cable circuit.

1.2.1.3 Control site. - The control site equipment, typically located at an AFSS, communicates to the base station via leased circuit and allows the Flight Service Specialist to converse with pilots.

1.2.2 Description. - See drawings listed in table 2.

LOCATION	TITLE	DRAWING NUMBER
High site	Equipment layout	ALD-000-761.005
	RF equipment case layout	ALD-000-761.006
	Wiring diagram, RF equipment case	ALD-000-764.006
	Wiring diagram, DC power regulator	ALD-000-764.008
	Layout, solar array junction Box	ALD-000-764.009
	Layout, DC power regulator	ALD-000-764.010
	Functional diagram, DC power regulator	ALD-000-764.011
	Functional diagram, SSO	ALD-000-764.012
	Wiring diagram, high site	ALD-000-764.013
	Shelter grounding diagram	ALD-000-764.015
	Functional diagram, RCO control	ALD-000-764.016
	Power supply cable	ALD-000-767.005
	RF cabling diagram, RF equipment case	ALD-000-767.006
Base	Cabling diagram, base station	ALD-000-767.007

Table 1-2. List of drawings.

1.2.2.1 High site. - The high site equipment consists of a shelter, solar array, power supply, RF equipment case, antenna system monitoring system, and grounding system.

1.2.2.1.1 Shelter. - The shelter which houses the RF equipment case, power supply, and antenna system, is a commercially built cylindrical fiber glass building with a 7 ft. diameter at the base. The building weighs 1500 lb. and is provided with lifting eyes for delivery to the high site by helicopter. It is usually painted green to blend in with the surrounding landscape.

1.2.2.1.2 Batteries. - Two banks of nickel-cadmium batteries supplies 12 Volt power to the RF equipment case.

1.2.2.1.3 Solar array. - Two solar arrays, each consisting of four panels, recharge the batteries on a yearly cycle.

1.2.2.1.4 DC power regulator. - The DC power regulator integrates the batteries, solar arrays, controls, gauges, and sensors in one enclosure.

1.2.2.1.5 RF equipment case. - The RF equipment case is an air-tight plastic enclosure which houses the radio repeater, RF bodies, and duplexer. The case is connectorized to permit quick removal and replacement with a maintenance spare when appropriate.

1.2.2.2 Base site. - The base site relays communications between the high site and the servicing AFSS. The base site will typically be located near the site the Mark III SSO is serving, such as the airport, and where access to leased circuits and commercial power are available. The base site will be preferably in the line of site to the high site.

1.2.2.2.1 Line equipment. - The base link radio, duplexer, RF body panel, antenna, and control equipment serve to interface the high site radio transmissions to the leased 4-wire circuit.

1.2.2.3 Controlling station. - Circuit control equipment passes audio signals to and from the controlling station and the base station in addition the equipment actuates the dry Push-To-Talk contacts on the base station radios. The Mark III SSO circuit is ultimately terminated at the ICSS.

1.2.2.4 Equipment specification data.

Solarex MSX-60	Maximum power generated	480 Watts
8 solar panels	Max. Charging current	29 Amps
	Open circuit voltage	24 Volts
	Short circuit current	30 Amps
Saft-Nife SUN-104	Voltage: nominal	12 Volts DC
	Voltage: float @ -20 C (10 cells combined)	17 Volts DC
	Voltage: float @ +40 C (10 cells combined)	15 Volts DC
	Combined capacity: 8 Hr discharge	2170 Amp-Hours
	Quantity	20
Daniels MT-3 repeater	A/G Emission designator	6K00A3E
	A/G Power	2 Watts
	A/G VSWR	1.5:1
	A/G impedance	50 Ohm
	A/G Sensitivity	-119 dBm
	A/G Modulation	Amplitude modulation
	A/G frequency control	crystal
	Link emission designator	16K0F3E
	Link power	2 Watts
	Link VSWR	1.5:1
	Link impedance	50 Ohm
	Link Sensitivity	-116 dBm
	Link Modulation	Frequency modulation
	Link frequency control	crystal
Sinclair SRL308 antenna	Type	Omnidirectional
	Gain	Unity
Sinclair SRL218 antenna	Type	7 element Yagi
	Gain	10 dBi
	Total drain current	120 mA

Table 1-3. Equipment specification data.

2. TECHNICAL DESCRIPTION

2.1 Simplified theory of operation. See figure 1-1 for block diagram for Mark III SSO.

2.1.1 RF equipment. - The Mark III SSO represents one more RF relay in between the pilot and the Flight Service Specialist. When the pilot brings up the correct AM carrier the Mark III SSO AM receiver will break squelch and retransmit the signal to the base. The receiver at the base will send the audio signal through the leased circuit to the AFSS. If the flight service specialist operates the push-to-talk, a signal in the circuit control equipment will send a PTT signal parallel with the voice through the circuit. The circuit control equipment at the base station will close the dry PTT contacts of the radio and terminate 600 Ω voice to the radio transmitter. The link relays the voice signal to the high site where it is again retransmitted over the A/G radio.

2.1.2 Power system. - The high site is completely self sufficient and requires no additional power inputs. Although the system is nominally a 12 Volt system, float voltages due to the nature of the solar panels and NiCad batteries will go as high as 17 volts. Constant power is supplied to the load by the batteries. The batteries are charged on an annual cycle by the solar panels. For 5 months during the winter the batteries can support the load without input from the solar panels.

2.2 RF equipment detailed theory of operation

2.2.1 RF equipment case. - The RF equipment case, designated unit 1, contains the MT-3 radio repeater, duplexer, and RF body panel. It is located inside the high site shelter.

2.2.1.1 Equipment case. - The RF equipment case is a sturdy, transportable, double entry case supplied by Hardigg Industries. Antenna and power cable connections are made on an exterior panel on the case; the case may be installed at the site and be made operational without ever opening the case on-site. Desiccant inside the air tight RF equipment case will insure that the electronics will remain dry, Frost free, and free of dust, fungus, and other contaminants. The case shell is composed of composite materials that will perform at temperatures of -40°F to 140°F. The double-sided, aluminum, 19" relay rack is shock mounted inside the case for shock and vibration resistance for a 30-40 pound load; access to either side of the relay rack is possible through securely fastened lids. The dead space between the relay rack and case shell circulate air to reduce excessive hot or cold spots. Outside case dimensions are 25" deep by 27" wide by 21" high.

2.2.1.2 MT-3 mountain top repeater. - The radio repeater used by the Mark III SSO is the Daniels Electronics LTD. MT-3 mountain top radio repeater system. These radios were specifically designed for mountain top repeater use. These radios have the added feature of stationary industrial use. These features include relay rack chassis, modular design, construction made with high reliability, oversized, military type components, and an open architecture that allows connectorized access to audio circuits, push-to-talk, muting, CTCSS tone and other circuits. Transmitters and receivers are built into separate modules that connect into a common backplane. A separate Audio Control Card automatically makes all cross-connects between transmitters and receivers and also contain the CTCSS tone encoder/decoders. The System Monitor modules accesses or makes all important test points, and includes an audio monitor, operation this device consumes only a negligible amount of current. Faulty modules may be swapped with good modules. Transmitters and receivers come in a wide variety of options for frequency, VHF and UHF, and power, 3 to 30 Watts; many combinations are possible. For more information, specifications, or schematics, consult the Daniels technical manual.

2.2.1.3 MT-3 configurations. - A typical Mark III SSO MT-3 configuration will include, on channel B, a VHF or UHF air-to-ground AM radio receiver and transmitter pair. The Transmit/Receive (TR) relay is located inside the Status Monitor module and is activated by the audio control card. The link ra[redacted] will fill channel A. A 3 Watt UHF FM transmitter receiver pair will work best when Line-Of-S[redacted] (LOS) is feasible between the Mark III SSO and its controlling base station.

2.2.1.4 Radio paths. - The A/G radios are half duplex because by convention there is only one frequency available per channel. Therefore A/G radios require a T/R relay to operate between the transmitter and receiver. The T/R relay is located in the System Monitor cassette of the MT-3 radio repeater.

2.2.1.5 Link radio path. - The link radio path is a full duplex operation, that is the link radios may simultaneously transmit and receive. Full duplex operation is made possible with separate transmit and receive frequencies and a Sinclair duplexer, a cavity filter that isolates incoming and outgoing signals to the antenna. The duplexer is temperature compensated and will not detune. If the A/G receiver cannot quiet, or is hung-up, the controller can force the A/G transmitter on by simply keying the radio; this will usually quiet the receiver. A specific and unique subaudible tone (CTCSS) is injected into the link carrier on both ends of the link, if this tone is not present in the carrier the UHF receiver will not squelch thus preventing coincidental UHF carriers on the same frequencies to interrupt flight service operations.

2.2.1.6 Antennas. - The antennas selected for the Mark III SSO include a unity gain, omni directional antenna for the A/G radio. The radiating elements of this antenna are directed downward at an angle to skew the main lobe slightly downward. The effect of this is to maximize coverage by keeping the main lobe down on the distant horizon; or, conversely, to keep the air traffic in the center of the main lobe. The link radio antennas are 7 element directional Yagis. Both antennas are products of Sinclair Rad[redacted] Laboratories Incorporated.

2.2.2 Power system.

2.2.2.1 DC power regulator. - The DC power regulator is the apparatus case that ties together the load, batteries, and solar panels. Two switching shunt regulators work in parallel to charge a common battery supply. As the battery supply reaches full charge the regulators will short circuit the solar panels cutting the voltage to the batteries off, a forward biased diode in the regulators prevents battery discharge. When charging the regulators place full solar panel voltage to the batteries, charging voltage is a function of available sunlight but can go as high as 18 Volts. Power supplied is 12 Volts DC, nominal.

2.2.2.1.1 Lightning Protection. - Lightning protection is provided by Polyphaser. Two Polyphasers are used, one for each solar array. These canisters are equipped with a network of passive elements and dual 50 Ampere breakers. The gas tubes short to ground at about 22 Volts insuring repeatable performance; the slow acting breakers will trip in the much larger and aggravated faults. The breakers are not repeatable and must be reset manually.

2.2.2.1.2 Voltage regulators. - The ASC-16s are solid-state , negative ground, switching shunt regulators, housed in an anodized aluminum chassis and encapsulated in a hard epoxy resin. Two voltage regulators working independently from each other supply current from their respective solar arrays to a common battery bank. When charging the batteries the controllers connect the batteries t[redacted] the solar arrays. The controllers short circuit the solar panels when the batteries have reached a fu[redacted] charge. Diodes protect the batteries from discharging during this phase of operation.

2.2.2.1.3 Low Voltage Disconnect. - The two ASC-16 solar controller also posses the Low Voltage Disconnects (LVD). When battery voltage drops below 10 Volts the LVD relay coil de-energizes and disconnects the load from the supply bus. Both LVDs are tied in parallel, therefore both LVDs must each release the load in order to disconnect the load from the battery. Disconnecting the load from the dangerously low charged batteries will save the batteries from ruin. Once the batteries reach 12 Volts, from charging, the LVD relay coils re-energize and reconnect the load.

2.2.2.1.4 Load Meter. - The load meter measures current directly to the load. This meter snaps directly to the terminal block railing in the center of the DC power regulator. The meter is supplied by Texmate.

2.2.2.1.5 High Current Meter. - The high current meters is switchable and may measure current generated from both controllers and measures current going into each battery string. Current is measured from a 0.01 Ohm current sensing resistor; a (-40)-300 milliVolt sense from each sensor will correspond to (-4)-30 Amperes on the meter. This meter snaps directly to the terminal block railing in the center of the DC power regulator. The meter is supplied by Texmate.

2.2.2.1.6 Current Sensors. - The five current sensors are 0.01 Ohm , 1% tolerance, 10 Watt rating, wire wound, type RN resistors with aluminum chassis/heat sinks. In each case one end of the resister is tied to ground. A voltage is read from the high potential side. These resister are not expected to realize more that 2.5 Watts.

2.2.2.2 Batteries. - Batteries are Saft-Nife Nickel-Cadmium (NiCad) model SUN 104. Each battery is 1.2 Volts and rated for 1070 Ampere-Hours. A string of batteries combines ten SUN 104 batteries, in series, to form 12 Volts at 1070 Amp-Hr. Two such strings, in parallel, a total of twenty Sun 104 batteries, doubles the capacity to 2140 Ampere-Hours. Float voltage for these batteries will range from 12 to 17 Volts depending on state of charge and temperature.

2.2.2.3 Solar Panels. - Solarex MSX-60's solar panels provide all power to the high site. An array of 4 solar panels, tied in parallel, may generate up to 14.6 Amperes. Each panel is diode protected and individually capable of generating up to 3.65 Amperes of current at charging voltage to the batteries, therefore if one, two, or three solar panels is damaged than the remaining array will still function with only diminished output. Both arrays may potentially generate 29 Amperes under ideal conditions. Each array is located on separate structures for diversity. Only one array is required to maintain constant power to the high site.

2.3 Controlling Station. - The controlling location point for the radios is technically similar to other RCO operations, that is the circuit starts with the ICSS with push-to-talk and 4 wire audio circuits. Circuit control equipment passes voice and PTT information to the base station.

2.3.1 MT-3 Base Station Radio. - The MT-3 base station radio system at the base is similar to the mountain top repeater. An AC power supply is attached to the back of the chassis supplying the radios with 12 Volt DC power. Only one transmitter and receiver habitat the chassis.

3. OPERATION

3.1 Introduction. - The Mark III SSO is operated the same way as an RCO, that is the Flight Servi specialist and pilot will do nothing different in their operation of equipment as their own equipment.

3.2 Controls and indicators.

3.2.1 DC power regulator controls. - Reference drawing ALD-000-764.010 and ALD-000-764.011.

Control or indicator	Ref. Des.	Function
Disconnect switches:		OUT position on switches DISCONNECTS or turns OFF. IN position CONNECTS or turns ON.
Solar array #1	2SW1	When plug is IN solar array #1 is connected to voltage regulator 1.
Solar array #2	2SW2	When plug is IN solar array #2 is connected to voltage regulator 2.
Voltage regulator #1	2SW3	When plug is IN voltage regulator 1 is connected to batteries.
Voltage regulator #2	2SW4	When plug is IN voltage regulator 1 is connected to batteries.
Battery #1	2SW5	When plug is IN battery 1 is connected to voltage regulators.
Battery #2	2SW6	When plug is IN battery 1 is connected to voltage regulators.
Load	2SW7	When plug is IN the load is connected to battery.
Load meter	2M1	Reads current into load in Amperes.
High current meter	2M2	Read current as indicated by 2SW8 in Amperes.
High current rotary switch:		
1: OFF	2SW8	Turns meter 2M2 OFF.
2: Battery		Meter 2M2 reads current from Battery.
3: Array #1		Meter 2M2 reads current from photovoltaic array #1.
4: Array #2		Meter 2M2 reads current from photovoltaic array #2.

Table 3-1. DC power regulator controls.

3.2.2 MT-3 controls. - Reference Daniels Electronics LTD. manual. Presented here are the front panel controls.

Control or indicator	Ref. Des.	Function
MT-3 repeater System Monitor. Function:		Function switch puts indicator voltage at test jacks save positions 1 and 8.
1	SW1	No connection. (OFF)
2		Input voltage.
3		Regulated voltage (+9.5 Volts)
4		Receiver A signal strength indicator output.
5		Receiver B signal strength indicator output.
6		Receiver A +6 Volt regulator.
7		Receiver B +6 Volt regulator.
8		Buffered A/B audio. Output on internal audio monitor.
9		No connection.
10		No connection.
		Receiver A AFC output.
12		Receiver B AFC output.
Push-To-Talk	SW2	Momentary switch: when in will turn both transmitters ON.
LED	CR1	Turns on when audio A/B switch are turned from middle position.
Audio A/B	SW4	When switch is position A, receiver A audio output is monitored. When switch is position B, receiver B audio output is monitored. When switch is in middle pos., audio monitor and LED are OFF.
Transmitter A Transmitter B		In normal position transmitters are controlled by audio control. On position forces transmitters ON. Off turns off prime power to transmitters.
Receiver A Receiver B		In ON position receiver is connected to prime power. In OFF position receiver is disconnected from prime power.

Table 3-2. RF equipment case controls.

3.3 Turn-on and checkout. -

TURN-ON AND CHECK OUT			
Location	Item	Action	Indication-Remarks
1. Base station radio	Function	Pos. 1	Turns OFF system monitor
	A/B	Middle	Turns OFF LED and audio monitor
	UHF rcvr	ON	Turns ON UHF receiver
	UHF tmtr	Normal	Turns ON UHF transmitter
2. Base station radio	Function	Pos. 1	Turns OFF system monitor
	A/B	Middle	Turns OFF LED and audio monitor
	UHF rcvr	ON	Turns ON UHF receiver
	UHF tmtr	Normal	Turns ON UHF transmitter
	A/G rcvr	On	Turns ON A/G receiver
	A/G tmtr	Normal	Turns ON A/G transmitter

Table 3-4. Turn on and checkout.

TURN-ON AND CHECKOUT			
Location	Item	Action	Indication-Remarks
3. High site	SW1	IN	Connects solar array 1 to VR1.
DC power regulator	SW2	IN	Connects solar array 2 to VR2.
	SW3	IN	Turns VR1 ON.
	SW4	IN	Turns VR2 ON.
	SW5	IN	Connects BATT1 to voltage regulators.
	SW6	IN	Connects BATT2 to voltage regulators.
	SW8	BATT	Read M2: current to battery If no current see 6.2.
		ARRAY1	Read M2: current from ARRAY 1. If no current see 6.2.
		ARRAY 2	Read M2: current from ARRAY 2. If no current see 6.2.
		OFF	Turns OFF meter M2.
	SW7	ON	Connects RF equipment case to power.
	M1	Read	Read drain current. Approx. 180mA. If not see 6.2.

Table 3-4. Turn on and checkout. (continued)

3.4 Equipment shutdown. - A formal procedure for a partial or complete equipment shutdown is not needed. Turning off equipment in any sequence will not cause damage or present a safety hazard.

4. STANDARDS AND TOLERANCE

Parameter	Procedure Reference Paragraph	Standard	Tolerance Limit	
			Initial	Operating
A/G transmitter	Daniels VT-2-AM Manual			
a) Carrier power	2.2.6	3 Watts	20% as standard	20% as standard
b) Frequency stability	2.3	118-136 MHz	5 ppm	5 ppm
c) Audio distortion @ 90%	3.2.4	3%	3%	5%
d) PTT time-out timer	2.4.1	5 minutes	20%	35%
e) VSWR at transmitter output	2.4	1.0:1		1.8:1
UHF transmitter	Daniels UT-2 manual			
a) Carrier power	tmtr alignment	3 Watts	20% as standard	20% as standard
b) Frequency stability	crystal module	118-136 MHz	5 ppm	5 ppm
c) Audio distortion @ 90%	audio processor levels	3%	3%	5%
d) PTT time-out timer	audio processor	5 minutes	20%	35%
e) VSWR at transmitter output	tmtr alignment	1.0:1		

Table 4-1. Standards and Tolerance.

Parameter	Procedure Reference Paragraph	Standard	Tolerance Limit	
			Initial	Operating
A/G receiver	Daniels VR-2-AM manual			
a) Sensitivity for 10 dB SINAD	3.2	-107 dBm	-107dBm	-95 to -110 dBm
b) Squelch open	3.4.7	-110 dB		
c) Squelch close	3.4.7	-95 dBm		
d) Frequency stability	3.5	118-136 MHz		
e) Selectivity @ 6 dB	3.2	12 kHz	12 kHz	8-12 kHz
f) Selectivity @ 60 dB	3.2	29 kHz	29 kHz	25-29 kHz
g) Nonsymetry @ 60 dB points	3.2	≤15%		≤15%
UHF receiver	Daniels MT-3 manual. Section 2 UHF receiver			
a) Sensitivity for 10 dB SINAD	rcvr alignment	-107 dBm	-107dBm	-95 to -110 dBm
b) Squelch open	audio processor	-110 dB		
c) Squelch close	audio processor	-95 dBm		
d) Frequency stability	crystal module	118-136 MHz		
e) Selectivity @ 6 dB	rcvr alignment	25 kHz	12 kHz	16-25 kHz
f) Selectivity @ 60 dB	rcvr alignment	35 kHz	35 kHz	23-35 kHz
g) Nonsymetry @ 60 dB points	rcvr alignment	≤12.5%		≤12.5%
High site battery float voltage	6.2.2	13.5 to 17 Volts	same as standard	same as standard

Table 4-1. Standards and Tolerance. (continued)

5 PERIODIC MAINTENCE

[redacted] order 6580.5, Remote Communications Facility (RCF) manual, is still in effect for the maintenance of the Mark III SSO. The below is a guide for the maintenance of components not outlined in order 6580.5.

5.1 Maintenance procedures

5.1.1 Maintenance schedule

1 year	5 year	10 year	15 year	20 year
Battery check	Battery check	Battery check	Battery check	replace batteries
solar panel check	solar panel check	solar panel check	solar panel check	replace panels
check solar PS	check solar PS	check solar PS	check solar PS	replace solar PS
		Replace RF equip case		replace RF equip case

Table 5-1. Maintenance schedule.

5.2 Replacement schedule

The solar panels and batteries both have a 20 year service life. Even if systems are functioning it is likely performance levels are dropping off and are in danger of complete failure. For this reason it is important to change the majority of the Mark III SSO. If the antennas and physical structures are in tact they may be reused.

[redacted]

5.3 Equipment to bring on-site.

a) Spare RF equipment case with correct frequencies.

b) Two spare solar panels.

c) Two spare voltage regulators.

d) Two spare Polyphaser lightning protectors.

e) Two spare series resistor.

f) Spare Weidmuller terminal block parts.

g) Multimeter.

h) Technicians toolbox.

i) One butane soldering iron.

[redacted]

6. MAINTENANCE PROCEDURES

6.1 Physical inspection

a) The physical inspection of the Mark III SSO should be done at every opportunity. It is important for this reason that scheduled maintenance trips be conducted in summer months.

b) Check guy wires and tighten if necessary.

c) Tight or replace loose or missing hardware.

d) Corrective maintenance should be scheduled immediately for items not quickly fixed such as loose or bent anchors.

6.2 Battery Check

a) Bring 10 gallons of distilled water for each visit. Fill the batteries to the water mark. Log the among of water used for each trip. If log indicates that water consumption is regular new solar controllers may be required with an adjusted float voltage.

b) Measure and log the voltage.

6.3 Solar panel check.

a) The solar panels have a design life of 20 years. However it may become necessary to replace them more often because of the extreme condition they must endure. Even with a shattered lens or gun shot holes the solar panel will continue to operate with little reduction in output. For this reason visiting technician should being replacement panels on each trip even if it there are no indication that it might be necessary.

b) Log which panels were replaced.

6.4 Solar PS check

a) Open the DC power regulator.

b) Check and record current going into each battery string separately and record. Current should be within 10 % in value.

c) Turn off controller two. Check current coming from controller one and record. Turn controller two back on.

d) Turn off controller one. Check current coming from controller two and record. Turn controller one back on.

e) Check current coming from controller two and record.

7. CORRECTIVE MAINTENANCE

7.1 RF equipment case. No attempt should be made to troubleshoot equipment inside the equipment case while at the high site. If a problem is suspected in the case it should be changed out with a spare case. The RF equipment case may then be examined at a technicians workbench.

7.1.1 Daniels radio repair. The Daniels MT-3 mountain top repeater manual should be consulted for any maintenance done to that system.

7.1.1.1 Daniels Electronics Inc. training. Daniels electronics offers an 16 hour on-site course for the MT-3 system. Some of the topics include a detailed theory of operation on all components of the system, field service checks, custom set up, crystal module, power supplies, CTCSS, and hang timer. Also included is component level servicing of the MT-3.

7.1.1.2 Module replacement. The MT-3 manual will be a guide in determining which module(s) are faulty. Faulty modules should either be repaired by a trained technician or sent to the manufacturer for repair.

7.1.1.3 Crystal replacement. A procedure is outlined in the Daniels MT-3 manual for the replacement of the crystal and retuning the module.

7.1.2 Cable Failure. If Daniels Radio modules appear to work individually but not as a system examine all cables for continuity. Replace the cable(s) that have failed.

7.1.3 Detuned Duplexer. No attempt should be made to retune a duplexer that has detuned. If the duplexer has detuned, send it to the manufacturer for retuning. Test the operation of the duplexer as follows.

a) Connect a RF signal generator and an RF power/vswr meter to the common port of the duplexer.

b) Connect an RF power meter and dummy load to the F1 port.

c) Dial frequency F1 to the signal generator and turn on.

d) Sweep and plot the power and VSWR response of the duplexer.

e) If actual F1 rejection is other than the nameplate frequency than the duplexer has detuned.

f) Repeat the above for F2.

7.2 DC power regulator. Spare components of the DC power regulator should be stocked. These parts include Weidmuller terminal block equipment, RN series resistors, Polyphaser lightning protection, and ASC-16 voltage regulators.

7.2.1 Reset Polyphaser. The breaker will punch out for a 50 Ampere fault. If one or both of the breakers has tripped reset the breaker. The performance of the Polyphaser lightning protection module is repeatable and will not need replacement.

7.2.2 Replace Polyphaser. If the Polyphaser is shorting the solar array or the breaker will not reset, replace the unit with a spare.

7.2.3 Replace voltage regulator. A voltage regulator may fail by either staying in the charge mode even if battery voltage exceeds 15 Volts or by staying in the short mode even if the battery voltage is low or nonexistent. If either of these conditions exist replace that unit. It is also possible, and normal, that one of the two parallel voltage regulators is charging but the other is off. If either voltage regulator is switched out of the circuit and the remaining regulator continues to charge than this operation is normal. This condition will exist if the batteries are near or at full charge.

7.2.4 Replace series resistor. If current does not flow but is expected to check the resistor for voltage across the series resistor with a voltmeter. If the full voltage drop is across the resistor terminals that the resistor has failed and has become an open circuit. Replace that resister with a spare.

7.2.5 Repair meters. If either meter M1 or M2 is showing a current although one is present than replace that meter.

7.3 Batteries. Follow procedure 6.2 to ensure that the full 20 year life cycle of the batteries are realized. If an individual battery has failed it will have a 0 Volt reading across its terminals because the positive and negative plates have grown together, shorting. This battery will need to be replaced. Switch that battery string off line and rely on the remaining string to support the high site until a replacement is available.

7.4 Replace solar panels. Solar panels will not fail unless physically damaged. It is possible that a solar panel is physically damaged but still generates power. Solar panels are not repairable items. Follow procedure 6.3.

8. PARTS LIST

Item	ALD-000-Dwg.	Description	Source
1	761.006	Daniels MT-2 repeater model RPD-3/AM-3	GSA #.:GSOOK93AGS0647
2	761.006	Daniels MT-2 repeater model RPS-3	Manufacturer:
3	761.006	Audio Control Card w/ CTCSS tone control AC-2	Daniels Electronics LTD. 43 Erie Street, Victoria, B.C. Canada V8V 1P8
4	761.006	Test Adapter Cable EC-32	Tel 206-671-8046 Fax 604-382-6139
5	761.006	AC power supply for RPS-3 PS-2-S	
6	761.006	Auxiliary control cable for MT-2 repeaters AUX-48	Source: Mannon Engineering 515 Kirkland Way Kirkland, WA 98033
7	761.006	Test adapter card and cable EC-48	Tel. 206-827-7449 Fax 206-827-7099

Item	ALD-000-Dwg.	Description	Source
8	764.010	Modular terminal blocks, dbl level, 2 poles type DK4Q 5901.6	Manufacturer:
9	764.010	Modular terminal blocks, feedthrough type SAK16 3806.2	Weidmuller 821 Southlake Blvd Richmond, VA. 23236
10	764.010	Modular disconnect terminal blocks type SAKC 4 3575.2	Tel 804-794-2877 Fax 804-794-0252
11	764.010	End section for DK4Q terminal block type AP/DK4Q 6313.6	Source:
12	764.010	End section for SAK16 terminal block type AP/SAK16 5901.6	Alaska Electronic Supply 2020 E Dowling Road Anchorage, AK 99507
13	764.010	End section for SAKC 4 disconnect blocks type AP/SAKC 4 (1.5) 1179.2	Tel. 907-563-3774 Fax 907-478-3774
14	764.010	Jumpers, to use with DK4Q terminal blocks type Q10/DK4 3686.0	
15	764.010	Numbered labels for SAKC4, numbers 1-50 type FS6.5 4682.6	
16	764.010	Numbered labels for terminal blocks numbers 1-50 and 51-100; type FS6, 4687.6	
17	764.010	Terminal block Mounting Rail, Aluminum, DIN 35 type TS 35 x 7.5 3308.0	
18	764.010	Terminal block, 6 Pole, type MK 10/6 4490.6	
19	764.010	Terminal block, 10 pole type MK 10/10 4494.6	

	ALD-000-Dwg.	Description	Source
20	764.010	Lightning protection from solar panels IS-17VDC-50A-NG	Manufacturer: Polyphaser PO Box 9000 Minden, NV 89423-9000 Tel 800-325-7174 Fax 702-782-4476 Source: Mannon Engineering 515 Kirkland Way Kirkland, WA 98033 Tel. 206-827-7449 Fax 206-827-7099
21	764.010	35 mm DIN rail mounted moving coil ammeter 0 - 4 Amp input for 0 - 4 Ampere scale	Manufacturer: Texmate 995 Park Center Drive Vista, CA 92083-8397 Tel 619-598-9899 Fax 619-598-9828
22	764.010	35 mm DIN rail mounted moving coil ammeter (-40) to 300 milliVolt input and (-4) to 30 Ampere scale	

Item	ALD-000-Dwg.	Description	Source
23	764.009	Terminal block, power distribution, #4 to #14 AWG, 3 Pole, p/n1492-PD3141	Source: Debenham Electric Supply 4502 Lois Drive Anchorage, AK 99517 Tel 907-562-2800 Fax 907-561-0346

	ALD-000-Dwg.	Description	Source
24	764.010	Hoffman Enclosure, steel, weather proof, NEMA type 12, RFI shielded 20" x 16" x 6", A1620061P	Source: Graybar 2020 E Dowling Road Anchorage, AK 99507
25	764.010	Hoffman mounting plate, steel, 20" x 16" nominal, p/n A20P16	Tel. 907-562-2214 Fax 907-562-3314
26	767.005	Cable, #4 AWG, 7-Stranded type XHHW	
27	764.013 & 764.015	Lugs, #4 AWG, Thomas & Betts, TNB 60112	
28	764.013	Cable, Arctic grade cable, #14 gauge 14-3 Super Vutron Cable	
29	764.009 & 764.010	Fittings, Crouse & Hinds, weather tight CGB 194	
30	764.009	Hoffmann Enclosure, stainless steal, weather proof, 6" x 6" x 4", NEMA type 4 A-606NF	
31	764.009	Hoffman mounting plate, stainless steal, 4.88" x 4.88", A-6P6	

Item	ALD-000-Dwg.	Description	Source
32	764.013	Solar Panels, 60 Watt, Solarex MSX-60	GSA#: GSA7F003506A Source:
33	764.010	Solar Panel controller, SCI ASC-12/16	Solar Engineering Services 1210 Homann Dr SE Lacey, WA 98503
34	764.008	Low Voltage Disconnect option for Solar panel controller ASC-OPT-E	Tel 800-777-7075 Fax 206-438-2115

n	ALD-000-Dwg.	Description	Source
35	761.005 & 767.007	Antenna, 7 element Yagi, UHF, Sinclair SRL-307	GSA #: GSAOOK92AGS0672 Source: Sinclair Radio Laboratories Inc. 675 Ensminger Road Tonawanda, NY 14150 Tel 907-562-2800 Fax 907-561-0346
36	761.005	Antenna, VHF omnidirectional, Sinclair SRL-238	
37	761.006 & 767.007	Duplexer, UHF, Sinclair, 70 dB isolation Q3220E	
38	761.005	Comshell; sections 'C', 'D' and roof.	Source: Mannon Engineering 515 Kirkland Way Kirkland, WA 98033 Tel. 206-827-7449 Fax 206-827-7099

Item	ALD-000-Dwg.	Description	Source
39	761.006	Double entry case, seven rack units high, shock mounted. Furnished with Stainless steal hardware and a pressure relief valve. M07/18-30/40-02/02	Manufacturer: Hardigg Industries 393 N. Main Street PO Box 201 South Deer Field, MA 01373 Tel.: 310-695-2544

	ALD-000-Dwg.	Description	Source
40	764.013	Batteries, Nickel-Cadmium, 1070 Ampere Hours. Sunica-104-1	Manufacturer: Saft-Nife Inc. PO Box 7366 Greenville, NC 27835-7366
41	764.013	Battery Cables, red and blue 3101258-01	Tel.: 919-830-1600 Fax: 919-758-0329
42	764.013	Battery cables, extension 3100429-22	Source: Alaska Power Systems 8300 King Street, suite 101 Anchorage, AK 99518 Tel.: 907-344-2631 Fax: 907-344-2631
		Order batteries "dry" to keep them air transportable. Electrolyte is shipped separately, in powder form, and mixed on location.	

Item	ALD-000-Dwg.	Description	Source
43	764.010	Resistor, 10 Watt, 1%, 0.01 Ohm	NSN 5905-01-247-7732
44	767.005	Amphenol connector, bulkhead, MS3102A14S-0S	NSN 5935-01-223-1563
45	764.010	3/8" Plastic, Snap-in, spacer	NSN 5988-01-298-2077

9. ESTABLISHMENT

9.1 INTRODUCTION. The Mark III SSO was designed to tolerate most environments in Alaska. However it is important to check each new site with respect power, radio coverage, and link radio margin. It may be necessary to specify new radio modules, antennas, batteries, or solar panels: it is also important to note that a change in one aspect of the SSO will possibly affect another. For example specifying 30 Watt transmitters will affect the power requirements of the SSO. The following two sections offer a guide to re-engineering the Mark III SSO to adapt to different operating environments.

9.2 Site selection. The site selection process starts with a demand for a targeted air-to-ground coverage specification. A pre site survey or map survey may start at this point. A Site survey team should include an environmental engineer and a electronics engineer. The site should be close to the service area, have line-of-site with the airport or service area, should have southern exposure, and it should provide the desired air-to-ground coverage. The environmental engineer should be responsible for environmental impact, feasibility to build, real-estate issues etc.

9.3 Engineering

9.3.1 RF power budget. A radio link budget must be performed for each installed site. A careful map survey, and possible site survey will help in determining the radio path potential. Line-of-sight is desirable but not absolutely necessary. If line-of-sight is obtainable the link radios should be made to operate in the 400 to 450 MegaHertz range, higher if such equipment is available. If line-of-site is not obtainable than a diffracted radio path may be scrutinized; higher power transmitters, higher gain antennas, and lower VHF frequencies will help in making diffracted radio paths work.

9.3.2 DC power budget. Sizing the Mark III SSO battery size and type is done through an solar energy budget. The Energy Budget must consider monthly changes in sun hours. Because the winter months offer little solar energy in most parts of Alaska the battery capacity must be large enough to sustain the SSO through the winter months. Additionally snow may cover the solar panels rendering them useless: the battery bank is sized to support the SSO through the winter without the solar support.

9.3.2.1 The Energy budget process:

a) The start of the energy budget starts with the load calculation, or the energy demands of the system as measured in Ampere-Hours. A 5% duty cycle is assumed for radio equipment.

b) Calculate the Solar Energy Production for each month. Use the chart below to find the nearest available sun-hour data. Energy Supplied = Sun-Hours x solar array capacity (in Ampere's) x 31 days x 80% (charging efficiency). If the optimum angle is not used than the cosine of the angle difference must be used to correct solar panel rating.

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	Angle
Adak	1.79	2.45	2.88	3.03	2.83	2.65	2.58	2.49	2.60	2.68	2.34	1.61	2.49	12.7
Annette	1.59	2.37	3.13	3.47	3.48	3.14	3.21	3.09	2.94	2.21	1.74	1.13	2.63	14.3
Barrow	0.0	1.61	4.33	4.33	2.96	3.52	3.57	2.63	2.00	1.55	0.01	0.00	2.21	14.1
Bethel	1.62	2.99	4.06	3.96	3.49	3.25	2.88	2.45	2.81	2.68	1.88	0.88	2.75	14.0
Bettles	0.58	2.57	4.36	4.54	4.25	3.97	3.54	3.12	3.27	2.61	1.42	0.00	2.85	15.9
Big Delta	1.24	2.85	4.43	4.25	3.98	3.69	3.53	3.45	3.44	2.84	1.92	0.21	2.99	11.8
Fairbanks	0.8	2.76	4.45	4.34	4.11	3.92	3.63	3.31	3.32	2.64	1.77	0.01	2.92	12.8
Gulkana	1.33	2.86	4.45	4.49	3.97	3.81	3.68	3.59	3.47	3.13	1.79	.050	3.09	16.9
Homer	1.94	2.95	4.03	4.06	3.77	3.71	3.56	3.26	3.21	3.18	2.43	1.05	3.10	11.7
Juneau	1.22	1.90	2.80	3.28	3.14	3.13	2.94	2.67	2.31	1.70	1.29	0.56	2.25	17.6
King Salmon	2.19	3.21	4.14	3.79	3.47	3.22	3.02	2.76	3.03	3.34	2.59	1.60	3.03	10.4
Kodiak	1.91	2.72	3.84	3.72	3.16	3.16	3.04	3.08	3.01	3.26	2.31	1.34	2.88	11.9
Kotzebue	0.22	2.39	4.13	4.31	4.09	3.92	3.46	3.00	3.12	2.73	0.98	0.00	2.70	9.5
Matanuska	2.93	3.65	5.46	4.26	3.77	3.48	3.19	3.09	2.95	2.91	2.49	1.92	3.34	11.7
McGrath	1.22	2.70	4.13	4.09	3.69	3.47	3.16	2.85	3.00	2.47	1.68	0.31	2.73	13.5
Nome	0.80	2.83	4.04	4.30	4.03	3.93	3.32	2.86	3.11	2.86	1.47	0.01	2.80	15.4
Summit	1.08	2.58	4.16	4.31	4.08	3.58	3.24	2.94	3.04	2.80	1.90	0.31	2.84	12.0
Yakutat	1.36	2.03	3.05	3.28	2.97	2.85	2.66	2.48	2.36	2.21	1.56	0.70	2.29	16.6

Table 9-1. Alaska sun-hours by location.

d) Battery rate degradation must be performed for each type of battery used and the average temperature. For example a Nickel-Cadmium battery retains 60% of its rated capacity at -40°F; a typical lead-acid battery may retain only 10% of its rating at -40°F. A battery may not store more charge (or energy) than its real rating; after rate degradation.

e) The estimated final charge on the battery for the month may now be estimated. The charge = previous month charge - load + solar production. If the charge is greater than its degraded capacity than the actual charge is the degraded capacity. This is an iteration process and is best done on a spreadsheet.

f) Repeat the process until an optimum balance between made between the amount of solar panels and the amount and type of batteries.

9.4 FABRICATION AND ASSEMBLY

9.4.1 Power System

9.4.1.1 DC power regulator

a) Materials list is included in respective drawings.

b) Reference drawing ALD-000-764.008, ALD-000-764.010, and ALD-000-764.011.

c) Knock out 8 holes into the bottom floor of the Hoffman enclosure such that the door opens to the left for 3/4" fittings, and install.

d) Solder 24" leads into Amphenol connector. Install Amphenol connector.

e) Tap and drill holes for Weidmuller terminal block at the bottom of the Hoffman enclosure, next to the Amphenol connector.

f) Fabricate switch mount in machine shop.

g) Set rotary switch for 5 positions.

h) Solder 24" wires to common and last 4 positions of switch.

i) Install switch into switch mount.

j) Solder 24" leads to both ends of resisters.

k) Drill and tap Hoffman mounting plate for the placement of controllers, Polyphasers, DIN rail, switch mount, and resisters.

l) Assemble Weidmuller terminal blocks and end plates.

m) Cut terminal jumpers to length and insert into terminal blocks as shown.

n) Snap in Weidmuller terminal blocks, switches, and Texmate meters.

o) All wiring is to be done with 12 AWG solid copper conductor unless otherwise Specified.

p) Wires to Polyphaser, meters, and controllers terminate with spades. Wires to terminal blocks are stripped and inserted.

q) Complete wiring as to ALD-000-764.008.

9.4.1.2 PV junction Box

a) Reference ALD-000-764.009.

b) Knock out holes for cable and liquid-tight fittings and install.

c) Drill and tap holes for terminal block into Hoffman mounting plate.

d) Install Terminal block.

e) Prepare a box for each photovoltaic array.

9.4.1.3 DC power regulator Cable

a) Reference ALD-000-767.005.

b) Assemble cable and tone test.

c) Connect cable to DC power regulator.

d) Connect 12 or 14 Volt power supply to terminals marked for battery input. Close switch. This may be used for checkout and bench testing.

9.4.2 RF Equipment - High site

9.4.2.1 RF Equipment Case

a) Reference ALD-000-761.006

b) Fabricate connector panel in machine shop. The panel will mount two type N feedthrough connectors, and one Amphenol type 14S bulkhead connector.

c) Mount connector panel to Hardigg enclosure.

d) Carefully mark holes into enclosure where connectors belong.

e) Remove connector panel and make holes in enclosure.

f) Solder 24" leads into Amphenol connector. Use 12 AWG stranded copper conductor.

g) Mount connectors to panel. Pull Amphenol connector wires through its hole.

h) Mount connector panel to enclosure. Use silicon or equivalent between panel and enclosure to seal.

i) Connect DC power regulator Cable between DC power regulator and RF Equipment Case.

j) Mount terminal blocks into relay rack of enclosure.

k) Label terminal block positions 1-10 for both blocks.

l) Trim and insert wires from Amphenol connector to correct position on 2TB1. Refer to ALD-764.006.

m) Fabricate RF body panel.

n) Install panel on the lower inside, back side of the relay rack facing outward

o) Connect DC connector cables to RF bodies.

p) Connect the tails of the DC connector cables to the indicated positions on 2TB2.

9.4.2.2 Antenna mount preparation.

a) Reference ALD-000-761.005 antenna mount detail.

b) Knock-out 1" hole from the center of the antenna mount.

c) Knock-out and drill holes for the placement of the Celwave antenna surge arresters, mounting holes, and ground wire lugs.

d) Attach copper plate to antenna mount as shown. Spread conducting, no oxidation grease between copper plate and steel mount.

e) Fasten surge arresters, and ground wire lug to copper plate.

f) "Dry fit" the antennas to the antenna mount as shown in ALD-000-761.005.

g) Remove antennas from mount for shipping.

9.4.2.3 MT-3 Repeater

a) Reference ALD-761-006 and ALD-000-764.006.

b) Insert specified modules into the correct spaces of MT-3.

c) Connect AUX-48 cable to MT-3 backplane connector labeled P-2 auxiliary control.

d) Wire in AUX cable wires into 1TB2. Trim off unused wires.

e) Wire in power to MT-3 repeater.

f) Install Sinclair duplexer.

g) Reference ALD-767.006.

h) Fabricate RF Cables. Cut each to the length required for connections.

9.4.3 Radio Installation

a) Rack MT-3, duplexer, RF body panel, and control equipment.

b) Install antenna. Fabricate and run RF cable to from antenna to RF body.

c) Fabricate RF cables and connect RF body, duplexer, and transmitter, receive pair.

d) Connect AUX-48 cable to MT-3 backplane connector labeled P-2 auxiliary control.

e) Wire AUX-48 cable wires to control equipment.

f) With RF equipment case on-site and powered up with antenna or load, test end-to-end operation of system.

9.4.4 High-Site Installation

9.4.4.1 High site installation Preparation.

a) High-site installation should not be attempted until all components at base station and controlling station are operational.

b) Test system with RF equipment case near the base station to insure complete operation.

c) DC power regulator should be completely operational.

d) Fabricate two 10 ft. lengths of RF cable with type N plugs at each end.

e) Check antenna mounting hardware for completeness.

f) High site installation will be best during sunny weather. Uncharged batteries will quickly charge once connected.

9.4.4.2 Solar Arrays

a) Reference ALD-000-764.009, 764.010, ALD-000-764.013.

b) Attach PV Junction boxes to both solar panel arrays.

c) Connect and seal liquidtight to fittings on PV Junction box and Comshell.

d) Run and label 4 AWG cable through conduit. Terminate inside PV junction box.

e) Examine voltage of each solar panel for correct open circuit voltage, 18 - 24 Volts depending on weather.

f) Wire together solar panels of each array. Terminate into PV junction box.

g) Check final voltage at the Comshell for each array.

h) Close all solar panel junction boxes and replace all wind blockers.

i) Place desiccant in PV junction box and seal shut.

9.4.4.3 Batteries

a) Reference the Saft-Nife battery instructions.

b) Place electrolyte into batteries.

c) Fill batteries to water mark.

d) Connect battery strings in a daisy chain; negative to positive.

9.4.4.4 DC power regulator

a) Bolt angled aluminum cross members to battery racks.

b) Bolt onto the aluminum cross members the DC power regulator.

c) Bring labeled cables for solar arrays through fittings and trim excess cable leaving some slack. Crimp #4 lugs to cables and connect to the correct poles of Polyphaser. Keep all switches open until all connections are complete.

d) Crimp #4 lugs to cables cut to length and connect to both poles of batteries. Run ends through fittings and connect into terminal block of DC power regulator.

e) Run controller temperature sensors to batteries. Tape the sensors between two batteries.

f) Check voltages to insure proper polarity on batteries, and solar panels.

g) Close switches of solar arrays.

h) Close switches to batteries.

i) Check current from each controller and current to each battery by using the high current meter.

j) Place desiccant in DC power regulator and seal.

9.4.4.5 Antennas

a) Install antennas with regard to ALD-000-761.005.

b) Orient Yagi antenna towards base station.

c) Connect antennas to marked surge arresters with prefabricated RF cables.

d) Connect surge arresters to RF equipment case.

e) Connect #6 wire to lug on the copper plate. Snake the wire around one of the support arms to the building outlet. Keep bending radiuses larger than 8". Connect t building ground system.

9.4.4.6 RF Equipment Case

a) Connect DC power regulator cable between DC power regulator and RF equipment case.

b) Close load switch in DC power regulator.

c) If the batteries are still low on voltage and still charging it may be necessary to temporarily disconnect the batteries and bypass the low voltage disconnect relay to checkout the RF equipment case.

d) While an Electronic Technician has a constant carrier turned on at the base, align directional Yagi for optimum performance.

e) Allow alignment of base station by turning on carrier of UHF Link radio until base station is fully aligned. Transmitters should not be allowed to run for more than 5 minutes at a time.

f) Check out repeater for operation.

g) Place desiccant in RF equipment case and seal shut.

9.5 Checkout and trouble shooting

9.5.1 DC power regulator

9.5.1.1 Solar panels

a) In sunny weather test open circuit voltage. (18-24 Volts depending on sun strength).

b) In sunny weather measure short circuit current. (3.8 A max.).

9.5.1.2 DC power regulator

a) Close all switches.

b) Two 12-13.8 Volt supplies required. Connect one to 2E1 (reference ALD-000-764.008), connect the other to 2TB1 58 and 60.

c) Turn on supply that is connect to 2E1. Then turn on the second supply.

d) Charging light to 2VR1 should be lit.

e) Is voltage present at load? (2TB2) A and B).

f) Turn supply at 2TB1 58 and 60 off.

g) Charging light to 2VR1 should go out.

h) No voltage should be at load.

i) Move power supply at 2E1 to 2E2.

j) Turn on supply that is connected to 2E2. Then turn on the second supply.

k) Charging light to 2VR2 should be lit.

l) Is voltage present at load? (2TB2 A and B).

m) Turn supply at 2TB1 58 and 60 off.

n) Charging light to 2VR1 should go out.

o) No voltage should be at load.

9.5.2 RF equipment

9.5.2.1 RF equipment case

a) Terminate air-to-ground and link transmitters with loads or antennas.

b) Supply voltage to RF equipment case with DC power regulator.

c) Measure forward power on air-to-ground radio.

d) Measure reverse power on air-to-ground radio. (1.3:1 max.).

e) With power meter still in circuit check the time out meter using the base radio. Key the hand held radio and observe the power meter. Measure the time required for the air-to-ground radio transmitter to drop out. (4-5 min.).

f) Measure forward power on link radio.

g) Measure reverse power on link radio. (1.3:1 max.).

h) With power meter still in the circuit check the time-out meter using the hand held AM radio. Key the hand held radio and observe the power meter. Measure the time required for the link radio transmitter to drop out. (4-5 min.).

i) Measure total idle current. (120mA).

j) Key base radio and measure current.

k) Key air-to-ground radio and measure current.

l) Measure raw voltage into radios be turning the knob on the status monitor to position 2. (13.8 Volts).

m) Measure regulated voltage by turning the knob on the status monitor to position 3. (9.5 volts).

n) Test audio quality be turning the status monitor knob to position 8 and moving the A/B switch to A. Operate the base radio and observe the audio on the monitor.

o) Test audio by turning the status monitor knob to position 8 and monitor the A/B switch to B. Operate the hand held air-to-ground radio and observe the audio on the monitor.

p) Test the end to end audio quality by turning off the audio monitor in the RF equipment case and turning on the audio monitor at the base radio. Speak through the hand held AM radio and listen the audio on the base monitor.

q) Test the end to end audio quality by speaking through the base and observing the voice on the hand held air-to-ground radio.

r) If any of the checkouts do not come within tolerances consult Daniels Electronics manual.

9.5.2.2 Base station radios

a) Power up base station radio with duplexer connected.

b) Measure forward power on link radio. (1.3:1 max.).

c) Measure raw voltage into radios by turning the knob on the status monitor to position 2. (13.8 Volts).

d) Measure regulated voltage by turning the knob on the status monitor to position 3. (9.5 Volts).

e) Test audio quality be turning the status monitor knob to position 8 and monitor the A/B switch to B. Operate the high site radio and observe the audio on the monitor.

f) Test the end to end audio quality by turning off the audio monitor in the RF equipment case and turning on the audio monitor at the base radio. Speak through the hand held AM radio and listen to the audio on the base monitor.

g) Test the end to end audio quality be speaking though the base and listen to the voice on the hand held air-to-ground radio.