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Environment, Safety, Health & Quality Directorate

Waste and Environmental Services

Standard Operation Procedure

Title: AIRNET – INSTALLING AND PROGRAMMING THE RADIO SYSTEMS

Reviewers:

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Derivative Classifier: ☐ **Classified** ☒ **Unclassified**

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The Waste and Environmental Services work is categorized as low hazard/risk operation. Any work to be performed in a Moderate or High Hazard Facility shall be coordinated through the appropriate Facility Manager.

1.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) states the responsibilities and describes the assembly and programming of the radio-frequency systems installed on selected AIRNET stations.

All **WES participants** shall implement this procedure when performing to assemble, install, and program the radio-frequency systems on selected AIRNET stations.

2.0 BACKGROUND AND PRECAUTIONS

2.1 Background

The radio frequency (RF) system used on the AIRNET stations is manufactured by Campbell Scientific, Inc. The base antenna is located on the top of building 54-1001 and is connected to a model RF-310 radio base station unit which is in turn connected to a COM port on the base computer. Stations equipped for RF monitoring have a data collection unit, a radio, and antenna. A station may communicate directly with the base station if the signal strength allows it, or it may communicate via another station that acts as a repeater.

The RF transmitters are installed on AIRNET stations that are considered critical, especially the FFCA (Federal Facility Compliance Act) stations that must meet completeness and runtime criteria. Other stations may have the RF systems installed as directed by the AIRNET Task Leader.

Two stations at TA-49 are connected to the base station via a phone line. These stations use the same internal components except for a DC-112 phone modem instead of a radio unit. Because no new phone-based communications are planned, the installation of a phone system is not described in this procedure but is similar to that for the RF units.

2.2 Precautions

The timer and the data logger must be connected to separate vacuum switches as shown in the diagram in Attachment 5. The timer signal can be falsely activated if the data logger and the timer are wired to share one vacuum switch. Vacuum switches can also clog with dirt and debris, rendering them inoperable. Vacuum switches should be replaced at least every 2 years.

3.0 EQUIPMENT AND TOOLS

- Campbell Scientific weathertight box with mounting hardware
- CR10X or CR1000 data logger
- PS 12 or PS 100 power supply unit with battery and wall charger
- RF95 RF modem
- Midland radio 310M Mode M, 167.825 MHz.
- Omni-directional or directional antenna, with mounting hardware
- Mounting brackets, screws, and hardware for attaching box to station legs
- 0.5” h2o vacuum switch
- 3/8” ID tubing and plastic T

4.0 STEP-BY-STEP PROCESS DESCRIPTION

4.1 Installing a CR-10X Data Logger and Radio

Warning: Be aware of power lines in the vicinity of the installation site. Do not allow any metal object, especially antenna poles, to come within 13 feet of a power line.

Worker	1.	Mount the equipment on the board inside the weatherproof housing.
	2.	Remove the lid on the RF modem and set the DIP switches to the ID number of the station. The ID number is the same as the AIRNET station number. Refer to the table in Attachment 1 for the settings.
	3.	Install the battery into the PS12 or PS100 (power supply) box. Plug into INT terminal. Leave the power switch off.
	4.	Connect the two power leads from the power supply to the + and – terminals in the CR10X.
	5.	Run the wall charger cord from AIRNET station housing to inside of weather proof data logger box. Hook up wires to charging terminals on PS 12 or PS 100. Plug in the charger.
	6.	Connect the power leads from the radio to the power terminals inside the PS12 or PS100 box.
	7.	Install the omni-directional or the unidirectional antenna on a sign post or on the side of the station. Run the antenna cable through the hole in the bottom of the Campbell box and connect the end to the radio unit.
	8.	Connect the communication cable (tape style) from the CR10X to the modem.
	9.	Connect the radio communication cable (tape style) from the modem to the radio.
	10.	Turn on the power switch on the power supply and observe the red light on the modem: it should blink twice and go out. This indicates everything is connected properly.
	11.	Put the lids back on the power supply unit and the modem.
	12.	Install the weatherproof housing at the AIRNET station, and connect the data logger to a vacuum switch inside the station as shown in Attachment 5. (This step may be performed at a later time after programming the logger outside of 54-1001.)

	13.	Use the “goop” supplied with the Campbell box to seal the opening in the bottom of the box (around the transformer power cord and the antenna lead). (This step is optional)
	14.	Close up the box and return to the Cave to initiate radio communications and program the unit.

4.2 Installing a CR1000 Datalogger and Radio

Worker	1.	Remove the cover of the PS100 power supply. Connect the positive and negative terminals on the internal battery to the terminal clip of the external charger.
	2.	Place the PS100 or equivalent power supply, the CR1000 data logger, a radio, and a modem into a weatherproof housing.
	3.	Connect the PS100 power supply to the 12v wall charger by inserting cord into charge terminals on the power supply.
	4.	Connect the red wire from the PS100 to the CR1000 data logger using the +12V terminal on the PS100 to power in on the CR1000. Connect the black wire (ground) to the G terminal on the CR1000.
	5.	Plug the wall charger into a 110V outlet.
	6.	Connect the RS-232 cable from the CR1000 to the desktop computer.
	7.	Turn on the power supply on the PS12 or PS100.
	8.	Start the Device Configuration Utility Software, choose the appropriate COM port and connect to the CR1000. Note: The phone modem is configured to use COM port 3, the RF radio is configured to use COM port 1 at the time of publication of this procedure. These assignments are optional and subject to change.
	9.	In the Deployment / Datalogger tab, enter the station name and enter the station number in the PakBus Address box. Example: For station #42, the name would be CR1000_42, and the PakBus address would be 42.

10. Go to the Ports Settings tab, and select “CS I/O – Modem Enable”, and a baud rate of “9600 Auto”.

11. Click Apply, and close the software.

12. Open the RF modem box, and program with the station ID. Refer to Attachment 1 for station ID configurations. Filp the switches on the red terminal to correspond to the configuration.

    Important: When programming an RF modem model 310M, the switch number 9 must be set to open.

13. Complete installation of components in the weather tight housing, ensure all components are secure and all cables between components are connected.

14. Take weather tight box outside building 54-1001, or to an AIRNET station, connect antenna, and plug in to a 110v power supply. Directional antennas should point in the direction of the base station or towards the nearest station to be used as a repeater.

15. If installing at an AIRNET station, connect the data logger to a vacuum switch inside the station as shown in Attachment 5. (This step may be performed at a later time after programming is complete).

4.3 Programming the CR10X or the CR1000 Data Logger

To create the primary file for a new AIRNET station:

After installing a RF system, it needs to be programmed. This is done with the computer program on the base computer and then transmitted to the station via radio. Programming may occur outside of building 54-1001 prior to taking the system to the final station destination, or the programming may occur after installing the system at the station location.

Worker

1. Open the Loggernet software on the base computer.

2. The RF transmitters need a direct line of sight with the base station in order to communicate effectively. Sometimes the use of a repeater is necessary to provide effective communication. If a repeater is needed, follow the steps below:

   - Open the EZSetup tab on Loggernet.
   - Highlight the station name, and click edit.
   - Scroll through the EZSetup Wizard to the RF95/RF3XX settings page.
   - Add repeaters as necessary, the station being programmed should be the last station on the list, more than one repeater may be added.

	3.	Go to the Connect tab, and highlight the station name.
	4.	Click the connect button, and establish communication with the datalogger.
	5.	Update the date and clock on the datalogger by clicking on the Set Station Clock button.
	6.	Click the send button, and select the program file to be sent to the datalogger. Examples of sample programs for the CR10X and the CR1000 are shown in Attachments 2 and 3 respectively. The CR1000 program file is the same for every CR1000 station, and the CR10X programs are station specific. A warning message will appear warning the user that all data on the logger will be erased when the new program installed. Click yes to proceed with sending the program.
	7.	Go to Set up, and set collection interval and output file name.
	8.	Allow the datalogger to collect several data points, then collect data to ensure everything is working properly.
	9.	If programming occurred at 54-1001, take the system to the station and complete installation by connecting the data logger to a vacuum switch as shown in Attachment 5. Communicate with the station after installation, and adjust repeaters as necessary, as described in step 2.
	10.	Record all installation activities in the AIRNET field logbook.

4.4 Checking the Data Logger Files on the Base Computer

Critical stations equipped with data logging equipment are checked every working day. To perform a daily station check, follow the steps below:

Worker	1.	Open the Loggernet software application.
	2.	Open the data file folder that contains the Loggernet data files.

3. Open the data file for each station to be checked, and look at the following information:
   - Check that the date is current – that the data was indeed collected on the day the check is being performed. Data files from the CR10X loggers will show the Julian date.
   - Look at station id and verify you are checking the correct station. For CR1000 data files, the station name is only displayed in the file name and header. For CR10X data files, the station name is displayed with each record.
   - Check the voltage of the station. The voltage should be at least 12V. Voltage lower than 12V may need to be checked with a physical check of the station to determine if there are power supply issues.
   - Check the vacuum data for the last 24 hours.
   - The vacuum data for a CR10X station should read "1". A reading of "0" indicates that the station is not running, or the pump could be blowing. A physical check of the station is required to obtain more information. Refer to SOP-5145 to perform a physical check of the station.
   - The vacuum data for a CR1000 station should read " ". A reading of "PumpOff" indicates that the station is not running, or the pump could be blowing. A physical check of the station is required to obtain more information. Refer to SOP-5145 to perform a physical check of the station.

4. Document the station data checks on the "AIRNET Critical Station Checks" form, Attachment 4. When a physical check is performed on a station, indicate that by putting a "PC" on the station check form.

4.5 Records Management

Worker

1. Maintains and submits records and/or documents generated to the Records Processing Facility according to EP-DIR-SOP-4004, Records Transmittal and Retrieval Process.

   Critical Station Check Forms should be submitted to the RPF quarterly.

5.0 PROCESS FLOW CHART

N/A

6.0 ATTACHMENTS

Attachment 1 "Appendix A: Setting the Station ID" from the Campbell Scientific "Radiotelemetry Network Instruction Manual". (1 page)

Attachment 2 Example Program for CR10X Unit (2 pages)

Attachment 3 Example Program for CR1000 Unit (2 pages)

Attachment 4 Example AIRNET Critical Stations Checks Form (1 page)

7.0 REVISION HISTORY

Revision No. *[Enter current revision number, beginning with Rev.0]*	Effective Date *[DCC inserts effective date for revision]*	Description of Changes *[List specific changes made since the previous revision]*
0	11/04/99	New document.
1	06/16/04	Added safety information about safe distance from power lines.
2	06/16/05	Quick-change revision to change HCP to HR.
0	4/16/09	New document number and reformatted for WES division. Formerly ENV-MAQ-231.
1	10/05/2010	Change the directorate name, change SME, minor editorial changes.
2	1/27/2011	Changed to include vacuum switch change out, program changes were incorporated. Added Attachment 5, wiring diagram.

If you have read and understand the preceding document, click here to receive EDS credit.

ATTACHMENT 1

SOP-5152-1

"APPENDIX A: SETTING THE STATION ID" FROM THE CAMPBELL SCIENTIFIC "RADIOTELEMETRY NETWORK INSTRUCTION MANUAL".

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APPENDIX A. SETTING THE STATION ID

Each RF95, including the one in the RF base station, must have a unique Station ID. Each RF modem has nine dip switches; the first eight must be set for a particular Station ID. Following is a list of all possible Station IDs with the corresponding setting of the dip switches. Here, 1 represents open, 0 is closed, and X is "don't care."

	SWITCHES			SWITCHES			SWITCHES	
ID	1234	56789	ID	1234	56789	ID	1234	56789
			43	1101	0100X	86	0110	1010X
1	1000	0000X	44	0011	0100X	87	1110	1010X
2	0100	0000X	45	1011	0100X	88	0001	1010X
3	1100	0000X	46	0111	0100X	89	1001	1010X
4	0010	0000X	47	1111	0100X	90	0101	1010X
5	1010	0000X	48	0000	1100X	91	1101	1010X
6	0110	0000X	49	1000	1100X	92	0011	1010X
7	1110	0000X	50	0100	1100X	93	1011	1010X
8	0001	0000X	51	1100	1100X	94	0111	1010X
9	1001	0000X	52	0010	1100X	95	1111	1010X
10	0101	0000X	53	1010	1100X	96	0000	0110X
11	1101	0000X	54	0110	1100X	97	1000	0110X
12	0011	0000X	55	1110	1100X	98	0100	0110X
13	1011	0000X	56	0001	1100X	99	1100	0110X
14	0111	0000X	57	1001	1100X	100	0010	0110X
15	1111	0000X	58	0101	1100X	101	1010	0110X
16	0000	1000X	59	1101	1100X	102	0110	0110X
17	1000	1000X	60	0011	1100X	103	1110	0110X
18	0100	1000X	61	1011	1100X	104	0001	0110X
19	1100	1000X	62	0111	1100X	105	1001	0110X
20	0010	1000X	63	1111	1100X	106	0101	0110X
21	1010	1000X	64	0000	0010X	107	1101	0110X
22	0110	1000X	65	1000	0010X	108	0011	0110X
23	1110	1000X	66	0100	0010X	109	1011	0110X
24	0001	1000X	67	1100	0010X	110	0111	0110X
25	1001	1000X	68	0010	0010X	111	1111	0110X
26	0101	1000X	69	1010	0010X	112	0000	1110X
27	1101	1000X	70	0110	0010X	113	1000	1110X
28	0011	1000X	71	1110	0010X	114	0100	1110X
29	1011	1000X	72	0001	0010X	115	1100	1110X
30	0111	1000X	73	1001	0010X	116	0010	1110X
31	1111	1000X	74	0101	0010X	117	1010	1110X
32	0000	0100X	75	1101	0010X	118	0110	1110X
33	1000	0100X	76	0011	0010X	119	1110	1110X
34	0100	0100X	77	1011	0010X	120	0001	1110X
35	1100	0100X	78	0111	0010X	121	1001	1110X
36	0010	0100X	79	1111	0010X	122	0101	1110X
37	1010	0100X	80	0000	1010X	123	1101	1110X
38	0110	0100X	81	1000	1010X	124	0011	1110X
39	1110	0100X	82	0100	1010X	125	1011	1110X
40	0001	0100X	83	1100	1010X	126	0111	1110X

ATTACHMENT 2

SOP-5152-2

EXAMPLE PROGRAM FOR CR10X UNIT

Records Use only

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```
};CR10X
;AIRCR10X.DLD
;$
;:ID      :COUNT    :Bat_Volt :CSI_R    :_________
;:_________:_________:_________:_________:_________
;:_________:_________:_________:_________:_________
;:_________:_________:_________:_________:_________
;:_________:_________:_________:_________:_________
;:_________:_________:_________:_________
;$

MODE 1
SCAN RATE 60

1:P20
1:8000
2:0000

2:P91
1:48
2:30

3:P30
1:1
2:0
3:4

4:P31
1:4
2:2

5:P95

6:P91
1:58
2:30
```

ATTACHMENT 2	
SOP-5152-2 EXAMPLE PROGRAM FOR CR10X UNIT (continued)	Records Use only Los Alamos NATIONAL LABORATORY EST. 1943

```
7:P30
1:0
2:0
3:4

8:P31
1:4
2:2

9:P95

10:P10
1:3

11:P92
1:0
2:60
3:10

12:P80
1:1
2:6

13:P77
1:1220

14:P74
1:1
2:00
3:3

15:P70
1:1
2:2
```

ATTACHMENT 3

SOP-5152-3

EXAMPLE PROGRAM FOR CR1000 UNIT

Records Use only

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```
'CR1000 Series Datalogger
'To create a different opening program template, type in new
'instructions and select Template | Save as Default Template
'date:09/16/2008
'program author:Dan Young
'data:11/17/2010
'program modifictations: Dan Young


'Declare Public Variables
Public batt_volt, CPort
Public CText as String * 16
Units batt_volt=Volts


'Define Data Tables
DataTable (Vacdat,1,-1)
        DataInterval (0,60,Min,10)
        Minimum(1,batt_volt,FP2,False,False)
        Sample (1,CPort,FP2)
        Sample (1,CText, String)
EndTable



'Main Program

BeginProg
        Scan (60,Sec,1,0)
                'PanelTemp (PTemp,250)
                Battery (Batt_volt)

                'read if Switch#1 is open or closed where
                '  1 is read if Control Port#8 is high; 0 if C8=low
                PortGet (CPort,8)
                '
                If CPort > 0 Then CText = " "
                If Cport = 0 Then CText = "PumpOff"

                CallTable(VacDat)
        NextScan
EndProg
```

ATTACHMENT 4

SOP-5152-4

EXAMPLE CRITICAL STATION CHECKS FORM

Records Use only

Los Alamos NATIONAL LABORATORY EST.1943

(Stations with radio systems change frequently with programmatic needs, therefore stations listed on this form are subject to change. Ensure the most current form is being used when performing a station checks.)

AIRNET Critical Station Checks

Instructions: Use one column for each daily check. Enter a check or "OK" in "Checked" column and initial and date bottom of column. Enter any comments in the AIRNET field logbook.

Station #	Checked	Checked	Checked	Checked	Checked'	Checked	Checked
6							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
20							
24							
26							
27							
30							
32							
34							
36							
39							
42							
55							
60							
61							
62							
63							
66							
67							
68							
71							
72							
73							
74							
75							
79							
90							
	Date: Initials:	Date: Initials:	Date: Initials:	Date: Initials:	Date: Initials:	Date: Initials:	Date: Initials:

ATTACHMENT 5	
SOP-5152-5 STATION WIRING DIAGRAM	Records Use only Los Alamos NATIONAL LABORATORY EST. 1943