Installation and Maintenance of Remote Telemetry Units (RTUs)

Effective Date:	4/11/2017
Next Review Date:	4/11/2020

Hazard Class: ☒ Low   ☐ Moderate   ☐ High/Complex
Usage Mode: ☒ Reference   ☐ UET   ☐ Both UET & Reference

The Responsible Manager has determined that the following organizations' review is required for initial procedure release as well as subsequent major revisions. Review documentation is contained in the Document History File.

Responsible Manager	Environmental Protection
Shift Operations Manager	Electrical Safety Officer
Technical Lead	Industrial Safety
Technical Reviewers	Quality Assurance
Engineering	Training

Classification Review: ☒ Unclassified   ☐ UCNI   ☐ Classified

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Name (print)	Z#	Signature	Date

Responsible Manager, Division and Title

Craig Douglass	/ 216051	/ /s/ Craig Douglass	/ 4/11/2017
Name (print)	Z#	Signature	Date

This document fully satisfies the requirements of P300, Integrated Work Management, in order to systematically describe the work activity, the associated hazards, and the controls that **MUST** be employed to mitigate the risks.

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REVISION HISTORY

Document No./Revision No.	Issue Date	Action	Description
ER-SOP-20308, R0	4/11/2017	New procedure	New procedure for field personnel to install and maintain RTU equipment.

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1. PURPOSE

This procedure provides direction for the installation and maintenance of remote telemetry units (RTUs) located at Individual Permit (IP) water/precipitation monitoring locations and repeater stations owned by Los Alamos National Laboratory.

2. SCOPE

This procedure applies to all Environmental Remediation (ER) personnel who perform RTU installation and maintenance and provides detailed instructions for performing a thorough inspection of the components required for operation and installation of the RTU, including the antenna and cable assemblies. The RTU assemblies consist of three main components: RTU circuit board enclosure assembly, antenna cable, and antenna. The inspection shall identify any abnormal or unusual conditions that prompt appropriate notification and authorized repair as outlined in this procedure.

3. PRECAUTIONS AND LIMITATIONS

- Personnel SHALL comply with all Facility Operations Director (FOD) entry requirements.
- Personnel SHALL read and follow ER-GUIDE-20292, Environmental Remediation (ER) General Field Worker Guidelines.
- Personnel SHALL wear all required Personal Protective Equipment (PPE) as identified in ER-GUIDE-20292, including eye protection at all times, work gloves, and safety vests/hard hats when heavy equipment is in operation.

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4. ACRONYMS

ER	Environmental Remediation
FOD	facility operations director
FTDI	Future Technology Devices International
IP	individual permit
kHz	kilohertz (10^3 Hertz)
MHz	megahertz (10^6 Hertz)
Ω	Ohm
PPE	personal protective equipment
SMA	Subminiature Version A
SME	subject matter expert
SOH	state of health
SWR	standing wave ratio
RF	radio frequency
RTU	remote telemetry unit

5. RESPONSIBILITIES

ER Field Personnel
- Verify components are in working condition prior to declaring the RTU operational.
- Correct deficiencies as noted.
- Document any abnormal physical conditions of key components.
- Ensure RTUs are handled with care.

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6. PREREQUISITE ACTIONS

6.1 <u>Training</u>

- Personnel SHALL be in compliance with general field training outlined in ER-GUIDE-20292.
- Personnel SHALL be in compliance with Battery Safety: Course 16745.
- Personnel SHALL be in compliance with non-energized electrical work, Electrical Safety Program at LANL: Course 33215. All electrical work completed is "low hazard 4.1a all modes."

6.2 <u>Planning and Coordination</u>

Supervisor or Designee

[1] **ENSURE** that the procedure is the latest revision, and **IDENTIFY** this document as Working Copy or Information Only on the title page.

[2] **ENSURE** that, at a minimum, one operator who is trained in the use of this procedure is available for performance of this procedure.

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6.3   Materials and Equipment

Operator or Supervisor

[1]   **ENSURE** that the following special tools and equipment are available, as required:

Cable Making (to be completed out of the field)
- Crimping set
- Small knife or wire-stripping tool
- Tape measure
- Coaxial cable
- Male Subminiature Version A (SMA) radio frequency (RF) connectors
- Male Type-N RF connectors
- 5 foot and/or 8 foot antenna
- RigExpert AA-1000 or AA-600 (Figure 2) antenna analyzer

Basic Inspections
- Copy of this procedure
- Copy of designated work order
- PPE, as required by this procedure and ER-GUIDE-20292
  - Safety glasses, work gloves, etc.
  - No jewelry
- Safety vests/hard hats when heavy equipment is in operation
- Eye protection at all times
- Radio
- Pager and/or cell phone
- Necessary keys

Advanced Inspections (in addition to equipment outlined above)
- Phillips head screwdriver
- Computer with terminal software (TeraTerm, PuTTY, etc.) installed
- USB to TTL (Future Technology Devices International [FTDI] type 3.3 Volt) serial cable with appropriate drivers installed on computer

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7. RTU HARDWARE AND PROCEDURES

7.1 Cable Installation and Testing

The steps in this section should ONLY be completed by or when accompanied by personnel familiar with the crimping tools and procedures.

NOTE 1 *Refer to Attachment 1 for RTU assembly. The cable assembly on the right of the diagram is connected to the power supply; the antenna connector is also on this side. The cable on the left connects to the triggering sensor.*

CAUTION

Attachment 2 shows which cable pins are connected to which wires. Avoid using tools near pins A and B when handling connected power or sensor cable for an RTU because this could create a short circuit.

NOTE 2 *Cable assembly should be completed at Pueblo Complex if possible.*

NOTE 3 *When constructing new cables, choose a cable length + antenna length that combined is over 8 - 10 times the signal wavelength. This will minimize the effects of possible signal reflectance caused by an untrimmed antenna. The RTUs operate at 414.975 MHz which yields about a 28.5 inch wavelength, so a 20 foot cable would be suitable for any common antenna types.*

[1] **CUT** appropriate length of cable needed at specific location, allowing plenty of slack in cable. The minimum cable length is 20 ft.

[2] **CUT** both ends of cable using a crimping tool set.

NOTE *Do not use the gold SMA connectors. ONLY use the silver connectors for field applications.*

[3] **SECURE** small male SMA connector to one side of cable.

[4] **SECURE** larger male N type connector to the other side of cable.

7.1   Cable Installation and Testing (continued)

NOTE   *Pins are positioned correctly if they can be felt by a finger placed over the end of the cable.*

[5]   **ENSURE** the center pins on both ends are positioned correctly (see Figure 1).

NOTE   *An ideal standing wave radio (SWR) should be between 1.00 - 2.00. If SWR is higher than 2.00, the cable either has poorly attached connectors OR is not cut to the appropriate length.*

[6]   **TEST** cable SWR using RigExpert AA-1000 or AA-600 analyzer:

    [A]   **CONNECT** N type end of cable to antenna.

    [B]   **CONNECT** other end of cable to the RigExpert Analyzer (Figure 2).

    [C]   **TURN ON** RigExpert Analyzer.

    [D]   **PRESS** 7 "Show SWR."

    [E]   **PRESS** √. The number on the screen is the SWR.

Figure 1. Antenna cable assembly   *Figure 2. AA-1000 analyzer*

7.2   Antenna Installation

NOTE   *Tripods are not always required. Antennas can be attached to existing structures on site using metal clamps, or any other suitable metal mounting system that firmly affixes the antenna to its support structure. Antennas should be appropriately grounded if not secured to a metal structure on the ground.*

[1]   **IF** required,
THEN SET UP and **SECURE** tripod.

NOTE   *Twenty feet of cable is adequate for most locations. However, longer cables might be required in certain locations. This should be taken into account before installation.*

[2]   **MEASURE** length of available cable to location of tripod to ensure there is plenty of slack in the cable and carefully **ATTACH** antenna to the tripod/structure.

[3]   **SECURE** tripod, using heavy rocks to ensure it is stable.

[4]   **ATTACH** N type side of cable to antenna.

[5]   **PROCEED** to 7.3.1 for RTU installation with an ISCO or 7.3.2 for RTU installation with PENS.

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7.3   General RTU Installation

CAUTION

For all RTU activations, maintenance, and testing the first connection is to the antenna. DO NOT power an RTU without an antenna attached, as it will damage the radio.

NOTE 1   *Do not force installed cables around a sharp corner or allow tension to pull away from the connector. Ensure that cable ends are properly inserted into connectors.*

NOTE 2   *ALWAYS check existing cables for breakage or damage upon arrival to sites. If you have any questions about the RTU, please contact RTU subject matter expert (SME) immediately.*

[1]   **ATTACH** antenna.

[2]   **ATTACH** sensor, if applicable.

[3]   **ATTACH** power.

7.3.1   RTU Installation with ISCO

NOTE   *The RTU will connect in-line with the liquid level actuator connected to the ISCO; the power supply will be the ISCO head unit.*

ER Field Personnel
 [1]   **PREPARE** the ISCO:

[A]   **FOLLOW** ISCO procedures to disable ISCO programming.

[B]   **DISCONNECT** liquid level actuator from sensor port on ISCO head unit or **UNCOVER** sensor port.

7.3.1   RTU Installation with ISCO (continued)

[2]   **SECURE** RTU under ISCO cover, ensuring antenna cable is not pinched or under strain.

NOTE   *There is a recess at the base of and alongside the ISCO head unit on the same side as the power and sensor ports.*

[A]   **CUT** a notch attachment hole on the RTU cover on the same side where the antenna is attached so that the notch can fit over the battery connection on the ISCO head unit.

NOTE   *There is a standoff block on the RTU that creates a support for this type of installation.*

[B]   With the RTU lid facing the ISCO head unit, **PLACE** the notch in the lid over the battery connector, and **ROTATE** the RTU down so that the standoff block locks into the ISCO's recess.

NOTE   *The RTU should now be securely positioned alongside the ISCO head unit.*

[3]   **ATTACH** the antenna to the RTU.

[4]   **ATTACH** the liquid level actuator to the appropriate RTU cable (only one will fit).

[5]   **ATTACH** remaining RTU cable to ISCO sensor port.

[6]   **SET** ISCO to resume/start sampling.

7.3.2   RTU Installation with PENS (i.e., 2milePENS)

The steps in this section should ONLY be completed by or when accompanied by personnel familiar with PENS electrical systems.

NOTE 1   *The RTU will connect to the existing power block inside the NEMA enclosure on site.*

NOTE 2   *RTU power cables should ONLY be acquired from, or constructed by a RTU SME.*

ER Field Personnel

[1]   **ROUTE** antenna cable into NEMA enclosure.

[2]   **PREAPRE** RTU power cable:

[A]   **CONNECT** the white lead to 12V positive source on power block.

[B]   **CONNECT** the black wire to the 12V negative source.

[3]   **CONNECT** the antenna to RTU.

[4]   **CONNECT** power cable to RTU.

[5]   **POSITION** and **SECURE** RTU inside NEMA enclosure so that unused sensor cable is away from any place water or moisture may collect.

7.3.3   RTU Repeater Stations

NOTE 1   *This procedure requires Battery Safety Training (Course 16745). Personnel should not directly interact with the battery or conductors unless replacing the battery. If replacing battery, verify connection location for ALL conductors before disconnecting them from battery and ensure they are replaced in the same configuration.*

NOTE 2   *Fused RTU power cables should ONLY be acquired from, or constructed by a RTU SME.*

NOTE 3   *The battery for this procedure SHALL be a 35 Ah or less rated 12V sealed lead acid type.*

NOTE 4   *Repeater stations may be serviced through this procedure, however installation of a repeater should only be completed by or when accompanied by an RTU SME.*

ER Field Personnel

[1]   **OPEN** battery box and **CONNECT** RTU power cable with fused leads to the battery (the RTU may share the box with the battery or be in a separate enclosure):

   [A]   **CONNECT** the red lead (with yellow fuse case) to the positive terminal of the battery.

   [B]   **CONNECT** the black lead to the negative terminal of the battery.

[2]   **ROUTE** antenna cable into RTU enclosure.

[3]   **CONNECT** the antenna to the RTU.

[4]   **CONNECT** power cable to RTU.

[5]   **POSITION** and **SECURE** the RTU inside enclosure so that unused sensor cable is away from any place water or moisture may collect.

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7.4 RTU Deactivation

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CAUTION

For all RTU deactivations, maintenance, and testing the first disconnection is the power.

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NOTE *Always check existing cables for breakage or damage upon arrival to sites. If you have any questions about the RTU, please contact RTU subject matter expert (SME) immediately.*

[1] **DETACH** power.

[2] **DETACH** sensor, if applicable.

[3] **DETACH** antenna.

7.5 Advanced RTU Procedures

There are no external indications as to whether a RTU is functioning. The only way to verify a RTU is functioning in the field is to interface with the unit with a computer through an FTDI cable. This requires at least basic knowledge of terminal applications and FTDI interfaces. If, and only if, you have these items and this knowledge, you will need to configure your terminal application with these settings:

- COM port will vary, but will be the one generated by the FTDI/USB cable
- Baud rate will be 115200
- Data: 8 bit
- No parity
- 1 stop bit
- No flow control
- Set your terminal for CR&LF on Rx and Tx
- Local echo should be on

7.5   <u>**Advanced RTU Procedures**</u> **(continued)**

Once you have these settings and have connected the computer to the RTU's circuit board via the FTDI cable, you can determine the general health of the unit as follows:

Information regarding firmware version, memory buffers, node ID, general state of health (SOH), etc. should automatically be generated on the terminal screen. You can request a SOH message from the attached node by sending a "$H" to the node, it should respond immediately with a SOH message showing battery voltages, temperatures, time since last reset, etc. An effective way to check the radio health is to request a SOH from another RTU within range. A common choice might be one of the repeaters or a RTU within line of sight. This is accomplished by sending the command "$h<RTU #>." For example, if you wanted to ask for the state of health of node 90 in the network, you would send the command "$h90." The attached RTU will then attempt to contact node 90 by sending it a SOH request, and after a short time, node 90 should respond with a SOH message.

[1]   **POWER UP** or **RESET** the unit.

[2]   **ALLOW** the computer to monitor the terminal connection for a few minutes. If the RTU was able to communicate with the node you called and/or starts interacting with other nodes in the network, the radio is likely healthy.

[3]   **IF** the RTU is uncommunicative,
       THEN INSPECT the antenna connections.

[4]   **IF** the antenna is good, but the RTU still refuses to interact with the network,
       THEN REPLACE the RTU and **RETURN** the unresponsive one to the Pueblo Complex for further testing.

[5]   **DOCUMENT** SOH of the RTU on work order.

8.   **RECORDS**

Any records (e.g., work orders) generated while performing this procedure must be processed and maintained in accordance with EP-AP-10003, Records Management.

9.   **REFERENCES**

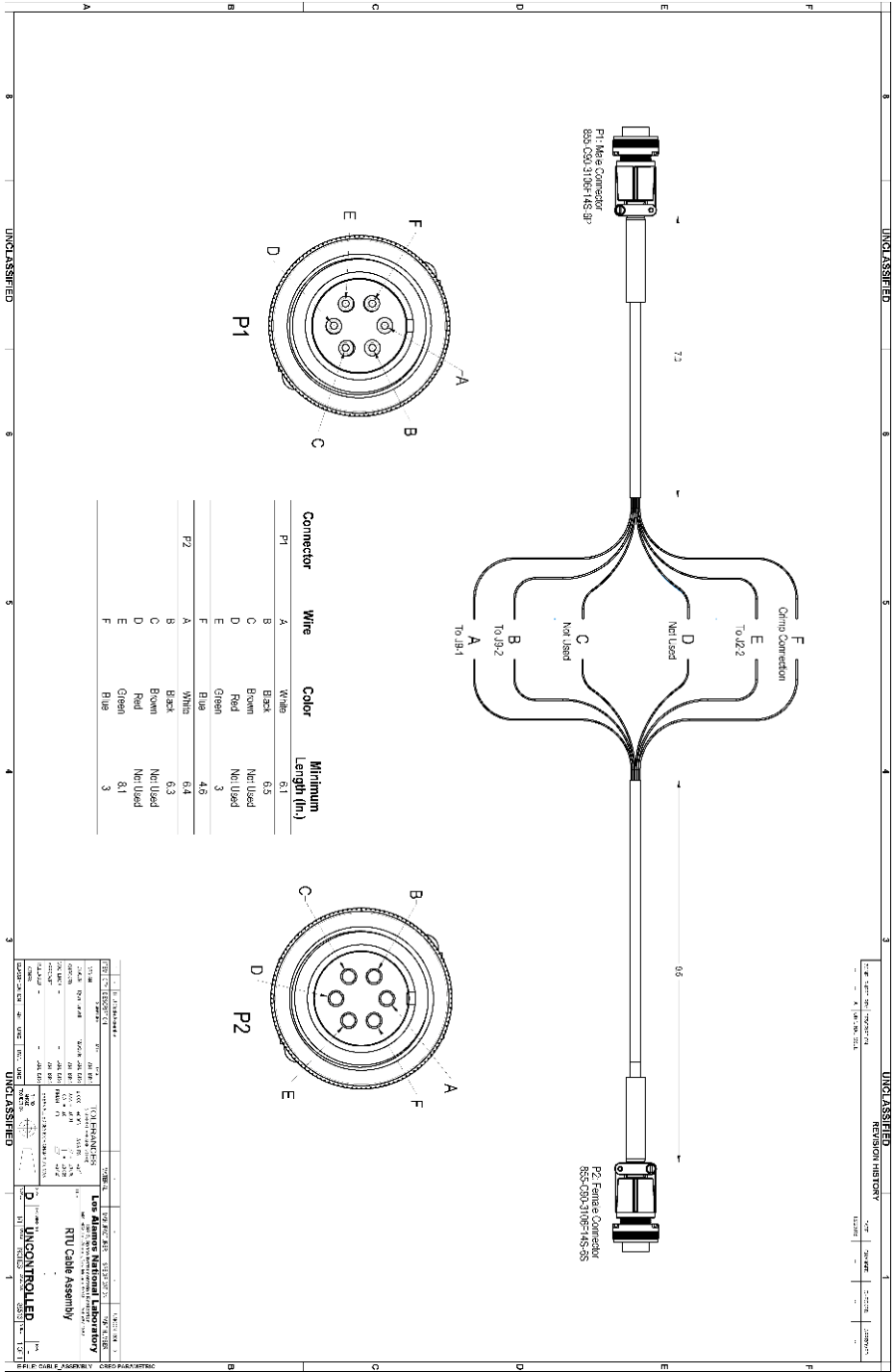EP-AP-10003, Records Management

10.   **ATTACHMENTS**

Attachment 1, RTU Assembly Diagram
Attachment 2, Cable Assembly Diagram

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ATTACHMENT 1

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RTU Assembly Diagram

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ATTACHMENT 2

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Cable Assembly Diagram

Connector	Wire	Color	Minimum Length (In.)
P1	A	White	6.1
	B	Black	6.5
	C	Brown	Not Used
	D	Red	Not Used
	E	Green	3
	F	Blue	4.6
P2	A	White	6.4
	B	Black	6.3
	C	Brown	Not Used
	D	Red	Not Used
	E	Green	8.1
	F	Blue	3