

ATTACHMENT A – 1 - STATEMENT OF WORK

SECTION 1 – GENERAL SITE INFORMATION

1.1 Site Name, Number, and Statement of Work Date

Site: Agency Plains

Site Number: F73314

Statement of Work date: September 9, 2014

1.2 General Statement of Work

This State Radio Project (“SRP”) Statement of Work (“SOW”) is for civil infrastructure improvements at an existing radio communications facility at Agency Plains located in Jefferson County, Oregon, Site # F73314. Project Work identified within the Final Construction Drawings (“FCDs”) and written in Sections 2 – 14 of this SOW includes but is not limited to the following:

1. Provide and install new Ice Bridge from new ODOT equipment shelter to tower. Install 6 posts with base mounts in concrete slab.
2. Remove interior wall in existing ODOT generator shelter to accommodate generator replacement.
3. Caulk, seal, and paint interior and exterior of existing ODOT generator shelter. Repair area where wall is removed.
4. Commission two (2) HVAC units in new ODOT equipment shelter.
5. Seal ports on existing ODOT generator shelter.
6. Deliver and install new 36 KW Owner-provided Generator and ATS.
7. Decommission and remove existing generator and ATS. Deliver to ODOT Building M, 455 Airport Road, Salem, OR 97301.
8. Complete electrical improvements in new ODOT equipment shelter.
9. Coordinate activation of new electrical service to new ODOT equipment shelter with the power company.
10. Provide and install new propane exhaust fan in existing generator shelter.
11. Provide and install new generator exhaust and intake hoods on existing ODOT generator shelter.
12. Provide and install new telemetry conduit from propane tank to existing ODOT generator shelter.
13. Provide and install new Appleton generator receptacle on existing ODOT generator shelter.
14. Upgrade interior grounding in both shelters. Ground existing interior components to existing halo. Connect interior halo to exterior ground ring.
15. Upgrade existing exterior site grounding on new building and tower.

16. Ground propane tank to existing grounding system.
17. Install Owner-provided feedlines, grounding, hardware and weatherproofing to connect existing antennas on existing tower to new ODOT equipment shelter19. Install new radio rack (pickup at ODOT at Del Webb Warehouse, Salem).
20. Install signs.

Refer to Sections 2-14 for specific descriptions of the Work.

Attachment A of this Contract identifies the site-specific Work directives. Attachment C supports these site-specific Work directives.

1.3 Site Directions and Coordinates

Site Directions:

From Warm Springs, Oregon: Travel East on US Highway 26 approximately 7.0 Miles. Turn left onto Gumwood NW Gumwood Lane. Travel 0.2 miles. Turn right onto NW Deschutes Avenue, travel 2.0 miles. Turn Left onto NW Ivy Lane. Travel 0.2 miles past to unlocked gate. Pass through gate and travel 1.2 miles along dirt road to site location.

Site Coordinates:

Latitude: 44 45 18.4 North / Longitude: -121 13 10.6 West

1.4 Key SRP Staff

The following personnel will be the primary contacts during construction. Their contact information will be provided at the time of award.

- a) SRP Principal Project Manager (“PPM”) – Jack Williams
- b) SRP Site Project Manager (“SPM”) – Shawn Hankins
- c) SRP Construction Quality Manager (“CQ” or “CQM”) – Bryce Foster
- d) Sr. Contracts Manager – Dennis Wright
- e) ODOT / SRP Document Control (email all deliverables to) - ODOTMPBDocCntrl@odot.state.or.us

SECTION 2 –MOBILIZATION, SITE USE, PERMITS, OWNER-FURNISHED MATERIALS AND INSPECTIONS.

2.1 PERMITS

The Building Permit application is the responsibility of Owner. Owner will ensure building permits are available at the time of the issuance of Notice to Proceed (NTP). In some cases the Contractor shall be responsible for picking up the permit at the jurisdiction. If there are any fees to be paid at the time of pickup those fees will be reimbursed by Owner and are not part of the Contract Price. No mark-up is allowed on these fees.

The Building Permit to be picked up by SRP.

Building and Trade Permit Jurisdiction is:

Jefferson County

2.1.1 Trade Permits

Contractor and sub-contractors are responsible for obtaining all required trade permits.

2.1.2 Oregon Department of Forestry ("ODF") Permits

All ODF property requires a Work permit issued from ODF. Contractor shall obtain this permit prior to start of Work. Owner can provide the contact information and forms if needed.

2.1.3 Property and Access Road Owner Permits

Contractor shall obtain the following additional permit and insurance requirements required by the property and access road owners.

1. [RESERVED]

2.2 MATERIALS

2.2.1 Owner-Provided Materials

Contractor shall pick up and take possession of Owner-provided materials, shall transport them to the project site, shall secure them until installed, and shall install this equipment in accordance with the project Plans and Specifications.

The following Owner-provided materials will be available for transfer to Contractor from ODOT MPB – 3210 Del Webb Avenue NE, Salem Oregon (unless otherwise noted).

1. See "F73314 Antenna Migration Parts List" document.
2. (1) Generator Set including one (1) ATS to be installed in existing ODOT generator shelter.
3. Assist ODOT technician with rack and radio movement to new equipment shelter in the same compound.

Contractor shall notify Owner's SPM one week in advance of the scheduled pickup time for the material listed above.

2.2.2 Contractor-Provided Materials

Contractor shall provide all other new materials necessary to complete the Work according to the Contract Plans and Specifications, including (but not limited to) the following:

- 1) Cable Management Apparatus (e.g. Ice Bridge, Trapeze, Cable Ladder, Waveguide Ladder, feedline support, etc. as applicable).

- 2) All paint and weather-proofing and galvanizing materials.
- 3) All interior and exterior electrical materials and equipment.
- 4) All interior and exterior grounding materials.
- 5) Propane lines, regulators and valves, and appurtenances.
- 6) All support structures.
- 7) LPG propane sensor and fan.
- 8) Generator exhaust vent.
- 9) Generator intake vent.
- 10) Appleton Generator Receptacle.
- 11) Fire Extinguishers.
- 12) Feedline connectors and ground kits.
- 13) Two (2) HVAC units.
- 14) Any additional material needed to complete the site in conformance with the Contract Documents.

Contractor-provided materials require a submittal for review and approval in accordance with the submittal requirements found in **Attachment C**.

2.3 HANDLING OF REMOVED MATERIALS:

Contractor shall handle removed materials in accordance with this Section and Section 14 of this SOW.

Seasonal Restrictions and Site Access

Contractor shall work with the local Stakeholders as needed to determine and establish additional Work requirements and controls that are a result of the fire restrictions in place at the time of construction. Contractor shall comply with all fire restrictions. The local Stakeholders this project (is/are):

BLM

Contact information will be provided at time of Contract award.

During fire season (typically late April through October) in forest areas the following minimum fire protection conditions must be followed.

- i) Each truck must have
 - i. 1 round-pointed shovel at least 8 inches wide, with a handle at least 26 inches long
 - ii. 1 axe or Pulaski with 26 inch handle or longer
 - iii. 1 fire extinguisher rated not less than 2 ½ pound ABC (OR-OSHA requires a 5 lb. extinguisher for all commercial Work)
 - iv. Adequate muffler and exhaust system to prevent sparks

- ii) No Smoking is allowed while working or traveling in the operation area
- iii) Full commercial Fire Equipment Requirements can be obtained on the Oregon Department of Forestry website: <http://www.oregon.gov/ODF/Pages/index.aspx>.

Contractor shall comply with all local, state, federal, and property owner fire regulations.

2.3.1 Site Access, Work Conditions and Special Usage

The following conditions apply to site access, Work, and usage.

1. Four wheel drive vehicles may be required to access the site.

2.4 CULTURALLY SENSITIVE SITES

If the Contractor finds a previously undiscovered sensitive cultural find, immediately cease all activities at that site and notify the Site Project Manager. If the Contractor inadvertently disturbs unknown sensitive cultural finds, but immediately ceases all activities and follows the procedures listed in 00290.50 (of the 2015 ODOT Standard Specifications for Construction), the Agency (as provided in 00290.51(b) of the 2015 ODOT Standard Specification for Construction), to the extent permitted by Article XI, Section 7 of the Oregon Constitution and the Oregon Tort Claims Act, will indemnify, within the limits of the Tort Claims Act, the Contractor for costs associated with monitoring, recovery, site restoration or other required archaeological work, provided neither the Agency nor the State shall be required to indemnify the Contractor for such costs resulting from, arising out of or relating to the willful misconduct, negligence or other wrongful acts attributable to the Contractor or other persons on the Project site. Delays to work due to discovery of new cultural sensitive finds will be considered for exclusion from Contract time.

The 2015 ODOT Standard Specifications for Construction can be viewed at:
http://www.oregon.gov/ODOT/HWY/SPECS/Pages/2015_Standard_Specifications.aspx

2.5 VANDALISM

Contractor shall provide protection of the Work from vandalism until the contracted Work is completed. If reasonable protection has been provided, Contractor’s responsibility for damage resulting from vandalism will be limited to \$2,000 per occurrence. Requests for reimbursement of amounts in excess of \$2,000 shall be in writing and directed to the Principal Project Manager (PPM). Upon receipt, the PPM will investigate, evaluate the amount of damages and their cause, and determine whether, and how much, Contractor will be recompensed.

2.6 DOCUMENT DEFINITIONS

Plans	FCD (REV 12) dated 09/02/2014. The project Plans provide the detail of what Work is needed at the Contract Site.
Statement of Work (SOW)	The Statement of Work is written specifically for this project and identifies and describes the Work to be completed as part of this Contract.
Specifications Manual	The Specifications Manual is a reference document to aid in defining technical requirements associated with the Work described in the Statement of Work and on the Plans. It is a comprehensive document that covers many types of Work contracted by SRP, many of which may not be applicable to this project. It is intended to be used in combination with the Statement of Work and the Plans.

Wireless Requirements	Microwave and antenna installation standards are included in the Wireless Requirements documents and take precedence over the Plans and the SOW. Please follow these guidelines very closely.
Shelter Plans	When applicable shelter Plans are included; these are for reference. When the Contract includes installation of a shelter by Contractor, Owner (State of Oregon) will provide the shelter structure. The Statement of Work will identify the location at which the shelter structure will be transferred to Contractor. <u>The shelter Plans are generated at the manufacture plant, by the manufacturer. These Plans are specific to the shelter however, not specific to the site and the site conditions. The SOW and the Contract Plans provide the site-specific conditions.</u>
Tower Plans	When applicable tower Plans are included; these are for reference. When the Contract includes installation of a tower, Owner (State of Oregon) will provide the tower components and the tower assembly drawings. Refer to the Statement of Work to determine the location of the tower for transfer to Contractor.
Climbing Certification	All Work to be performed 6-ft or more above the tower foundation requires a valid Climbing Certification. The certificates are a requirement of the State and must be submitted as a submittal for approval by the State. Even if the tower Work is accessed by means other than climbing, the Climbing Certification is still required.
Order of Precedence	In the event that there is conflicting information among the Wireless Requirements, SOW, Plans, or Specifications, the Contractor shall notify Owner. The order of precedence for these documents is Wireless Requirements, SOW, Plans, and then Specifications.

2.7 CONSTRUCTION INSPECTIONS

The Contractor shall coordinate all required inspections with the inspector and Construction Quality Manager (CQ) at least 48 hours prior to need for inspection. Notifications are “work-week” hours and exclude weekends and State holidays. In the event that an inspection must be canceled, Contractor shall provide written notice of the cancellation to the inspector and CQ no less than 24 hours in advance of the scheduled inspection. **If cancelations are not made 24 hours in advance or if the inspection results are found to be failing, the Contractor may be subject to the cost incurred by Owner for the canceled service or the re-inspection of work that failed inspection. Failed inspections are not justification for time extensions.**

The Contractor is subject to additional cost incurred by the Owner for inspections requested on Saturday, Sunday, and Holidays.

Contractor shall coordinate all inspections required by Owner and the Jurisdiction. The following inspection services are provided by Owner as needed (These are in addition to Jurisdiction inspections.):

1. Special inspection (“SI”) for Soils Density for: foundation sub-grade (under concrete with design strength exceeding 2500 PSI), fills materials that will support vehicles or cranes, and compound sub-grade.
2. SI for Concrete reinforcement (for reinforced concrete with design strength exceeding 2500 PSI). Both special inspection and Owner inspection are required for concrete reinforcement.

3. SI for Concrete placement (for reinforced concrete with design strength exceeding 2500 PSI) - Both special inspection and Owner inspection are required for concrete placement. NOTE: The Special Inspector will collect up to eight (8) compression cylinders; for five (5) of the cylinders, Owner will define the break schedule and for the remaining cylinders, Contractor may choose the break dates, if needed.
4. Grounding Inspection - Owner will inspect all grounding. No grounding hidden or below grade grounding is to be covered until it has been inspected by Owner.
5. Gas line pressure test - Owner will inspect the gas line pressure test, the Contractor shall provide the materials and labor for the test.
6. HVAC and Generator Commissioning - Owner will witness commissioning provided by the Contractor.
7. Tower inspections - Owner's tower crew will inspect the tower Work performed by Contractor. NOTE: Tower inspection by Owner requires one calendar week notice for scheduling. This inspection also requires that the Contractor have a tower crew on site to resolve any issues found during the inspection.

SECTION 3 – CIVIL LAND IMPROVEMENTS

3.1. GENERAL REQUIREMENTS

- 3.1.1. Contractor shall provide, install and maintain all necessary sedimentation control and erosion prevention per the Plans.
- 3.1.2. Contractor shall install, for future use, pull strings in all conduits installed.
- 3.1.3. Contractor shall install appropriate termination at each end of all conduits.
- 3.1.4. High water levels may be encountered. Based on pre-Bid observation of the site, Contractor shall include sufficient time in the proposed construction schedule to accommodate dewatering that may be required. Should high water levels be encountered during construction, Contractor shall consult with Owner and Engineer to agree on a construction plan for dewatering the site. The dewatering plan and compensation, if applicable, must be implemented by a Contract Change Order ("CCO").
- 3.1.5. Based upon compaction test results, if native soils are deemed unsuitable for structural compaction requirements, Contractor may request a CCO to use imported structural fill material in order to meet the project requirements.
- 3.1.6. In the event that Contractor does not find the excavated materials suitable for grading of the project, Contractor shall seek written approval from Owner to use imported fill.
- 3.1.7. Contractor shall use all efforts to make the best use of the native earth materials to accomplish excavation, backfilling and grading of the site. Contractor shall take care to schedule and execute the excavation, backfill and grading Work in a manner that manages the moisture content of otherwise-suitable native earth material to be optimum for compaction, including protecting and preserving excavated soil for future use. Contractor shall not use imported fill unless Contractor clearly demonstrates that native fill material is not suitable for use and Contractor has gained written authorization from Owner to use imported fill.

- 3.1.8. If Contractor fails to appropriately schedule and execute the Work and to protect, preserve, and properly handle earth materials suitable for fill such that suitable soil materials become unusable, Contractor shall be responsible to provide suitable imported fill material at no cost to Owner.
- 3.1.9. All tree stumps, debris and slash resulting from clearing of the project site, and all excess excavation materials become property of Contractor. Contractor shall remove all tree stumps, debris, slash and all excess excavation materials from the project Site and dispose of them. Contractor shall make all arrangements for suitable disposal. Contractor shall not burn debris and slashes on Site.
- 3.1.10. Contractor shall ensure site compound is free of vegetation upon Site completion.
- 3.1.11. During construction, Contractor shall maintain all access roads to the Site and upon completion of construction shall leave roads in the pre-construction condition or better. Contractor shall create and include in the site closeout package a video record of the pre-construction and post construction condition of the entire length of the site access road. Contractor shall provide, at no cost to Owner, all necessary materials, equipment, and labor required to repair any damage to the road that occurs as a result of construction activities, snow removal for site access, equipment transport, or materials delivery for the project Site.
- 3.1.12. Road improvements may be necessary for construction activities. Any road improvements for or as a result of construction activities are the responsibility of Contractor. The Contractor shall, at no cost to Owner, provide all materials, equipment, and labor to perform the improvements. Contractor shall obtain pre-approval from the SPM and the property owner for any and all proposed road improvements.
- 3.1.13. Inspections required for this section are soils density. Soils density is performed by Owner's SI and CQ. Contractor shall coordinate the density testing with the SI and CQ at least 48 hours prior to need for inspection. All fill material is required to be compacted in accordance with the Plans and Specifications. Only structural fill (foundation sub grade, vehicle and crane areas) require special inspection.
- 3.1.14. Contractor shall coordinate with Owner's SI for all concrete, soils density, proctor, and steel inspections. Contractor shall collect all Proctor samples for all proposed fill material (native and imported).
- 3.1.15. Contractor shall coordinate with the CQ and SPM at least 48 hours prior to need for inspection. The minimum required inspections include concrete, steel, soils density, grounding, erosion control, and periodic inspections. All required inspections are defined in the Plans and SOW.
- 3.1.16. Contractor shall inspect all installed equipment and structures for damages and quality, and shall document the installation with photos immediately upon final construction, installation or assembly. Contractor shall include sufficient photos in the Contractor's Daily Construction Report to document the installation and sufficient photos in the Closeout Package to document the quality of the installation.
- 3.1.17. Trench backfill and areas of fill below foundations and structural areas require the fill to be tested in 6" lifts. Contractor shall coordinate with Owner's SI for these tests. If tests are not performed as required, Contractor shall excavate and refill the area with the tester on site at Contractor's expense.

3.2. SITE-SPECIFIC WORK

[RESERVED]

SECTION 4 – FOUNDATIONS AND EQUIPMENT SUPPORT

4.1 GENERAL REQUIREMENTS

- 4.1.1 Contractor shall install foundations as depicted on Construction Drawings and per ODOT SRP Specifications Manual, Division 2, Section 02465 and Division 3, Section 03300.
- 4.1.2 Contractor shall cure foundations to the following strengths before use or equipment or structure installation.
 - 4.1.2.1 Shelter Foundations – 100% of design strength.
 - 4.1.2.2 Tower Foundations – 80% of design strength.
 - 4.1.2.3 Propane Tank Foundations – 100% of design strength or a full 7 day cure.
 - 4.1.2.4 All other concrete under 2500 psi– 100% of design strength or a full 7 day cure.
 - 4.1.2.5 All other concrete over 2500 psi – 100% of design strength.
- 4.1.3 Owner will provide the SI for testing. Contractor shall coordinate all inspections with the SI, CQ, and SPM at least 48 hours prior to need for inspection. Special Inspection (provided by Owner) and Owner inspections are required for all reinforced concrete with specified strength greater than 2500 psi. Concrete inspection required includes both reinforcing steel prior to pour and concrete during pour.
- 4.1.4 Owner’s SI will provide up to eight (8) compression cylinders, five (5) of which will be tested (broken) on the following schedule: 7, 14, two at 28 days, and hold/56 days. The remaining three (3) cylinders are at the Contractor’s discretion for the test (break) days.

4.2 SITE-SPECIFIC WORK

[RESERVED]

SECTION 5 – TOWER, STEEL PLATFORMS, AND STEEL INSTALLATION

5.1. GENERAL REQUIREMENTS

- 5.1.1. Contactor shall provide stainless steel or galvanize all exterior hardware per Specifications Manual requirements.
 - 5.1.1.1. Contractor shall hot-dip galvanize all Contractor-supplied steel parts.
- 5.1.2. All required field modifications to steel must be properly treated with cold galvanizing compound.
- 5.1.3. All exterior zip ties must be stainless steel. Protruding ends of all interior nylon zip ties must be flush cut. All interior zip ties must be black UV resistant nylon.
- 5.1.4. Contractor shall provide a new lock on the anti-climb device; the lock must be a master lock 175LH or equivalent. The lock combination to be used will be provided by the CQ during construction.
- 5.1.5. All exposed unistrut and all-thread ends must be covered with appropriately sized rubber caps.

- 5.1.6. Contractor shall notify the CQ 48 hours in advance of beginning construction of the tower and 24 hours in advance of completing construction of the tower to full height.
- 5.1.7. All installations on the tower require an inspection by Owner. Contractor shall request this inspection through the SPM and CQ at least one week in advance of desired inspection date.
- 5.1.8. Contractor shall have tower climbers on Site during Owner's tower inspection. The tower climbers shall be equipped with the necessary equipment to address deficiencies found during inspection.

5.2. SITE-SPECIFIC WORK

- 5.2.1. Contractor shall provide and install new 15' x 24" ice bridge system from new ODOT equipment shelter, under existing ODOT tower; to existing ODOT vertical waveguide ladder. Ice bridge posts shall be anchored to existing tower foundation as required.
- 5.2.2. [RESERVED]

SECTION 6 – SHELTER AND SHELTER IMPROVEMENTS

6.1. GENERAL REQUIREMENTS

- 6.1.1. Contractor shall field-assemble and install components of the shelter, such as, but not limited to, fire extinguishers, first aid kit, eye wash station, exterior hoods, generator exhausts, and electrical connections.
- 6.1.2. [RESERVED]

6.2. SITE-SPECIFIC WORK

- 6.2.1. Contractor shall remove interior wall in existing ODOT generator shelter to accommodate generator replacement.
- 6.2.2. Contractor shall provide wall penetrations to accommodate new generator exhaust, intakes and vents as needed.
- 6.2.3. Contractor shall provide wall penetrations to accommodate new LPG propane sensor and fan as needed.
- 6.2.4. Contractor shall provide wall penetration for new Appleton or equivalent generator receptacle.
- 6.2.5. Contractor shall prepare, caulk, seal, and paint the interior and exterior of existing ODOT generator shelter as needed. Paint to match existing.
- 6.2.6. Contractor shall provide and install new generator exhaust hoods and vents per the plans and shall prepare, install, caulk, seal, and paint new installed hoods, vents and other components. Paint to match existing.
- 6.2.7. Contractor shall prepare, caulk, seal and paint unused openings or penetrations as needed on/in existing shelters.

SECTION 7 – FENCES, GATES, AND SIGNAGE

7.1 GENERAL REQUIREMENTS

- 7.1.1 On all new fence gates installed, Contractor shall provide a combination padlock - Master Lock 175LH (2 ¼" resettable brass combination lock with a hardened steel shackle) or equivalent.
- 7.1.2 Combination for the gate lock will be provided by the SPM or CQ.
- 7.1.3 All installed gates must swing freely with latch and locks working as intended.

7.2 SITE-SPECIFIC WORK

- 7.2.1 Contractor shall procure and install all signage in coordination with the SPM.
- 7.2.2 [RESERVED]

SECTION 8 – ELECTRICAL SYSTEMS

8.1. GENERAL REQUIREMENTS

- 8.1.1 Contractor shall perform all electrical Work in compliance with the National Electric Code and the local jurisdiction requirements.
- 8.1.2 Contractor shall obtain any electrical permits required by the local jurisdiction.
- 8.1.3 Contractor shall install electrical Work per the Plans.
- 8.1.4 Contractor shall notify the SPM and CQ 24 hours prior to Installation of a new power meter.
- 8.1.5 All electrical Work will be reviewed by Owner in addition to jurisdiction inspections. The Contractor shall provide access to all closed electrical boxes in which Contractor has performed Work.
- 8.1.6 For all new installed generators (including generators provided with a new building), Contractor shall provide generator commissioning using a licensed generator technician. Commissioning shall include a 1-hour load-bank test. Contractor shall coordinate scheduling of the commissioning with the SPM and CQ at least 48 hours in advance of the commissioning, shall provide a copy of the commissioning results to the CQ within 24 hours of commissioning, and shall include commissioning results in the closeout documents.

8.2. SITE-SPECIFIC WORK

- 8.2.1 Contractor shall install Owner-provided generator, ATS, and MTS.
- 8.2.2 Contractor shall relocate electrical components in existing ODOT generator shelter as needed to accommodate interior wall removal.
- 8.2.3 Contractor shall provide and install new manual disconnect and exterior generator receptacle and all associated components in/on existing ODOT generator shelter.
- 8.2.4 Contractor shall provide and install new LPG sensor and exhaust fan and associated materials for electrical connectivity.
- 8.2.5 Contractor shall provide and install all breakers, panels, wiring, conduit, conductors all other materials and components needed to be provided electrical functionality for all contractor installed items.

SECTION 9 – GROUNDING

9.1 GENERAL REQUIREMENTS

- 9.1.1 Contractor shall install all new grounding and grounding upgrades required by the project Plans and SOW.
- 9.1.2 Contractor shall perform all grounding Work in accordance with the Plans, Statement of Work, and current revision of the Harris Corporation Installation Manual AE/LZT 123 4618/1 “Site Grounding and Lightning Protection Guidelines” (the “Harris Grounding Guidelines”) in addition to all applicable local, state, and national codes.
- 9.1.3 Contractor shall provide three point fall of potential test of the installed ground ring upon site completion. The testing procedure must be in conformance with Harris Grounding Guidelines. This test requires an Owner’s witness; therefore Contractor shall coordinate and schedule the test one (1) week in advance with the CQ and SPM. Contractor is not responsible for the resulting measured resistance (ohms) of the Site ground system that has been installed according to the Plans and Harris Grounding Guidelines.
- 9.1.4 All below-grade grounding constructed as part of this Contract requires inspection before back fill. Contractor shall schedule the grounding inspection, coordinating that schedule with the CQ at least 48 hours prior to need for inspection.
- 9.1.5 In the event that there is a conflict between the Plans or SOW and the Harris Grounding Guidelines, Contractor shall request clarification through the SPM and CQ.
- 9.1.6 New buildings, tower, ice bridge installations, and grounding upgrades require new ground bar installations as shown in the Plans. Ground bar locations are at the tower (“TGB”) and interior (“MGB”) and exterior (“EGB”) of the entry port.
- 9.1.7 The Plans may not give a full representation of all required grounding bonds. Contractor shall bond all exterior metal components and structures per Harris Grounding Guidelines.

9.2 SITE-SPECIFIC WORK

- 9.2.1 Contractor shall replace damaged or missing grounding components around ODOT shelters and tower and tie into existing site ground ring.
- 9.2.2 Contractor shall provide and install new replacement exterior ground buss bars at tower and shelter and tie into existing site ground ring. Valmont “B2988” or equivalent 24” ground buss bar.
- 9.2.3 Contractor shall provide and install new ground kits on new feedlines as required, land on ground bars and tie into existing site ground ring.
- 9.2.4 Contractor shall provide and construct a new interior shelter halo ground and ground all interior and exterior metal components where needed for the two (2) existing ODOT shelters and tie into existing site ground ring.

SECTION 10 – LOW VOLTAGE/ALARMS/TELCO

10.1. GENERAL REQUIREMENTS

- 10.1.1. All electrical Work shall be performed in compliance with the National Electric Code and the local jurisdiction requirements.
- 10.1.2. Contractor shall obtain any electrical permits required by the local jurisdiction.
- 10.1.3. Contractor shall install electrical Work per the Plans and Specifications.

10.2. SITE-SPECIFIC WORK

[RESERVED]

SECTION 11 – EQUIPMENT SET AND TRANSPORTATION

11.1 GENERAL REQUIREMENTS

- 11.1.1 Contractor shall provide all permits, labor and equipment, including crane and trailers, needed for transporting equipment and materials to site location. This includes all highway permits, overweight permits, flagging, pilot cars, road work or any other additional cost items related to moving the shelter.
- 11.1.2 Contractor shall notify the SPM at least one (1) week prior to the desired shelter pickup date.

11.2 SITE-SPECIFIC WORK

- 11.2.1 Contractor shall transport generator, ATS, and other associated components from ODOT MPB located at 3210 Del Webb Ave NE, Salem, OR 97301 and install at site location. See Section 2 of the SOW.
- 11.2.2 Contractor shall coordinate the generator commissioning with generator manufacturer and 8.1.6 in the SOW.

SECTION 12 – FIRE PROTECTION AND HVAC

12.1. GENERAL REQUIREMENTS

- 12.1.1. For all new HVAC installs, refurbishments, and new building installs, Contractor shall provide HVAC commissioning utilizing a licensed HVAC professional. Contractor shall coordinate scheduling of the commissioning with the CQ and SPM at least 48 hours in advance of HVAC commissioning and provide copies of the commissioning report to the CQ within 24 hours of commissioning and also include copies of the commissioning report in the closeout documents.

12.1.2. [RESERVED]

12.2. SITE-SPECIFIC WORK

- 12.2.1. Contractor shall provide and coordinate HVAC servicing and commissioning for two (2) existing HVAC units on (N) ODOT equipment shelter.
- 12.2.2. Contractor shall provide and install new fire extinguishers in two (2) existing shelters per the Plans.

SECTION 13 – COMMUNICATION EQUIPMENT INSTALLATION AND TESTING

13.1. GENERAL REQUIREMENTS

- 13.1.1. Contractor shall provide sweep test for all installed Coax and Waveguide.
- 13.1.2. Contractor shall provide, on the same day as a sweep test, the test image results of the sweep test for review and preliminary approval by Owner. Contractor shall provide the sweep test data files as the basis for acceptance of the tested installation and payment.
- 13.1.3. Contractor shall provide the sweep test data files as part of the closeout package and make those files available upon request of Owner before issue of the closeout package.
- 13.1.4. Contractor shall provide stainless steel or galvanize all exterior hardware per Specifications Manual requirements.
- 13.1.5. Contractor shall coordinate testing with the SPM at least 48 hours prior to performing sweep tests.
- 13.1.6. All required field modifications to steel must be properly treated with cold galvanizing compound.
- 13.1.7. All exterior zip ties must be stainless steel. Protruding ends of all interior nylon zip ties must be flush cut. All interior zip ties must be black UV resistant nylon.
- 13.1.8. All exposed unistrut and all-thread ends must be covered with appropriately sized rubber caps.
- 13.1.9. All radio, antenna, and microwave installation must be performed in accordance with ODOT Wireless Site Antenna Installation Standards.
- 13.1.10. All tower installations require an inspection by Owner. Contractor shall request this inspection through the SPM and CQ at least one week in advance of desired inspection date.
- 13.1.11. Contractor shall have tower climbers on site during Owner's tower inspection. The tower climbers shall be equipped with the necessary equipment to address deficiencies found during inspection.

13.2. SITE-SPECIFIC WORK

- 13.2.1. Contractor shall install Owner-provided feedlines and associated components to existing antennas.
- 13.2.2. Contractor shall provide and install feedline connectors, ground kits, weather-proofing, and supports as needed to the existing ODOT antennas. Components in section 2.2 will be provided by Owner; any remaining components needed for complete installation are to be provided by Contractor.
- 13.2.3. Contractor shall provide antenna system testing per ODOT requirements for all Antenna System Components.
- 13.2.4. Contractor shall relocate two (2) existing radio racks, radio and other components within the racks from existing ODOT generator shelter to the new ODOT equipment-only shelter within the same compound.

SECTION 14 – CUTOVERS, COORDINATION, DECOMMISSIONING, AND SITE DEMOLITION

14.1. GENERAL REQUIREMENTS

- 14.1.1. All cutovers for power, radios, fuel systems, or other systems that could interrupt service require 48 hours advance notice to the SPM and CQ unless note otherwise below. Contractor shall submit a cutover schedule for approval before cutover to new feedlines or components.
- 14.1.2. Unless otherwise noted, Contractor shall handle all salvaged, repurposed, or waste material in accordance with the plans and Sections 14.2 of this SOW.

14.2. SITE-SPECIFIC WORK

14.2.1. HANDLING OF REMOVED MATERIALS

- 14.2.1.1. Salvaged Materials: Contractor shall deliver the following salvaged materials as noted below. Obtain point of contact for delivery from the SPM and coordinate delivery prior to transport.
 - 14.2.1.1.1. (1) Existing generator and associated components to be returned to ODOT, 455 Airport Road Bldg. M, Salem, OR 97301.
- 14.2.1.2. Repurposed Material: Materials required by this Contract to be removed for reuse at another Site are to be handled in accordance with this Section and Section 14 of this SOW.
 - 14.2.1.2.1. [RESERVED]
- 14.2.1.3. Waste Materials:
 - 14.2.1.3.1. Materials required by this Contract to be removed and not designated as Salvage or Repurposed are waste and become the property of Contractor at time of removal. Contractor shall make arrangements for disposal and shall dispose of waste materials in accordance with all Contract requirements and as approved by ODOT.

14.2.2. [RESERVED]

SECTION 15 – EXISTING CONDITIONS AND DOCUMENTATION

If designated below as Applicable, the related documents are available for Bidders to review. Please contact Agency Contract Representative to arrange a date and time.

A. Construction Pre-Construction Memo:

- Not Applicable
- Applicable
- Attached to bid package
- To be provided before start of Work
- Comments: N/A

B. Environmental Reference Documents:

1. Environmental Site Assessment

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

2. NEPA Report

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

3. FAA Approval

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

C. Engineering Study Reference Documents:

1. Tower Structural Analysis (including the Foundation Design)

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

2. Shelter Structural Analysis

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

3. Tower Mapping

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

4. Soil Resistivity Report

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

5. Geotechnical Evaluation

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

6. Survey

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

D. Leasing Reference Documents:

1. Fully Executed Lease

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

E. Utility Reference Documents:

1. Easement Access

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

2. Utility Coordination Report

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

F. Permitting Reference Documents

1. Zoning Approval

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

2. Land Use Approval

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

3. Building Permit Application

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

G. F73314 Antenna Migration Parts List & Antenna Requirements

Not Applicable

Applicable

Attached to bid package

To be provided before start of Work

Comments: N/A

F73314 Agency Plains Antenna Migration

QTY.		NOTES
5	3M Super 33+ Electrical Tape (3/4" x 66")	
	Andrew 5004S-MTD Insulated Top Bracket for Colinear Antenna	
	Andrew CSG12-12B2U Heliax Ground Kits (1/2" Heliax)	
14	Andrew CSG78-12B2U Heliax Ground Kits (7/8" Heliax)	
6	Andrew LDF4-50A 1/2" Heliax	
345	Andrew LDF5-50A 7/8" Heliax	
	Band-it AA3138 Stainless steel cable tie 12" X 3/8" 100# strength	
	Kathrein 523221 Panel Antenna	
	Kathrein 55292 Dipole Antenna	
	Kathrein 552921 Dipole Antenna	
	Kathrein CL6-450B Log Periodic Antenna	
	Kathrein CL7-150URM Log Periodic Antenna (Max mount 2" pipe)	
	Kathrein K61120 Mounting Kit for Panel Antenna (2 1/2-4 1/2" mount)	
	Kathrein MKPS-1 Mount for CL6 Antenna (2" pipe)	
	Kathrein MKPS-2 Mount for CL6 Antenna 2 1/2" pipe)	
	Kathrein MKPS-3 Mount for CL6 Antenna (3 1/2" pipe)	
	Kathrein MKPS-4 Mount for CL6 Antenna (4" pipe)	
	Kathrein MKPS-5 Mount for CL6 Antenna (4 1/2" pipe)	
	Polyphaser IS-B50LN-C1 Surge suppressor N Female	
	Polyphaser VHF50HD Surge suppressor DIN Female	
	PPC CC-DF-L5 7/8 DIN Female connector for Andrews LDF-5 Heliax	
	PPC CC-DM-L4 DIN Male connector for Andrews LDF-4 Heliax	
	PPC CC-DM-L5 7/8 DIN Male connector for Andrews LDF-5 Heliax	
	PPC CC-NM-L4 1/2N Male connector for Andrews LDF-4 Heliax	
	PPC UXP-DF-12 Universal DIN Female connector for 1/2" Heliax	
3	PPC UXP-DM-12 Universal DIN Male connector for 1/2" Heliax	
	PPC UXP-NF-12 Universal N Female connector for 1/2" Heliax	
	PPC UXP-NM-12 Universal N Male connector for 1/2" Heliax	
4	PPC UXP-DF-78 Universal DIN Female connector for 7/8" Heliax	
9	PPC UXP-DM-78 Universal DIN Male connector for 7/8" Heliax	
	PPC UXP-NF-78 Universal N Female connector for 7/8" Heliax	
3	PPC UXP-NM-78 Universal N Male connector for 7/8" Heliax	
2	PPC WPS-4A Weather Hood	
3	PPC WPS-5 Weather Hood	
2	PPC WPS-DF Weather fitting	
	RF Industries RFD-1604-2I Din connector for LMR-400 cable	
	RFI 91-00-114 Antenna Clamp / New Part #UC-13	
	RFI COL-54-160 "Bluebird" antenna	
	SCALA PDL2-72/50 147-174 Power Divider 75/25%	
	SCALA PDL2-55/50/ 147-174 Power Divider 50/50%	
	Sinclair Technologies Clamp-005 Antenna Clamp (SD series)	reuse existing
	Sinclair Technologies Clamp-006B (SD-R series)	
	Sinclair Technologies Clamp-006C (HD 4 bay series)	
	Sinclair Technologies SD210-HF2P2LDF(D00) 1 bay loop dipole antenna 1/2 λ Heavy Duty	
	Sinclair Technologies SD210-HF2P4LDF(D00) 1 bay loop dipole antenna 1/4 λ Heavy Duty	
	Sinclair Technologies SD210R-SF2P120LDF(D00) 1 bay loop dipole reflector antenna	
	Sinclair Technologies SD210-SF2P2LDF(D00) 1 bay loop dipole antenna 1/2 λ	
	Sinclair Technologies SD210-SF2P4LDF(D00) 1 bay loop dipole antenna 1/4 λ	reuse existing
	Sinclair Technologies SD212-HF2P2LDF(D00) 2 bay loop dipole antenna 1/2 λ Heavy Duty	
	Sinclair Technologies SD212-HF2P4LDF(D00) 2 bay loop dipole antenna 1/4 λ Heavy Duty	
	Sinclair Technologies SD212R-SF2P120LDF(D00) 2 bay loop dipole reflector antenna	
	Sinclair Technologies SD212R-SF2P60LDF(D00) 2 bay loop dipole reflector antenna	
	Sinclair Technologies SD212R-SF2P90LDF(D00) 2 bay loop dipole reflector antenna	
	Sinclair Technologies SD212-SF2P2LDF(D00) 2 bay loop dipole antenna 1/2 λ	
	Sinclair Technologies SD212-SF2P4LDF(D00) 2 bay loop dipole antenna 1/4 λ	
	Sinclair Technologies SD235-SF2PALDF Multo Dipole Antenna	
	Telewave ANT150F2DIN 2.5 dB Omnidirectional Antenna	reuse existing
	Valmont 92093 Antenna Mount for Q Tower	
	Valmont ADP238-U Antenna mounting Bracket (for CL7-Log) MTSMT-397	
	Valmont ADP-U Antenna Mounting Bracket (15" standoff)	
3	Valmont CH120 Coax Hanger Hardware	
3	Valmont Hoist Grip GRIP78-C	
	Valmont P30174 Pipe (2 7/8" X 7')	
	Valmont P3084 Pipe (2 7/8" X 14')	
	Valmont R5 Antenna Mounting Bracket (flush for Pirod towers)	
	Valmont SAM-U Stiff arm attachment	
	Valmont SR121M-K (5 pack) Cushions 2X1/2" and 1X7/8"	
	Valmont SR122 M-K (5 pack) Cushions 1X1/2" and 2X7/8"	
	Valmont SR122-K (5 pack) Cushions 1/2" X 2 hole and Hardware as needed per install specs.	
	Valmont SR123-K (5 pack) Cushions 1/2" X 3 hole and Hardware as needed per install specs.	
	Valmont SR124-K (5 pack) Cushions 1/2" X 4 hole and Hardware as needed per install specs.	
1	Valmont SR12-K (5 pack) Cushions 1/2" X 1 hole and Hardware as needed per install specs. AND294684	
4	Valmont SR782-K (5 pack) Cushions 7/8" X 2 hole and Hardware as needed per install specs. AND 294698	
3	Valmont SR783-K (5 pack) Cushions 7/8" X 3 hole and Hardware as needed per install specs. AND294699	
	Valmont SR784-K (5 pack) Cushions 7/8" X 4 hole and Hardware as needed per install specs.	
10	Valmont SR78-K (5 pack) Cushions 7/8" X 1 hole and Hardware as needed per install specs. AND294697	
	Valmont STK1 Round Leg Cushion Standoff Kits (3/4-1 1/2" leg) (10 pack) AND294555	
1	Valmont STK2 Round Leg Cushion Standoff Kits (1 1/2-3" leg) (10 pack) AND294556	
	Valmont STK3 Round Leg Cushion Standoff Kits (3-4" leg) (10 pack) AND294557	
1	Valmont STK4 Tower Standoff Kits (3-6" leg) AND294561	
	Valmont STK-U Mounting Bracket Brace (for USF brackets) PIPE 2 3/8" x 12'6"	

8	Valmont SW75 Stainless Hardware kit AND294586	
	Valmont TAM-2U Antenna Mounting Bracket (1' standoff, brackets only)	
	Valmont TAM-LL Large Leg Adapter	
	Valmont TAP472 Antenna Mounting Bracket (offset mount for Pirod and Rohn G towers)	
	Valmont TAP-NP Tubular mount with no pipe	
	Valmont TAP-PM Pipe mount hardware	
	Valmont TCHM1-L Pole Chain Mount	
	Valmont USF-2U Antenna Mounting Bracket (2' standoff)	reuse existing
	Valmont USF-3U Antenna Mounting Bracket (3' standoff)	
	Valmont USF-4U Antenna Mounting Bracket (4' standoff)	
2	Valmont ADAP Angle adapter (10 pack) AND31768A	
	Valmont E1448 Entry Panel 2X4" AND204673-2A	
	Valmont E220 Entry Panel 1X4" AND204673-1	
3	Valmont B400 4" Entry Boot AND294573	
	Valmont BA783 4" Entry Boot and Cushion AND294573	
	Wireless Solutions AR-36-175-0-L Cable Tie Assortment	
4	Wireless Solutions FT-3430 Waterproofing Silicone tape	
2	Wireless Solutions WK-U Universal Weatherproofing Kit	
	Valmont DCP18K 1-1/2" to 5" Pipe to Pipe Clamp	
	Valmont P2150 Bulk Pipe (2 3/8" X 12.5')	
	Valmont Universal Side Arm Mount USA3 3' Side arm Mounts to 1-3/4" to 8-5/8"	
1	Times Microwave LP-STR-DFE 800-2500 Mhz Surge Protector	
1	Commscope F4A-PDMNR-3M Superflex Jumper cable	

Site Name	Agency Plains	Agency Plains	Agency Plains	Agency Plains
Agency	ODOT	ODOT	OSP	OSP
System	D 10 Fill	D 10 Donor	Bend	M/W
mode of operation	TX/RX	TX/RX	TX/RX	TX/RX
Antenna Type	SD210-SF2P4LDF	SD210-SF2P4LDF	ANT150-F2	6' M/W Grid
Height	75	104	23	80
Coax size	7/8"	7/8"	7/8"	7/8"
Total Estimated Heliax run	110	140	60	30' Extend existing Heliax into new building, replace Heliax clips with cushions.
Leg of tower	A	A	B	B
Tower specifics at mounting location				
Direction / Azimuth (True North bearing)	310	310	146	
Mounting Brackets / Offsets	USF-2	USF-2	USF-2	

Site Antenna Install Standards

For the purposes of this document, “**approved**” means reviewed and confirmed as acceptable by a member of the ODOT/OSP Wireless Section.

Installation Coordination

- Installation schedules will be scheduled and coordinated through the ODOT/OSP Wireless group.
- A Wireless Technician will be assigned as a Project Liaison and Quality Control point for a specific installation location.
- For installs that require antenna or coax replacements that take a radio system out of service, coordination is required at least 2 days prior to work scheduling to allow for notification to system users.
- For installs that require antenna or coax replacements that take a radio system out of service, a work plan will be developed before work begins to minimize the out of service time for the affected radio system. The Wireless group will participate in developing the work plan.

Antenna Mounting

- Antenna(s) shall be installed per manufacturer instructions using the manufacturer’s recommended brackets. Re-use of old brackets is not allowed.
- All antennas, brackets, and mounting hardware shall be mounted in a manner that ice or wind loading will not twist the mounting system.
- All antennas will be mounted in the vertical polarity unless otherwise stated and will be plumb in all planes.
- If an antenna is more than fifteen feet long, an RF-transparent top brace (such as CommScope DB5004s-MTD) will be used, unless manufacturer specifications state a brace is not needed. Some sites will be required to have a top brace. These sites will be stated as such in the Statement of Work.
- The jumper from the main coax to the antenna will be 1/2 Andrews, or an approved equivalent.
- If it is likely the antenna will be subject to damage by falling ice, an ice shield will be installed.
- Omni directional antennas mounted below the top of a tower will be mounted on a minimum 3’ standoff mount with stiff arm. Mount will be rated for the antenna installed.
- Antennas located on a sloping leg shall be installed with a tapered pipe mount.
- All hardware shall be tightened to manufacturers torque specifications.

Coax Support & Grounding

- All coax will be supported by rubber cushions using proper hardware. Round, angle, or other required adapters will be used where cables are not routed on the cable ladder. Maximum distance between hangers shall be 6 feet.
- Cushions that support multiple runs of coax are recommended for all installs.
- All vertical runs of coax on the tower will be on cable ladder, unless specified by Wireless Group.
- The portion of coax runs not on a cable ladder shall be located on the **underside** of tower members, or in a manner to provide maximum protection from falling items, crushing, abrasions, and other hazards.
- All coax shall be hoisted with the use of a cable hoist grip or similar method. In no event shall a coax be hoisted by a connector.
- Radius bends exceeding manufactures specifications, kinks, dents, and compromised coax jacketing are not acceptable.
- Coax will be grounded near the antenna, at the base of the tower, and at the building entry port.
- If the vertical run of coax is longer than seventy feet, additional ground kits will be installed at regular intervals. Maximum distance between grounds is 70 feet.
- The coax ground kit at the antenna and any mid-point of the coax run shall be connected to the tower by a stainless steel or galvanized angle adapter.
- The coax ground kit at the tower base will be connected to a copper bus bar if equipped or by a stainless steel or galvanized angle adapter.
- The ground kits at the building entry port will be connected to the copper entry port ground bus.
- All ground bus wiring shall be routed towards the ground (downwards) with no sharp corners, bends, or loops.
- All coax between the tower and the building will be routed under and protected by an ice bridge.
- Any site where the tower is bolted to or directly adjacent to the building without an ice bridge will have a “Drip Loop” to allow moisture to drain before the entry port.
- Any threaded rod, bolts, or strut material (uni-strut) used will be galvanized or stainless steel. All associated hardware will be stainless steel, nylon, aluminum, or hot-dip galvanized steel.
- All ground kits on the building entry port will use 3/8” two-hole lugs with no-ox compound between the lug and copper bus bar. Polyolefin heat-shrink tubing will be installed over the crimp area and extend one inch past exposed wire onto the insulation.
- All ground kits on the tower will have single-hole 3/8 lug with polyolefin heat-shrink tubing over the crimp area extending one inch over the insulated wire.
- All lugs used on ground kits will be tin-plated copper.
- Ground kits shall be Andrew CSG78-12B2U or CSG12-12B2U, or approved equivalent.
- Any vertical wraps of electrical tape should be applied so the final outer layer covers the entire area, starting from the bottom and ending at the top.

- Cable ties, or Ty-Raps, are only approved for securing jumper cables from antennas to the main coax. All cable ties shall be UV rated, and have a minimum breaking strength of 150 lbs.

Coax, Coax Connectors and Weatherproofing

- For total runs over fifty feet, coax will be Andrew LDF5-50 or an **approved** equivalent. Otherwise, Andrew LDF4-50 or an **approved** equivalent can be used.
- Coax connector will be PPC compression connector. If no PPC connector is made for the application, an **approved** Andrew or equivalent connector can be used.
- Installers shall obtain certification by PPC on the proper installation of PPC connectors and shall use approved PPC cable prep and connector installation tools.
- The connector between the antenna jumper and the main line will be DIN type.
- Unless the application would require an adapter, a DIN connector is will be used on the antenna.
- All coax runs entering a building will be connected to a Polyphaser that is rated for the frequency and wattage of the connected equipment. All Polyphasers will have N-female connectors and will be grounded to the entry port ground buss. Any transmission lines shall not be spliced.
- All antenna cable(s) shall be uniquely color coded at each end, with each tape wrap designed for this purpose, and that is a minimum of three (3) inches wide.
- Each antenna line will be uniquely identified at the building entrance with the tower height and leg the cable terminates. This label will be affixed to the coax, and will be weatherproof.
- Outdoor coax connections will be sealed in the following manner:
 - o For PPC connectors use of PPC weather hoods is required. WPS-5, WPS-4A, and WPS-DF are commonly used.
 - o For other than PPC connectors, a wrap of electrical tape **with adhesive facing outward** will be placed covering the connection.
 - o Butyl will then be applied over the connection, and a minimum of two adhesive-inward wraps of electrical tape—alternating top-down to bottom-up, or vice versa—will be applied, covering the entire area.
 - o Regardless of connector type, a final adhesive-inward wrap of electrical tape will be applied, starting at the bottom and ending at the top, covering the entire area. This will result in one adhesive-inward wrap for PPC connectors, and a minimum of three wraps for non-PPC connectors. After the wrap is completed, electrical tape will be applied around the top of the wrap two or three times, putting minimal tension on the tape as it comes off the roll.

Additional Antenna Installation Standards To Be Adhered To

- All coax runs entering a building will be connected to a Polyphaser that is rated for the frequency and wattage of the connected equipment. All Polyphasers will have N-female connectors and will be grounded to the entry port ground buss.

- All work shall be performed in a neat and professional workmanship like manner. Ensure that HARRIS Workmanship standards are observed and followed, contained in Harris Tower Requirements and General Specifications Guidelines, and Practices Installation Manual LBI-39185
- All trash generated from this antenna installation / replacement scope of work shall be removed from the work site daily by the installation subcontracting company, and disposed of properly and legally.
- At the end of the installation work on site the entire area inside and outside the shelter will be carefully “policed” for any install materials, to include, but not limited to; nuts, bolts, washers, boxes, trash, trimmings from cables or wire and other items that were not present at start of work.
- The antenna tower site and shelter shall be left as clean as it was before start of work.
- The actual installation shall be in accordance with site working drawings and site outlines provided addressing antenna location on the tower, position and orientation. These will be representative of the final drawings provided by Harris engineering.
- Company is to assist in providing information as required to the Project Manager so "As built" documents and system drawings can be supplied to Customer. Documentation to include close-up photographs of all antennas, mounts, and weatherproofed connections.

Antenna System Testing

- All Antenna system tests will be performed by, or supervised by a Wireless group technician.
- After the coax run is installed, it will be terminated with 50 Ω load and swept with an Anritsu Site Master or equivalent to test for return loss, constant impedance through bends and connectors, cable fault, and for any other defects. The sweep test images shall be saved in electronic format, presented to, and **approved** by the Wireless Group.
- Once the feed line has been swept, the 50 Ω termination will be removed, and the antenna attached to the feed line. Another sweep test for return loss will be run from 150 MHz to 160MHz (or appropriate frequency band). The purpose of this sweep is to check the frequency response of the antenna. These sweep test images shall be saved in electronic format, presented to, and **approved** by the Wireless Group.
- Antennas, antenna mounts, coax connectors, coax mounting, ground kits, and weatherproofing are subject to inspection by Wireless Group Technicians.
- Perform a four (4) hour pressure test of the waveguide and antenna system.
 - Preasurize the system to between 3 and 5 psi and shut off the gas distribution manifold valve to antenna being tested.
 - Record the starting pressure in pounds per square inch (psi).
 - Record the finishing pressure (psi) after four (4) hours.
- A pressure loss of ≤ 1 psi is within tolerance.

**Oregon Department of Transportation
Wireless Communications Division
LMR Antenna System Standard Method
of Testing Procedures.**

Draft- 9-5-2013 R. Wilson

This is a draft document to set a standard test procedure for testing of new LMR Antenna System installations.

To ensure a quality installation of LMR Antenna Systems and to present a standardized set of testing parameters, the ODOT WCD follows this Standard Method of Testing Procedures. This procedure is to be followed in the order presented to ensure accurate and repeatable test results that can be used to verify a proper install and to provide reference data for future testing.

Testing Equipment-

The Standard test equipment preferred for all testing is the Anritsu Site Master 331 or functional equivalent. Test equipment used shall be in good working order and have current certificates of calibration for all portions of the test setup including any terminations used for testing. Testing configurations are set to ensure enough data collection to provide good “granularity” of test results. All test measurements will contain a minimum of 500 data points, and will be saved in a raw data format. All test results will be identified by the site name, the designator tag at the cable entry port, or other relevant marker, as well as the service of the line being tested. Testing equipment shall be properly configured for the brand and type of Feedline being tested. Test personnel shall be competent in the use of the test instrument.

Distance to Fault (DTF) testing-

A standard set of configurations will be used to test LMR VHF-UHF antenna systems. There is a standard configuration for feedline lengths 1-250’ and one for feedline lengths of 250 to 600’. These setting will provide DTF resolution of ~.5’ and 1.25” respectively. The following settings are based on the Anritsu S331D Site Master. Other test instruments will match these settings to the best ability of the instrument. These tables will be calibrated and stored as a preset in the instrument. Recalibration is necessary any time calibration limits are exceeded. All measurements will be made in the Distance to Fault- Return Loss format.

Feedlines from 1-250’ DTF parameters		Feedlines from 250-600’ DTF parameters
D1	0’	0’
D2	As needed to display line length	As needed to display line length
F1	100 MHz	100 MHz

F2	1 GHz	450 MHz
Resolution	517 pts	517 pts
Windowing	Rectangular	Rectangular
Cable	Select for feedline in use	Select for feedline in use
Prop Vel	Auto selected by instrument	Auto selected by instrument
Cable Loss	Auto selected by instrument	Auto selected by instrument
Display Amplitude	Top- 0 dB Bottom- 60 dB	Top- 0 dB Bottom- 60 dB

Return Loss (RL) testing-

A standard set of configurations will be used to test LMR VHF-UHF antenna systems. There is a standard configuration VHF and one for UHF. The following settings are based on the Anritsu S331D Site Master. Other test instruments will match these settings to the best ability of the instrument. These tables will be calibrated and stored as a preset in the instrument. Frequency values represent the widest bandwidth of the antennas commonly used by the WCD. Recalibration is necessary any time calibration limits are exceeded. All measurements will be made in the Distance to Fault- Return Loss format.

	VHF parameters	UHF parameters
D1	0'	0'
D2	As needed to display line length	As needed to display line length
F1	138 MHz	400 MHz
F2	174 MHz	512 MHz
Resolution	517 pts	517 pts
Windowing	Rectangular	Rectangular
Cable	Select for feedline in use	Select for feedline in use
Prop Vel	Auto selected by instrument	Auto selected by instrument
Cable Loss	Auto selected by instrument	Auto selected by instrument
Display Amplitude	Top- 0 dB Bottom- 50 dB	Top- 0 dB Bottom- 50 dB

Test #1- Feedline Distance to Fault Open

1. The appropriate DTF template will be used based on feedline length.
2. The instrument will be set to the DTF-Return Loss mode.
3. DTF measurement will include the feedline and any jumper at the antenna end of the line.
4. DTF measurement will be made with a calibrated Open.
5. A Marker will be set with the "Marker to Peak" function.
6. This test will be saved in raw data format with the cable designator plus DTF OPEN. (ie- SITE NAME RED3 ODOT DTF OPEN)

Test #2- Feedline Distance to Fault Load

1. The appropriate DTF template will be used based on feedline length.
2. The instrument will be set to the DTF- Return Loss mode.

3. DTF measurement will include the feedline and any jumper at the antenna end of the line.
4. DTF measurement will be made with a calibrated 50 Ohm Load.
5. A Marker will be set with the "Marker to Peak" function.
6. This test will be saved in raw data format with the cable designator plus DTF Load. (ie- SITE NAME RED3 ODOT DTF LOAD)

Test #3- Return Loss to Load

1. The appropriate VHF or UHF template will be used based on system Frequency.
2. The instrument will be set to the FREQ-Return Loss mode.
3. RL measurement will include the feedline and any jumper at the antenna end of the line.
4. RL measurement will be made with a calibrated 50 Ohm Load.
5. A Limit will be set with the "Limit" function at 30 dB.
6. Test results should exceed the limit line.
7. This test will be saved in raw data format with the cable designator plus DTF Load. (ie- SITE NAME RED3 ODOT RL LOAD)

Test #4- Cable Loss to Open

1. The appropriate VHF or UHF template will be used based on system Frequency.
2. The instrument will be set to the FREQ-Return Loss mode.
3. RL measurement will include the feedline and any jumper at the antenna end of the line.
4. RL measurement will be made with a calibrated Open.
5. The Display Amplitude will be set to 0 to 5 dB.
6. This test will be saved in raw data format with the cable designator plus DTF Load. (ie- SITE NAME RED3 ODOT CL OPEN)

Test #5- Return Loss to Antenna

1. The appropriate VHF or UHF template will be used based on system Frequency.
2. The instrument will be set to the FREQ-Return Loss mode.
3. RL measurement will include the feedline and any jumper at the antenna end of the line, and the antenna.
4. A Limit will be set with the "Limit" function at 14 dB. For SCALA Panel antennas, K523221, the Limit will be set to 23 dB.
5. Test results should exceed the limit line.
6. This test will be saved in raw data format with the cable designator plus DTF Load. (ie- SITE NAME RED3 ODOT RL SYSTEM)

Test #6- Feedline Distance to Fault System

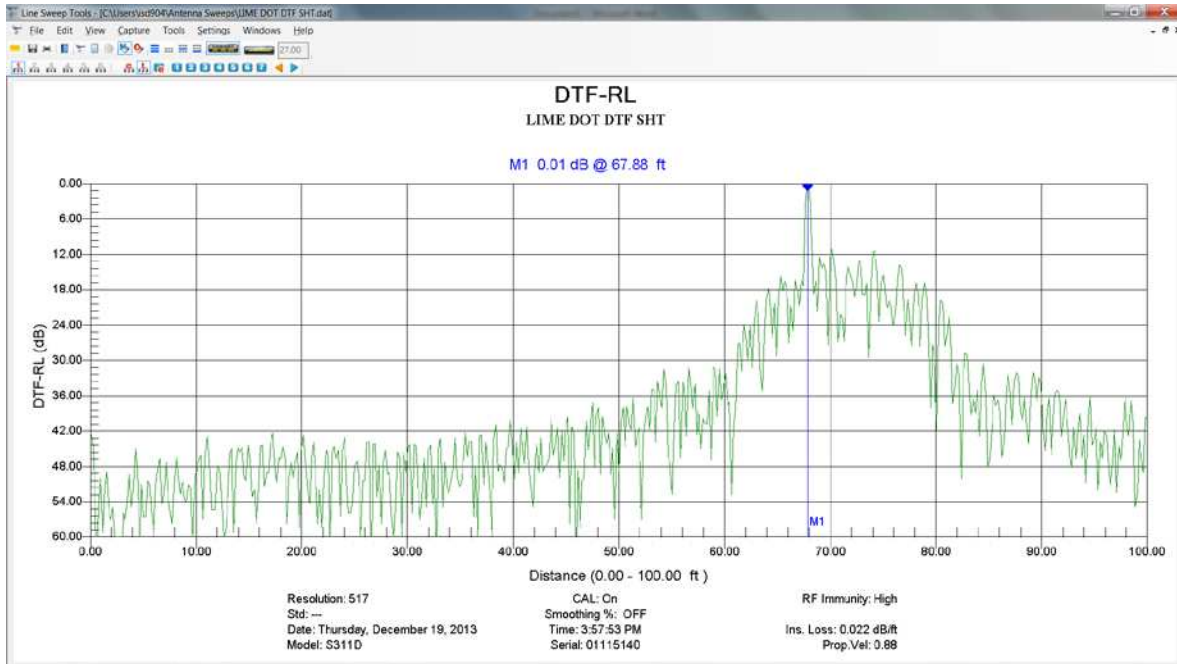
1. The appropriate DTF template will be used based on feedline length.
2. The instrument will be set to the DTF- Return Loss mode.
3. DTF measurement will include the feedline, any jumper at the antenna end of the line, and the antenna.
4. A Marker will be set with the "Marker to Peak" function.

5. This test will be saved in raw data format with the cable designator plus DTF Load. (ie- SITE NAME RED3 ODOT DTF SYSTEM)

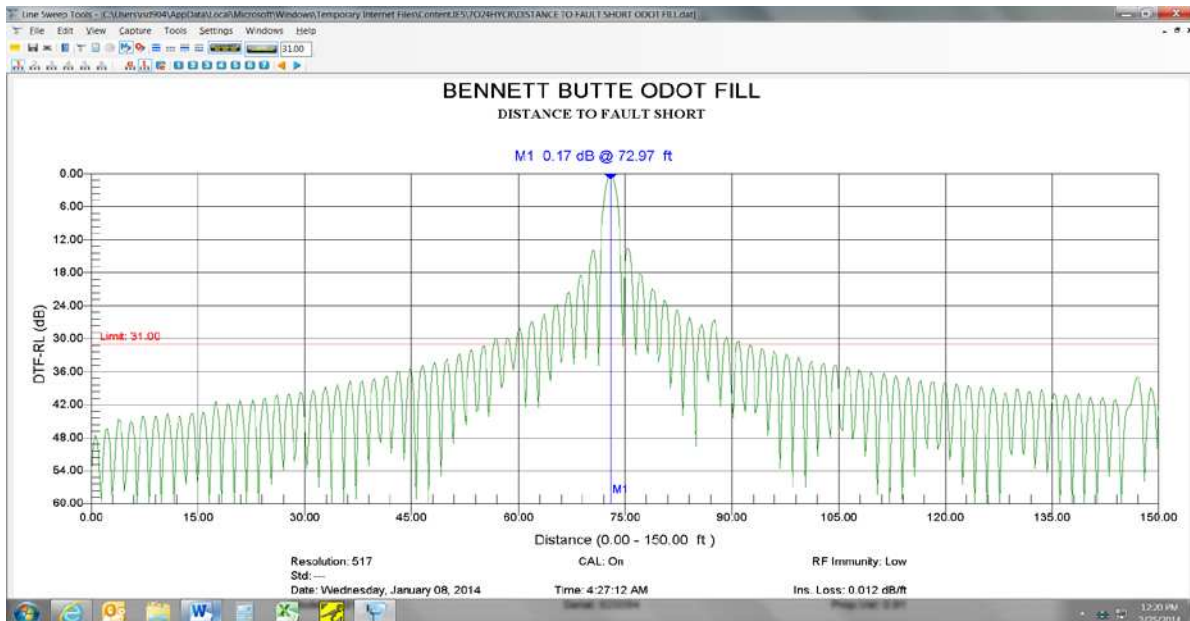
ODOT SMOTP Appendix

Anritsu Sweep display examples

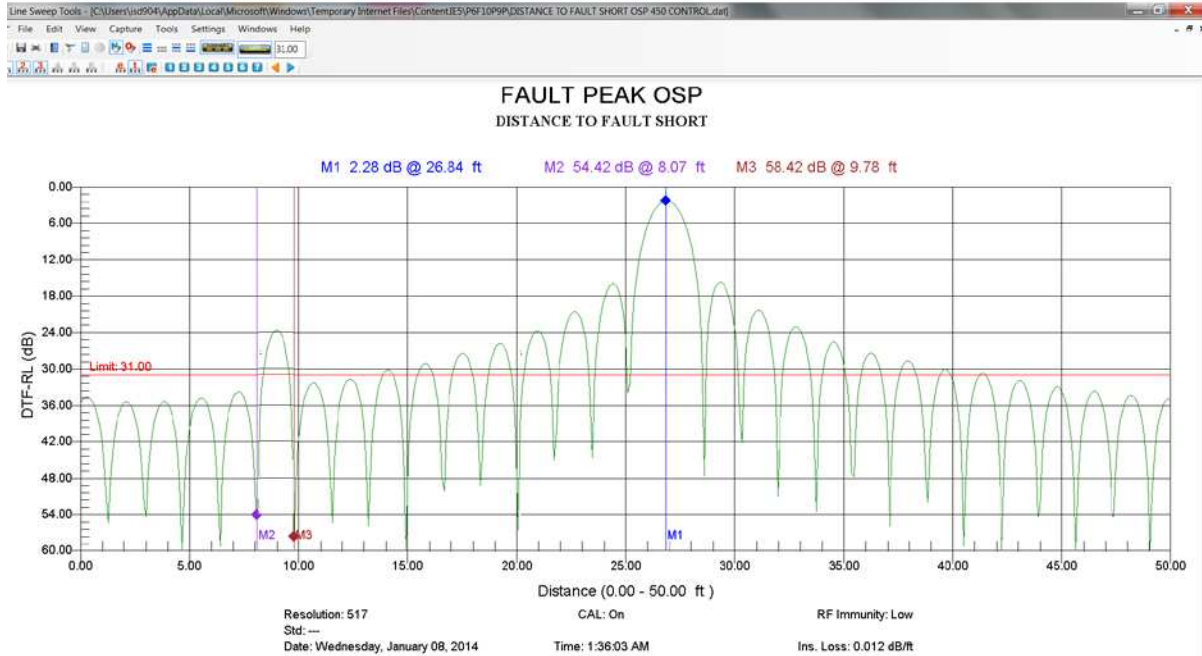
Feedline Distance to Fault Open- Acceptable Sweep- Sweep shows gradual rise up to the end of the Feedline (open or short). The display shows the end of the cable at 67.88'.



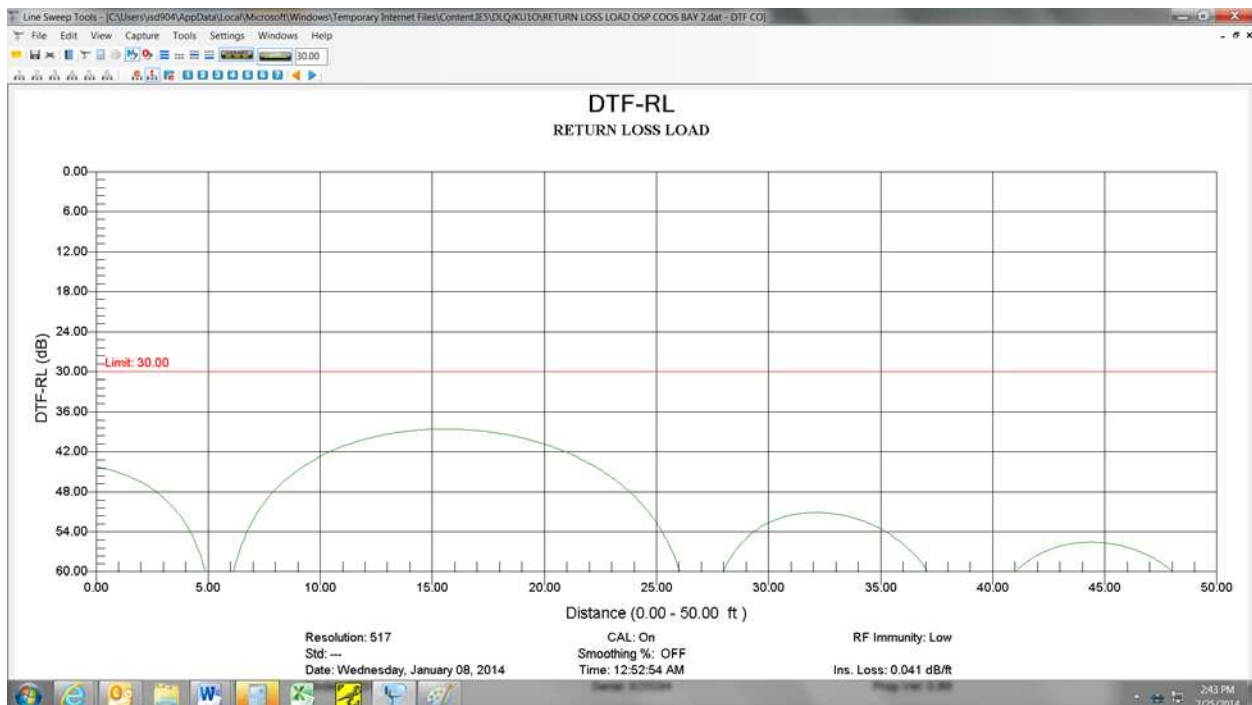
Feedline Distance to Fault Open - Acceptable Sweep- Sweep shows gradual rise up to the end of the Feedline (open or short). The display shows the end of the cable at 72.97'. Notice that "smoothing" is used by the Anritsu on this display.



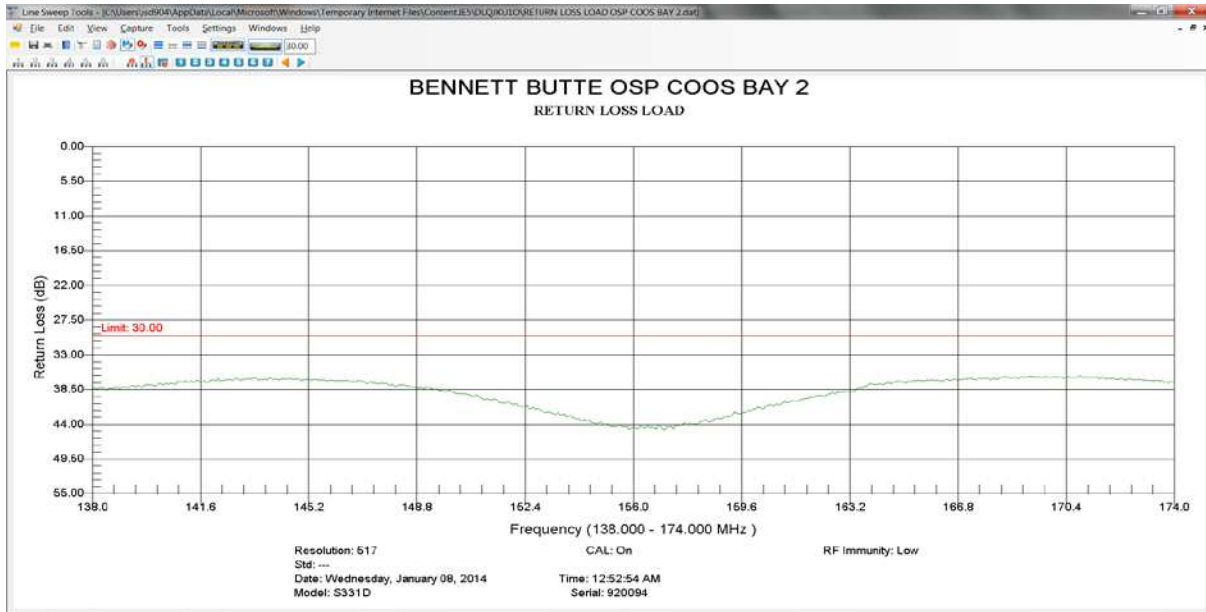
Feedline Distance to Fault Open- Suspect Sweep- Sweep shows gradual rise up to the end of the Feedline (open or short) EXCEPT for the high peak a~9'. This could be a kink, bad connector, etc in the line. Further investigation including inspecting the cable around that distance from the test device is necessary.



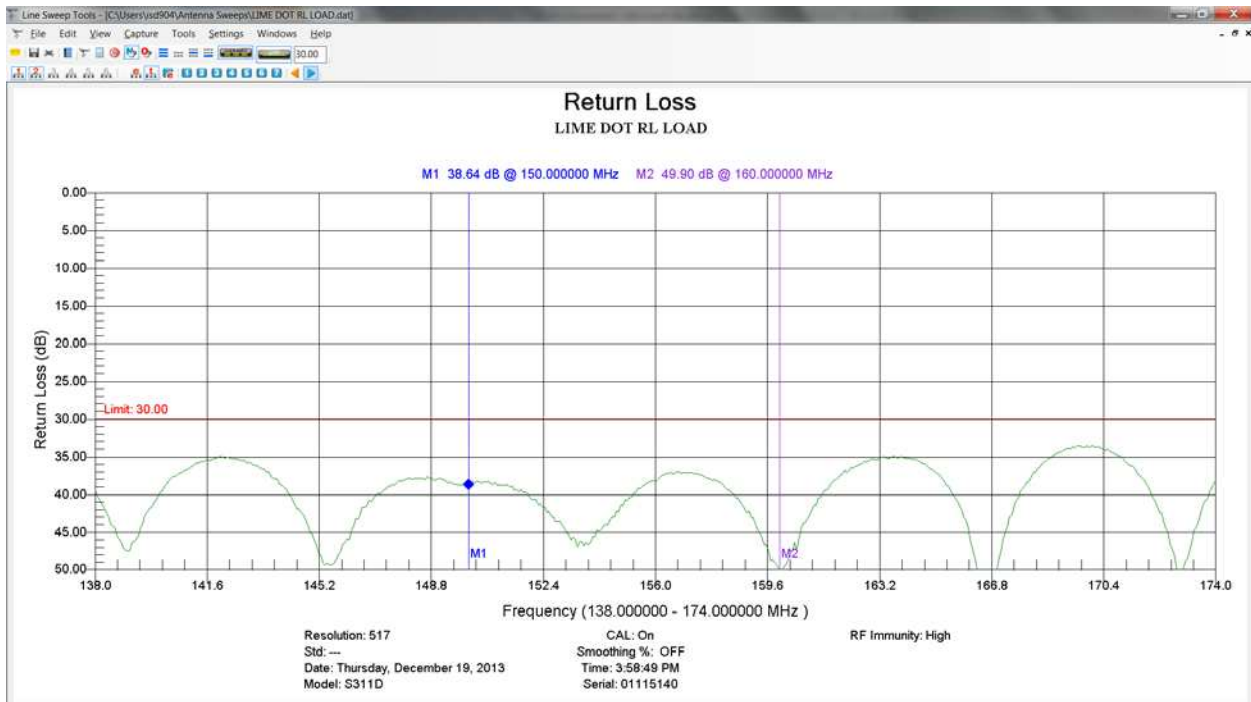
Feedline Distance to Fault Load- This sweep is for future use. It will be very similar to the DTF (short/open) reading, but will be affected the return loss of the load.



Feedline Return Loss Load- Acceptable Sweep- RL is BELOW 30 dB, and the trace is relatively smooth with no wild deviations.

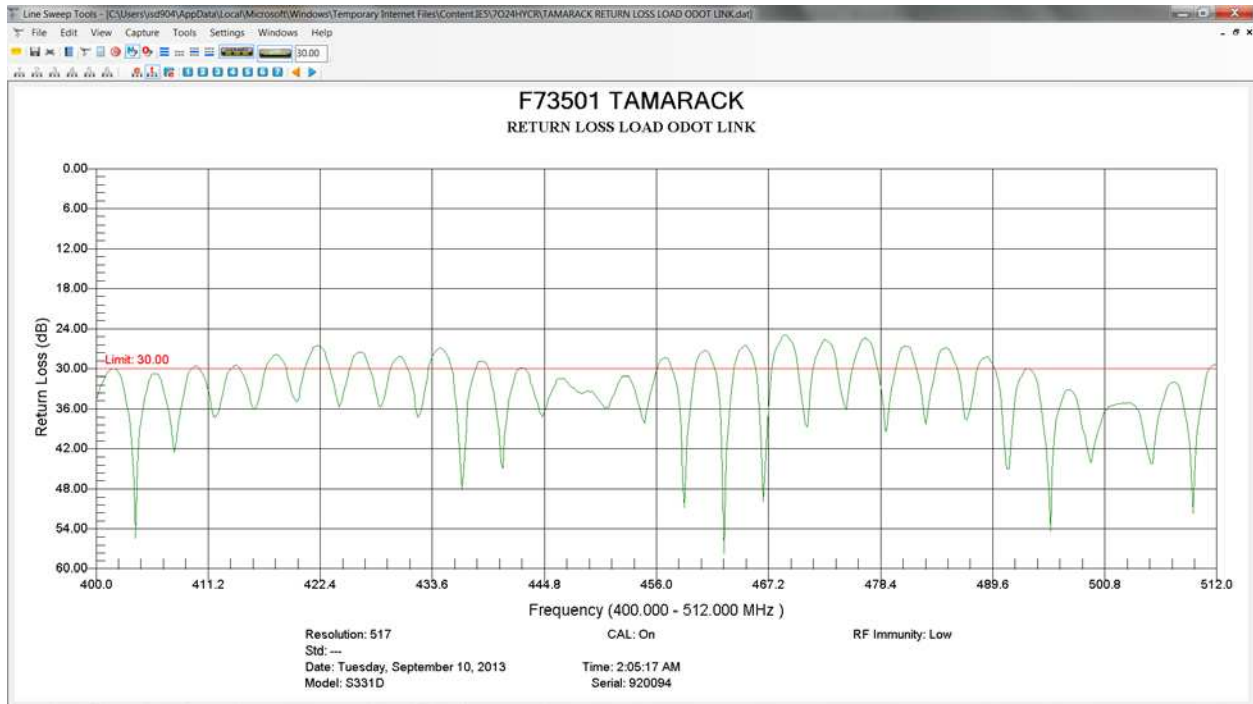


Feedline Return Loss Load- Acceptable Sweep- RL is BELOW 30 dB, there are deviations. Feedline length can impact the return loss vs. frequency.

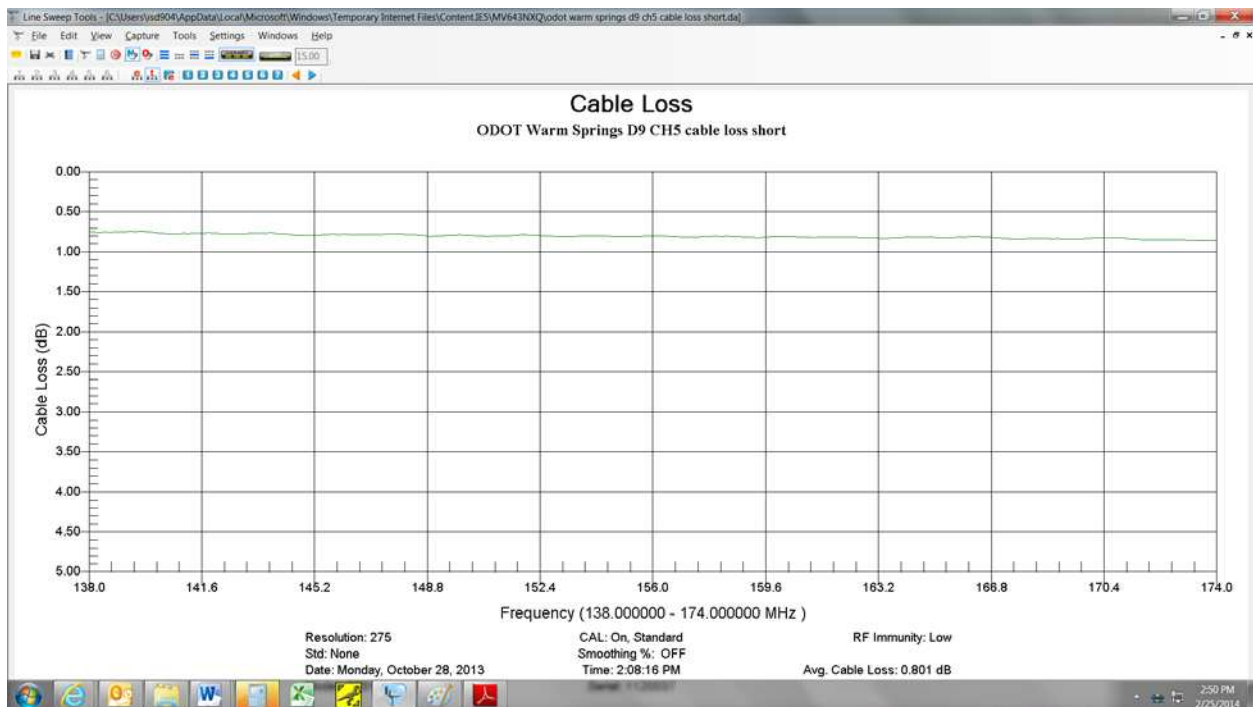


Feedline Return Loss Load- UNACCEPTABLE Sweep- RL is not below 30 dB, there are serious deviations in the RL.

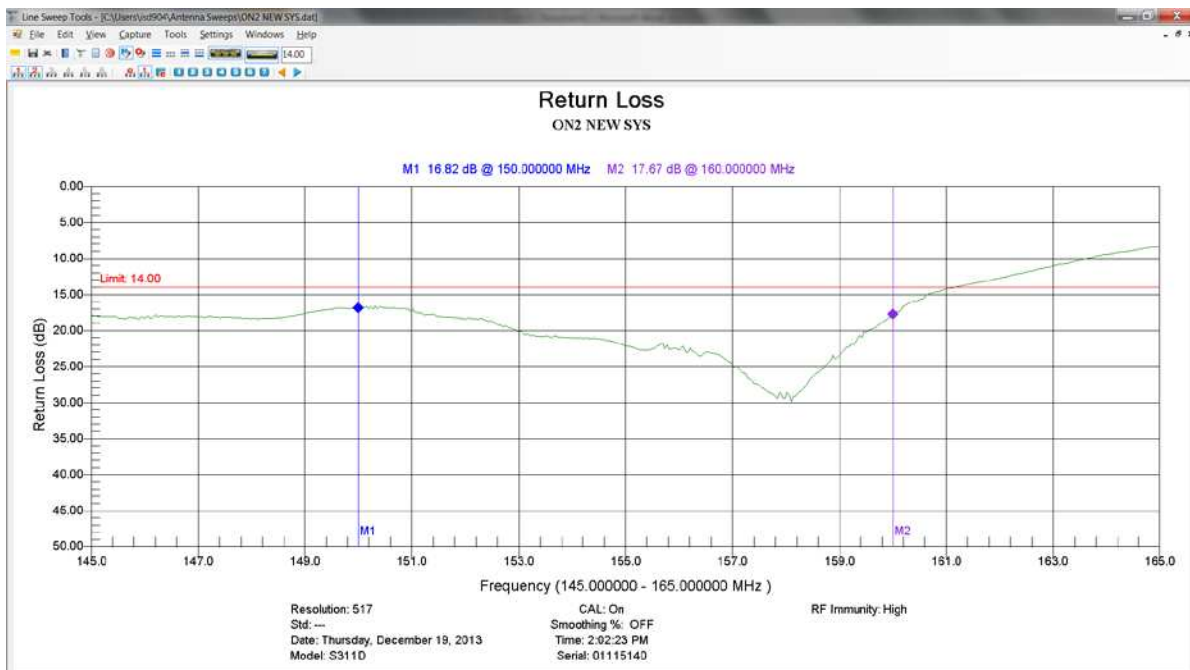
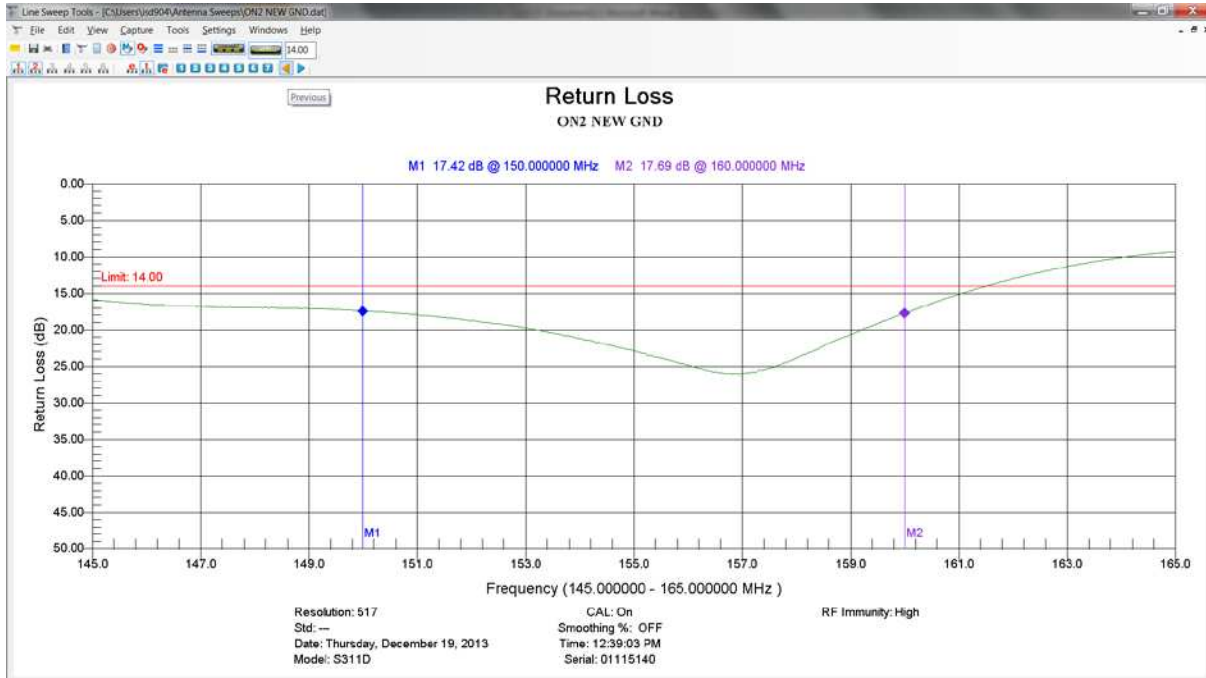
Loos to



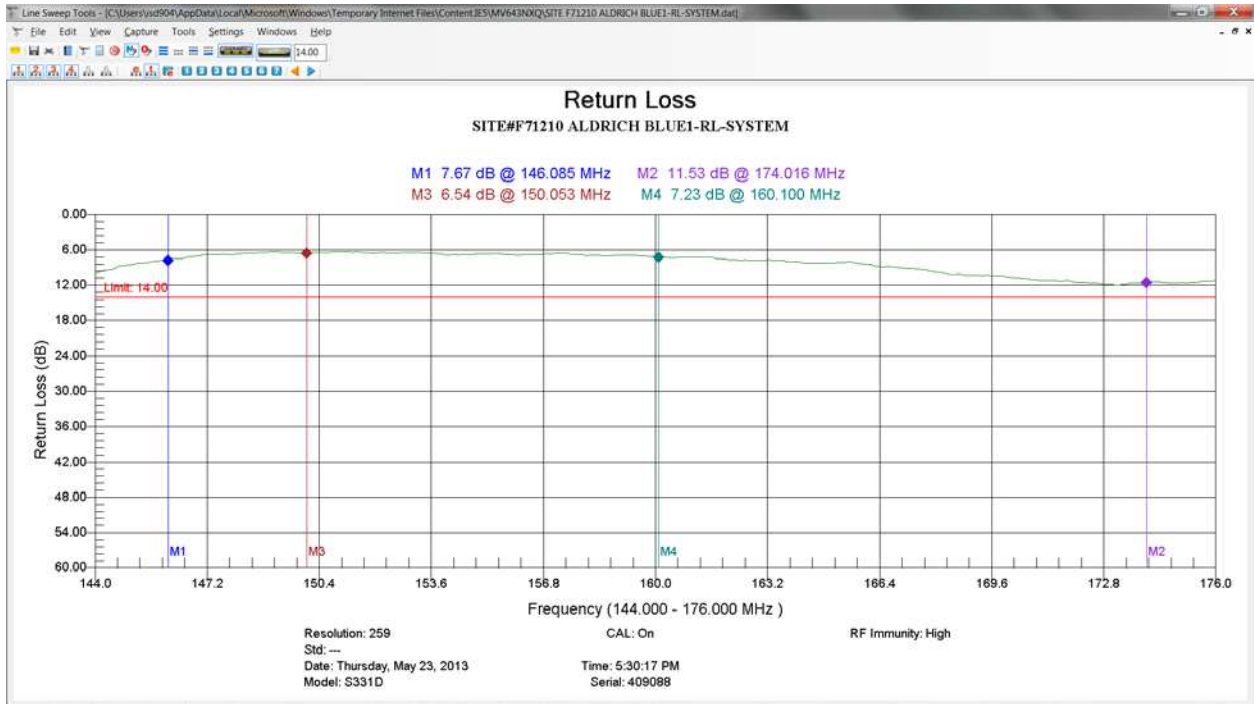
Feedline Cable Loss to Open (or short)- Acceptable sweep- This is a sweep that needs to be looked at carefully. This is a 7/8" Heliax that is ~100' long, with a 1/2" jumper at the end. Factory data says .449 dB of loss for 100' at 150 MHz, adding 4 connectors and ~10' of jumper, this is OK.



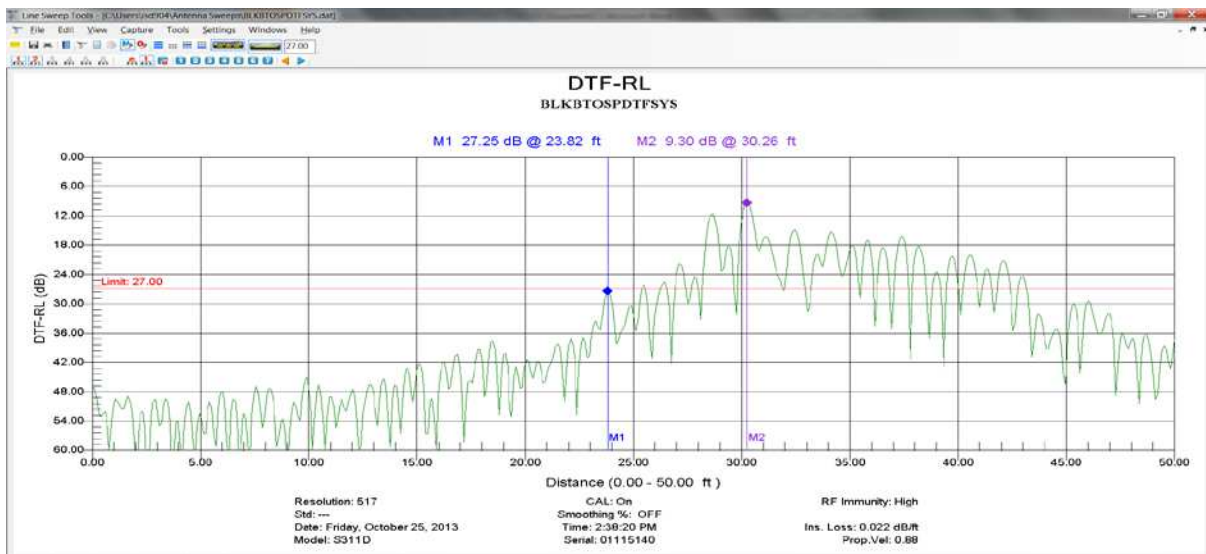
Feedline Return Loss to Antenna (System)- Acceptable sweep- This is a somewhat subjective sweep at times. It is highly influenced by the antenna type, and some environmental factors. This is a good sweep of a Bluebird antenna- All sweeps must meet at least 14 dB (1.5:1 VSWR) within the passband of the antenna to be acceptable. Of the two sweeps below, sweep one is the antenna only in a quiet RF environment. Sweep two is installed on Lime Hill in a high RF environment. Both pass, but you can see the effect of nearby RF, feedline, etc.



Feedline Return Loss to Antenna (System)- Unacceptable sweep- This is a ANT-150 antenna that is bad. Return Loss is above 14 dB.



Feedline Distance to Fault System- This sweep is for future use. It will be very similar to the DTF (short/open) reading, but will be affected the return loss of the antenna as well. In this example, M1 is the end of the feedline, the rest up to M2 is the Anritsu trying to "interpret" the elements of the Bluebird antenna connected to the feedline.



SAMPLE ANTENNA SWEEP PROFILES- Here are sweep profiles for the most used antennas we are installing for reference....

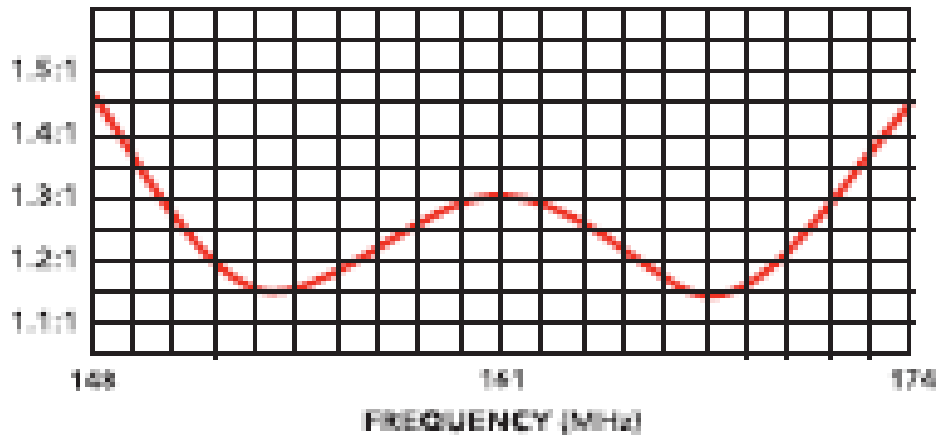
-90

ANT150F2 156 MHz

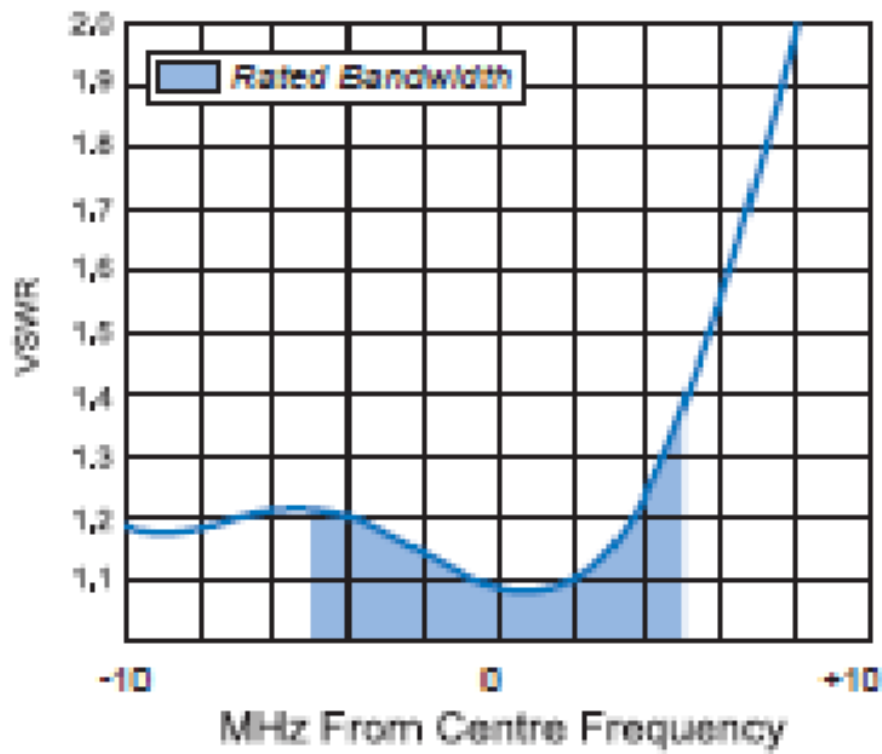
Vertical Plane

Gain = 2.55 dBd

TYPICAL VSWR RESPONSE



Typical VSWR response (COL54-160)



FEB 13/13 SD212-SF2P4LDF(D00) CC62096-2-11

▶ Tr1 S11 Log Mag 2.000dB/ Ref -14.00dB [F1]



1 Start 133 MHz

IFBW 30 kHz

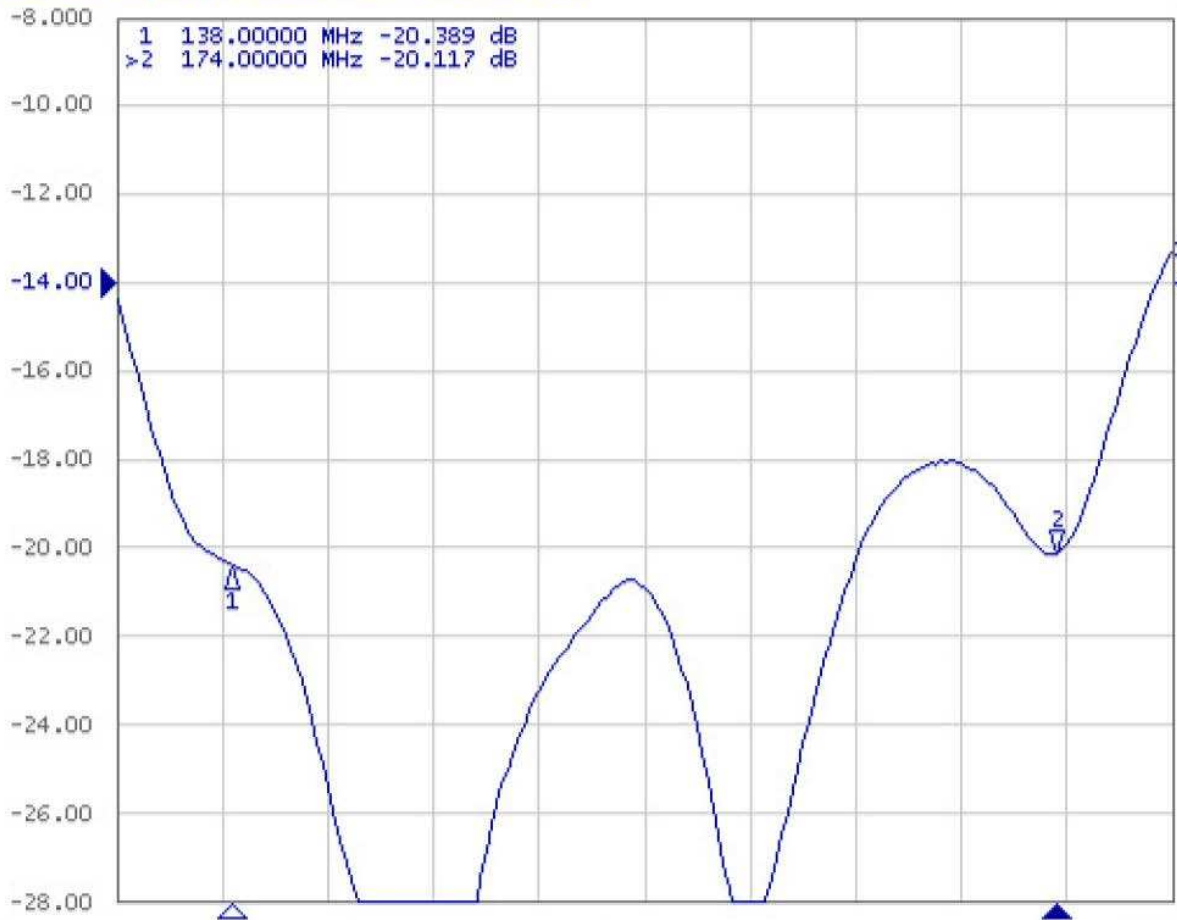
Stop 179 MHz

Cor |

1 Active Ch/Trace 2 Response 3 Stimulus 4 Mkr/Analysis 5 Instr State

FEB 4/13 SD212-SF2P2LDF(D00) CC62096-3-3

▶ [F1] S11 Log Mag 2.000dB/ Ref -14.00dB [F1]



1 Start 133 MHz

IFBW 30 kHz

Stop 179 MHz Cor !

APR 11//13 SD210-SF2P2LDF CC63062-2-1

► **Tr2** S11 Log Mag 2.004dB/ Ref -14.00dB [F1]



1 Start 133 MHz

IFBW 30 kHz

Stop 179 MHz **Cor** |

1 Active Ch/Trace 2 Response 3 Stimulus 4 Mkr/Analysis 5 Instr State

APR 26/13 SD210-SF2P4LDF CC63092-1-1

► Tr2 S11 Log Mag 2.004dB/ Ref -14.00dB [F1]

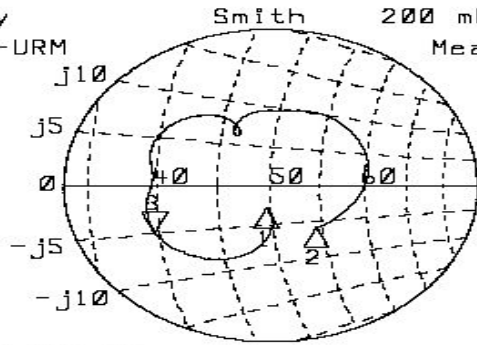


1 Start 133 MHz

IFBW 30 kHz

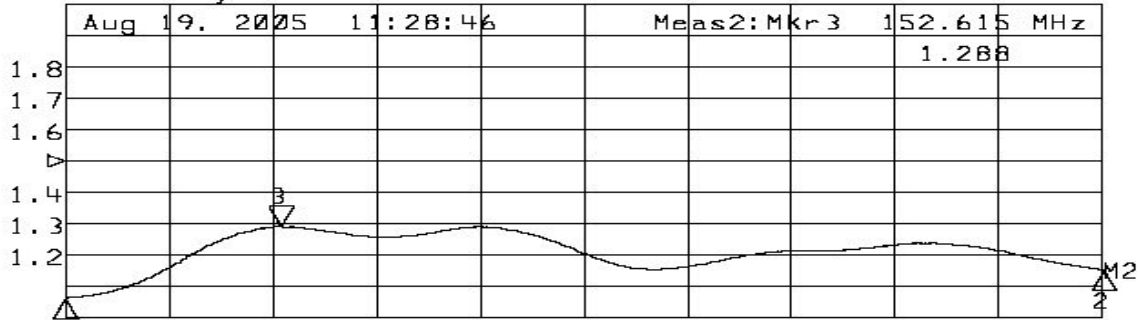
Stop 179 MHz Cor !

▼1:Memory
CL7-150-URM



Meas1:Mkr3 152.615 MHz
39.680
-4.7760
218.4pF

Start 147.000 MHz Stop 174.000 MHz
▼2:Memory SWR 0.1 / Ref 1.500 C



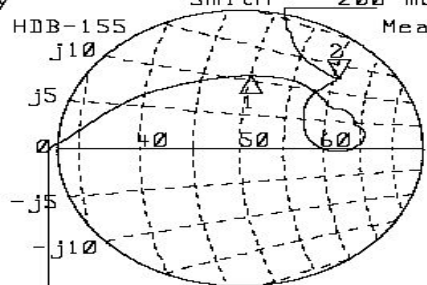
Start 147.000 MHz Stop 174.000 MHz

1: Mkr (MHz)	Ohm	Ohm	2: Mkr (MHz)	
1: 147.000	49.55	-2.844	1: 147.0000	1.060
2: 174.000	54.35	-5.774	2: 174.0000	1.151
3> 152.615	39.68	-4.776	3> 152.6150	1.288

▷1:Memory
 K552921 HDB-155
 J10
 J5
 0
 -J5
 -j10

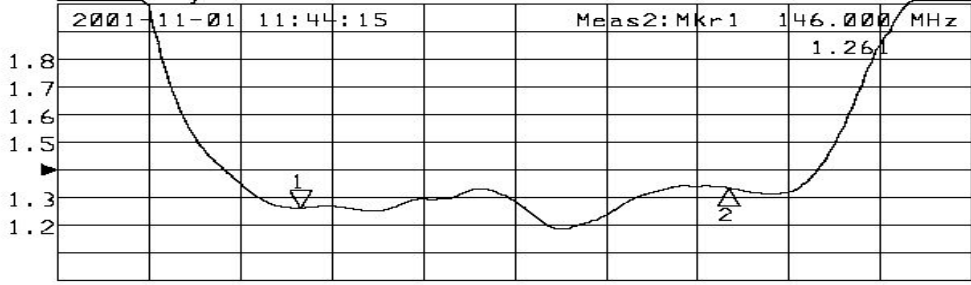
Smith

200 mU FS
 Meas1:Mkr2 174.000 MHz
 60.76Ω
 12.67Ω
 11.59nH



Center 160.000 MHz Span 60.000 MHz

▷2:Memory SWR 0.1 / Ref 1.400 C M2
 2001-11-01 11:44:15 Meas2:Mkr1 146.000 MHz



Center 160.000 MHz Span 60.000 MHz

1:Mkr (MHz)	Ohm	Ohm	2:Mkr (MHz)	
1: 146.000	50.11	10.68	1> 146.0000	1.261
2: 174.000	60.76	12.67	2: 174.0000	1.334