



July 14, 2020

ADDENDUM NO.: One

TO ALL OFFERORS:

REFERENCE: Request for Proposal No: **RFP# FDC-1078**
Dated: June 29, 2020
Commodity: Public Safety Distributed Antenna System
RFP Closing On: **July 29, 2020 @ 2:00pm**

Please note the clarifications and/or changes made on this proposal program:

The JMU Public Safety Distributed Antenna System Specification document is now a part of the RFP by way of attachment with this addendum.

Signify receipt of this addendum by initialing "*Addendum #1* _____" on the signature page of your proposal.

Sincerely,

Doug Chester
Buyer Senior
Phone: (540-568-4272)

MSC 5720
752 Ott Street, Room 1042
Wine Price Building
Harrisonburg, VA 22807
Office of 540.568.3145 Phone
PROCUREMENT SERVICES 540.568.7936 Fax

JMU PUBLIC SAFETY DAS - SPECIFICATIONS (Published Revision 2020-07-01)

JMU DAS/BDA Specifications and Scope of Work:

- This Public Safety DAS Specification shall apply to all JMU DAS/BDA Systems installed on JMU owned or operated facilities.
- Any variances, discrepancies, or additional requirements from this standardized specification for JMU DAS/BDA Systems will be addressed in the corresponding sections of a separate but specific site related **Scope Of Work** which will be issued prior to the time of procurement for any DAS/BDA design for new building, building refresh or system upgrade.

JMU DAS/BDA Ownership:

- Public Safety DAS/BDA Ownership and Administration in JMU Owned Buildings will be by the JMU IT Telecom Department; MSC 5732 – JMAC1, 1021 S Main St, Harrisonburg, VA 22807; Phone 540-568-6471.

JMU Public Safety DAS/BDA Systems Must Support Enhanced Communications for:

- 450-470 MHz LMR for JMU Legacy UHF System
- 806-869 MHz NPSPAC channels for Local HRECC P25 Public Safety Trunked 800 Mhz System usage.
- 700 MHz Band 14 FirstNet LTE in anticipation of migration to the FirstNet Public Safety Network in Virginia is not a requirement for Band 14 coverage in the DAS today.
- It is anticipated that all the services will be taken over the air and the proposed DAS network should include rooftop donor antennas for each service and each signal source. It is not a requirement to provide a donor antenna for FirstNet at this time, although connectivity and an appropriately sized roof penetration should be provided for future installation of additional donor antennas and cabling to support 700 Mhz FirstNet.
- The proposed system should also be able to support connectivity for a local base station for FirstNet.

Location of Current Radio System Sources for the 450 MHz and 800 MHz bands:

- **UHF JMU Frequencies to be repeated:**
 - UHF Frequencies DownLinks (DL) are listed in MHz
 - All UpLinks (UL) are 5 MHz higher than the DL frequencies
 - **UHF Donor Site 1:**
 - **JMUPD** (DL) 453.9000 (UL) 458.9000
 - **ADMIN** (DL) 453.6250 (UL) 458.6250
 - Repeater Site: Showker Hall, 421 Bluestone Dr, Harrisonburg, VA 22807
 - GIS: LAT: 38°26'00" N LONG: 78°52'21.6" W
 - **UHF Donor Site 2:**
 - **FM** (DL) 453.4250 (UL) 458.4250
 - Repeater Site: Wilson Hall, 951 Madison Dr, Harrisonburg, VA 22807
 - GIS: LAT: 38-26-17.1 N LONG: 078-52-23.3 W
 - **UHF Donor Site 3:**
 - **B&G** (DL) 453.2250 (UL) 458.2250
 - **UREC** (DL) 453.8125 (UL) 458.8125
 - Repeater Site: ISAT/CS Building A1, 701 Carrier Dr, Harrisonburg, VA 22807
 - GIS: LAT: 38°26'03" N LONG: 78°51'44.9" W
 - You may combine the signals from multiple UHF donor antennas with a combiner between the surge arrestors and the UHF repeater Donor port. The use of an Omni donor antenna may be a better way of aggregating multiple UHF serving sites into the system.

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- **800 MHz HRECC trunked frequencies to be repeated.**
 - 800 Frequency DownLinks (DL) are listed in MHz.
 - All UpLinks (UL) are 45 MHz lower than the DownLink (DL) frequencies.
 - 800 Mhz Donor is part of the HRECC P25 TRUNKED RADIO SYSTEM:
 - HRECC Trunked Radio System Frequencies:
 - (DL) 851.4625 (UL) 806.4625
 - (DL) 851.5625 (UL) 806.5625
 - (DL) 852.1125 (UL) 807.1125
 - (DL) 852.3375 (UL) 807.3375
 - (DL) 852.6000 (UL) 807.6000
 - (DL) 852.6875 (UL) 807.6875
 - (DL) 852.8625 (UL) 807.8625
 - (DL) 853.1250 (UL) 808.1250
 - (DL) 853.1875 (UL) 808.1875
 - (DL) 853.3750 (UL) 808.3750
 - (DL) 853.9250 (UL) 808.9250
 - Potential Donor Sites – AHJ has the final approval on the specific donor site to use.
 - Tower Site: Tower Street, 653 Tower St, Harrisonburg, VA 22802
 - GIS: LAT: 38°27'07.1" N LONG: 78°51'06.9" W
 - Tower Site: Stone Spring, 1565 Peach Grove Ave, Harrisonburg, VA 22801
 - GIS: LAT: 38°25'04.3" N LONG: 78°52'31.8" W
 - Tower Site: Massanutten Peak, 856 Rainier Rd, Massanutten, VA 22840
 - GIS: LAT: 38°23'34.2" N LONG: 78°46'11.5" W
 - Tower Site: Kaylor Hill, 1319 W Mosby Rd, Harrisonburg, VA 22801
 - GIS: LAT: 38°24'47.7" N LONG: 78°54'52.3" W
 - Tower Site: HRECC, 101 N Main St, Harrisonburg, VA 22802
 - GIS: LAT: 38°27'02.3" N LONG: 78°52'07.1" W

Designated Critical Area Coverage Requirements:

- Critical Areas specifically designated by JMU and AHJ include [REF: NFPA 1221, 9.6.7.4]:
 - ALL Elevators, Elevator Lobbies & Elevator Control Rooms
 - ALL Mechanical & Equipment Rooms
 - ALL Exit Stairwells
 - ALL Exit Passageways
 - ALL Areas of Refuge and/or Areas of Rescue Assistance
 - ALL Fire Control Rooms
 - ALL Command & Control Centers
 - ALL Commercial Kitchen and Food Preparation Areas
 - ALL HAZMAT Usage Areas (labs) and Storage Areas
 - ALL Sprinkler Sectional Valve Locations
 - ALL Standpipe Cabinets
 - Any other areas that may be designated by JMU and/or AHJ as Critical Areas for specific structures.

Delivered Audio Quality (DAQ) Requirements:

- JMU requires that BDA/DAS systems installed in JMU Facilities provide an overall targeted **[95/95 @ 4.0 DAQ = (*Speech easily understandable. Little noise or distortion. 95% of the time across 95% of the general coverage area.*)]** over the entire service area. In the presence of exigent circumstances that significantly hinder the ability to obtain a 4.0 DAQ, JMU may allow a minimal acceptance level of **[95/95 @ 3.4 DAQ = (*Speech understandable without repetition. Some noise or distortion present. 95% of the time across 95% of the general coverage area.*)]** for approval by JMU and the AHJ for both UHF and 800 Mhz. [REF: NFPA 1221, 9.6.7.5]
- Critical Areas in the buildings require **[99/99 @ DAQ 3.4 (*Speech understandable without repetition. Some noise or distortion present. 99% of the time across 99% of the critical coverage area.*)]** coverage or better by JMU and as approved by the AHJ for both UHF and 800 Mhz. [REF: NFPA 1221, 9.6.7.4]

Radio Signal Strength Coverage Requirements (RSSI in -dBm):

- In an effort to meet the JMU Targeted Standard of [95/95 @ 4.0 DAQ], Design Propagation Prediction Modeling for 800 Mhz relative to Received Signal Strength Indicators (RSSI) of -95 dBm or better for the designated coverage areas.
- The entire coverage area shall meet the -95 dBm Minimum Propagation Signal Strength Requirements set forth in NFPA 1, 0.3.3 & 11.10; NFPA 72 and NFPA 1221.

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- JMU and AHJ will test for 4.0 DAQ and 800 MHz Signal Strength using test transmissions and signal strength indicators on first responder public safety radios and other signal strength analyzers during walk through testing of completed projects to determine Delivered Audio Quality and Propagated Signal Strength for the overall coverage area and specifically in Designated Critical Areas and will note compliance on Final Approval & Acceptance Documentation.

System Design and Approval:

- Design, engineering and installation of the entire DAS by any contractor will require continued close communications and coordination efforts the JMU Project Manager (JMU PM), JMU IT Telecommunications Department (JMU ITT), JMU Public Safety (JMUPD), Local Fire Marshall's Office (AHJ) and with the VA State Fire Marshall (VSFM).
- An additional assessment of the coverage area shall be coordinated by the Contractor/Designers with the JMU PM and include JMU ITT, JMUPD, AHJ and the VSFM, to be conducted generally when the building is 85% complete to take into consideration construction design, environmental conditions and materials used that may be found to impede the distribution of radio frequency signal in the structure when it is 100% complete and that the system design accurately addresses system area coverage requirements. This will allow for conduits and additional power installation needs to be addressed while pull paths are still accessible and give JMU the opportunity to assess whether the system is over or under designed so they may approve any necessary change orders.
- Requirements set forth by first-responder code, ordinance, or the AHJ shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor's responsibility to ensure that the system complies with all JMU, local and state codes, ordinances and/or requirements established by the AHJ (whichever is more stringent).
- The Contractors/Designers shall perform thorough reviews of the construction drawings, and perform their site survey with the JMU representative prior to submitting the preliminary design document to include a color coded Propagation Prediction Map that demonstrates proposed design meets specifications.

Electrical and Mechanical:

- Active equipment should be modern equipment only, and to the greatest extent, shall use modular design to facilitate potential upgrades and expansions.
- All operating parameters shall be stored in electrically alterable non-volatile memory technology and shall be field programmable.

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- All equipment assemblies and sub-assemblies shall be shielded to the greatest extent possible to minimize susceptibility to electromagnetic interference from, or to other co-located and/or adjacent equipment in accordance with FCC approved standards.

Programming Software:

- Programming, alignment and service software shall be supplied. All programming software shall be the latest version and be licensed to JMU.
- System design, hardware and software shall be serviceable for not less than 5 years from date of acceptance.
- Required programming, alignment and service cable, as well as extender cards shall be supplied by contractor at time of installation.

Equipment Locations and Enclosures:

- Head end equipment should be located in the MDF or other room identified by JMU Telecom for this purpose where space is available to:
 - Support a 2' x 3' Wall Mounted Device weighing 100 lbs with adequate clearance, power and ventilation.
 - Accommodate a Free Standing Rack/Cabinet/Enclosure weighing up to 500 lbs and occupying no more than 3'L x 3'W x 6'H of floor space with adequate clearance, power, and ventilation.
- Should remote hubs or amplifiers be required, wall space or rack space will be identified by JMU Telecom for the Contractor/Designer to install this equipment in IDFs, etc.
- All BDA/DAS RF Equipment Enclosures should be (at minimum) NEMA-4 TYPE or NEMA4X TYPE enclosures and/or RATING of IP65 or HIGHER for interior 19" equipment rack mounted hardware, and consistent with other code requirements.
- Stand Alone UPS Battery Enclosures should be NEMA-3R Complaint or higher
- Active equipment shall be supported safely to prevent falling or damage in normal use and maintenance.

Head End Design:

- System shall provide for independent donor downlink level control for each frequency for conventional channel, and band isolation controls for trunked channels, to allow for signal

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level modifications should the external radio source be relocated or reconfigured in the future.

- Uplink and downlink paths shall be equipped with automatic level or gain control to provide more consistent signal performance and protect from amplifier overload and intermodulation products.
- Critical network equipment shall provide SNMP alarm message capability compatible with existing JMU SNMP monitoring capabilities to indicate a condition or conditions that would disrupt or degrade DAS performance.
- All passive components must be sold and supported by a US headquartered manufacturer or supplier. The term 'supplier' does not include a Distributor; but the products can be procured through a distributor.
- The Contractor/Designer is responsible for proving routes for coaxial cabling.
- Equipment shall be FCC Type Certified for all proposed operating bands.
- All RF equipment provided shall be installed to comply with operational requirements of FCC authorizations and the manufacturer's FCC Type Certification.
- JMU Prefers Passive Distributed Antenna System Designs in our structures if they can sufficiently meet coverage signal strength and audio quality requirements. However, alternative approaches are welcome should the designer believe that these alternatives offer acceptable performance with cost saving or other technical advantages.

Cabling Selection, Design Layout and Supply:

- Cabling used in the DAS, including coaxial, solid copper and fiber-optic, shall be selected by the Contractor/Designer, so long as it is compliant with NFPA 72 and approved by JMU.
- Installation of indoor and outdoor antennas, bi-directional amplifiers, fiber RF distribution hardware, RF and optical cabling, filters, backup power, and all cabling and wiring required to interface, monitor and power supplied devices, etc., shall be the responsibility of the Contractor.
- The Contractor shall be responsible for installation of roof-mounted donor antennas fixed or on sleds, antenna connecting jumpers, grounding and termination, roof penetrations and sealing of said penetrations.

Interior Antennas:

- Internal DAS antennas should be chosen and installed with a balance towards minimizing aesthetic impact on the building and achieving dominant signal level inside the building. Ceiling, Wall Stand-off or Pole Mounts may need to be provided or painted by the installer to blend aesthetically with the surrounding color palette as approved by the University
- Samples of the indoor antennas and mounting options chosen for the DAS must be presented to JMU IT Telecom personnel managing the project prior to approval being given for the project design.
- All installations must be approved by JMU Engineering and be approved by the University for aesthetic and safety considerations before work begins.
- Selection of the specific antenna models for use inside the building structure shall be the responsibility of the Contractor/Designer.
- Antennas, cabling and mounting hardware in proposed areas should not be readily accessible by the public or non-maintenance personnel. In some cases, to be determined by JMU, additional tamper proof measures may be required.
- Unless otherwise specified, All DAS Antennas, splitters and cabling shall support multiple band width spectrums to include JMU UHF 450 MHz and Regional 800 MHz frequencies regardless of whether or not BDA's for both UHF 450 MHz and/or 800 MHz are initially installed.

Interior Cabling and Fittings:

- Cable routing will be coordinated with JMU Telecom and JMU FM Engineers to identify and utilize proposed and/or existing pathways within a structure that take into consideration the specific needs of this project and the potential needs for future projects when considering pathway, junctions, size and access portals to conduits. [REF: NFPA 70, 312.5(A-C)] [REF: NFPA 1221, 5.5]
- All Cabling will need to be neat, hidden out of sight in open ceiling systems, structural framing, poles, conduits, wire molding or raceways such that it is reasonably protected, aesthetically acceptable or blends with surroundings and not easily accessible to the general public as approved by the University.
- All Vertical Riser Cabling inside the structure SHALL BE INSIDE of NFPA approved conduits and/or tubing as approved by AHJ.
- Horizontal cabling on separate floors IS NOT REQUIRED TO BE INSIDE of conduit and/or tubing, but must have a UL Certification of **CMP** or NEC Certification of **MPP** (cable

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meeting **CSA FT6** Flame Test or ANSI/NFPA 262 / UL 910 standards) for exposed cabling with fire retardant sheathing as approved by AHJ.

- All exposed Horizontal cabling in plenum areas must be (UL) **CMP** and/or (NEC) **MPP** Certified as approved by the AHJ or it will be required to be in NFPA approved conduit or tubing.
- All Horizontal cabling support systems need to be installed according to manufacturing specifications.
- Install electrical style junction boxes at each floor for Vertical Riser to Horizontal Cabling connections. These boxes must be labeled "DAS # FLOOR RISER CONNECTION"
- All Exposed Horizontal Cabling must terminate inside NFPA approved enclosures or electrical style junction boxes at junctures with riser cabling as approved by AHJ.
- All Vertical Riser Wiring Inside of Buildings, Conductors and Fiber-optic cables shall be installed in accordance with NFPA 70 in any one of the following wiring methods [REF: NFPA 1221, 5.5.2]:
 - Electrical Metallic Tubing
 - Intermediate Metal Conduit
 - Rigid Metal Conduit
 - Surface Metal Raceways
 - Rigid Polyvinyl Chloride Conduit only if specifically, pre-approved by AHJ [REF: NFPA 1221, 5.5.2.1]
- Splitters and couplers shall be independently and separately supported from the coax. In no case may the weight of the splitter or coupler be suspended only from the coax in any orientation. Wire or other supports for splitters and couplers shall attach to structure or other building components per governing code.
- Coax cables must be installed and supported in a fashion that meets local codes, or this project's specifications for low voltage cabling.
- Coax cannot be installed as "laid on" or "lay-in" above tile ceilings. It must be suspended above the lay-in tile ceiling per local code requirements, and in accordance with requirements for other interior low voltage communications cabling. Support with J-Hooks above lay-in ceilings not to exceed 5' on center [REF: TIA 569] is acceptable.
- Contractor/Designer shall provide appropriately sized conduit everywhere else as approved by JMU ITT and Engineering where penetrating partitions (floors or walls) that is adequate to prevent cable damage and capable of meeting potential future needs.

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- The bend radii for ALL COAXIAL CABLE installs SHALL be within manufacturers specifications.
- Use of powered mechanical pullers on ANY coax cable is prohibited.
- Indoor Coaxial Cable from the Repeater Output for the indoor DAS must be at least:
 - (UL) **CMP** or (NEC) **MPP** rated outer jacket (Meeting CSA FT6 Flame Test Requirements).
 - Appropriately sized cabling, non-radiating, 50 ohms impedance.
 - Other corrugated coax cable substitutes for this coax are allowed under the following conditions. Must meet a return loss specification of > 30 dB at 400-900 MHz when used with the manufacturer's connectors specified for the cable.
- Coax connectors:
 - Connectors must be fully threaded onto the mating connector and torqued to manufacturer's specifications.
 - Cable end preparation must be done with manufacturer's precision, preset cable end preparation tools. Manual flaring tools must also be used for flare type connectors if offered for sale by the manufacturer; installing connectors without manual flaring of the outer conductor is not acceptable.
 - Cable integrity testing shall be completed by the installer by means of a Sweep Test with Spectrum Analyzer or other acceptable procedure at the time of install and meet minimum industry standards. Results of integrity test shall be included with "As-Built" documentation submitted by vendor/installer to JMU ITT upon project completion.
- Coax surge arrestors:
 - 50 ohm type using gas tube surge arrestors.
 - Maximum gas tube break over voltage shall be 90V.
 - Connectors used in the system must meet the performance standards equivalent to or greater than an N-Type Connector.
 - Must include grounding stud or lug connection on surge arrestor body which may be removable.

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- Stainless steel or nickel plated brass body.
- Indoor splitters and couplers:
 - 50 ohm impedance.
 - Industry standard coupling values of 6, 10, 15 and 20 dB for couplers must be used.
 - Use of either Wilkinson type splitters or 'tappers' is allowed.
 - Connectors used in the system must meet the performance standards equivalent to or greater than an N-Type connector.
 - Machined metal outer housing painted, anodized or passivated for corrosion resistance.
 - Frequency range must be specified for the 450-900 MHz frequency range or greater.

Exterior Antennas:

- External donor antennas should be installed in compliance with industry standards and methodology.
- The Contractor/Designer will work with JMU to identify all donor antenna locations. All installations must be approved by JMU Engineering and be approved by the University for aesthetic and safety considerations before work begins.
- Selection of the specific antenna models for use outside the building structure shall be the responsibility of the Contractor/Designer.
- Antennas shall be high quality, ruggedized models designed for long-term, outdoor use with high-reliability performance and reduced generation of passive intermodulation (PIM)
- Couplers, duplexers, filters, combiners and related hardware utilized outside the building should be designed for long-term, outdoor use with high reliability and minimal PIM.
- Each exterior transmission line shield shall be equipped with a ground kit and connected to an external ground bus bar provide by the Contractor. JMU, for existing buildings, and the General Contractor, for new construction, will provide the ground conductor and the Contractor shall attach securely to this ground bus bar.

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- External DAS or BDA antennas shall be protected from lightning and static discharges with an appropriate Transient Voltage Surge Suppression (TVSS) device.
- All exterior mounting hardware shall be of steel and hot-dipped galvanized. Grounding hardware shall be stainless steel with copper conductors as appropriate.
- Samples of the exterior antennas and mounting options chosen for the DAS must be presented to JMU IT Telecom personnel managing the project prior to approval being given for the project design.
- Antennas, cabling and mounting hardware proposed for areas accessible by the public shall be tamper-proof and protected from easy manipulation and/or damage.
- UHF band donor antennas:
 - Minimum 50 ohm, Omni, Yagi or log-periodic type.
 - Minimum gain of 6 dBd over 450-470 MHz.
- Outdoor donor antenna: 800 MHz Trunked public safety donor:
 - Minimum 50ohm, Yagi or log-periodic type.
 - Applicable gain for 806 to 862 MHz and intended purpose of the system.
 - Heavy aluminum or stainless construction; Directional elements shall be mounted to the boom through holes through the center line of the boom and welded in place or pinned in place with stainless steel fasteners.

Exterior Cabling and Fittings:

- Cable routing will be coordinated with JMU Telecom and JMU FM Engineers to identify and utilize proposed and/or existing pathways within a structure that take into consideration the specific needs of this project and the potential needs for future projects when considering pathway, junctions, size and access portals to conduits. [REF: NFPA 70, 312.5(A-C)] and [REF: NFPA 1221, 5 (Applicable Sections)]
- All Cabling will need to be neat, hidden out of sight in open ceiling systems, structural framing, poles, conduits, wire molding or raceways such that it is reasonably protected, aesthetically acceptable or blends with surroundings and not easily accessible to the general public as approved by the University.

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- All Wiring on the Exterior of the Structure, Conductors and Fiber-optic cables shall be installed in accordance with NFPA 70 in any one of the following wiring methods [REF: NFPA 1221, 5.5.2]:
 - Electrical Metallic Tubing
 - Intermediate Metal Conduit
 - Rigid Metal Conduit
 - Surface Metal Raceways
 - Rigid Polyvinyl Chloride Conduit only if specifically, pre-approved by AHJ [REF: NFPA 1221, 5.5.2.1]
- Coax cable from donor antennas to repeater should be:
 - Black UV rated outer jacket.
 - (UL) **CMP** or (NEC) **MPP** rated outer jacket (Meeting CSA FT6 Flame Test Requirements).
 - 1/2" or .400" nominal industry size or appropriately sized cabling.
 - Use a single corrugated outer conductor, or a combination braid + conductive tape outer conductor.
 - Have a specified loss per 100' not exceeding 2.9 dB at 450 MHz.
- Coaxial Jumpers:
 - Coax type: Preferred RG142 or other double shielded coax type that is size equivalent to RG-58. Contractor/Designer may suggest alternates if engineering design identifies better potential solution.
 - See section on indoor antennas for jumpers from DAS to indoor antennas.
- Coax connectors:
 - 50 ohm impedance, .400" or 7/8" nominal industry size or appropriately sized cabling to match the coax size on which the connector is mounted.
 - Connectors used in the system must meet the performance standards equivalent to or greater than an N-Type connector.

- Connector mounting:
 - For corrugated outer conductor coax, use threaded front and back, shell type connectors designed for automatic flare-and-clamp field assembly design.
 - High Quality Matching Connectors that match the coax type required. Crimp style connectors are not acceptable.
- Passivated stainless steel or silver-plated outer shell.
- Gold plated captivated center conductor.
- Manufacturer shall match to coax on which the connector is mounted. Coax type and connector type shall be specified by that manufacturer as made for each other.
- Connector type is to be N type unless noted otherwise for the indoor antennas.

System Power, UPS Backup and Automatic Emergency Generator

- All electrical outlets supplying power to radio communications equipment that are connected to Emergency Generator circuits shall be RED in color and labeled to identify the respective breaker box and circuit number that controls that outlet.
- All BDA/DAS Systems shall be installed on circuits supported by Automatic Building Emergency Generator Power to maintain Controller/Repeater during domestic power outages when available.
- If multiple Generators are present BDA/DAS Systems shall be connected with Emergency Generators designated and labelled specifically for Telecom, Emergency Notification, and Communications Services.
- Where an Automatic Emergency Generator Power Transfer Switch is present a UPS system shall be installed that provides **at least 3 hours** of uninterrupted electrical power to all communications devices until the automatic transfer switch fully engages to provide stabilized Emergency Generator electrical supply or until the power can be manually transferred in the event of an automatic transfer switch failure as approved by AHJ. [REF: NFPA 1221, 4.7.8]
- Dedicated Stand-alone UPS options shall be used if Automatic Building Emergency Generator Power circuits are not available. These UPS Systems shall also include battery backup for all electronic devices capable of supporting normal communications usage for a period of **24 hours** in accordance with NFPA standards
- Power loss, power restoration, surges, sags and/or brownouts shall not alter the unit's operating parameters. The unit shall remain fully operational when supplied power is

within the specification of its design. The unit shall automatically recover within a maximum of **90 seconds** after experiencing any of the aforementioned occurrences.
[REF: NFPA 110 Generators & Emergency Standby Power]

- Stand Alone UPS Battery Enclosures should be NEMA-3R Complaint or higher.

Grounding, Lightning & Power Surge Protection

- Equipment shall be properly grounded.
- Care shall be taken to minimize the length of the connection to the internal ground bus and sharp bends in the ground lead shall be avoided.
- All Interior electronic equipment racks and chassis shall be connected to the internal building grounding bus using copper wire.
- All ground wire shall be #6 Gauge Wire or heavier with non-ferrous compressive connectors or crimp on lugs on each end.
- Ground connections to structure must be clean, bare metal, and to surfaces that are treated with a conductive paste prior to attachment of the ground lug.
- Circuit Protection shall be in accordance with NFPA 70 and NFPA 1221, 5.6 (Applicable Sections).
- Surge suppression devices should be provided for all active components.
 - This includes but is not limited to the Main repeater ground and any added donor coax surge suppressor at the main repeater.
 - Donor coax surge suppressor ground in each donor coax line must be installed and grounded within 10' of the building entry of the coax.
- Exterior Ground connections may be compressive grounds, or CadWeld grounds. Appropriate precautions for the use of the CadWeld process must be taken to prevent burning or excessive smoke.
- The following Exterior grounding must be performed:
 - Donor antenna mast ground; Earth ground is preferred but this mast ground path can be to structure if earth ground isn't readily available. (Requires approval from JMU ITT)
 - Connections:

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- Any compressive or other mechanical exterior ground connection must be treated with a ground paste prior to ground installation, and then covered with a protective layer of Butyl followed by a covering layer of vinyl electrical tape. Caulk protection is not acceptable.
- The ground connection to the mast may alternatively be a CadWeld ground to the mast and a #2 Gauge solid ground wire or a pipe grounding ring connection and #6 Gauge stranded wire.
- o Compressive grounding to an aluminum ground ring cable must be done with metallurgically appropriate connections and surface treatments that prevent direct contact of the aluminum cable and the copper ground wire, to prevent long term corrosion.
- Exterior coax connection water proofing: Any exterior coax connections must be water proofed with 3 layers. Layer 1 is to be vinyl electrical tape, layer 2 is to be butyl, and the top layer is to be vinyl electrical tape. All layers shall be applied with even, overlapping wraps of the specified materials. The weather proofing layers must extend over the coax jacket, and onto the surface to which the mating connector is affixed.

System Monitoring:

- Alarm reporting for the DAS and power supply circuit shall be supervised and/or monitored 24/7/365.
- Both the DAS and the Power Supply Systems should be interfaced with the specified fire panel in the building to provide standardized alarms for faults within the DAS or the battery backup or be connected to JMUPD Communications Center where they can be monitored on a separate stand-alone alarm tied to the Universities Central Alarm Monitoring Panel or at minimum via SNMP to JMU Centralized IT Management System.
- Alarm capability should support all components within the DAS system. Design and performance shall comply with NFPA 72, 24.5.2.6 (System Monitoring). Signaling cables shall be supplied, installed and tested by the Contractor.
- BDA/DAS alarms shall include at minimum [REF: NFPA 1221, 9.6.13.1 and NFPA 72, 10]:
 - o Donor Antenna Malfunction.
 - o Head-end Degradation or Failure.
 - o Telco Dialer Circuit Continuity or Failure (For independent direct connect alarms to JMUPD Communications Central Centralized Alarm Monitoring Station that are not

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connected to an in-building Fire Alarm System that reports to JMUPD and FM Life Safety).

- Power supply alarms shall include [REF: NFPA 1221, 4.7.8.7 and NFPA 1221, 9.6.12.3 and NFPA 1221, 9.6.13.1]:
 - Source Power Failure (i.e.-Normal Domestic AC Power), Over Voltage, Under Voltage
 - High and Low Battery Voltage
 - UPS in By-pass Mode
 - And failure of the battery charger power and/or low-battery capacity (if required).
- If DAS monitoring is tied directly to JMUPD Communications Center Centralized Alarm Monitoring Station, then the telco alarm dialer circuit should be monitored and check in periodically on Alarm Panel and indicate an error or trouble alarm if it misses scheduled check-in alarms at least once daily with twice daily preferred consistent with other JMU fire alarm dialer circuit check-ins.
- If DAS monitoring is connected to JMUPD Communications Central Alarm Monitoring Station or other remote monitoring station via a VoIP primary circuit then additional telco circuits and connections may be required (i.e. POTS or CELL circuits) to ensure communications connectivity during potential IP network disruptions or outage and require approval by JMU ITT and AHJ.
- As a JMU POLICY for all JMU Entities, Maintenance Personnel and/or Related Contractors specifically working on JMU BDA/DAS systems. In the event of a malfunction or system maintenance issue that is known to affect the operational capability of an on-line system being reported to them or detected remotely, responding personnel will notify Operational Staff at the following locations immediately of any degraded functionality for first responders and again when full coverage is restored.
 - **JMUPD Communications Center (540-568-6911)**
 - **Harrisonburg/Rockingham Emergency Communications Center (540-434-4436)**
 - **JMU Work Control (540-568-6101)**

Interference:

- System shall be designed as to not interfere with its own equipment or other systems.

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- Interference in this case is defined as a degradation of effective receive performance 1 dB or greater. Interference includes Passive Intermodulation (PIM), which must be kept 10dB below the noise floor of all co-located receivers. Special attention shall be given to locations having co-located control or base stations.

Testing and Acceptance:

- There are four types of Testing specified:
 - **System Design Testing** – Performed by the Contractor/Designer and submitted to the JMU PM and JMU ITT to demonstrate projected coverage for approval prior to project initiation or as change orders during completion of project.
 - **Commissioning Testing** - Conducted by the Contractor/Designer with results submitted to JMU PM and JMU ITT for validation through inspections and verification performed by JMU FM and JMU ITT in cooperation with JMUPD and AHJ.
 - Hardware Installations will be subject to inspection by JMU PM, JMU ITT and JMU FM Engineering for compliance with this specification.
 - The Contractor/Designer will be required to provide current documentation of the results of their **BER** testing of the as-built system at the time of the system commissioning to JMU ITT for system as-built archives.
 - Test all coax runs after connectors have been installed for return loss to the following specification:
 - -25 dB return loss or lower across the frequency band of 450 to 862 MHz, with a precision 50 ohm load terminating the coax under test at the far end of each coax tested
 - Tabulate test results and plots for submission for approval.
 - Tune repeater for gain and channel and filter bandwidth settings. For 800 MHz frequencies, narrowband, minimal delay filter mode is to be employed; filter bandwidth is to be 50 kHz, 31 second delay. Narrow bandwidths shall be used for UHF as well. Determine and install any uplink overload attenuators beyond any shown on the drawings to avoid uplink front end overload (-30 dBm peak uplink signals into repeater). Document all settings for submittal as part of the maintenance baseline document. Note that particular care needs to be taken to not radiate excess uplink noise back to the 800 MHz BTS site. Uplink noise figure of the BTS from this repeater shall be increased by 0dB as required by the AHJ. The use of the uplink muting feature in the repeater may be required.

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- Measure and record isolation between indoor antennas and outdoor antenna for both UHF and 800 MHz bands. The system deployment must meet the isolation requirements as defined by NFPA 1221 (2016) and IFC 810. These publications require the isolation to be 20dB + total system gain as a minimum. For example, if a final system gain setting is 80dB, the measured isolation from the donor antenna to the inbuilding services antennas must be 20dB + 80dB = **100dB total**. Recorded measurements and testing methodology shall be provided as part of the system testing and As-Built documentation.
- Record input spectrum from donor antenna on spectrum analyzer showing at least one channel in the active state in both UHF and 800 MHz systems, to show input downlink power levels. Use the spectrum analyzer on Max Hold for at least 30 minutes to detect any other strong potential interfering signals coming in from the donor antennas. (Cellular signals in the 862-894 MHz range are of particular concern and must be documented.) Document for submittal as part of the maintenance baseline document.
- Record repeater downlink output spectrum on spectrum analyzer showing at least one Harrisonburg-Rockingham County system channel in the active state, to show output downlink power levels. Document for submittal as part of the maintenance baseline document.
- Call quality tests must be met with the final system gain settings.
 - If settings are changed after the call quality tests by more than 3 dB (to meet 800 MHz base site noise figure requirement as an example), then the call quality ATP must be repeated.
- Downlink Coverage Levels - The facility shall be tested for coverage levels and to insure proper system settings and connections as follows:
 - A test antenna and spectrum analyzer shall be used to measure control channel power radiated from each of the system's indoor antennas for the 800 MHz system. The test antenna brand/model must be documented, and may be a test antenna with known gain, or the same antenna as specified for indoor omnidirectional antennas in this specification and is to be connected to the spectrum analyzer input via short jumper with loss of < 0.5 dB at 850 MHz.
 - For indoor system antennas within 10' of the floor level, the test antenna shall be placed in as clear an area as possible at distance of 10' +/- 1' from the system antenna under test, and as close to the same horizontal plane as

the antenna under test, and no more than 3' below the antenna under test. The level of the control channel on the spectrum analyzer shall be recorded.

- For indoor system antennas that are more than 10' above the floor, make the measurement at a location where the test antenna is within the specified vertical beam width of the antenna under test. Record both the spectrum analyzer reading and the horizontal distance between the test antenna and the system antenna under test. Note the test location in sufficient detail so that the test can be repeated as part of maintenance measurements.
 - Care must be taken in spectrum analyzer bandwidth, detection, and sweep speed settings, as well as test antenna polarization, to ensure that the digital control channel levels are accurately displayed. 'Max hold' shall be used for recording the levels in systems that do not employ a control channel.
 - These spectrum analyzer results must be compared with the computed EIRP from the systems antennas plus computed distance loss. Any deviation more than +/- 10 dB requires investigation as to the cause, and rectification of any problems found. Any antenna requiring fixes to meet this requirement must be re-tested after any repairs.
 - These spectrum analyzer test results, along with the computed EIRP's from each antenna, are to be submitted as part of the final documentation. They can be in tabular or building plan view format. Note any non-standard test locations in sufficient detail so that the test can be repeated as part of maintenance measurements.
- Interferer and Repeater Filtering Tests:
- Provide spectrum analyzer readings for the main repeater output in the downlink direction, showing any strong in-band signals that are not part of the JMU UHF system or the Harrisonburg-Rockingham County Regional 800 MHz trunked system. For the UHF band, use of Max Hold for at least 30 minutes during the hours of 8 AM to 5 PM local time is required for this test. For the 800 MHz band, show the frequency range of 851-894 MHz for at least 30 minutes in the same time period. A coupler on the repeater output may be used to prevent spectrum analyzer damage; the value of any such coupler used must be documented.
 - Use of the repeaters internal spectrum analyzer function is not acceptable for these tests. However, such plots can be included as supplementary information.

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- Uplink Noise Figure Checks for 800 MHz Base Station sites.
 - Confirmation from the AHJ must be received that no excess increase in uplink noise figure at the base station sites is being received after this DAS is put into operation. Increase is to be 0dB as required by the AHJ. ATP call quality tests must be met with the final uplink gain settings.
- **Acceptance Testing** – Performed by JMU ITT, JMUPD, and the AHJ to be approved by JMU ITT, AHJ & VSFM with documentation provided by Contractor/Designer and JMU PM.
 - Contractor shall coordinate testing with the Project Manager, JMU IT Telecom, JMU Police & Safety, and Local Public Safety Providers (AHJ) including HRECC to ensure acceptable coverage and delivered audio quality to UHF & 800 Mhz System Users that operate within the coverage area.
 - JMU ITT will utilize their PCTel SeeGull IBFlex RF Scanner when available to test and document DAS coverage and signal strength in facility and/or manual perform Call Quality Tests as necessary to verify coverage area and actual signal strength meets established levels and Delivered Audio Quality specifications for acceptance by JMU and AHJ.
 - Call Quality Tests are to be conducted as follows:
 - Call Quality tests are to be conducted in all areas of the facility.
 - Most areas are to be tested as grid areas.
 - Critical individual spaces smaller than the grid size but larger than closets, are to be tested individually.
 - Testing may be done by individual room if their size and usage dictates and/or if building design makes it necessary to document specific room coverage.
 - Side halls (<20' long) may be tested as part of the grid.
 - Grid tested areas: Test point number and location.
 - Divide the grid tested areas into grid spaces sized 20' x 20' for confined individual office or academic spaces or 50' x 50' for general use open air arenas and parking structures or other pre-approved grid size) Each grid space is to be tested in its approximate center, and the test call within a grid space must exceed AQ 3.4 for the grid space to pass.

- Call quality of minimum DAQ 3.4 is to be recorded in each test grid area for both 800 Mhz and UHF on a DAQ Scale Score rating (i.e. – 3.4 or 4.0).
- Propagated 800 Mhz Signal Strength at each test site should also be recorded in -dBm as indicated on Radios used for testing or Spectrum Analyzer.
- Hallway testing: Test point numbers and locations.
 - Each major connecting hallway is to be tested every 30' along its length. Test in the center of the hall, and each test call at a hall test point must exceed DAQ 3.4 for the location to pass.
- If a call fails in a grid space or individual area, then that grid space or individual area is to be re-tested in the center of smaller areas of approximately 10'x 10' each. The whole grid space or area is to be recorded as failed if this test fails in 2 or more of the 4 quadrants.
- The system passes if the average of 95% or more of the test locations pass at a DAQ 4.0. If the system does not meet the targeted 95% requirement for DAQ 4.0. JMU ITT will have the option of accepting the system if it meets minimum of at least a DAQ 3.4 as required by AHJ, but must sign a letter of variance explaining why DAQ 4.0 was not achieved or JMU ITT may require the contractor to make necessary improvements to the system to achieve the overall DAQ 4.0 as specified in JMU's initial requirements.
- Any calls that do not go through due to a system busy condition are not counted as pass or fail.
- Call quality tests are to be conducted with multiple radios (4) provided by the AHJ that are in known good operating condition, and that meet specified power output, frequency accuracy, and receive sensitivity, and shall include at least one portable radio operated on-site in the test grid on 800 Mhz JMU ADM, a second portable radio on-site in close proximity to the test grid on JMU UHF ADMIN frequency, a third portable or mobile radio operated off-site operating on 800 Mhz JMU ADM and a radio console or remote control station operated from a communications center on the 800 Mhz JMU ADM talk group and on UHF JMU ADMIN.
 - This methodology will allow the multiple evaluators to test and record DAQ across both bandwidths simultaneously through the established gateway that links the two together.

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- Baseline testing should be done on each individual talkgroup/frequency, 800 Mhz (JMU ADM) and JMU UHF (ADMIN-R) to ensure that gatewayed DAQ is representative of the DAQ on each talkgroup/frequency if tested individually.
- Contractor/Designer shall work through the JMU PM to provide electronic and hard copies of the Building Plan with Grid Overlay Test Recording Sheets to JMU ITT, JMUPD, AHJ, and VSFM at least 48 hours before the scheduled ATP.
- Building Plan with Grid Overlay Test Recording Sheets shall preferably be formatted and printed on 8.5" x 11" paper sheets as a representation of the corresponding floor plan to include assigned room numbers on the floorplan layer with font and lines printed in medium **(50%) GREY**.
- Multiple sheets per structure level/section are acceptable if the structures size requires blow-up views to be able to clearly record ATP results.
- Grid blocks (representing grid tested spaces sized 20' x 20' for confined individual office or academic spaces or 50' x 50' for general use open air arenas and parking structures or other pre-approved grid size) on the Test Scoring Sheets should be no smaller than ½" x ½" square and consist of outlines and font printed in **RED for grid blocks that encompass any Designated Critical Coverage Areas** and **BLUE for all other grid blocks that encompass General Coverage Areas**.
- Grid blocks shall be numbered sequentially starting in the upper left corner of the sheet and increasing from Left to Right across the rows, and from Top to Bottom as rows continue down the grid overlay on the page.
- Each DAS GRID TEST LOG SHEET will need a Header to include: Building Name; Floor Represented; Grid Numbers Included on this Particular Page; Blank for Evaluators Name; Blank for Evaluators Location & Method (i.e. - On-site 800 Mhz, On-Site UHF, Remote 800 Mhz, Remote UHF, JMUPD Console 800, JMU Stadium Console UHF, etc.) Blank for Date Test Performed.
- Each Evaluator will use the following format to transmit audio starting with the On-Site 800 Evaluator:
 1. **"ON-SITE 800 TRANSMITTING, TEST, TEST, X FLOOR, GRID #"**
 2. **"ON-SITE UHF TRANSMITTING, TEST, TEST, X FLOOR, GRID #"**
 3. **"REMOTE 800 TRANSMITTING, TEST, TEST, X FLOOR, GRID #"**

- 4. "REMOTE UHF TRANSMITTING, TEST, TEST, X FLOOR, GRID #"**
- 5. "CONSOLE 800 TRANSMITTING, TEST, TEST, X FLOOR, GRID #"**
- 6. "CONSOLE UHF TRANSMITTING, TEST, TEST, X FLOOR, GRID #"**

- Each evaluator will record their overall perceived DAQ quality test results in the specified grid block on their copy of the DAS GRID TEST LOG SHEET which corresponds to the grids on the Building Plan with Grid Overlay in the following format DAQ: 3.4 or 4.0 ; RSSI -dBm Mhz Signal Strength 82 or 95, 121, etc.).
- Any unusual call quality issues other than the prescribed DAQ / RSSI shall be thoroughly documented and reported to JMU PM, JMU ITT and the AHJ with a complete description of the symptoms, test conditions and include any recommended remedial actions that could or should be taken to resolve the issue.
- JMU ITT and the AHJ may allow alternative testing using RSSI and DAQ results from test TX/RX individually on designated 800 Mhz Talkgroups and UHF 450 frequencies or through established system gateways that will link specific frequencies and talkgroups and recorded in JMU ITT's PCTel SeaGull IBflex RF DAS Testing Unit.

○ **Annual Maintenance/Warranty Testing** – Performed by the Maintenance Contractor under supervision of JMU ITT.

- Review any reports of degraded service since last test.
- Inspect All infrastructure hardware for signs of damage or malfunctions.
- Inspect All external antennas, cabling and grounds for signs of weathering, deterioration, or damage.
- Test all UPS batteries to ensure that they hold for prescribed durations, replace as necessary.
- Conduct RSSI – Radio Signal Strength Indicator Testing either with a portable radio or spectrum analyzer in all areas listed as Critical Coverage Areas documenting current RSSI levels and all test locations.
- Do spot testing throughout at least 25% of the remainder of the General Coverage Areas of the structure documenting current RSSI levels and all test locations.

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- Conduct Full Grid RSSI level testing on any areas of the structure that may have been modified or had significant changes in usage or equipment present since last Maintenance/Warranty Test was conducted.
- Compare the results of current testing with RSSI documentation from original acceptance testing and last maintenance/warranty testing and/or any JMU ITT PCTel SeaGull IBflex RF DAS Testing Documentation to identify any discrepancies or variations in coverage.
- Use results of testing to identify any areas that need hardware tuning, repair, or upgrades to meet required standards of coverage.
- Document any tuning, repairs, modifications or replacements to the system conducted as a result of this test.
- Submit all documentation to JMU ITT for DAS System Archive file.

Documentation:

- Contractor/Designer shall provide copies of ALL design related supporting documents and images related to DAS/BDA which will be maintained by JMU IT Telecom with their RF Documentation Files.
- Provide a detailed materials list and inventory of all installed equipment to include: Manufacturer; Model; Serial Number; Installation Date; Physical Address of all equipment to include Room Number or Descriptive Location on within the Interior or on the Exterior of Structure; Specify RX & TX Frequencies tuned to boost. Materials list should also include: JMU Building Name; 911 Street Address, Installing Vendor/Representative Name, Address and Contact Info; Maintenance/Warranty Vendor Name, Address and Contact info.
- Provide labelled digital images of all: Radio Repeaters; Signal Boosters; Different Antennae Types Deployed Internally and Externally; Equipment Cabinets; Roof Penetrations; Equipment Supporting Battery or UPS Hardware and Equipment Ground Connections.
- Provide comprehensive As-Built Diagrams in MS Visio or other approved format. Should also be included in IBCW/IBX floorplan files provided to JMU ITT when Commissioning and Acceptance Testing is performed.
- Provide electronic and hard copies of the Building Plans to included DAS Hardware Designations and Locations WITH and WITHOUT acceptable Grid Overlay in both IBCW/IBX and PDF File formats Testing and Recording to JMU ITT as specified in the

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Commissioning & Acceptance Testing Procedures Section of this policy at least 48 working hours prior to any type of Inspection or Testing.

- Provide supporting Spectrum Analyzer Graph and Report Print Outs from all tests and final inspections performed in electronic PDF format to demonstrate design progression and final as-delivered levels. Signal Strength Propagation coverage maps (i.e. - Heat Maps) shall be kept on file with JMU ITT RF Documentation from original acceptance of the installed system. These may be used for future comparison in the event of signal degradation, system failure, or future system refresh to compare differences or similarities.
- Provide all design propagation maps in electronic PDF format during design and testing phases of the project and shall be kept on file with JMU ITT RF Documentation. These may be pulled out and compared to current RSSI signal strength conditions to see if something has degraded or changed to compare difference or similarities.
- Final acceptance will be granted once the all public safety authorities (JMU & Local AHJ) approve the performance of the DAS for public safety first responders and daily users and JMU accepts the DAS for use with their radio system, all punch list items have been completed and all documentation has been submitted and approved by JMU IT Telecom.

Warranty:

- All equipment furnished, including hardware and software components, shall be fully warranted to be free from defects in material and workmanship for a period of one (1) year from the date of final acceptance.
- Contractor shall be responsible for all warranty activities related to product registration.
- At the end of the warranty period, Contractor shall hand over all warranty related records to JMU
- Costs associated with base warranty and options shall be itemized and included in the pricing section of any design proposals for DAS installations at JMU.

Preventative Maintenance:

- All preventive maintenance necessary for the system and its components shall be performed during the warranty period and during year two through five. This maintenance shall be limited to the hardware, software and firmware furnished by the Contractor.
- Manufacturer-recommended software and firmware updates associated with security, operation or maintenance shall be provided during this period and shall include local and/or remote installation.
- JMU expects such maintenance to be performed at regularly scheduled intervals in accordance with the recommendations of the manufacturer at a minimum. Contractor shall perform the agreed-upon preventive maintenance twice annually during the original warranty period, during the entire life of any active extended maintenance contract with that contractor, or as often as recommended by the manufacturer in accordance with [REF: NFPA 1221, 11.3.9], whichever is more stringent.
- Any potential costs associated with this type of support or service that will be the responsibility of JMU shall be clearly and individually identified in the pricing section of any proposals to provide DAS related Hardware or Services.
- JMU may issue separate Preventative Maintenance & Service Contracts beyond those services covered by initial installation warranty period.

Nuisance Malfunctions and Failures:

- Nuisance malfunctions and/or failures are recurring operational or functional problems that prevent systems and/or equipment from providing the degree of reliability and services specified at the time of procurement or usefulness necessary for JMU operations, or cause JMU to assign significant resources to resolve on three or more occasions, on similar models of equipment. Such problems can be caused by software, firmware or hardware that is faulty or improperly designed, engineered, manufactured, installed or configured. It does not include degraded operation, which could be resolved through additional optimization within the term of the initial contract.

NFPA Reference List by Subject Matter used to develop policy:

- NFPA 1, 11.10 or 0.3 (DAS Standards)
- NFPA 72, 24.9 (Two-Way Radio Communications Enhancement Systems)
- NFPA 70, 312.5 (Cabinets, Cutout Boxes and Meter Socket Enclosures)
- NFPA 1221, 9.6.2 (Pathway, Risers, Couplings, Survivability)
- NFPA 1221, 9.6.11.2 (Enclosure Standards)
- NFPA 1221 (Standards for Installation, Maintenance and Use of Emergency Services Communications Systems)
- NFPA 1221, 5 (Communications and Signal Wiring)
- NFPA 1221, 9.6.7 (Radio Coverage Areas and Signal Strength DAQ / -dBm)
- NFPA 1221, 9.6.12, NFPA 1, 0.3.6 (Power and Secondary Power Supply standards)
- NFPA 1221 (Status monitoring with regard to the 450 MHz and 800 MHz systems and Power Systems)

Abbreviations and Acronyms:

- **AHJ** - Authority Having Jurisdiction over the Public Safety Radio System
- **ATP** - Acceptance Test Plan
- **BER** - Bit Error Rate
- **BDA** - Bi-Directional Amplifier
- **BOM** - Bill-of-Material
- **BTS** - Base Transceiver Station
- **DAS** - Distributed Antenna System
- **DAQ** - Delivered Auto Quality
- **DL** - Radio Frequency Down Link
- **dBm** - The power ratio in decibels (dB) of the measure power per one milliwatt (mW).
- **FCC** - Federal Communications Commission
- **HRECC** - Harrisonburg/Rockingham Emergency Communications Center
- **JMU FM** - JMU Facilities Management Department
- **JMU ITT** - JMU IT Telecom Department
- **JMU PM** - JMU Project Manager
- **JMUPD** - James Madison University Department of Police & Public Safety
- **LMR** - Land Mobile Radio
- **MTBF** - Mean Time Between Failure
- **NFPA** - National Fire Protection Association
- **PSN** - Public Safety Network
- **REF** - Reference
- **RSSI** - Received Signal Strength Indicator
- **SNIR** - Signal-to-Noise Interference Ratio
- **SOW** - Scope of Work
- **UL** - Radio Frequency Up Link

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- **VoIP** - Voice Over Internet Protocol
- **VSFM** - Virginia State Fire Marshall

Definitions:

- **Acceptance** - Expressed approval by the Owner or AHJ.
- **Active** - Components that require AC or DC power for operation.
- **Component** - A main system element of the DAS.
- **DAQ 3.4** - Speech understandable; repetition only rarely required. This term will be applied to both digital and analog voice transmissions.
- **DAQ 4.0** - Speech easily understandable; Little noise or distortion. This term will be applied to both digital and analog voice transmissions.
- **Passive** - Components that do not require AC/DC power for operation.
- **Supplier** - A seller of manufactured products who controls the specifications of a product and warrants the product directly, regardless whether the seller actually manufactures the product directly. A distributor is not a Supplier but an approved Supplier's products may be procured through a distributor.