

**Appendix S**

**System Requirements  
and  
Testing Specifications**

## **1.0 Introduction**

Appendix S - System Requirements and Testing Specifications is intended as a “first pass” at WyoLink testing requirements for inclusion in an RFP document. As such, this appendix may require editing to ensure conformity with the final system requirements that are called out in the final RFP.

## **2.0 References to Previous *FE* Documents**

Previously in the PSMC Project, Federal Engineering described various examples of acceptance test procedures under Phase 1 - Assessment, Section 4.5 and testing under Phase 2 - Planning, Section 4.9.8. The material contained in these sections is revised herein to meet the needs of an RFP and Required Features listed within Appendix A(2). Those WyoLink system requirements that are not vendor requirements (State or local responsibilities) are addressed within Section 5.0.

## **3.0 WyoLink Requirements**

### **3.1 Radio Infrastructure**

#### **3.1.1 Basic Interoperability**

The basic infrastructure (repeaters) and subscriber devices (mobiles, portables, base/ control stations) shall be of a VHF High Band, narrowband, trunked design, and meet P25 Phase I specifications. During the transition period to support existing wideband analog systems, at least one channel (State Mutual Aid) will be operated in a wideband, analog mode. In addition, all subscriber devices will be capable of operation in wideband, analog mode on a channel-by-channel basis for communications to existing non-WyoLink systems.

#### **3.1.2 P25 Features**

Radio site equipment shall be capable of transmitting and receiving encrypted signals in the P25 CAI conventional mode. The vendor will certify compliance with the State’s requirements including the proposed system design. The vendor will identify which P25 standards are followed or not followed, system/subscriber equipment specifications, and limitations of operation under wideband/analog mode. Infrastructure shall comply with all applicable standards of P25; if WyoLink features are covered by a mandatory or optional P25 standard, the vendor proposal shall offer compliance with those standards. If the vendor proposes features outside P25, these features shall be clearly identified and justified. The selected vendor will be required to demonstrate P25 capabilities during factory testing and installed

system acceptance testing. The vendor shall also detail plans to incorporate future P25 standards, including Phase II and high-speed data standards. This shall include the identification of WyoLink costs to upgrade both infrastructure and subscriber devices. For encryption, the infrastructure shall include systemwide encryption capability from all sites and all channels. Further details on the basic P25 primary interoperability standards for CAI - Common Air Interface, trunking, vocoder, data, encryption, and OTAR (Over-The-Air-Rekeying), are outlined in Appendix R - APCO Project 25 Standards.

### 3.1.3 VHF High-band Frequency Range

Radio site equipment shall be capable of operations from 137-174 MHz. This range is intended to allow flexible use of FCC/NTIA government and commercial frequencies.

## 3.2 Mobile Coverage

Site selection is important to the overall coverage success of WyoLink. WyoLink VHF-57 is one possible solution that maximizes the use of existing or planned WyDOT-only sites to achieve the target WyoLink goal of 95% mobile coverage statewide (except for Yellowstone National Park area), 95% availability to a QoS of DAQ 3.0. It shall be the vendor's responsibility to ensure this coverage. The State prefers the use of the listed 57 sites (see Appendix P), however the vendor may propose other existing state, local or federal sites to meet this coverage goal (e.g., from Appendix O, Exhibit 2). The VHF-57 WyoLink solution and its specific sites are not meant to be the only solution; rather, it is a starting point for an interactive design effort between the successful vendor and the State's staff to consider any and all factors that make up the selected sites. It is the State's goal to have the selected sites meet coverage parameters while minimizing extensive microwave backbone additions beyond those already planned and funded by WyDOT.

The vendor shall provide a list of sites and coverage analysis engineering assumptions used, highlighting all variations from the 57-site solution documented in the PSMC Plan Appendix P. Proposers shall provide statewide coverage probability plots for mobile coverage, showing specific sites used. The selected vendor must demonstrate, during acceptance testing, actual coverage via field measurements as described later in this document.

## 3.3 Limited Area Portable Coverage

WyoLink requires upgraded portable availability coverage in selected areas. Agencies that rely on portable subscriber units such as cities and forestry agencies require additional signal margins to allow reliable portable operation. As a minimum the WyoLink network

will be designed for increased signal strength and margins in selected geographic areas that need portable coverage to a 90% target coverage probability level and 90% availability to a QoS of DAQ 3.0, measured at shoulder height at ground level. The preliminary plan for augmenting mobile coverage is to add voting receivers; however, vendors may offer alternatives to accomplish portable coverage in selected areas. WyoLink will provide a list of the selected areas to be covered for portable coverage. WyoLink estimates that 20 voting receiver sites will be needed. Additional plots will be provided by vendors for portable coverage probability.

### 3.4 In-Building Portable Coverage

WyoLink partner cities also require additional signal strength and/or margins for in-building coverage. The WyoLink design will allow optional enhancement solutions beyond the voting receivers allocated for general portable coverage to increase signal strengths and margins allowing portable subscriber units to operate within buildings. This may include additional voting receivers and/or repeater sites or passive/active in-building enhancements as the particular problems are investigated and the best solution determined. Vendors shall present design solutions to overcome in-building coverage concerns. Margins for moderate office building shall be 10 dB. Area coverage plots presented for portable coverage shall clearly show areas where in-building enhancements are not needed (*i.e.*, areas exceeding established in-building margins).

### 3.5 Network Control Reliability

The system infrastructure must be designed to incorporate multiple master control points and other provisions for high network reliability. The primary network control location will be in Cheyenne, secondary control point(s) have not been specified. Vendors shall provide costs associated with a primary network control location and secondary location(s).

### 3.6 Low-Speed Data Capability

WyoLink will be a statewide dual purpose network serving and supporting both voice communications and low-speed (up to 9.6 kbps) data applications. The infrastructure will be designed to provide voice and data channels as traffic needs dictate. The vendor's design shall incorporate and include all necessary equipment/software to interface into the State's main public safety data center at DCI including security provisions. Other data interfaces may be requested by individual user agencies into their own data networks. The vendor shall document the equipment and cost of generic interfaces anywhere off-network to accomplish this. The vendor shall address if their proposed solution includes dual function subscriber radios or depends on separate voice and data radios. The vendor shall include as separate optional requirements and demonstrate, all ancillary components

needed at the subscriber end for complete data capability (*i.e.*, laptops, cables, software, heaters, mounting brackets, modems, and other ancillary devices; specialty input devices: card swipe reading; specialty output devices: mobile printing), to accomplish WyoLink's need for text messaging (email without attachments) and inquiries to public safety databases.

### 3.7 High-Speed Data Capability

The vendor shall propose, as an option, their methodology of offering higher-speed data transmissions (over 19.2 kbps) for large file applications. The vendor shall detail the additional system requirements, transmission range, and transmission speed. WyoLink may exercise this option either as a demonstration or as a systemwide application in selected "hot-spot" areas. This requirement is in addition to the statewide requirement for low-speed data.

### 3.8 Paging

The vendor shall propose, as an option, a statewide test paging system that would be designed to meet public safety dispatching requirements for approximately 7,000 statewide users, considering:

1. System shall be capable of individual paging as well as group notifications.
2. System shall be capable of supporting multiple levels of priority.
3. Reliability - 99.99% available per year for the entire paging network.
4. Network Management Monitor and Control capabilities to indicate for paging system resources and status.
5. Voice, tone, and two-way text messaging capabilities, if feasible.

### 3.9 Casual Use

While the primary application of WyoLink is public safety communications, the State also requires casual use (as a lower priority) for other wireless needs during idle periods for activation and/or monitoring applications such as: activating sirens, SCADA, and general data collection applications. While the infrastructure and its design must include this capability, the vendor shall not include the ancillary equipment needed by the user (such as sirens, message boards, etc.), other than control unit receivers and interfacing requirements. The required environment shall have a level of security that will prevent activation by unauthorized transmitters.

### 3.10 Subscriber Devices

The vendor shall propose a wide range of subscriber devices including mobile, portable, and fixed control stations. All subscriber devices shall be capable of meeting the requirements corresponding to the infrastructure as outlined in Section 3.1, and shall also be capable of operating with existing wideband, analog systems. As a minimum there shall be at least three (3) levels or tiers with increasing public safety features. Tier 1 shall include basic features without encryption, Tier 2 shall add encryption and Tier 3 keypad functions. All subscriber radios shall include (or optionally incorporate) an emergency button. Subscriber radios shall be quoted as both clear and optionally equipped encryption transmission units. Individual communications may be encrypted or clear as needed. All subscriber radios shall include automatic user identification and will allow remote shutdown of unauthorized use of the subscriber radio. Subscriber radios shall be capable of adding AVL (automatic vehicle location) modules/features. The WyoLink infrastructure will support and include: subscriber identification and control as well as AVL. The vendor shall detail the complete features of each type subscriber radio proposed, individual unit costs and ancillary items offered including but not limited to: AVL, batteries (standard and high capacity types), antennas, programming, installation, feedline, cases, chargers, remote mobile control heads, etc.

WyoLink subscriber units shall be compatible with emerging Federal government systems. This includes at a minimum P25 CAI and extended frequency band operation covering the Federal frequencies. In addition to Federal VHF frequencies, WyoLink subscriber devices shall cover both new VHF WyoLink frequencies and existing Wyoming VHF high band public safety frequencies.

### 3.11 Roaming

The WyoLink infrastructure will support statewide roaming. WyoLink will be designed to accommodate statewide roaming whereby any subscriber can communicate to their "home" area from anywhere within the state.

### 3.12 Interoperability

The WyoLink network will support the ability of different WyoLink partner organizations and subscribers to communicate with one another when necessary.

#### 3.12.1 Intrastate Interoperability

WyoLink will be designed to provide intrastate interoperability between WyoLink subscribers for normal day-to-day and emergency communications between local agencies, within regions (inter-county), among all state agencies, and Federal

agencies (including Warren AFB, Yellowstone Park, and BLM) as determined by WyoLink user agencies

### 3.12.2 800 MHz Systems

Special attention to design will be required by the WyoLink infrastructure to interface with the Casper and Cheyenne 800 MHz systems.

WyoLink will acquire a system that will overlay the Casper and Cheyenne 800MHz trunked systems; WyoLink will buy the connections necessary to provide "seamless interoperability" between the WyoLink and these other systems. WyoLink will not upgrade the Casper and Cheyenne 800 MHz systems beyond what is required for interoperability in areas where the existing systems' coverages overlap the WyoLink coverage area. WyoLink will not extend 800MHz system coverage elsewhere in the state.

"Seamless interoperability" between WyoLink users and the Casper and Cheyenne 800MHz users includes: shared talkgroups, talkgroup merge, console priority override, and encryption functionality. WyoLink will interconnect such existing features with equivalent WyoLink features, but will not build them into the existing 800MHz systems if they do not already exist. Unit ID functionality is desirable between users of the two systems, but is not vital for seamless interoperability.

Interconnect of the WyoLink system with the Casper and Cheyenne 800 systems must not degrade any function or feature now provided to users within the existing 800MHz system. The interconnections between the WyoLink and Casper, and the WyoLink and Cheyenne 800 MHz systems will not employ an audio patch solution.

### 3.12.3 Interstate Interoperability

WyoLink will provide interstate interoperability to neighboring state and out-of-state local networks during joint operations. WyoLink will be designed to interface with those mutually cooperating out-of-state agencies (as specified elsewhere) to allow interoperability between them and WyoLink partners.

### 3.12.4 Talk Group Inclusion and Exclusion

WyoLink will provide the ability to setup talk groups as defined by WyoLink partner agencies and to disallow communications from unauthorized agencies within exclusive talk groups.

### 3.12.5 Task Force

WyoLink will interface with some non-WyoLink users through the use of

baseband switching technologies.

### 3.12.6 Mutual Aid

Mutual Aid will operate as a wideband, conventional, analog channel to allow non-WyoLink users to interoperate with WyoLink subscribers, potentially well beyond the expected transition date for the new VHF architecture.

### 3.13 Channels

The initial design of WyoLink will incorporate a minimum of four (4) simultaneous talk channels statewide and an additional two simultaneous talk channels (6 total) at 10% of the sites (as specified by the State), where higher traffic is anticipated in urban areas. Vendors shall include fifty-one 4-channel sites and six 6-channel repeater sites (57 total). Voting receiver sites shall include ten 4-channel and ten 6-channel sites (20 total). All sites shall be expandable to allow eight or more simultaneous talk channels of operation, allowing future additions.

## 4.0 Acceptance Test Procedures

A set of comprehensive acceptance test procedures shall be included in the vendor's proposal to ensure compliance with the RFP requirements and industry practices, detailing specific test and measurement parameters expected. This section of the vendor's proposal will provide the means to verify all requirements for the WyoLink network. Specific tests will be identified including the details of what tests are to be performed, who performs the tests, the parameters to be tested, where the tests will be conducted, the data to be recorded, and when the tests will be conducted.

WyoLink will be built by regions or sections of the State, therefore acceptance will be on a per-region basis, with interoperability between multiple regions tested as the network is built out, and final acceptance when the overall WyoLink network is completed. The testing requirements include but are not limited to the following:

1. Shelter and Site Inspections
2. Factory Integration (Staging) Test and Pre-Ship Acceptance
3. Field Functionality Testing
4. Failure Mode Testing
5. Physical Configuration Audits
6. Coverage Testing
7. Interoperability Testing
8. Operational Testing by Users
9. Regional/Statewide Acceptance.

Guidelines for vendor deliverables pertaining to acceptance testing for each WyoLink requirement are shown in Table 1 below:

WyoLink Requirement	Guidelines for Vendor Deliverables - Acceptance Testing	
	With Proposal	Post Proposal
1. Overall WyoLink system design	1.1 Overall design, inter-site communication requirements, performance expectations/ guarantees, off-network interface details/ requirements (other systems, dispatch points, data networks, etc.), representative detailed site designs. Examples of compliance with P25 standards, frequency range capabilities, as well as all other WyoLink requirements.	1.2 Specific design details based on actual implementation plan (initial pilot system); 30-day burn-in period before acceptance testing of all infrastructure equipment and sample testing of subscriber units; 90-day final acceptance after customer use ( to be repeated as system is expanded), including off-network interfaces, and testing of non-WyoLink subscriber devices. Test period is restarted at the State's option upon any system or subsystem failure. Vendor will be required to assist in resolving any P25 compatibility issues that may involve other manufacturers' equipment.
2. Mobile coverage	2.1 Proposed repeater sites, statewide mobile coverage probability prediction plots, coverage area availability guarantees, site/mobile parameters, and testing/acceptance methods/procedures.	2.2 Statewide coverage proof of performance drive test based on mobile unit parameters including both signal measurements and voice quality
3. Portable Coverage	3.1 Proposed additional voting receiver sites, portable area coverage probability prediction plots, coverage area availability guarantees, site/mobile parameters, and testing/acceptance methods/procedures.	3.2 Selected area coverage proof of performance drive test with mobile units adjusted to portable unit parameters including both signal measurements and voice quality.
4. In-Building Coverage	4.1 Proposed solutions, portable in-building coverage probability plots without enhancements.	4.2 Coverage proof of performance based on requirements of optional enhancements implemented.
5. Network Control	5.1 Proposed details of network control points.	5.2 Acceptance testing of primary control point and secondary if implemented.
6. Low-Speed Data	6.1 Proposed details of mobile data operation.	6.2 Acceptance testing.
7. High-Speed Data	7.1 Proposed solutions.	7.2 Acceptance testing if implemented.

WyoLink Requirement	Guidelines for Vendor Deliverables - Acceptance Testing	
	With Proposal	Post Proposal
8. Paging	8.1 Proposed solutions and coverage.	8.2 Coverage proof of performance based on requirements, acceptance testing if implemented.
9. Casual Use	9.1 Acceptance of requirement and operational methods.	9.2 Demonstrate operation of casual use systems.
10. Subscriber Devices	10.1 Offered subscriber units and accessories.	10.2 Acceptance testing of purchased units with fully functional WyoLink infrastructure, system testing of non-WyoLink (analog/wideband) subscriber devices.
11. Roaming	11.1 Acceptance of requirement and operational methods.	11.2 Demonstration of roaming as WyoLink network expands.
12. Interoperability	12.1 Descriptions/details of proposed interconnections with non-WyoLink systems.	12.2 Demonstration and acceptance testing of implemented non-WyoLink systems, demonstration of interoperability between WyoLink and non-WyoLink subscribers.
13. Channels	13.1 Site details of 4 and 6 channel sites, showing built-in expansion to 8 channels.	13.2 Site-by-site confirmation and acceptance testing of required number of channels.

Table 1 - Guidelines for Vendor Deliverables - Acceptance Testing

#### 4.1 General Principles

The principles of the acceptance testing process will include:

1. Wyolink reserves the right to review for completeness and approve all test procedures prior to execution of the tests.
2. WyoLink reserves the right to have a representative present to witness all testing, re-testing, and/or inspections
3. WyoLink reserves the right to independently perform any test as specified
4. All test/inspection results shall be documented, signed off, and submitted to WyoLink in hardcopy (paper) and softcopy (permanent CD-ROM) unless otherwise mutually agreed, in advance in writing
5. Any test/inspection that fails shall be documented on a master list of all test/inspection results plus on a separate list for failures only
6. All tests shall be conducted utilizing certified calibrated test equipment each of which is traceable to the National Institute of Standards and Technology (NIST) and has not exceeded its calibration expiration date
7. All tests shall be conducted utilizing equipment representative of off-the-shelf equipment that will be deployed throughout the network

8. The vendor shall be held accountable to correct any test/inspection failure, and repeat the test/inspection that failed to verify compliance.

#### 4.2 Shelter and Site Inspections

WyoLink is responsible for the site shelters. The vendor shall schedule, early in the project, site visits to inspect each sites to ensure conditions are proper and space is adequate for new equipment. Following the site inspections, the vendor will detail where new equipment will be located, existing site equipment that needs to be relocated, modifications required to accommodate the new equipment, and any site/shelter/tower deficiencies that will be unacceptable for new WyoLink installation and/or operation.

Site inspection will also include primary dispatch facilities (reference Section 4.4.6) and external interfaces for mobile data transmissions. The vendor will document upgrades and/or improvements need to allow WyoLink interface.

#### 4.3 Factory Integration (Staging) Test and Pre-Ship Acceptance

This testing provides the ability to ensure that the equipment meets the minimum required level of specifications. The vendor must provide factory integration (staging) tests and pre-ship acceptance on all equipment (subscriber radios, network infrastructure, etc.) that will be provided to create in a fully functional system, including interfaces to simulated non-WyoLink equipment and systems. This testing shall include technical parameters and both functional and operational tests.

Testing will cover the full hardware and software functionality of all equipment. Testing shall be done using the equipment (hardware and software) integrated, as it will be implemented in the field. Acceptance for shipment to the sites shall be granted only after WyoLink has received all test results and has verified that the equipment has passed all specified tests. WyoLink may witness all factory tests at its option.

#### 4.4 Field Functionality Testing

The Vendor shall conduct testing on the pilot system and continue on a regional basis to verify the functionality of all equipment and systems deployed in the field. Major elements of the system include, but are not limited to, the following:

1. Telecommunications Backbone Network Tests (including any leased circuit services)
2. Land-Mobile Radio (LMR) System Tests (portable, mobile, control station)

### 3. Network Operational Control Tests

#### 4.4.1 Backbone Tests

WyoLink will be responsible for the replacement digital backbone microwave network. The vendor will examine test data (and may conduct its own tests) to verify compliance with WyoLink backbone needs. This will also include any leased lines where used in lieu of microwave. It shall be the vendor's responsibility to ensure end-to-end performance of the network.

#### 4.4.2 LMR Testing

All functional aspects of the WyoLink system must be tested. LMR tests will include the following for the site installed equipment and each channel as necessary:

1. Transmitter Power
2. Transmitter Frequency
3. Transmitter Modulation
4. Voltage Standing-Wave Ratio (VSWR) for fixed and mobile stations
5. Receiver Sensitivity
6. Pre-amplifier gain (if used)
7. Combiner Loss
8. Multi-coupler Loss
9. System Failure Modes
10. Grade of Service

#### 4.4.3 Radio System Feature Testing

Radio system feature sets shall be tested to ensure the following typical call types can be properly completed (for trunked systems):

1. System All Call
2. Group Call
3. Emergency Group Call
4. Private or Individual Call

In addition, the conventional Mutual Aid channel (wideband/analog) will be tested in conjunction with digital trunked channels to verify operational integration as a complete system.

#### 4.4.4 Tone Testing

The following typical trunking tones shall be tested to ensure proper operation:

1. Transmit Grant Tone
2. Out-of-Range Tone
3. Group Scan
4. Transmit Busy Lockout
5. Call Busy or Queue Alert
6. Emergency Declaration
7. Clear

#### 4.4.5 Trunking System Features

The following trunking system features shall be tested to ensure proper operation:

1. Continuous Control Channel Update
2. Transmission/Message Trunking
3. Call Queuing
4. Call Priority
5. Emergency Call Priority
6. Call Validation
7. Confirmed Call
8. Unconfirmed Call
9. Multi-site Routing
10. Digital Voter Functional Tests
11. Analog Voter Functional
12. Telephone Interconnect Calls - Radio Originated (if allowed)
13. Telephone Interconnect Calls - Telephone Originated (if allowed).

#### 4.4.6 Dispatch Features

The vendor will deliver with their proposal dispatch requirements and after contract award, inspect and document improvements needed to any dispatch facility to be integrated into WyoLink. Features shall be tested to ensure the consoles can perform the following (as required):

1. Transmitting with Microphone or Headset
2. Group Call
3. Private or Individual Call
4. Alert Tones
5. Receiving Calls
6. Call History
7. Emergency Call
8. Agency Broadcast
9. Patch
10. Console Pre-Empt

11. Console Intercom
12. Console Crossmute
13. Supervisor Console takeover
14. Priority Override (Pre-empt)
15. Conventional Interface
16. Cross Patching
17. Telephone Interconnect answering and patching a Call
18. Logging Recorder

All functional aspects of the Network Operation Center (NOC) control system shall be tested. Success criteria for the NOC system will be based on manufacturer specifications, engineering parameters, and WyoLink requirements. Where these specifications differ, the most stringent specification parameter, as determined by WyoLink, will apply. Specific NOC tests will be identified by WyoLink, appropriate to the proposed WyoLink technology solution offered by the vendor. Acceptance of the NOC shall be granted when all tests have been passed.

#### 4.5 Failure Mode Testing

The backbone network (e.g., microwave system, leased lines, etc.) and the Land Mobile Radio system, collectively the infrastructure, are required to survive various degrees of failure of system components, including, but not limited to: individual base station/repeater failure, system switch failure, trunking control channel interference, and receive pre-amplifier failure. The vendor will document in its proposal these and other failure modes as describe all of the failure recovery modes inherent in the proposed infrastructure. During the initial regional build out, the vendor will simulate each of these failure modes and demonstrate successful failure recovery. As a further part of failure mode testing, automatic alarm reporting will be demonstrated, and telephone numbers for reporting equipment failure and service problem escalation procedures will be tested.

##### 4.5.1 System Failure Priority Level Determination

Due to the complex nature of the WyoLink network, a certain degree of errors and failures are inevitable during acceptance testing. The following is a list of Priority Levels for such failures during acceptance testing:

- Priority Level 1 failures are major system failures that render the system completely unusable or inoperable. Just one of these is unacceptable and requires a detailed explanation and a complete restart of the test period.
- Priority Level 2 failures are major and minor system failures that significantly reduce system operability and usability. Just one of these

is unacceptable and requires a detailed explanation and a complete restart of the test period.

- Priority Level 3 failures are minor system failures that minimally reduce system operability or usability. These are undesired but acceptable and require a detailed explanation. A complete restart of the test period is not required.
- Priority Level 4 failures are minor system failures and punch-list items that have little effect on system operability and usability. These are undesired but acceptable and require an explanation. A complete restart of the test period is not required.

#### 4.5.2 Failure Mode Definition

The following is a list of Priority Level 1 and 2 Acceptance Testing Failure Modes:

1. Total loss of the system
2. Mobile coverage availability < 95% throughout service area
3. Loss of more than one radio site
4. Loss of more than one channel
5. Failure of any other critical component.

#### 4.6 Physical Configuration Audit

A visual inspection, or physical configuration audit, must be done at each installation site to ensure tidiness and workmanship consistent with best current practices.

##### 4.6.1 Physical Configuration Audit Documentation Requirements

The vendor will perform a physical configuration audit at each equipment location to verify that the installed system is accurately documented, thereby creating the network management and configuration control database. The audit may be witnessed by WyoLink staff, at their option. This audit will be conducted at each location immediately after concluding testing and acceptance of each site or service area, and will include:

1. Verification that the WyoLink radio equipment is operating on the frequencies identified in the system master frequency plan and as listed on the station license, a copy of which shall be posted at each site
2. Verification of the tower latitude and longitude are as stated on the station license
3. Verification that WyoLink antennas are mounted at the elevations specified on the respective station license and if directional that they

- are oriented to the correct azimuth and polarization identified in the system master frequency plan and the station license
4. Verify that all site drawings correspond accurately to all installed equipment fixtures, racks, and cabinets
  5. Verify site signal-flow wiring accurately corresponds to the cable running lists
  6. Inventory major material items comprising each site
  7. Document uncorrected discrepancies remaining at the site, to be completed before final site acceptance.

#### 4.6.2 Physical Configuration Audit Inventory Requirements

At each site the vendor will perform and document an inventory of the type, serial number, quantity, and latest revision number of all contractual deliverable equipment. At WyoLink's option, WyoLink staff may witness the inventory process or spot check the results.

1. A combined inventory list will be provided to WyoLink in a mutually agreeable electronic form, along with a complete set of documentation
2. Discrepancies between installed items, equipment configurations, and quantity, type, and accuracy of documents will be documented and reported to WyoLink, to be corrected by the vendor.

#### 4.7 Coverage Testing

Vendor supplied coverage test procedures will be used to verify that the required coverage availability performance is provided by the network for voice and data communications throughout the service areas within the State. Coverage testing will be performed on a regional area basis, as several sites usually contribute to the overall area coverage. Coverage testing shall not be performed until all sites within a region are fully operational.

Separate sections of the test procedure shall be dedicated to verifying, via field measurements, data-transfer capability and voice communications. The voice communications section shall describe the regional area to be tested, the testing methodologies, the coverage availability requirements, and the desired channel performance (minimum of DAQ 3.0). The section for data communications will add the data-transfer performance requirements and BER (bit error rate) testing. The testing methodology used will optimally be based on the Telecommunications Industry Association (TIA) Telecommunications Systems Bulletin TSB88-A, titled "Wireless Communications Systems, Performance in Noise- and Interference-Limited Situations, Recommended Methods for Technology-Independent Modeling, Simulation, and Verification."

#### 4.7.1 Responsibilities

The primary burden of resources is placed on the vendor for this testing:

1. The vendor will prepare all drive-route planning and/or test-location planning, subject to approval by WyoLink
2. The vendor will provide all test equipment that is necessary to conduct its tests
3. The vendor will provide test vehicle(s), driver(s), test technician(s) and all ancillary equipment necessary to conduct the tests and record the data
4. At least one WyoLink representative shall be present during testing
5. If, for any reason(s), test measurements are deemed unusable or inaccurate by WyoLink, the test will be performed as many times as necessary to compile accurate and acceptable data
6. As coverage is statewide for mobile and regional for portable, there will not be a requirement for a maximum acceptable number of nonconforming adjacent tiles, however these areas will be noted for future review.

#### 4.7.2 Coverage Test Procedure

The coverage test procedure will be used to verify that the specified coverage availability and channel performance are provided by the radio system throughout the service areas specified for mobile communications within Wyoming. The vendor is limited to three classifications of service areas as follows:

- Broad Service Area
- Regional Service Area
- Specific Geographical Area.

The following is a description of each type of service area:

- *Broad Service Area* is any area that has a sufficient number of test 'tiles' that are uniformly distributed and that can be accessed by roads for coverage verification. A *Broad Service Area* may also contain *Regional Service Areas*, as well as portable coverage area requirements.
- *Regional Service Area* is any area that has a small proportion of roads in relation to the geographical area contained within the service area. These areas may or may not have sufficient road coverage to ensure that the required number of uniformly distributed test tiles can be accessed utilizing a conventional four-wheeled vehicle

(automobile, truck, sport utility vehicle). A *Regional Service Area* may also contain *Specific Service Areas*, as well as portable coverage area requirements.

- *Specific Service Area* is any area deemed to require coverage, but may require special access methods to test. The *Specific Service Areas* will be based on a geographical area that can vary greatly in size. The area can be as small as a specific address, or may encompass a larger area such as a city or town. The *Specific Service Areas* will be tested separate from the test tiles used to validate *Broad* or *Regional Service Area* coverage.

#### 4.7.3 Coverage Testing Modes

Two modes of coverage testing are envisioned. The mode of testing to be employed will be determined by the WyoLink staff. Suggested modes of testing are:

- Service Area - this will determine the coverage in the service areas that are of most importance to measure. Since it is not possible to measure coverage in every square foot of the State, the most important (and some random) service areas shall be chosen to validate the predicted coverage.
- Interference testing (in selected areas where there is suspicion of interference from other transmission origins) shall be done to ensure that any interference does not degrade the quality of the communications below the desired level.

##### 4.7.3.1 Bit-Error-Rate Testing

For both voice and data digital services, a Bit-Error-Rate (BER) test will be performed on both the talk-out and talk-in paths. The talk-out path is the network to a subscriber unit and the talk-in is the subscriber unit to the network. Talk-in testing may be evaluated using the talk-out test with an agreed-to differential applied that corresponds to the difference in link budget between these paths. However, irrespective of the test/analysis method, satisfactory in-service two-way performance is required. Before starting drive tests, transmitter measurements from each network site in use shall be made and adjusted as necessary to site specifications.

The test equipment will measure BER while traveling in a drive-test vehicle or by alternative method approved by WyoLink, for all coverage verification. The test vehicle will be equipped with a mobile antenna system representative of that which will be used by WyoLink users, and be mounted

in the same location as a user vehicle antenna will be mounted. Gains/losses associated with the mobile antenna and cabling must be known, and the recorded data adjusted accordingly.

Mobile equipment used for testing must be representative of equipment that will be used by WyoLink users. All equipment must be certified that it is performing within its specifications. At minimum, the data collected will consist of received signal strength (RSS), BER results, GPS position data (latitude & longitude, augmented by dead reckoning), date and time stamp for all measurements, seasonal conditions (e.g., foliage), and general weather/environmental conditions. All data collected shall be made available to WyoLink staff for review and analysis. In addition to the BER test to validate coverage, speech samples shall be recorded, meeting a minimum DAQ 3.0 and shall be able to be referenced with BER measurements taken simultaneously.

#### *4.7.3.2 Testing in Less-than-Full-Foliated Conditions*

Full-foliated conditions are considered to occur from June 1 to October 1 inclusive. If testing is done under less-than-full-foliated conditions, coverage acceptance will only be conditional. Retesting of the service area using the same drive route shall be repeated to verify compliance during full-foliated conditions. Final acceptance will only be granted if no coverage-related problems occurred during the full-foliated conditions.

#### *4.7.3.3 Re-testing Methodology*

If a service area fails to meet the coverage performance requirements, the vendor will correct the coverage problem, after which re-testing of the entire service area will be required, using the same drive route and/or test locations. This process will continue until the service area meets the criterion for passing.

#### *4.7.3.4 Portable Service Area Testing*

Selected areas of the State where portable subscriber unit operation is critical will require that drive test thresholds be adjusted for lower signal levels due to the additional path losses from “portable on-hip” operation, antenna gain, and transmit power. Portable operation will be spot checked along the drive route at location mutually agreed to by the State and the vendor. Additional margins for in-building testing may also be required and will depend on the actual coverage area.

#### 4.7.3.5 Data Coverage Test Procedure

The vendor shall propose a data coverage test procedure based on the technology proposed by the vendor. A similar process for testing the voice coverage will be followed to verify data coverage.

### 4.8 Interoperability Testing

After complete WyoLink system testing, the vendor shall move into interoperability testing. Interoperability testing shall include the ability of WyoLink subscriber radios to communicate to legacy VHF systems, joint inter-system testing (*i.e.*, Casper/Cheyenne 800 MHz systems, Federal systems such as Yellowstone National Park, Warren Air Force Base, and the Bureau of Land Management) and systems in participating neighboring states.

The following inter-site testing with other network sites will be performed after satisfactory completion of performance and coverage testing of each individual site:

#### 4.8.1 Subscriber Static Functionality

Using a subscriber unit operating stationary at the new site, perform tests of all of the unit's voice and data services with another subscriber in a random sampling of the other sites. Voice quality, Bit Error Rate and latency from one unit to the other shall be included in the testing.

#### 4.8.2 Mobility Management

While communicating in the new site's area, the tester will travel into the adjacent site's coverage area and note that the communication continued without interruption as the service area changed from the new site's area to the adjacent site's area. It is desirable to perform this test in an area where the radio signal coverage transition to an adjacent region is more abrupt.

#### 4.8.3 Internetworking with Legacy Systems

Test the predefined functionality to be provided through interfaces with WyoLink user units and consoles. This will also include tests of inter-regional communication with other systems through appropriate gateway interfaces.

#### 4.9 Operational Testing by Users

After acceptance of regional areas such as the pilot system, selected WyoLink partner agency personnel will be issued subscriber units to perform functionality tests using portable radio units, consoles, and vehicles with installed WyoLink subscriber voice and data terminal devices. The operational system testing shall proceed with sufficient qualities to demonstrate actual working conditions and environment. Testing shall include interface testing to “foreign” systems (*i.e.*, data servers, non-WyoLink sites or systems). As portions of WyoLink become operational, performance shall be monitored, including:

1. Reported poor coverage areas
2. Reported poor audio quality
3. Reported poor data performance
4. System/channel uptime and overall performance

#### 5.0 **WyoLink Responsibilities**

This section identifies WyoLink requirements which are not the responsibility of the vendor. The WyoLink administrative team will ensure that all (State, local, and Federal) sites used by WyoLink will be upgraded to WyoLink standards as necessary and required. These include:

1. Memorandums of Understanding (MOUs) agreements for non-WyoLink sites to cover such items as: site access, site management, and site sharing agreements.
2. Power
  - a. Add/expand utility supplied and generator kW/kVA capacity for environmental, lighting, and communication needs.
  - b. Add/expand generator fuel capacity to ten (10) days at full load.
  - c. Add/expand UPS backup time to a minimum of 15 minutes while supplying communication needs.
3. Physical Structures
  - a. Upgrade/replace towers where necessary due to age/condition, physical loads to handle additional microwave/radio antennas/feedlines and to improve tower grounding.
  - b. Upgrade internal grounding for equipment, racks, and feedlines.
  - c. Upgrade/replace shelters due to condition or to provide additional space.

4. Physical Security
  - a. Upgrade building security with building alarms to monitor entry, power conditions, and environmental status.
  - b. Upgrade site security to include locked gates at the entry point of the access road and more advanced methods (*i.e.*, remote monitoring of gate entry, vehicle detectors near the shelter and/or video security).
5. Environmental - Add or increase air conditioning with temperature monitoring.
6. Backbone Network Reliability and Capacity
  - a. Upgrade capacity with digital microwave - ongoing under separate WyDOT project. Vendors shall specify their requirements of channel or bandwidth capacity needed at each site.
  - b. Improve reliability with closed loops - under evaluation by WyDOT.
7. Site upgrades requested by the vendor as described in Section 4.2, Site Inspections.

WyoLink personnel will also be responsible for overall project management, final design approval, providing site access and meeting facilities, FCC/FAA licensing, and arranging contacts to non-WyoLink agencies and facilities.