

# **GWX 68 Weather Radar Installed in Beech 90 Series Installation Data**

**FAA STC Project No. ST9355SE-A**

**P/N 190-00286-05 Rev. A**

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## TABLE OF CONTENTS

1. INTRODUCTION .....	1
1.1 PURPOSE .....	1
1.2 Scope .....	1
1.3 Document Revision .....	1
1.4 Document Distribution .....	1
1.5 Permission to Use Certain Documents .....	1
1.6 License Requirements.....	2
1.7 Certification .....	2
1.8 Technical specifications .....	2
1.9 Definitions.....	3
1.10 Reference Documents.....	3
2. SAFETY INFORMATION .....	4
2.1 General Precautions.....	4
2.2 Body Damage.....	4
2.3 Safe Distance Determination.....	5
2.4 Combustible Materials.....	5
2.5 Maximum Permissible Exposure Level (MPEL).....	5
3. EXISTING SYSTEM AND EQUIPMENT REMOVALS.....	7
4. SUPPORT STRUCTURE / MODIFICATION OF EXISTING STRUCTURE .....	7
4.1 Model C-90, Bulkhead F.S. 30 .....	7
5. INSTALLATION .....	7
5.1 Items Installed .....	7
5.2 General Installation Practices .....	7
5.3 Special Installation Practices / Special Tools Recommended .....	8
5.4 Radar Orientation to Aircraft.....	8
5.5 Electrical System Components .....	8
6. POST INSTALLATION CONFIGURATION AND CHECKOUT .....	8
7. SERVICE & MAINTENANCE INFORMATION .....	8
7.1 Servicing Information.....	8
7.2 Maintenance Information.....	9
8. ELECTRICAL LOADS AND ANALYSIS .....	9
9. WEIGHT AND BALANCE .....	9
APPENDIX A: GWX 68 DRAWINGS AND INTERCONNECTS .....	A1
APPENDIX B: SAFE DISTANCE DETERMINATION.....	B1
B1. Near Field/Far Field Intersection .....	B1
B2. Distance to Safe Limit .....	B1
B3. Summary .....	B2

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## **1. INTRODUCTION**

### **1.1 PURPOSE**

The purpose of this document is to provide Installation Instructions and Installation Data specific to all series of Raytheon Model C-90 aircraft (King-Air and Queen-Air), as covered on TCDS 3A20. The information contained in this document goes beyond that supplied by the general *GWX 68 Installation Manual*, 190-00286-01. The original installation was performed on C-90 N89TM (Serial Number LJ-610), at the Garmin AT facility in Salem, Oregon.

### **1.2 Scope**

This document provides a summary of the changes that may have to be made to the C-90 aircraft as part of the GWX 68 Weather Radar installation. The major components and mounting hardware needed are listed. Mechanical interfaces with, and possible modifications to, the aircraft are shown. Electrical interconnections particular to the C-90 are shown. The prototype installation was done in aircraft N89TM (model C-90), which was a basic model without all of the factory-installed options. Consequently, this modification summary will not be representative of all changes that may have to be made to all current C-90 models. In cases where a particular part number or model number of an interfacing unit is not included, sufficient detail is given to identify the unit's primary interconnects. The changes to the aircraft weight and balance resulting from this modification are summarized in Section 9 of this report.

### **1.3 Document Revision**

This document shall be released, archived, and controlled in accordance with Garmin ENG-008. As such, when this and other documents are revised, the entire document is revised and the new revision nomenclature is changed on each page of the revised document. Typically change bars are utilized to direct the reader to changed sections within the document.

Any Garmin documents that are not released are clearly labeled "PRELIMINARY" or "DRAFT" in the revision block on each page or by annotating the document with a "water mark" indicating "PRELIMINARY" or "DRAFT".

### **1.4 Document Distribution**

This document, or the information contained within, will be retained in the aircraft's permanent records. The latest revision of this document will be available on the Garmin website ([garmin.com](http://garmin.com)).

### **1.5 Permission to Use Certain Documents**

Permission is granted to any corporation or person applying for approval of a Garmin GWX 68 Weather Radar to use and reference appropriate STC documents to accomplish the Installation and show compliance with STC engineering data. This permission does not construe suitability of the documents. It is the responsibility of the applicant to determine the suitability of the documents for the installation.

## 1.6 License Requirements

The Telecommunications Act of 1996, effective February 8, 1996, provides the FCC discretion to eliminate radio station license requirements for aircraft and ships. The GWX 68 installation must comply with current transmitter licensing requirements. To find out the specific details on whether a particular installation is exempt from licensing, please visit the FCC web site <http://wireless.fcc.gov/aviation>.

If an aircraft license is required, make application for a license on FCC form 404, Application for Aircraft Radio Station License. The FCC also has a fax-on-demand service to provide forms by fax. The GWX 68 owner accepts all responsibility for obtaining the proper licensing before using the transponder.

<b>CAUTION</b>
----------------

The transmitter in this equipment is guaranteed to meet Federal Communications Commission acceptance over the specified operating temperature range. Modifications to Garmin equipment not expressly approved by Garmin could invalidate the license and make it unlawful to operate the equipment.

## 1.7 Certification

The conditions and tests required for TSO approval of this article are minimum performance standards. It is the responsibility of those installing this article either on or within a specific type or class of aircraft to determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The article may be installed only if performed under 14 CFR part 43 or the applicable airworthiness requirements.

### 1.7.1 TSO/ETSO Compliance

TSO-C63c Class 7

## 1.8 Technical specifications

It is the installing agencies responsibility to obtain the latest revision of the *GWX 68 Environmental Qualification Form* (005-00171-00), for environmental specifications.

It is the installing agencies responsibility to obtain the latest revision of *GWX 68 Installation Manual* (190-00286-01), for the latest unit physical characteristics, performance specifications and power requirements.

## 1.9 Definitions

The following terminology is used within this document:

- 1) **AC:** Advisory Circular
- 2) **ACO:** Aircraft Certification Office
- 3) **AEG:** Aircraft Evaluation Group
- 4) **CFR:** Code of Federal Regulations
- 5) **DER:** Designated Engineering Representative
- 6) **FAA:** Federal Aviation Administration
- 7) **IAW:** In Accordance With
- 8) **ICA:** Instructions for Continued Airworthiness
- 9) **MFD:** Multi-Function Display unit
- 10) **MPEL:** Maximum Permissible Exposure Limit
- 11) **PMI:** Primary Manufacturing Inspector
- 12) **POI:** Primary Operations Inspector
- 13) **STC:** Supplemental Type Certificate
- 14) **TC:** Type Certification or Type Certificate
- 15) **TSO:** Technical Standard Order

## 1.10 Reference Documents

### 1.10.1 Garmin

- 1) 190-00286-01, *GWX 68 Weather Radar Installation Manual*
- 2) 005-C0171-00, *GWX 68 Weather Radar Master Data List*
- 3) 001-00029-00, *Garmin Installation Standard Practices*
- 4) 190-00286-04, *GWX 68, Instructions for Continued Airworthiness*
- 5) 560-1025-09, *MX 20 Multi Function Display Installation Manual*
- 6) 005-00171-00, *GWX 68 Environmental Qualification Form*

## 2. SAFETY INFORMATION



The image shows a yellow rectangular warning sign. On the left side, there is a black triangular hazard symbol containing a radio tower with signal waves. To the right of the symbol, the words "MICROWAVE RADIATION" are written in large, bold, black capital letters. Below this, the word "WARNING" is written in red capital letters. Underneath "WARNING", there is a white rectangular box with a black border containing the following text: "This radar device produces microwave radiation. DO NOT OPERATE THIS DEVICE UNTIL ALL SAFETY PRECAUTIONS AND INSTRUCTIONS IN THE OPERATING AND INSTALL MANUALS HAVE BEEN READ. IMPROPER USE OR EXPOSURE MAY RESULT IN BODILY INJURY. CAUTION All personnel should remain the prescribed "safe distance" from this radar. Never expose any part of the body to an unterminated waveguide."

Information derived from AC 20-68B:

### 2.1 General Precautions

Airborne weather radar should be operated on the ground only by qualified personnel.

Installed airborne radar should not be operated while the aircraft is in a hanger or other enclosure unless the radar transmitter is not operating, or the energy is directed toward an absorption shield which dissipates the radio frequency energy. Otherwise, radiation within the enclosure can be reflected throughout the area.

### 2.2 Body Damage

To prevent possible human body damage, the following precautions should be taken:

Personnel should never stand nearby and in front of a radar antenna which is transmitting. When the antenna is not scanning, the danger increases.



## 2.3 Safe Distance Determination

Table 2.1 lists the minimum safe distance from the antenna, for personnel near an operating airborne weather radar. The minimum safe distance is based upon the FCC's exposure limit at 9.3 to 9.5 GHz for general population/uncontrolled environments which is  $1 \text{ mW/cm}^2$ . See AC 20-68B and Appendix B of this report, for more information on safe distance determination.

Antenna Size	Safe Distance
10"	9.16 ft
12"	10.8 ft

**Table 2-1  
Minimum Safe Distance From Antenna**

The recommended safe distance which is established above should be followed. The distance from any person to the radar should be greater than that distance.

Personnel should be advised to avoid the end of an open waveguide unless the radar is turned off.

Personnel should be advised to avoid looking into a waveguide, or into the open end of a coaxial connector or line connector to a radar transmitter output, as severe eye damage may result.

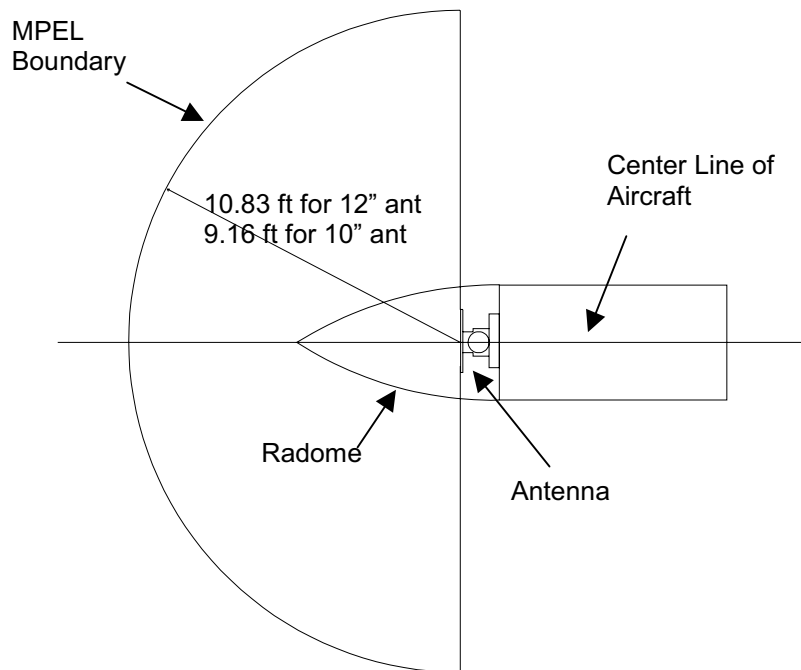
Personnel should be advised that when high power radar transmitters are operated out of their protective cases, X-rays may be emitted. Stray X-rays may emanate from the glass envelope type pulser, oscillator, clipper, or rectifier tubes, as well as magnetrons.

## 2.4 Combustible Materials

To prevent possible fuel ignition, an installed airborne weather radar should not be operated while an aircraft is being refueled or defueled.

## 2.5 Maximum Permissible Exposure Level (MPEL)

The zone in which the radiation level exceeds the US Government standard of  $1 \text{ mW/cm}^2$ , is the semi-circular area of at least 9.16 ft from the 10" antenna and 10.83 ft from the 12" antenna as indicated in the illustration below. All personnel must remain outside of this zone. The distance to the MPEL boundary is calculated upon the basis of each antenna available with the GWX 68 system, rated output power of the transmitter, and in the non-rotating or boresight position of the antenna (see example calculations in Appendix B of this report). With a scanning or rotating beam, the averaged power density at the MPEL boundary is significantly reduced.



### **3. EXISTING SYSTEM AND EQUIPMENT REMOVALS**

This document is based on installing the GWX 68 in a C-90 aircraft that does not currently have a Garmin weather radar unit installed. For aircraft with existing weather radar units, remove the weather radar assembly, associated configuration module, and any wiring that does not correspond to Figure A-3 of this report.

### **4. SUPPORT STRUCTURE / MODIFICATION OF EXISTING STRUCTURE**

#### **4.1 Model C-90, Bulkhead F.S. 30**

This document assumes that the bulkhead @ F.S. 30 contains mounting holes and gussets as shown in Figure A-2. This will be the case in most aircraft with existing weather radar units.

For aircraft that have gussets per Figure A-2, but are not pre-drilled, holes may be added per Flagnote 2, Figure A-2.

### **5. INSTALLATION**

#### **5.1 Items Installed**

This document covers installation of Garmin P/N 011-00883-20, a GWX 68 Weather Radar with 12 inch Antenna. An Installation Kit, P/N 011-01114-00 is also available, containing connector, contacts and a backshell kit. (If the radar and install kit are both needed, they can be ordered together, as Garmin catalog number 010 00299-21).

#### **5.2 General Installation Practices**

*Garmin Installation Standard Practices Manual 001-00029-00* should be referenced for wire and cable routing, and hardware torque values. All wiring shall be in accordance with FAA Advisory Circular AC 43.13-1B (or later FAA Approved revision).

The unit must be checked for clearance in all extreme positions.

The wiring harness must be routed and secured in such a way that it can not be struck by or interfere with unit movement throughout the full range of sweep and tilt.

The GWX 68 base and electrical equipment shall be electrically bonded to the aircraft structure. The surface preparation shall be per SAE ARP 1870, Section 5. The electrical bond shall achieve a direct current (DC) resistance of 2.5 Milliohms or less between each faying surface and the aircraft structure. Compliance shall be verified by inspection using a calibrated milliohmmeter. Electrical equipment includes metal connectors with shields. Electrical bond test shall be performed with the radar connector disconnected.

### 5.3 Special Installation Practices / Special Tools Recommended

Special care must be exercised to avoid any contact between any tools that can become magnetized and the magnetron. Even momentary contact of a potentially magnetic object with the magnetron case will cause serious weakening of the magnetic field. Use of non-magnetic tools (typically beryllium copper or titanium) is recommended when installing or servicing the GWX 68.

### 5.4 Radar Orientation to Aircraft

The GWX 68 must be mounted to within 1° of level in both the vertical and horizontal planes, with the aircraft in its level-flight orientation. The GWX 68 must also be mounted near the longitudinal (fore-aft) centerline of the aircraft.

There are rivet heads protruding forward from the mounting Bulkhead (F.S. 30), which will cause uneven stresses on the base of the GWX 68, if it is not shimmed above them. Typically, two AN960-416 washers under the GWX 68 base at each bolt will allow the base to clear the rivet heads. More AN960-416 washers may need to be installed between the GWX 68 base and F.S. 30 to create a plumb mounting. Refer to figure A-2.

A general rule of thumb is; One AN960-416 washer difference between the top and bottom mounting bolts will typically correct ½ ° of tilt. Two washers will generally correct 1°, etc.

Level flight orientation is shown in Figure A-2. Securely support the aircraft in this orientation preparatory to mounting the radar.

### 5.5 Electrical System Components

Install unit connector and wiring harness per Sections 3.2 and 3.3 of *GWX 68 Installation Manual*, 190-00286-01. If a Configuration Module is necessary (as with MX20 interface), install the configuration module per Sections 3.3.2 and 3.3.3 of 190-00286-01.

## 6. POST INSTALLATION CONFIGURATION AND CHECKOUT

The GWX 68 does not have a direct pilot interface. The GWX 68 is configured and controlled via a separately installed display / control device. This document assumes use of a Garmin MX20 Multi-Function Display Unit, for configuration, display and control (See 560-1025-09, *MX 20 Multi-Function Display Installation Manual*). For other display / control unit(s), see applicable installation manual(s).

To validate the operation of the GWX 68, monitor the weather depiction page of the Multi-Function Display and look for display of weather data.

## 7. SERVICE & MAINTENANCE INFORMATION

### 7.1 Servicing Information

None. In the event of system failure, return the unit to the manufacturer or an approved Garmin repair station.

## 7.2 Maintenance Information

Refer to *GWX 68 Instructions for Continued Airworthiness*, 190-00286-04, for maintenance information and schedule.

## 8. ELECTRICAL LOADS AND ANALYSIS

An electrical load analysis should be completed on each aircraft prior to installation in accordance with AC 43.13-1B, Chapter 11. Use the following values for computation:

<b>Table 8-1 - Unit Power Loads</b>				
<b>GWX 68 Input</b>	<b>14 VDC</b>		<b>28 VDC</b>	
	<b>Typical</b>	<b>Max</b>	<b>Typical</b>	<b>Max</b>
GWX 68 Main Power (P400 connector)	3.0	4.0	1.5	2.0

## 9. WEIGHT AND BALANCE

Weight and Balance calculations for this installation are shown on the following page. The particular aircraft used for installation had a Honeywell ART 2000 radar in place, which was removed. As this document can apply to older aircraft, with an existing radar to be removed, the weight and balance calculations include removal of the existing unit.

## Supplemental Weight and Balance Data / Equipment List

Aircraft Make:	<u>Beechcraft</u>	Today's Date:	<u>09-14-05</u>
Aircraft Model:	<u>C90</u>	Prepared by:	<u>Mike Hughes</u>
Aircraft Year:	<u>1974</u>	Repair Station	<u>Garmin AT</u>
Aircraft Serial #	<u>LJ-610</u>	Certificate No.	<u>JC6R634N</u>
Aircraft Reg #	<u>N89TM</u>		

**Description of work performed:** . Removed Honeywell ART 2000. Installed Garmin GWX 68 and interfaced to MX20. Updated W&B, Equipment List as follows.

Note: Temporary wiring per Wiring referenced here as per Garmin AT drawing number RI-34-43-11 is to be replaced with wiring per Figure A3, this report.

Previous Aircraft Weight and Balance	Useful Load	Empty Weight	C.G.	Moment
KGP 560 Installation {06-15-05}	3491.85 lbs.	6158.15 lbs..	153.03	942379.40

Description of items removed <b>from</b> aircraft	Weight	Arm	Moment
Honeywell ART-2000 Radar	10.6	26.9	285.14
Description of items added <b>to</b> aircraft	Weight	Arm	Moment
Garmin GWX 68 Radar, P/N 011-00883-20	9.0	27.4	246.6
<b>Total</b>	<b>-1.6</b>		<b>-38.54</b>

New Aircraft Weight and Balance	Useful Load	Weight	C.G.	Moment
GWX 68 Installation {09-14-05}	<b>3496.65</b>	<b>6156.55lbs.</b>	<b>153.06</b>	<b>942340.86</b>

NOTE: See aircraft weight & balance loading chart to compute operable limits for each flight.

Allowable C.G. range: 145" – 160" (Gross Weight less then 7,400 lbs.)

153" – 160" (Gross Weight of 9,650 lbs.)



# APPENDIX A: GWX 68 DRAWINGS AND INTERCONNECTS

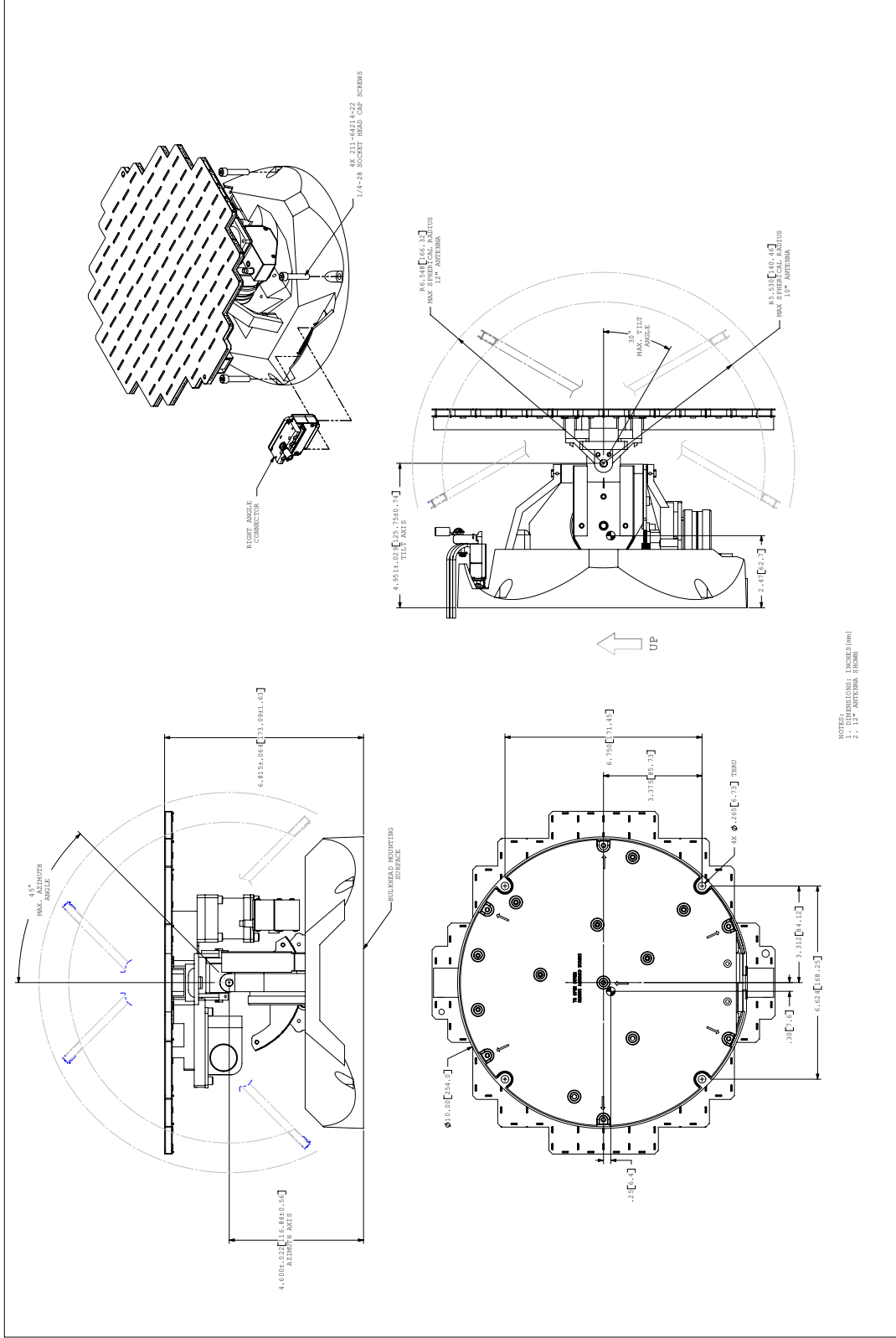
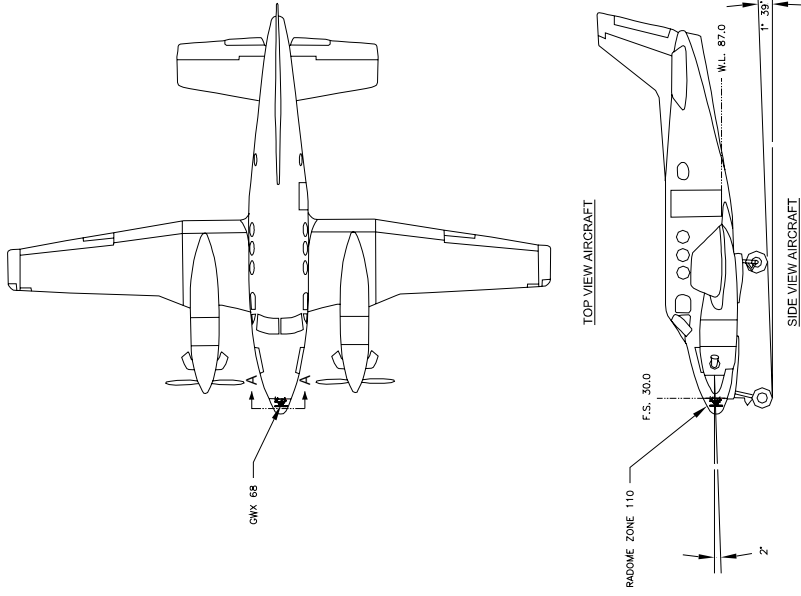


Figure A-1, GWX 68 Outline Drawing

# APPENDIX A: GWX 68 DRAWINGS AND INTERCONNECTS



## NOTES:

1. PRIOR TO INSTALLING THE GWX 68 WEATHER RADAR, LEVEL THE AIRCRAFT TO THE HORIZONTAL POSITION. THE AIRCRAFT MUST BE LEVEL TO THE HORIZONTAL POSITION TO THE POINT OF INSTALLATION. THE AIRCRAFT MUST BE LEVEL TO THE HORIZONTAL POSITION TO THE POINT OF INSTALLATION. THE AIRCRAFT MUST BE LEVEL TO THE HORIZONTAL POSITION TO THE POINT OF INSTALLATION.
2. IF FORWARD BULKHEAD IS NOT ALREADY DRILLED, ADD THE BOLT HOLE PATTERN WITH LOCATIONS AS SHOWN ON SHEET 2 OF FIGURE A-2.
3. ELECTRICAL EQUIPMENT & SUPPORTING BRACKETS SHALL BE ELECTRICALLY BONDED. THE SPACE BETWEEN THE BRACKET AND THE AIRCRAFT STRUCTURE SHALL BE FILLED WITH AN ANTI-CORROSION COMPOUND. THE BRACKET SHALL BE MOUNTED TO THE AIRCRAFT STRUCTURE WITH AN ANTI-CORROSION COMPOUND. THE BRACKET SHALL BE MOUNTED TO THE AIRCRAFT STRUCTURE WITH AN ANTI-CORROSION COMPOUND. THE BRACKET SHALL BE MOUNTED TO THE AIRCRAFT STRUCTURE WITH AN ANTI-CORROSION COMPOUND.

ITEM	P/N	DESCRIPTION	QTY	SUPPLIER
1	011-00863-XX	GWX 68	1	GARMIN
2	211-04214-22	SCREW, SOCKET HEAD, 1/4-28 X 1.25	4	
3	AN890-116	WASHER, 3/85 ID, .500 OD	4	ARI
4	MS21042-4	NUT, SELF-LOCKING, 1/4-28	4	

Figure A-2, Sheet 1 GWX 68 Installation For Raytheon C90 Series



# APPENDIX A: GWX 68 DRAWINGS AND INTERCONNECTS

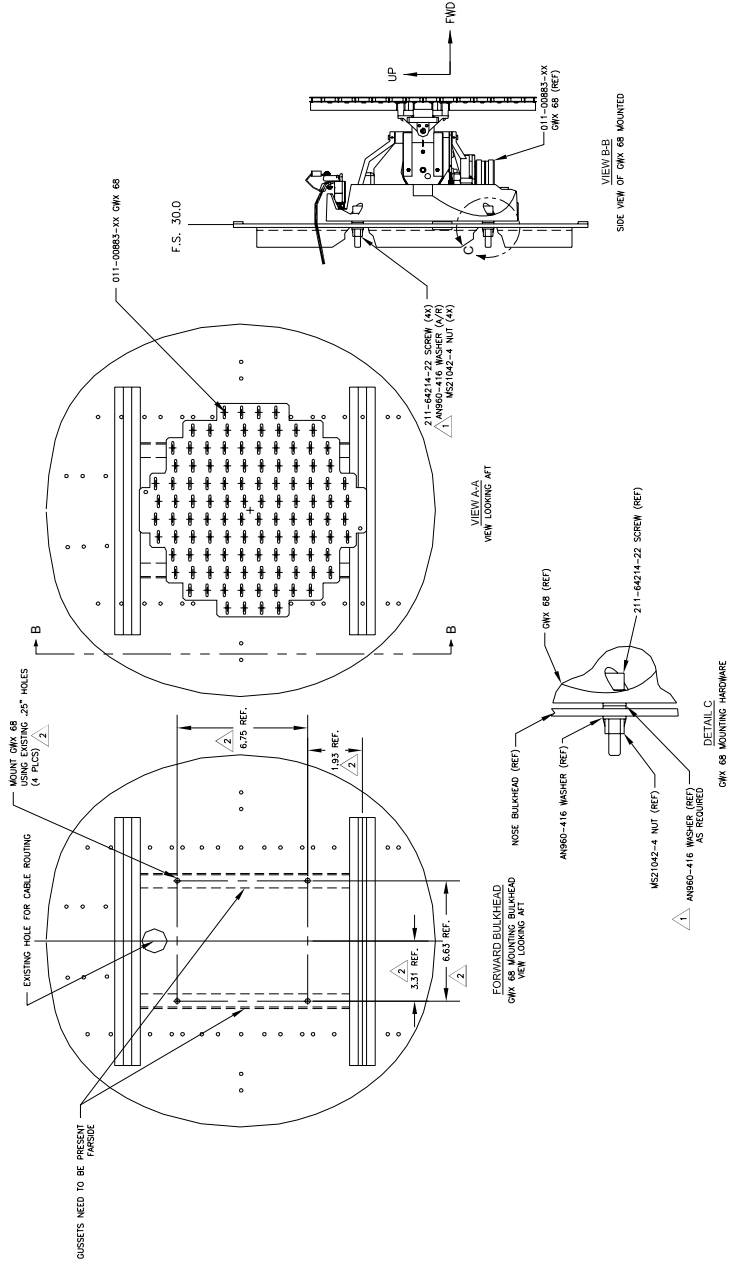
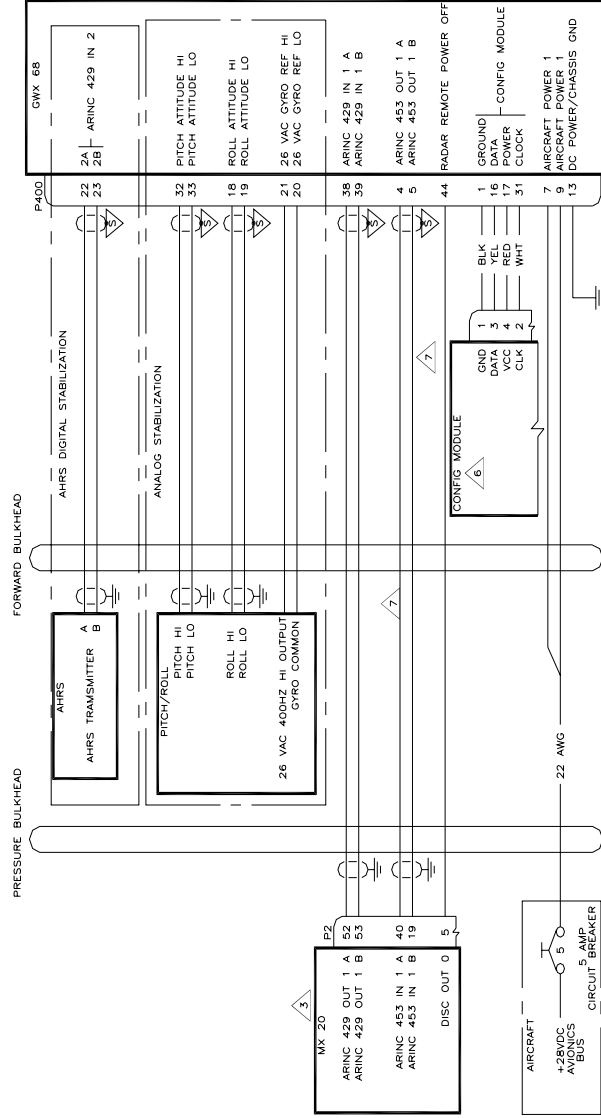


Figure A-2, Sheet 2 GWX 68 Installation For Raytheon C90 Series

# APPENDIX A: GWX 68 DRAWINGS AND INTERCONNECTS



- NOTES:**
3. MX 20 INTERCONNECT SHOWN FOR OTHER DISPLAY/CONTROL UNITS. SEE APPLICABLE INSTALL MANUAL.
  4. UNLESS OTHERWISE NOTED, ALL STRANDED WIRE MUST CONFORM TO MIL-W-22759/16 OR EQUIVALENT.
  5. UNLESS OTHERWISE NOTED, ALL SHIELDED WIRE MUST CONFORM TO MIL-C-27500 OR EQUIVALENT.
  6. REFER TO FIGURE 3-5 OF GWX 68 INSTALL MANUAL.
  7. 78 OHM CABLE SUITABLE FOR ARINC453 TRANSMISSION IS REQUIRED. UNLESS OTHERWISE NOTED, ALL SHIELD GROUNDS MUST BE MADE TO THE RESPECTIVE UNIT BACKSHELLS. ALL OTHER GROUNDS SHOULD BE TERMINATED TO AIRCRAFT GROUND AS CLOSE TO THE RESPECTIVE UNIT AS POSSIBLE.
  8. THIS INTERCONNECT DOES NOT SHOW ANY INTERMEDIATE CONNECTORS.

**Figure A-3. GWX 68 Installation Wiring Diagram For Raytheon C90 Series**

## APPENDIX B: SAFE DISTANCE DETERMINATION

The following information establishes a minimum safe distance from the antenna for personnel near an operating airborne weather radar. The minimum safe distance is based upon the FCC's exposure limit at 9.3 to 9.5 GHz for general population/uncontrolled environments which is 1 mW/cm<sup>2</sup>.

### B1. Near Field/Far Field Intersection

The distance from the transmitting antenna to the near field/far field intersection ( $R_i$ ) can be computed by:

$$R_i = \frac{G \cdot \lambda}{8 \cdot \pi}$$

where:

$R_i$  = Intersection distance from the antenna (in meters)

$\lambda$  = Wave length (in meters)

$G$  = Antenna gain (numeric / not dB)

The gain of the 10" GWX 68 antenna is 25.0 dB or 316.2

The gain of the 12" GWX 68 antenna is 26.5 dB or 446.7

The wavelength ( $\lambda$ ) is 0.032 m

$R_i$  for the 10" version is 0.403 m

$R_i$  for the 12" version is 0.569 m

### B2. Distance to Safe Limit

For a far field power density of  $PD_{SafeLimit}$ , the distance from the antenna may be calculated by:

$$R_s = \sqrt{\frac{G \cdot P}{40 \cdot \pi \cdot PD_{SafeLimit}}}$$

## B2. Distance to Safe Limit, continued.

where:

$R_s$  = The minimum safe distance (in meters)

$P$  = Transmitted average power (in Watts)

$G$  = Antenna gain (numeric / not dB)

$PD_{SafeLimit}$  = Desired Safe Limit Power Density (in mW/cm<sup>2</sup>)

$PD_{SafeLimit}$  is considered to be 1 mW/cm<sup>2</sup> from the FCC "Limits for General Population/Uncontrolled Exposure"

$P$  is 3.1 Watts

The gain of the 10" GWX 68 antenna is 25.0 dB or 316.2

The gain of the 12" GWX 68 antenna is 26.5 dB or 446.7

$$R_s(10'') = \sqrt{\frac{316.2 \cdot 3.1}{40 \cdot \pi \cdot 1}} = 2.79 \text{ m} = 9.16 \text{ ft}$$

$$R_s(12'') = \sqrt{\frac{446.7 \cdot 3.1}{40 \cdot \pi \cdot 1}} = 3.32 \text{ m} = 10.8 \text{ ft}$$

## B3. Summary

Because the  $R_s$  values for both antennas are longer than the  $R_i$  value, the safe distance is considered to be the greater value.

The safe distance for the 10" antenna is therefore 9.16 ft and the safe distance for the 12" antenna is therefore 10.8 ft.