TECHNICAL SPECIFICATION
FOR THE SUPPLY AND INSTALLATION
OF
VHF & UHF ATC RADIO SYSTEMS

Identification: TSSI-P-DO-03-PP2
Version: 1.0
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1 Introduction

1.1 Purpose

Croatia Control Ltd. (referred to as: the Employer) plans to replace the existing VHF and UHF radio equipment at the sites: Japetić, Sljeme, Kozjak, Valtura, V.Mlaka/Mićevec, Čiovo, TWR Pula, TWR Split, TWR Osijek, TWR Lošinj and TWR Brač. as well as to open new radio (VHF/UHF) site at Northern Adriatic.

The upgrade of existing VHF and UHF Radio Network is intended for:

- Coverage improvement in the area of TMA Pula below 5000ft.
- Increase capacity (number of frequencies) on the following locations; Kozjak, Valtura, V. Mlaka/Mićevec and TWR Split
- Increase overall ACC capacity demands, especially Sector Group West, with introduction of the new radio site;
- Implementation of air-ground voice channel spacing requirements below FL195
- Future seamless and easy migration to VoIP technology;

1.2 Scope

An upgrading process shall be divided in two phases.

The first phase shall include the following:

- Replacement of the existing radio equipment on the following locations: ACC radio site Japetić, Sljeme, Kozjak, Valtura, V. Mlaka/Mićevec, Čiovo, TWR Pula, TWR Split, TWR Osijek, TWR Lošinj and TWR Brač. The number of frequencies to be installed on these locations is defined in the chapter Quantity of Radio Equipment.
- Installing the DC power supply equipment as described in relevant chapters.
- Integration of RCMS equipment for the above mentioned systems/sites.
- Uninstallation of existing antenna systems where new antenna systems need to be installed on the same position according to the Schedule of prices
- Installation of antenna systems where indicated in the relevant chapters.

The second phase shall include the following:

- Adding the Northern Adriatic mountain site to the radio network – installing the required number of frequencies and DC power supply equipment.
- Integration of RCMS equipment for the above mentioned system/site.
- Installation of antenna systems where indicated in the relevant chapters.
1.3 General

GERQ0010 The submitted tender documentation, together with the technical documentation, shall be sorted in adequate sections that shall be stated in the Tender Contents in the sequence they are sorted.

GERQ0020 The response to the specification is required to be comprehensive with a completed Compliance Matrix as set out below.

GERQ0030 Tenderers are encouraged to offer the existing baseline products that are compliant with or equivalent to all mandatory requirements.

GERQ0040 The offered systems shall have at least the same or better technical characteristics as requested in this tender.

GERQ0050 The compliance matrix in an Appendix of this document provides an entry for each requirement. Each row of the table uniquely identifies each paragraph requiring response in this specification by Chapter, Paragraph (and sub paragraph).

The Tenderer shall also provide additional remarks if they are considered helpful for assessing the response (column Remarks in the compliance matrix). Each remark shall be uniquely referred to corresponding document (Chapter, Paragraph).

GERQ0060 The Tenderer compliance status shall be indicated against each paragraph of this specification in the ‘Compliance’ column with a C for Compliance or an N for Non-Compliance. No other response shall be recognised during the evaluation and absence of C or N shall be counted as Not Compliant.

GERQ0070 The Tenderer shall provide the proof/explanation of every indicated C - Compliance in the ‘Compliance’ column. Additionally, where the answer can be found in the submitted documentation, the Tenderer shall provide the reference and point to the specific line/paragraph/chapter/document where the compliance status can be verified.

GERQ0080 The offered types of radio equipment shall be in operational usage at ANSPs in period not less than two years.

EVERY NON-SUBSTANTIATED REQUIREMENT MARKED WITH “C” BY THE TENDERER, SHALL BE DECLARED AS NON-COMPLIANT IN THE TENDER EVALUATION BY THE EMPLOYER.

1.4 Reference Documents

Wherever reference is made in this technical specification to specific regulations, standards and codes, the provisions of the latest current edition or revision of the relevant regulations, standards or codes in effect shall apply unless otherwise expressly stated in the technical specifications. Where such standards and codes are national or related to a particular country or region, other authoritative standards that ensure substantial equivalence to the standards and codes specified will be acceptable.

1.4.1 Standards

RDST0010 The whole supplied equipment shall work completely in conformity with the following documents:

ICAO Annex 10, Vol. II,
ICAO Annex 10, Vol. III,
ICAO Annex 10, Vol. V,
ICAO Doc 9718, Handbook on Radio Frequency Spectrum Requirements for Civil Aviation
ETSI EN 300 676 (latest official edition) Ground-based VHF hand-held, mobile and fixed radio transmitters, receivers and transceivers for the VHF aeronautical mobile service using amplitude modulation; Technical characteristics and methods of measurement
ETSI EN 301 489-22 (latest official edition), EMC standard for radio equipment and services; Specific conditions for ground-based VHF aeronautical mobile and fixed radio equipment.
ETSI EN 301 489-1 (latest official edition), Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements

RDST0020 The equipment shall also meet the following standards for electrical safety:
EN 60215 - Safety of Radio Frequency Transmitters.

RDST0030 The radio equipment shall be newly-produced and shall meet the requirements for ground based aeronautical stations laid down in standard documents listed in RDST0010.

A TENDER FOR THE EQUIPMENT WHICH DOES NOT COMPLY WITH ALL ABOVE LISTED REQUIREMENTS SHALL BE REJECTED BY THE EMPLOYER.

1.4.2 Regulatory Documents

RDRD0010 The offered concept, design and equipment shall be fully compliant with EC Reg. No. 1079/2012 + 657/2013 laying down requirements on air-ground voice channel spacing for the single European sky (VCS).

RDRD0020 The offered concept, design and equipment shall be fully compliant with EC Reg. No. 29/2009 + 441/2014 + 2015/310 laying down requirements on data link services for the single European sky (DLS)

RDRD0030 The offered concept, design and equipment shall be fully compliant with EC Reg. Directive 2014/30/EU laying down requirements on the Electromagnetic Compatibility.

A TENDER FOR THE EQUIPMENT WHICH DOES NOT COMPLY WITH ALL ABOVE LISTED REQUIREMENTS SHALL BE REJECTED BY THE EMPLOYER.

1.5 Definitions

<table>
<thead>
<tr>
<th>Term/Phrase</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Availability</td>
<td>A measure of the degree to which an item is in an operable state at any time.</td>
</tr>
<tr>
<td>Reliability</td>
<td>The probability that an item will perform its intended function for a specified interval under stated conditions.</td>
</tr>
<tr>
<td>Maintainability</td>
<td>A measure of the ability of an item to be retained in, or restored to, a specified condition when maintenance is performed using prescribed procedures and technician skill levels.</td>
</tr>
<tr>
<td>Consumable spare</td>
<td>Expendable item, such as fuses, lamps, air filters, etc., that can be easily replaced by use of standard tools and procedures.</td>
</tr>
</tbody>
</table>
The terms Contractor and Tenderer have been used interchangeably in this document and tenderers should respond to all requirements, no matter whether these relate to the tenderer or contractor.

1.6 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning, description</th>
</tr>
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<tbody>
<tr>
<td>ACC</td>
<td>Air Control Centre</td>
</tr>
<tr>
<td>AC</td>
<td>Alternating Current</td>
</tr>
<tr>
<td>BITE</td>
<td>Built-in Test Equipment</td>
</tr>
<tr>
<td>CCL</td>
<td>Croatia Control Limited, Croatian Air Navigation Services provider. Also, The Employer.</td>
</tr>
<tr>
<td>COTS</td>
<td>Commercial-Of-The-Shelf</td>
</tr>
<tr>
<td>CWP</td>
<td>Controller Working Position</td>
</tr>
<tr>
<td>DT</td>
<td>Delivery Time. Defined as the time elapsed between the date of order of a part by the Employer (in case of need of the order of additional spare parts) and the date of shipment of ordered part from the Contractor to the Employer.</td>
</tr>
<tr>
<td>DC</td>
<td>Direct Current</td>
</tr>
<tr>
<td>EMP</td>
<td>Electromagnetic pulse</td>
</tr>
<tr>
<td>FAT</td>
<td>Factory Acceptance Test</td>
</tr>
<tr>
<td>GP</td>
<td>Glide Path</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LOC</td>
<td>Localiser</td>
</tr>
</tbody>
</table>
| LRU          | Line Replaceable Unit that is repairable and that shall:  
  - in case of failure be identified by the Built-In-Test-Equipment (BITE) monitoring system, with the help of Technical Manual(s) and use of standard tool;  
  - be easily accessible and replaceable (e.g. plug-in unit, screwed terminals or connectors);  
  - have minimal adjustment requirements (e.g. voltage level setting, etc.)  
  - be designed in such a way to ensure that the system returns to its full operational status within a meantime of 60 minutes (MTTR < 1 hour) when only one LRU has failed. |
| MDF          | Main Distribution Frame |
| MRT          | Mean Response Time in hours (i.e. the average time from notification of failure for a technician to be ready to commence repair action). |
| MTBF         | Mean Time Between Failures. A basic measure of reliability for repairable items. The average time during which all parts of the item perform within their specified limits, during a particular measurement period under stated conditions. |
| MTTR         | Mean Time To Repair. A basic measure of maintainability. The sum of corrective maintenance times divided by the total number of failures within an item. The average time it takes to fully repair a failed system. Typically includes fault isolation, remove and replacement of failed item(s) and checkout. It excludes logistics downtime needed for spare part transport from stock to the site. |
| OAT          | Operational Acceptance Test |
| PC           | Personal Computer    |
| RF           | Radio Frequency      |
| RCMRS        | Remote Control and Monitoring System |
| RDR          | Radar                |
| Rx           | Receiver             |
| SRU          | Shop Replaceable Unit, defined as a unit which is replaced within a LRU and is repairable. |
2 Functional and Technical Requirements

2.1 General

FTGE0010 The Contractor is solely responsible for the System Design. If any changes to the design are necessary to meet the Specifications, the Contractor shall carry out such changes at no cost to the Employer.

FTGE0020 The Contractor shall be responsible for the system engineering efforts associated with the design, production, installation, testing and audit of the systems and equipment being provided.

FTGE0030 The Tenderer shall deliver a detailed rack layout and equipment placement scheme for every location, from which the placement of all equipment (transmitters, receivers, multicouplers, remote control system…) shall be clearly visible inside the object and each telecommunication rack.

FTGE0040 The Tenderer shall design a radio system according to the specified system described in this document and in its attachment diagrams.

FTGE0050 The Tenderer shall deliver detailed schematic diagrams for RCMS layout interconnection from which a general and detailed design of the RCMS system shall be clearly visible.

FTGE0060 The Tenderer shall deliver detailed schematic diagrams for radio and antenna system interconnection from which a general and detailed design of the radio system shall be clearly visible for every radio site independently.

FTGE0070 The Tenderer shall deliver the colocation analysis for each radio site with the calculation of intermodulation products included.

FTGE0080 The Tenderer shall design a radio system in the way which allows the migration to IP connection to the VCS/CWP to be established without any software and hardware changes.

2.2 Functional

2.2.1 Position and Replacement of Equipment

2.2.1.1 Positioning of Equipment

Japetić:

POSE0010 At Japetić, the equipment (transmitters and receivers) shall be installed in separate objects (Japetić Tx Center and Japetić Rx Center). The positioning of equipment is described in Chapter 10.2.1.
**Sljeme:**

**POSE0020** At Sljeme, the equipment (transmitters and receivers) shall be installed in separate objects (Sljeme Tx Center and Sljeme Rx Center). The positioning of equipment is described in Chapter 10.2.2.

**Kozjak:**

**POSE0030** At Kozjak, the equipment (transmitters and receivers) shall be installed in separate objects (Kozjak Tx Center and Kozjak Rx Center). The positioning of equipment is described in Chapter 10.2.3.

**Northern Adriatic:**

**POSE0040** At Northern Adriatic, the equipment (transmitters and receivers) shall be installed in same object (Northern Adriatic VHF Radio Center). The positioning of equipment is described in Chapter 10.2.4.

**Valtura:**

**POSE0050** At Valtura the equipment (transmitters and receivers) shall be installed in the same object (Valtura radio Center). The positioning of equipment is described in Chapter 10.2.5.

**V. Mlaka/Mićevec:**

**POSE0060** At V. Mlaka/Mićevec the transmitters and receivers shall be installed in separate objects (V. Mlaka Tx Center and Mićevec Rx Center). The positioning of equipment is described in Chapter 10.2.6.

**Čiovo:**

**POSE0070** At Čiovo, the equipment (transceivers) shall be installed in the technical room. The positioning of equipment is described in Chapter 10.2.7.

**TWR Pula:**

**POSE0080** At Pula TWR, the equipment (transmitters and receivers) shall be installed in separate objects (TWR Pula and GP Pula). The positioning of equipment is described in Chapter 10.2.8.

**TWR Split:**

**POSE0090** At Split TWR, the equipment (transmitters and receivers) shall be installed in separate objects (TWR Split and GP Split). The positioning of equipment is described in Chapter 10.2.9.

**TWR Osijek:**

**POSE0100** At Osijek TWR, the equipment (transceivers) shall be installed in separate objects (Osijek GP and Osijek LOC). The positioning of equipment is described in Chapter 10.2.10.

**TWR Lošinj:**

**POSE0110** At Lošinj TWR, the equipment (transceivers) shall be installed in technical room. The positioning of equipment is described in Chapter 10.2.11.

**TWR Brač:**

**POSE0120** At Brač TWR, the equipment (transceivers) shall be installed in the technical room. The positioning of equipment is described in Chapter 10.2.12.
2.2.2 Quantity of Radio Equipment

The Tenderer shall offer appropriate equipment and ensure its full functionality for the following sites/frequencies:

QTYE0010  **Japetić**:

The Japetić VHF site shall consist of 16 VHF and 3 UHF frequencies designed in the Main/Stand-By mode. A detailed RF scheme of the site Japetić is shown in paragraph 10.3.1. Japetić RF diagrams.

The quantity of radio equipment and required frequencies installed on the site Japetić are shown in table 1:

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx</th>
<th>Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>118.500 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>121.500 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF3</td>
<td>122.525 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF4</td>
<td>123.100 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF5</td>
<td>124.375 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF6</td>
<td>128.275 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF7</td>
<td>128.525 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF8</td>
<td>129.650 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF9</td>
<td>130.2167 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF10</td>
<td>130.625 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF11</td>
<td>131.275 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF12</td>
<td>132.3417 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF13</td>
<td>135.050 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF14</td>
<td>135.800 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF15</td>
<td>136.300 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF16</td>
<td>127.1083 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF1</td>
<td>246.525 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF2</td>
<td>359.800 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF3</td>
<td>361.450 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

**Table 1.** Quantity and required frequencies installed on the site Japetić
QTYE0020  **Sljeme:**

The Sljeme VHF/UHF site shall consist of 12 VHF and 3 UHF frequencies designed in the Main/Stand-By mode. A detailed RF scheme of the site Sljeme is shown in paragraph 10.3.2. Sljeme RF diagrams.

The quantity of radio equipment and required frequencies installed on the site Sljeme are shown in table 2.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx</th>
<th>Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>120.700 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>121.500 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF3</td>
<td>122.575 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF4</td>
<td>124.375 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF5</td>
<td>124.600 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF6</td>
<td>127.1083 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF7</td>
<td>127.675 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF8</td>
<td>129.425 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF9</td>
<td>130.2167 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF10</td>
<td>131.275 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF11</td>
<td>132.125 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF12</td>
<td>133.6333 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF1</td>
<td>243.000 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF2</td>
<td>361.450 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF3</td>
<td>359.800 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

**Table 2.** Quantity and required frequencies installed on the site Sljeme
QTYE0030 Kozjak:

The Kozjak VHF/UHF site shall consist of 16 VHF and 3 UHF frequencies designed in the Main/Stand-By mode. A detailed RF scheme of the site Kozjak is shown in paragraph 10.3.3. Kozjak RF diagrams.

The quantity of radio equipment and required frequencies installed on the site Kozjak are shown in table 3.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx</th>
<th>Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>120.875 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>121.500 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF3</td>
<td>122.525 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF4</td>
<td>123.100 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF5</td>
<td>124.675 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF6</td>
<td>125.225 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF7</td>
<td>125.775 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF8</td>
<td>127.3667 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF9</td>
<td>127.875 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF10</td>
<td>128.675 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF11</td>
<td>129.425 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF12</td>
<td>131.275 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF13</td>
<td>135.800 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF14</td>
<td>132.3417 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF15</td>
<td>124.375 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF16</td>
<td>122.575 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF1</td>
<td>243.000 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF2</td>
<td>246.525 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF3</td>
<td>361.450 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

Table 3. Quantity and required frequencies installed on the site Kozjak
QTYE0040  **Northern Adriatic:**

The Northern Adriatic VHF/UHF site shall consist of 12 VHF frequencies designed in the Main/Stand-By mode. A detailed RF scheme of the site Northern Adriatic is shown in paragraph 10.3.4. Northern Adriatic RF diagrams.

The quantity of radio equipment and required frequencies installed on the site Northern Adriatic are shown in table 4.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx</th>
<th>Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>121.500 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>122.525 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF3</td>
<td>124.600 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF4</td>
<td>127.675 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF5</td>
<td>131.275 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF6</td>
<td>133.6333 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF7</td>
<td>135.800 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF8</td>
<td>136.300 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF9</td>
<td>132.3417 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF10</td>
<td>128.275 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF11</td>
<td>124.375 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF12</td>
<td>123.100 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

**Table 4.** Quantity and required frequencies installed on the site Northern Adriatic
QTYE0050  Valtura:

The Valtura VHF site shall consist of 8 VHF and 2 UHF frequencies designed in the Main/Stand-By mode. A detailed RF scheme of the site Valtura is shown in paragraph 10.3.5. Valtura RF diagrams.

The quantity of radio equipment and required frequencies installed on the site Valtura are shown in table 5.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx</th>
<th>Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>121.500 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>122.575 MHz (+7,5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF3</td>
<td>123.100 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF4</td>
<td>124.600 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF5</td>
<td>127.675 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF6</td>
<td>132.000 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF7</td>
<td>135.800 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF8</td>
<td>122.100 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF1</td>
<td>243.000 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>UHF2</td>
<td>359.800 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

Table 5. Quantity and required frequencies installed on the site Valtura
**QTYE0060  V.Mlaka/Mićevec:**

The V.Mlaka/Mićevec VHF site shall consist of 8 VHF frequencies designed in the Main/Stand-By mode. A detailed RF scheme of the site V.Mlaka/Mićevec is shown in paragraph 10.3.6. V.Mlaka/Mićevec RF diagrams.

The quantity of radio equipment and required frequencies installed on the site V.Mlaka/Mićevec are shown in table 6.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx</th>
<th>Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>118.300 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>118.500 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF3</td>
<td>119.125 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF4</td>
<td>120.700 MHz (-5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF5</td>
<td>124.575 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF6</td>
<td>127.800 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF7</td>
<td>122.100 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF8</td>
<td>130.2167 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

**Table 6.** Quantity and required frequencies installed on the site V.Mlaka/Mićevec

**QTYE0070  Čiovo:**

The Čiovo VHF site shall consist of 4 VHF frequencies designed in the transceiver Main/Stand-By mode. A detailed RF scheme of the site Čiovo is shown in paragraph 10.3.7. Čiovo RF diagrams.

The quantity of radio equipment and required frequencies installed on the site Čiovo are shown in table 7.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx/Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>120.875 MHz</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>121.500 MHz</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF3</td>
<td>125.300 MHz</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF4</td>
<td>128.675 MHz</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

**Table 7.** Quantity and required frequencies installed on the site Čiovo
**QTYE0080  TWR Pula:**

The TWR Pula VHF site shall consist of 6 VHF frequencies designed in the Main/Stand-By mode. A detailed RF scheme of the site TWR Pula is shown in paragraph 10.3.8. TWR Pula RF diagrams.

The quantity of radio equipment and required frequencies installed on the site TWR Pula are shown in table 8.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx</th>
<th>Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>120.000 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>121.500 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF3</td>
<td>124.600 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF4</td>
<td>127.675 MHz (+5)</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF5</td>
<td>129.150 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF6</td>
<td>132.000 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

Table 8. Quantity and required frequencies installed on the site TWR Pula

**QTYE0090  TWR Split:**

The TWR Split VHF site shall consist of 4 VHF frequencies designed in the Main/Stand-By mode. A detailed RF scheme of the site TWR Split is shown in paragraph 10.3.9. TWR Split RF diagrams.

The quantity of radio equipment and required frequencies installed on the site TWR Split are shown in table 9.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx</th>
<th>Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>118.100 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>120.550 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF3</td>
<td>124.675 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF4</td>
<td>122.100 MHz</td>
<td>M/STBY</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

Table 9. Quantity and required frequencies installed on the site TWR Split
QTYE0100  **TWR Osijek:**

The TWR Osijek VHF site shall consist of 2 VHF frequencies designed in the Main/Stand-By mode. A detailed RF scheme of the site TWR Osijek is shown in paragraph 10.3.10. TWR Osijek RF diagrams.

The quantity of radio equipment and required frequencies installed on the site TWR Osijek are shown in table 10.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx/Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>118.800 MHz</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>121.500 MHz</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

**Table 10.** Quantity and required frequencies installed on the site TWR Osijek

QTYE0110  **TWR Osijek CWP**

The TWR Osijek site shall consist of two (2) Radio control positions with similar or better characteristics than those described in chapter 2.3.13.

QTYE0120  **TWR Lošinj:**

The TWR Lošinj VHF site shall consist of 2 VHF frequencies designed in the transceiver Main/Stand-By mode. A detailed RF scheme of the site TWR Lošinj is shown in paragraph 10.3.11. TWR Lošinj RF diagrams.

The quantity of radio equipment and required frequencies installed on the site TWR Lošinj are shown in table 11.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx/Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>120.300 MHz</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>121.500 MHz</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

**Table 11.** Quantity and required frequencies installed on the site TWR Lošinj

QTYE0130  **TWR Lošinj CWP**

The TWR Lošinj site shall consist of two (2) Radio control positions with similar or better characteristics than those described in chapter 2.3.13.
QTYE0140  **TWR Brač**:

The TWR Brač VHF site shall consist of 2 VHF frequencies designed in the transceiver Main/Stand-By mode. A detailed RF scheme of the site TWR Brač is shown in paragraph 10.3.12. TWR Brač RF diagrams.

The quantity of radio equipment and required frequencies installed on the site TWR Brač are shown in table 12.

<table>
<thead>
<tr>
<th>No</th>
<th>Frequency</th>
<th>Tx/Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF1</td>
<td>118.025 MHz</td>
<td>M/STBY</td>
</tr>
<tr>
<td>VHF2</td>
<td>121.500 MHz</td>
<td>M/STBY</td>
</tr>
</tbody>
</table>

**Table 12.** Quantity and required frequencies installed on the site TWR Brač

QTYE0150  **TWR Brač CWP**

The TWR Brač site shall consist of two (2) Radio control positions with similar or better characteristics than those described in chapter 2.3.13.

The defined exact receiving and transmitting frequencies installed on all radio sites may be changed by the Employer in the implementation phase. The Employer shall confirm the exact frequencies prior to the factory acceptance.

2.2.3  Quantity of 19” Cabinet Racks

The following quantities can be reduced by Tenderer if installed radio equipment does not occupy the lowest 10 HU of relevant cabinet.

**CRMR0010** Japetić Tx; The Tenderer shall offer five (5) Tx cabinet racks cabled for placing 4 pairs of VHF transmitters (main+standby) and a multicoupler each (Four cabinet racks for placing the VHF transmitters and one cabinet rack for placing the UHF transmitters, 4 VHF + 1 UHF). The Tenderer shall offer a rack blower unit, if necessary.

**CRMR0020** Sljeme Tx; The Tenderer shall offer four (4) Tx cabinet racks cabled for placing 4 pairs of transmitters (main+standby) and a multicoupler each. (Three cabinet racks for placing the VHF transmitters and one cabinet rack for placing the UHF transmitters, 3 VHF + 1 UHF). The Tenderer shall offer a rack blower unit, if necessary.

**CRMR0030** Kozjak Tx; The Tenderer shall offer five (5) Tx cabinet racks cabled for placing 4 pairs of VHF transmitters (main+standby) and a multicoupler each (Four cabinet racks for placing the VHF transmitters and one cabinet rack for placing the UHF transmitters, 4 VHF + 1 UHF). The Tenderer shall offer a rack blower unit, if necessary.
CRMR0040 Northern Adriatic Tx; The Tenderer shall offer three (3) Tx cabinet racks cabled for placing 4 pairs of transmitters (main+standby) and two multicouplers each. The Tenderer shall offer a rack blower unit, if necessary.

CRMR0050 Valtura VHF Tx; The Tenderer shall offer two (2) Tx cabinet racks cabled for placing 4 pairs of transmitters (main+standby) and a multicoupler each. The Tenderer shall offer a rack blower unit, if necessary.

CRMR0060 Valtura UHF Tx and Rx; The Tenderer shall offer one (1) Tx and Rx cabinet rack cabled for placing 2 pairs of transmitters (main+standby), 2 pairs of receivers (main+standby) and associated UHF transmitter and receiver filters. The Tenderer shall offer a rack blower unit, if necessary.

CRMR0070 V.Mlaka/Mićevec Tx; The Tenderer shall offer two (2) Tx cabinet racks cabled for placing 4 pairs of transmitters (main+standby) and a multicoupler each. The Tenderer shall offer a rack blower unit, if necessary.

CRMR0080 Čiovo Tx/Rx; The Tenderer shall offer one (1) Tx/Rx cabinet rack cabled for placing 4 pairs of transceivers (main+standby) and associated transceiver filters. The Tenderer shall offer a rack blower unit, if necessary.

CRMR0090 TWR Pula Tx; The Tenderer shall offer two (2) Tx cabinet racks cabled for placing 3 pairs of transmitters (main+standby) and multicoupler each. The Tenderer shall offer a rack blower unit, if necessary.

CRMR0100 TWR Split Tx; The Tenderer shall offer one (1) Tx cabinet rack cabled for placing 4 pairs of transmitters (main+standby) and a multicoupler. The Tenderer shall offer a rack blower unit, if necessary.

CRMR0110 TWR Osijek Tx/Rx; The Tenderer shall offer two (2) Tx/Rx cabinet racks cabled for placing 1 pair of transceivers (main+standby). The Tenderer shall offer a rack blower unit, if necessary.

CRMR0120 TWR Lošinj Tx/Rx; The Tenderer shall offer one (1) Tx/Rx cabinet rack cabled for placing 2 pairs of transceivers (main+standby) and associated transceiver filters. The Tenderer shall offer a rack blower unit, if necessary.

CRMR0130 TWR Brač Tx/Rx; The Tenderer shall offer one (1) Tx/Rx cabinet rack cabled for placing 2 pairs of transceivers (main+standby) and associated transceiver filters. The Tenderer shall offer a rack blower unit, if necessary.

CRMR0140 Japetić Rx; The Tenderer shall offer four (4) Rx cabinet racks (3 cabinet racks for placing 16 pairs of VHF receivers, two pairs of multicouplers for supporting all of the VHF receivers and 1 cabinet rack for placing 3 pairs of UHF receivers and two multicouplers). The Tenderer shall offer a rack blower unit, if necessary.

CRMR0150 Sljeme Rx; The Tenderer shall offer three (3) Rx cabinet racks (2 cabinet racks for placing 12 VHF receivers and two multicouplers each and 1 cabinet rack for placing 3 pairs of UHF receivers and two multicouplers). The Tenderer shall offer a rack blower unit, if necessary.

CRMR0160 Kozjak Rx; The Tenderer shall offer four (4) Rx cabinet racks (3 cabinet racks for placing 6 pairs of VHF receivers each, two pairs of multicouplers for supporting all of the VHF receivers and 1 cabinet rack for placing 3 pairs of UHF receivers and two multicouplers). The Tenderer shall offer a rack blower unit, if necessary.

CRMR0170 Northern Adriatic Rx; The Tenderer shall offer three (3) Rx cabinet racks for placing 4 pairs of VHF receivers and multicoupler each. The Tenderer shall offer a rack blower unit, if necessary.

CRMR0180 Valtura VHF Rx; The Tenderer shall offer two (2) Rx cabinet racks cabled for placing 4 pairs of receivers (main+standby) and a cavity filter multicoupler each. The Tenderer shall offer a rack blower unit, if necessary.
2.2.4 Quantity of Multicouplers

CRMC0010 Japetić; The Tenderer shall offer four (4) VHF cavity filter multicouplers such as defined in chapter 2.3.2.1 VHF Multicoupler type 1 and three (3) UHF cavity filters such as defined in chapter 2.3.2.4 UHF cavity filter specification of this document for the Tx site, four (4) VHF Rx multicouplers and two (2) UHF Rx multicouplers such as defined in chapter 2.3.13. VHF/UHF Receiver Multicoupler Requirements of this document for the Rx site.

CRMC0020 Sljeme; The Tenderer shall offer three (3) VHF cavity filter multicouplers such as defined in chapter 2.3.2.1 VHF Multicoupler type 1 and three (3) UHF cavity filters such as defined in chapter 2.3.2.4 UHF cavity filter specification of this document for the Tx site, four (4) VHF Rx multicouplers and two (2) UHF Rx multicouplers such as defined in chapter 2.3.13. VHF/UHF Receiver Multicoupler Requirements of this document for the Rx site.

CRMC0030 Kozjak; The Tenderer shall offer four (4) VHF cavity filter multicouplers such as defined in chapter 2.3.2.1 VHF Multicoupler type 1 and one (1) UHF cavity filter multicoupler such as defined in chapter 2.3.2.2 UHF Multicoupler type 1 of this document for the Tx site, four (4) VHF Rx multicouplers and two (2) UHF Rx multicouplers such as defined in chapter 2.3.13. VHF/UHF Receiver Multicoupler Requirements of this document for the Rx site.

CRMC0040 Northern Adriatic; The Tenderer shall offer three (3) VHF multicouplers such as defined in chapter 2.3.2.5 VHF Multicoupler type 2 of this document for the Tx system and three (3) Rx multicouplers such as defined in chapter 2.3.2.5 VHF Multicoupler type 2 of this document for the Rx system.

CRMC0050 Valtura; The Tenderer shall offer two (2) VHF cavity filter multicouplers such as defined in chapter 2.3.2.1 Multicoupler type 1, two (2) UHF cavity filters as defined in chapter 2.3.2.4 UHF cavity filter specification of this document for the Tx system and two (2) VHF cavity filter multicouplers such as defined in chapter 2.3.2.1 Multicoupler type 1 and two (2) UHF cavity filters as defined in chapter 2.3.2.4 UHF cavity filter specification of this document for the Rx system.

CRMC0060 V.Mlaka/Mičèvec; The Tenderer shall offer two (2) VHF cavity filter multicouplers such as defined in chapter 2.3.2.1 Multicoupler type 1 of this document for the Tx site and two (2) VHF Rx multicouplers such as defined in chapter 2.3.13. VHF/UHF Receiver Multicoupler Requirements of this document for the Rx site.

CRMC0070 Čiovo; The Tenderer shall offer two (2) VHF cavity filters per main/standby pair of transceivers such as defined in chapter 2.3.2.3 Cavity filter specification of this document.
CRMC0080  **TWR Pula:** The Tenderer shall offer two (2) VHF cavity filter multicouplers such as defined in chapter 2.3.2.1 Multicoupler type 1 of this document for the Tx site and two (2) VHF Rx multicouplers such as defined in chapter 2.3.13. VHF/UHF Receiver Multicoupler Requirements of this document for the Rx site.

CRMC0090  **TWR Split:** The Tenderer shall offer one (1) VHF cavity filter multicoupler such as defined in chapter 2.3.2.1 Multicoupler type 1 of this document for the Tx site and two (2) VHF Rx multicouplers such as defined in chapter 2.3.13. VHF/UHF Receiver Multicoupler Requirements of this document for the Rx site.

CRMC0100  **TWR Lošinj:** The Tenderer shall offer two (2) VHF cavity filters per main/standby pair of transceivers such as defined in chapter 2.3.2.3 Cavity filter specification of this document.

CRMC0110  **TWR Brač:** The Tenderer shall offer two (2) VHF cavity filters per main/standby pair of transceivers such as defined in chapter 2.3.2.3 Cavity filter specification of this document.

2.2.5 **Antenna System Quantity**

**Note:** At Sites TX Japetić and TX Sljeme, the existing antennas planned to be reused are equipped with low loss cables, RF connectors, RF grounding kits and RF EMP protectors. The Tenderer shall offer only jumper cables.

CRAN0010  **Japetić:** The principal positioning and distances between Tx and Rx antenna systems on the site Japetić are shown in paragraph 10.1.1. *Principal positioning of antennas, site Japetić.* Existing Tx antennas mounted on Tx communications mast shall be used. Rx antennas shall be mounted on Rx communications mast. The Japetić antenna system shall consist of:

- Two (2) VHF Tx antennas with similar or better characteristics than described in chapter 2.3.1.3 Antenna type 3 of this document are already installed, and shall be used.
- One (1) UHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.6 Antenna type 6 of this document is already installed, and shall be used.
- Additionally, one (1) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be mounted on a mast and cabled up to the entry point of the Tx center Japetić for spare purposes.
- Two (2) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.2 Antenna type 2 of this document shall be used.
- One (1) UHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.5 Antenna type 5 of this document shall be used.
- Additionally, one (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 and one (1) UHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.4 Antenna type 4 of this document shall be mounted on a mast and cabled up to the entry point of the Rx center Japetić for spare purposes.
- Four (4) Cavity filter multicouplers for the Tx system with similar or better characteristics than described in chapter 2.3.2.1 Cavity filter Multicoupler type 1 of this document shall be used.
- Three (3) cavity filters with similar or better characteristics than described in chapter 2.3.2.3. *UHF Cavity filter specification* shall be used.
- Four (4) Rx VHF Multicouplers/Multicoupler systems capable of connecting 8 VHF receivers each with similar or better characteristics than described in chapter 2.3.13. VHF/UHF Receiver Multicoupler’s requirements.
- Two (2) Rx UHF Multicouplers/Multicoupler systems capable of connecting 4 UHF receivers each with similar or better characteristics than described in chapter 2.3.13. VHF/UHF Receiver Multicoupler’s requirements.
- Sixteen (16) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 *Lightning protector specification* shall be used.
- Low loss cables for connecting Tx and RX antennas shall have similar or better characteristics than described in 2.3.7.1 *RF Cable type* shall be used.
- At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
- Four (4) VSWR meters with similar or better characteristics than described in chapter 2.3.3 *SWR Monitor specification* shall be used.
- Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.

**CRAN0020 Sijeme:** The principal positioning and distances between Tx and Rx antenna systems on the site Sijeme are shown in paragraph 10.1.2. *Principal positioning of antennas, site Sijeme.* Existing Tx antennas mounted on Tx communications mast shall be used. Rx antennas shall be mounted on Rx communications mast. The Sijeme antenna system shall consist of:

- Two (2) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.3 *Antenna type 3* of this document are already installed, and shall be used.
- One (1) UHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.6 Antenna type 6 of this document is already installed, and shall be used.
- One (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.2 *Antenna type 2* of this document shall be used.
- Two (2) UHF Rx antennas with similar or better characteristics than described in chapter 2.3.1.4 *Antenna type 4* of this document shall be used.
- Three (3) Cavity filter multicouplers for the Tx system with similar or better characteristics than described in chapter 2.3.2.1 *Cavity filter Multicoupler 1* of this document shall be used.
- Three (3) cavity filters with similar or better characteristics than described in chapter 2.3.2.3. *UHF Cavity filter specification* shall be used.
- Four (4) Rx VHF Multicouplers/Multicoupler systems capable of connecting 8 VHF receivers each with similar or better characteristics than described in chapter 2.3.13. VHF/UHF Receiver Multicoupler’s requirements.
- Two (2) Rx UHF Multicouplers/Multicoupler systems capable of connecting 4 UHF receivers each with similar or better characteristics than described in chapter 2.3.13. VHF/UHF Receiver Multicoupler’s requirements.
- Four (4) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector specification shall be used.
- Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.1 RF Cable type1 shall be used.
- At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
- Three (3) VSWR meters with similar or better characteristics than described in chapter 2.3.3 SWR Monitor specification shall be used.
- Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.

**CRAN0030 Kozjak:** The principal positioning and distances between Tx and Rx antenna systems on the site Kozjak are shown in paragraph 10.1.3. Principal positioning of antennas, site Kozjak. Tx antennas shall be mounted on the Tx communication mast, the Rx antenna system shall be mounted on the RDR Kozjak platform, and Rx antennas shall be mounted on the existing Rx communication mast. The Kozjak antenna system shall consist of:

- Two (2) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.2 Antenna type 2 of this document shall be used.
- One (1) UHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.4. Antenna type 4 of this document shall be used.
- Additionally, one (1) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be mounted on a mast and cabled up to the entry point of the Tx center Kozjak for spare purposes.
- One (1) VHF Rx antenna system with similar or better characteristics than described in chapter 2.3.1.7 VHF Antenna system of this document shall be used.
- One (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.2 Antenna type 2 of this document shall be used.
- Two (2) UHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.4 Antenna type 4 of this document shall be used.
- Additionally, one (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 and of this document shall be mounted on a mast and cabled up to the entry point of the Rx center Kozjak for spare purposes.
- Four (4) VHF Cavity filter multicouplers for Tx system with similar or better characteristics than described in chapter 2.3.2.1 VHF Multicoupler type1 of this document shall be used.
- One (1) cavity filter multicoupler with similar or better characteristics than described in chapter 2.3.2.2. UHF Multicoupler type1 of this document shall be used.
- Four (4) Rx VHF Multicouplers/Multicoupler systems capable of connecting 8 VHF receivers each with similar or better characteristics than described in chapter 2.3.13. VHF/UHF Receiver Multicoupler's requirements.
- Two (2) Rx UHF Multicouplers/Multicoupler systems capable of connecting 4 UHF receivers each with similar or better characteristics than described in chapter 2.3.13. VHF/UHF Receiver Multicoupler’s requirements.
Eleven (11) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector shall be used.

Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.1 RF Cable type 1 shall be used.

At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.

Four (4) VSWR meters with similar or better characteristics than described in chapter 2.3.3 SWR meter shall be used.

Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.

CRAN0040 Northern Adriatic: The principal positioning and distances between Tx and Rx antenna systems on the site Northern Adriatic is shown in paragraph 10.1.4. Principal positioning of antennas, site Northern Adriatic. Tx and Rx antennas shall be mounted on the same communications mast. The Northern Adriatic antenna system shall consist of:

- Three (3) VHF Tx antennas with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be used.
- Additionally, one (1) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be mounted on a mast and cabled up to the enter point of the Northern Adriatic radio center for spare purposes.
- Three (3) VHF Rx antennas with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be used.
- Additionally, one (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be mounted on a mast and cabled up to the enter point of the Northern Adriatic radio center for spare purposes.
- Three (3) Cavity filter multicouplers for Tx system with similar or better characteristics than described in chapter 2.3.2.5 VHF Multicoupler type 2 of this document shall be used.
- Three (3) Cavity filter multicouplers for Rx system with similar or better characteristics than described in chapter 2.3.2.5 VHF Multicoupler type 2 of this document shall be used.
- Eight (8) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector specification shall be used.
- Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.2 RF Cable type 2 shall be used.
- At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
- Three (3) VSWR meters with similar or better characteristics than described in chapter 2.3.3 SWR Monitor specification shall be used.
- Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.
Valtura; The principal positioning and distances between Tx and Rx antenna systems on the site Valtura is shown in paragraph 10.1.5. Principal positioning of antennas, site Valtura. Tx antennas shall be mounted on Tx antenna mast and Rx antennas shall be mounted on the Rx antenna mast. The Valtura antenna system shall consist of:

- One (1) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.2 Antenna type 2 of this document shall be used.
- Two (2) UHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.4 Antenna type 4 of this document shall be used.
- Additionally, one (1) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be mounted on a mast and cabled up to the entry point of the radio center Valtura for spare purposes.
- One (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.2 Antenna type 2 of this document shall be used.
- Two (2) UHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.4 Antenna type 4 of this document shall be used.
- Additionally, one (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be mounted on a mast and cabled up to the entry point of the radio center Valtura for spare purposes.
- Two (2) Cavity filter multicoupler for Tx system with similar or better characteristics than described in chapter 2.3.2.1 VHF Multicoupler type 1 of this document shall be used.
- Two (2) Cavity filter multicouplers for Rx system with similar or better characteristics than described in chapter 2.3.2.1 VHF Multicoupler type 1 of this document shall be used.
- Two (2) Tx cavity filters with similar or better characteristics than described in chapter 2.3.2.3. UHF Cavity filter specification shall be used.
- Two (2) Rx cavity filters with similar or better characteristics than described in chapter 2.3.2.3. UHF Cavity filter specification shall be used.
- Ten (10) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector specification shall be used.
- Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.1 RF Cable type 1 shall be used.
- At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
- Two (2) VSWR meters with similar or better characteristics than described in chapter 2.3.3 SWR Monitor specification shall be used.
- Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.
Velika Mlaka/Mićevec: The principal positioning and distances between Tx and Rx antenna systems on the site Velika Mlaka/Mićevec is shown in paragraph 10.1.6. Principal positioning of antennas, site Velika Mlaka/Mićevec. Tx antennas shall be mounted on the Tx communication mast, and Rx antennas shall be mounted on the Rx communications mast. Velika Mlaka/Mićevec antenna system shall consist of:

- One (1) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.2 Antenna type 2 of this document shall be used.
- Additionally, one (1) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be mounted on a mast and cabled up to the entry point of the Tx center V. Mlaka for spare purposes.
- One (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.2 Antenna type 2 of this document shall be used.
- Additionally, one (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be mounted on a mast and cabled up to the entry point of the Rx center Mićevec for spare purposes.
- Two (2) Cavity filter multicouplers for Tx system with similar or better characteristics than described in chapter 2.3.2.1 VHF Multicoupler type1 of this document shall be used.
- Two (2) Rx VHF Multicouplers/Multicoupler systems capable of connecting 8 VHF receivers each with similar or better characteristics than described in chapter 2.3.13. VHF/UHF Receiver Multicoupler’s requirements.
- Six (6) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector specification shall be used.
- Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.1 RF Cable type 1 shall be used.
- At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
- Two (2) VSWR meters with similar or better characteristics than described in chapter 2.3.3 SWR Monitor specification shall be used.
- Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.

Čiovo: The principal positioning and distances between transceiver antennas on the site Čiovo is shown in paragraph 10.1.7. Principal positioning of antennas, site Čiovo. Transceiver antennas shall be mounted on the roof of the Čiovo object. The Čiovo antenna system shall consist of:

- Two (2) VHF Tx/Rx antennas with similar or better characteristics than described in chapter 2.3.1.3 Antenna type 3 of this document shall be used.
- Additionally, unused dipoles of antennas shall be cabled up to the entry point of radio center Čiovo for spare purposes.
- Six (6) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector specification shall be used.
- Four (4) pairs of cavity filters with similar or better characteristics than described in chapter 2.3.2.3. Cavity filter specification shall be used.
• Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.3 RF Cable type 3 shall be used.
• At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
• Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.

CRAN0080  TWR Pula; The principal positioning and distances between Tx and Rx antenna systems on the site TWR Pula is shown in paragraph 10.1.8. Principal positioning of antennas, site TWR Pula. Tx antennas shall be mounted on the roof of TWR Pula object, and Rx antennas shall be mounted on the Rx communications mast. TWR Pula antenna system shall consist of:

• One (1) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.3 Antenna type 3 of this document shall be used.
• Additionally, unused dipole of Tx antenna shall be cabled up to the entry point of radio center TWR Pula Tx for spare purposes.
• One (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.2 Antenna type 2 of this document shall be used.
• Additionally, one (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be mounted on a mast and cabled up to the entry point of the Rx center TWR Pula for spare purposes.
• Two (2) Cavity filter multicouplers for Tx system with similar or better characteristics than described in chapter 2.3.2.1 VHF Multicoupler type 1 of this document shall be used.
• Two (2) Rx VHF Multicouplers/Multicoupler systems capable of connecting 6 VHF receivers each with similar or better characteristics than described in chapter 2.3.13. VHF/UHF Receiver Multicoupler’s requirements.
• Six (6) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector specification shall be used.
• Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.1 RF Cable type 1 shall be used.
• At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
• Two (2) VSWR meters with similar or better characteristics than described in chapter 2.3.3 SWR Monitor specification shall be used.
• Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.

CRAN0090  TWR Split; The principal positioning and distances between Tx and Rx antenna systems on the site TWR Split is shown in paragraph 10.1.9. Principal positioning of antennas, site TWR Split. Tx antennas shall be mounted on the roof of TWR Split object, and Rx antennas shall be mounted on the Rx communications mast. TWR Split antenna system shall consist of:
- One (1) VHF Tx antenna with similar or better characteristics than described in chapter 2.3.1.3 Antenna type 3 of this document shall be used.
- Additionally, unused dipole of Tx antenna shall be cabled up to the entry point of radio center TWR Split Tx for spare purposes.
- One (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.2 Antenna type 2 of this document shall be used.
- Additionally, one (1) VHF Rx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be mounted on a mast and cabled up to the entry point of the Rx center TWR Split for spare purposes.
- One (1) Cavity filter multicoupler for Tx system with similar or better characteristics than described in chapter 2.3.2.1 VHF Multicoupler type1 of this document shall be used.
- Two (2) Rx VHF Multicouplers/Multicoupler systems capable of connecting 4 VHF receivers each with similar or better characteristics than described in chapter 2.3.13. VHF/UHF Receiver Multicoupler’s requirements.
- Six (6) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector specification shall be used.
- Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.1 RF Cable type1 shall be used.
- At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
- One (1) VSWR meter with similar or better characteristics than described in chapter 2.3.3 SWR Monitor specification shall be used.
- Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.

**CRAN0100 TWR Osijek;** The principal positioning and distances between Tx and Rx antenna systems on the site TWR Osijek is shown in paragraph 10.1.10. Principal positioning of antennas, site TWR Osijek. Tx/Rx antennas shall be mounted on the roof of GP Osijek object, and the roof of LLZ Osijek object. TWR Osijek antenna system shall consist of:

- Two (2) VHF Tx/Rx antenna with similar or better characteristics than described in chapter 2.3.1.1 Antenna type 1 of this document shall be used.
- Two (2) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector specification shall be used.
- Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.1 RF Cable type1 shall be used.
- At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
- Jumper cables for connection between radios and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.
CRAN0110  TWR Lošinj; The principal positioning and distances between transceiver antennas on the site TWR Lošinj is shown in paragraph 10.1.1. Principal positioning of antennas, site TWR Lošinj. Transceiver antennas shall be mounted on the roof of TWR Lošinj object. TWR Lošinj antenna system shall consist of:

- One (1) VHF Tx/Rx antenna with similar or better characteristics than described in chapter 2.3.1.3 Antenna type 3 of this document shall be used.
- Additionally, unused dipole of Tx/Rx antenna shall be cabled up to the entry point of radio center TWR Lošinj for spare purposes.
- Two (2) pairs of cavity filters with similar or better characteristics than described in chapter 2.3.2.3. Cavity filter specification shall be used.
- Three (3) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector specification shall be used.
- Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.1 RF Cable type 1 shall be used.
- At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
- Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.

CRAN0120  TWR Brač; The principal positioning and distances between transceiver antennas on the site on the site TWR Brač is shown in paragraph 10.1.12. Principal positioning of antennas, site TWR Brač. Transceiver antennas shall be mounted on the roof of TWR Brač object. TWR Brač antenna system shall consist of:

- One (1) VHF Tx/Rx antenna with similar or better characteristics than described in chapter 2.3.1.3 Antenna type 3 of this document shall be used.
- Additionally, unused dipole of Tx/Rx antenna shall be cabled up to the entry point of radio center TWR Brač for spare purposes.
- Two (2) pairs of cavity filters with similar or better characteristics than described in chapter 2.3.2.3. Cavity filter specification shall be used.
- Three (3) EMP protector devices with similar or better characteristics than described in chapter 2.3.4 Lightning protector specification shall be used.
- Low loss cables for connecting antennas with similar or better characteristics than described in 2.3.7.1 RF Cable type 1 shall be used.
- At least two (2) grounding kits per RF cable for grounding an outer connector of all RF cables shall be used.
- Jumper cables for connection between Multicouplers and lightning protectors shall be used as well as the jumper cables for connection between main RF cable and antennas.

2.2.6 Ethernet equipment Quantity
ETHE0010 The Tenderer shall offer appropriate quantity of Ethernet equipment (switches, etc) to ensure full redundancy of main and stand by radio chains at each radio site (in order to avoid single point of failure).

### 2.2.7 RCMS Site equipment Quantity

RCQT0010 The Tenderer shall offer appropriate quantity of RCMS Site equipment to ensure full functionality of RCMS system according to the relevant requirements in this specification.

### 2.3 System

#### 2.3.1 Antenna Specification

ANTE0010 Antenna systems shall be designed to withstand at least 15 years constant outdoor environmental conditions typical for high-altitude mountain conditions. At least the following antenna handling requirements shall be met:

- temperature: -40°C to 80°C;
- Air humidity: up to 97%;
- Altitude: 2000m above mean sea level;
- Air Exposure to direct sunlight;
- Exposure to ice;
- Exposure to severe wind gusts at speed of 200 km/h;
- Exposure to combination of above mentioned conditions i.e. extreme wind and ice
- Exposure to sea salt corrosive atmosphere;
- Exposure to severe lightning strikes;

ANTE0020 Antennas shall be delivered together with mounting brackets necessary for fixing antennas to masts.

ANTE0030 Lightning protection solutions based on high speed gas-tube protectors shall be provided for each delivered antenna.

ANTE0040 Elements necessary for connecting antennas to the radios shall be determined, specified and delivered by the Contractor.

ANTE0050 All antenna systems shall be fully installed at all locations (including lightning protections, grounding kits, all necessary connectors, all necessary mounting brackets for mast fixation, cable hangers, etc.).

ANTE0060 The transmit and receive antennas shall be vertically erected omni-directional dipoles, either combined, stacked or individually mounted, depending on the local situation.

ANTE0070 Standard broadband VHF dipole antennas shall be required with an omnidirectional radiation diagram.

ANTE0080 Transmit and receive antennas shall be of such a type with power handling capacity to sufficiently afford the total power emission needs.
ANTE0090  The frequency range shall be 118-137 MHz for VHF equipment and 225-400 MHz for UHF equipment with VSWR better than 2:1.

In designing the antenna systems the following types of antennas shall be used and offered:

2.3.1.1 Antenna type 1

ANTE0100  The antenna polarization shall be vertical.
ANTE0110  The antenna frequency range shall be 118-137 MHz (VHF Air band). The bandwidth shall not exceed 45 MHz.
ANTE0120  The antenna height shall be less than 1400 mm.
ANTE0130  The antenna diameter shall be less than 130 mm
ANTE0140  An RF connector shall be N female.
ANTE0150  The antenna impedance shall be 50Ω.
ANTE0160  The maximal power handling of the antenna shall be at least 110W at a summer temperature of 50˚C.
ANTE0170  The antenna weight shall not exceed 5,5 kg.
ANTE0180  The maximal wind velocity of the antenna shall be at least 200km/h.
ANTE0190  The antenna gain shall be at least 0 dB (ref. to the half wave dipole).
ANTE0200  The antenna SWR shall be less than 2.0.

2.3.1.2 Antenna type 2

ANTE0210  The antenna shall consist of two (2) vertically stacked and independently fed dipoles (stacked antenna).
ANTE0220  The antenna polarization shall be vertical.
ANTE0230  The antenna frequency range shall be 118-137 MHz (VHF Air band). The bandwidth shall not exceed 45 MHz.
ANTE0240  The antenna height shall be less than 4500 mm.
ANTE0250  The antenna radome diameter shall be less than 125 mm.
ANTE0260  RF connectors shall be N female.
ANTE0270  The antenna impedance shall be 50Ω.
ANTE0280 The maximal power handling of the antenna shall be at least 100W at a summer temperature of 50°C.

ANTE0290 The antenna weight shall not exceed 35 kg.

ANTE0300 The maximal wind velocity of antenna shall be at least 200km/h.

ANTE0310 The antenna gain shall be at least 0.5 dBi (ref. to the half wave dipole).

ANTE0320 The antenna SWR shall be less than 1.8.

ANTE0330 The attenuation between adjacent dipoles shall be at least 27 dB.

ANTE0340 The antenna wind load shall not exceed 500N.

2.3.1.3 Antenna type 3
ANTE0360 The antenna shall consist of three (3) vertically stacked, independently fed dipoles (stacked antenna).

ANTE0370 The antenna polarization shall be vertical.

ANTE0380 The antenna frequency range shall be 118-137 MHz (VHF Air band). The bandwidth shall not exceed 50 MHz.

ANTE0390 The antenna height shall be less or equal than 6000 mm.

ANTE0400 The antenna radome diameter shall be less than 125 mm.

ANTE0410 RF connectors shall be N female.

ANTE0420 The antenna impedance shall be 50Ω.

ANTE0430 The maximal power handling of antenna shall be at least 100W at summer temperature of 50°C.

ANTE0440 The antenna weight shall not exceed 55 kg.

ANTE0450 The maximal wind velocity of antenna shall be at least 200km/h.

ANTE0460 The antenna gain shall be at least 0.5 dB (ref. to the half wave dipole).

ANTE0470 The antenna SWR shall be less than 1.8.

ANTE0480 The attenuation between adjacent dipoles shall be at least 27 dB.

ANTE0490 The antenna wind load shall not exceed 700N.

2.3.1.4 Antenna type 4
ANTE0500 The antenna polarization shall be vertical.

ANTE0510 The antenna frequency range shall be 225-400 MHz.

ANTE0520 The antenna height shall be less than 1300 mm.
ANTE0530 RF connector shall be N female.
ANTE0540 The antenna impedance shall be 50Ω.
ANTE0550 The maximal power handling of antenna shall be at least 500W.
ANTE0560 The antenna weight shall not exceed 3 kg.
ANTE0570 The maximal wind load of antenna shall not be greater than 150 N at 160km/h.
ANTE0580 The antenna gain shall be at least 0dB (ref. to the half wave dipole).
ANTE0590 The antenna SWR shall be less than 2.3.

2.3.1.5 Antenna type 5

ANTE0600 The antenna shall consist of two (2) vertically stacked, independently fed dipoles (stacked antenna).
ANTE0610 The antenna polarization shall be vertical.
ANTE0620 The antenna frequency range shall be 225-400 MHz
ANTE0630 The antenna height shall be less than 2700 mm.
ANTE0640 RF connectors shall be N female.
ANTE0650 The antenna impedance shall be 50Ω.
ANTE0660 The maximal power handling of antenna shall be at least 110W at summer temperature of 50°C.
ANTE0670 The antenna weight shall not exceed 30 kg.
ANTE0680 The maximal wind velocity of antenna shall be at least 200km/h.
ANTE0690 The attenuation between adjacent dipoles shall be at least 27dB.
ANTE0700 The antenna SWR shall be less than 2.0.
ANTE0710 The antenna gain shall be at least 1 dB (ref. to the half wave dipole).
ANTE0720 The antenna wind load shall not exceed 430N.

2.3.1.6 Antenna type 6

ANTE0730 The antenna shall consist of three (3) vertically stacked, independently fed dipoles (stacked antenna).
ANTE0740 The antenna polarization shall be vertical.
ANTE0750  The antenna frequency range shall be 225-400 MHz
ANTE0760  The antenna height shall be less than 3700 mm.
ANTE0770  RF connectors shall be N female.
ANTE0780  The antenna impedance shall be 50Ω.
ANTE0790  The maximal power handling of antenna shall be at least 110W at summer temperature of 50˚C.
ANTE0800  The antenna weight shall not exceed 40 kg.
ANTE0810  Them maximal wind velocity of antenna shall be at least 200km/h.
ANTE0820  The attenuation between adjacent dipoles shall be at least 27dB.
ANTE0830  The antenna SWR shall be less than 2.0.
ANTE0840  The antenna gain shall be at least 1 dB (ref. to the half wave dipole).
ANTE0850  The antenna wind load shall not exceed 600N.

2.3.1.7  VHF Antenna system

The antenna system shall be installed at the RDR mast at the site Kozjak. The dimensions of the mast are described at the 10.5 RDR Kozjak mast.

ANTE0860  The antenna system polarization shall be vertical.
ANTE0870  The antenna system frequency range shall be at least 118-137 MHz.
ANTE0880  The antenna system shall consist of more than one VHF antenna element, forming together the antenna system mounted on a radar building in order to achieve a 360˚ coverage.
ANTE0890  The antenna system shall form a 360˚ radiation diagram with gain nulls less than 10dB.
ANTE0900  RF connectors shall be N female.
ANTE0910  The antenna system impedance shall be 50Ω.
ANTE0920  The maximal input power of antenna element shall be at least 150 W.
ANTE0930  Them maximal wind velocity of all elements of antenna system shall be at least 200km/h.
2.3.2 Multicoupler specification

In designing the antenna systems the following types of cavity filters and multicouplers shall be used:

2.3.2.1 VHF Multicoupler type 1

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COUP0010</td>
<td>The number of cavities per channel shall be 1.</td>
</tr>
<tr>
<td>COUP0020</td>
<td>The cavity tuning range shall be within 118-137 MHz.</td>
</tr>
<tr>
<td>COUP0030</td>
<td>Due to the lack of space, the maximum cavity size shall not exceed 8.75&quot;.</td>
</tr>
<tr>
<td>COUP0040</td>
<td>The multicoupler cavity insertion loss shall not exceed 0.9 dB.</td>
</tr>
<tr>
<td>COUP0050</td>
<td>The cavity isolation channel to channel shall be not less than 30 dB.</td>
</tr>
<tr>
<td>COUP0060</td>
<td>The isolation antenna to transmitter shall be at least 25 dB.</td>
</tr>
<tr>
<td>COUP0070</td>
<td>The maximum power handling per channel shall be at least 50W.</td>
</tr>
<tr>
<td>COUP0080</td>
<td>The maximum channel insertion loss shall be less than 2.5 dB.</td>
</tr>
<tr>
<td>COUP0090</td>
<td>The isolator insertion loss shall be less than 0.6 dB.</td>
</tr>
<tr>
<td>COUP0100</td>
<td>The minimum channel separation in the multicoupler shall be at least 200 kHz.</td>
</tr>
<tr>
<td>COUP0110</td>
<td>The maximum number of channels shall not exceed four (4).</td>
</tr>
</tbody>
</table>

2.3.2.2 UHF Multicoupler type 1

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COUP0120</td>
<td>The number of cavities per channel shall be 1.</td>
</tr>
<tr>
<td>COUP0130</td>
<td>The cavity tuning range shall be within 225-400 MHz.</td>
</tr>
<tr>
<td>COUP0140</td>
<td>Due to the lack of space, the maximum cavity size shall not exceed 8.75&quot;.</td>
</tr>
<tr>
<td>COUP0150</td>
<td>The multicoupler cavity insertion loss shall not exceed 0.7 dB.</td>
</tr>
<tr>
<td>COUP0160</td>
<td>The cavity isolation channel to channel shall be not less than 22 dB.</td>
</tr>
<tr>
<td>COUP0170</td>
<td>The isolation antenna to transmitter shall be at least 17 dB.</td>
</tr>
<tr>
<td>COUP0180</td>
<td>The maximum power handling per channel shall be at least 100W.</td>
</tr>
<tr>
<td>COUP0190</td>
<td>The maximum channel insertion loss shall be less than 2 dB.</td>
</tr>
<tr>
<td>COUP0200</td>
<td>The isolator insertion loss shall be less than 1.0 dB.</td>
</tr>
<tr>
<td>COUP0210</td>
<td>The minimum channel separation in the multicoupler shall be at least 1 MHz.</td>
</tr>
</tbody>
</table>
2.3.2.3 VHF Cavity filter specification

COUP0220  The cavity tuning range shall be within 118-137 MHz.
COUP0230  Due to the lack of space, the maximum cavity size shall not exceed 8,75".
COUP0240  The cavity insertion loss shall not exceed 0.9 dB.
COUP0250  Connectors shall be an N female type.
COUP0260  The cavity impedance shall be 50Ω.
COUP0270  The cavity input power shall be at least 100W.
COUP0280  Attenuation at ± 1MHz from central frequency shall be at least 15 dB with the insertion loss of 1dB.

2.3.2.4 UHF Cavity filter specification

COUP0290  The cavity tuning range shall be within 225-400 MHz.
COUP0300  Due to the lack of space, the maximum cavity size shall not exceed 8,75".
COUP0310  The cavity insertion loss shall not exceed 0.9 dB.
COUP0320  Connectors shall be an N female type.
COUP0330  The cavity impedance shall be 50Ω.
COUP0340  The cavity input power shall be at least 100W

2.3.2.5 VHF Multcoupler type2

COUP0350  The number of cavities per channel shall be 2.
COUP0360  The cavity tuning range shall be within 118-137 MHz.
COUP0370  Due to the lack of space, the maximum cavity size shall not exceed 8,75".
COUP0380  The multicoupler cavity insertion loss shall not exceed 0.9 dB.
COUP0390  The cavity isolation channel to channel shall be not less than 35 dB.
COUP0400  The isolation antenna to transmitter shall be at least 25 dB.
COUP0410  The maximum power handling per channel shall be at least 50W.
COUP0420  The maximum channel insertion loss shall be less than 3 dB.
COUP0430  The isolator insertion loss shall be less than 0.6 dB
COUP0440  The minimum channel separation in the multicoupler shall be at least 200 kHz.
2.3.3 SWR Monitor Specification

**SWRM0010** The Antenna VSWR Monitor shall have at least 250W power ratings.

**SWRM0020** Impedance of the Antenna VSWR Monitor shall be 50Ω.

**SWRM0030** The main line return loss of the Antenna VSWR Monitor shall be greater than 30dB.

**SWRM0040** The frequency range of the Antenna VSWR Monitor shall be at least from 100-400 MHz.

**SWRM0050** The insertion loss of the Antenna VSWR Monitor shall be less than 0.1dB.

**SWRM0060** The Antenna VSWR Monitor shall have an N type connector.

**SWRM0070** The temperature range of the VSWR Monitor shall be at least -10 to +50˚C.

**SWRM0080** The output alarm contacts of the Antenna VSWR Monitor shall be a relay contact or opto isolated.

**SWRM0090** The SWR Monitor output shall be integrated into the RCMS system.

**SWRM0100** The power supply of the Antenna VSWR Monitor shall be 24V DC.

2.3.4 Lightning Protector Specification

**LIGT0010** The lightning protector shall be a Gas Tube type.

**LIGT0020** The Lightning Protector SWR shall be at least ≤ 1.06 in range 0 to 1000 MHz and at least ≤ 1.2 in range 1000 to 2500 MHz.

**LIGT0030** The Lightning Protector insertion loss shall be ≤ 0.1 dB

**LIGT0040** All Lightning Protector connectors shall be an N female type.

**LIGT0050** The Lightning Protector frequency range shall be at least DC – 2500 MHz.

**LIGT0060** The Lightning Protector sparkover voltage shall be around 230V.

**LIGT0070** The Lightning Protector operating temperature shall be at least -40 to +85˚C.

2.3.5 Ethernet switch specification

**ETHS0010** The ethernet switch shall have at least 8 ports.

**ETHS0020** The ethernet switch shall meet requirements according to:
- IEEE802.3 for 10BASE-T,
- IEEE802.3u for 100BASE-TX
- IEEE802.3x for Flow Control
**ETHS0030** The ethernet switch shall have redundant power inputs.

**ETHS0040** The input voltage of ethernet switch shall be at least in range 12 - 45VDC.

**ETHS0050** The ethernet switch shall have following Alarm Contact:
- 1 relay output with current carrying capacity of 1 A @ 24VDC.

**ETHS0060** The ethernet switch shall meet requirements according to following standards:
- EN61000-4-2 (ESD) EN61000-4-3 (RS)
- EN61000-4-4 (EFT) EN61000-4-5 (Surge)
- EN61000-4-6 (CS) EN61000-4-8

**ETHS0070** The operating temperature of ethernet switch shall be at least -0 to +60°C.

**ETHS0080** The ethernet switch shall meet environmental requirements according to following standards:
- IEC60068-2-27 (Shock)
- IEC60068-2-6 (Vibration)

### 2.3.6 Telecommunication Cabinet Specification

**TRCA0010** All telecommunication cabinets shall be designed for housing the 19” equipment.

**TRCA0020** All telecommunication cabinets shall be prepared for connecting all equipment to the AC and DC power supply.

**TRCA0030** All telecommunication cabinets shall have an AC and DC power distribution panel with individual fuses dedicated for every device.

**TRCA0040** All telecommunication cabinets shall have all necessary cabling for the connection of all radio equipment; audio cables, Ethernet cables, data cables, RF cables, grounding cables.

**TRCA0050** All telecommunication cabinets shall have wiring blocks necessary for connecting analog audio and signaling data to the MDF.

**TRCA0060** All telecommunication cabinets shall be equipped with all necessary additional RF equipment; Multicouplers, Filters, antenna relays, an SWR monitor.

**TRCA0070** Due to the technical room dimensions, all 19” telecommunication cabinets prepared for housing Tx and Rx radio equipment shall be maximum 43U high.

**TRCA0080** The cabinet shall have a lockable rear door that restricts access to the rear AC and DC distribution.

**TRCA0090** In case that the telecommunication cabinet has front doors it shall be transparent so that the radio equipment is visible.

**TRCA0100** The equipment cabinets shall be professionally made.

**TRCA0110** In order to minimize the radio equipment accidental switch off, a power on/off button shall be mechanically protected.
TRCA0120 The cabinet front unused spaces shall be fitted with blank 19” panels.

TRCA0130 In order to establish communication between VCS/CWP and radio equipment via IP protocol, all telecommunication cabinets shall be equipped with all necessary IP equipment.

### 2.3.7 RF Cable Specification

#### 2.3.7.1 RF Cable type 1

**RFCA0010** The cable type shall be Foam-Dielectric, Corrugated.

**RFCA0020** The cable size shall be 7/8”.

**RFCA0030** The cable shall meet flame and fire retardant requirements according to IEC 60332-1 and IEC 60332-3.C

**RFCA0040** The cable shall meet requirements according to IEC 61034 (up to 2-1/4) for a smoke emission test.

**RFCA0050** The cable shall meet requirements according to UL 1581-1991 Sect. 1080 VW 1 Flame test, for flame test on single cable and UL 1581-1991 Sect. 1160 Vertical Tray Flame test, for a fire test on a bunched cable.

**RFCA0060** The cable shall meet requirements according to IEC 60754-1 and IEC 60754-2 for gasses emitted during the combustion of material form cables.

**RFCA0070** The cable weight shall not exceed 0.51 kg/m.

**RFCA0080** The cable Minimum Bending Radius shall be at least 120 mm for a single bend.

**RFCA0090** The cable Minimum Bending Radius shall be less than 250 mm for repeated bends.

**RFCA0100** The cable impedance shall be 50Ω.

**RFCA0110** The declared cable Attenuation (dB/100m) shall be less than 1.5 dB/100m measured on a 150 MHz frequency (Standard conditions; VSWR 1.0, cable temperature 20˚C).

**RFCA0120** The cable operating temperature shall be at least in a range -40˚C to 85˚C.

#### 2.3.7.2 RF Cable type 2

**RFCA0130** The cable type shall be Foam-Dielectric, Corrugated.

**RFCA0140** The cable size shall be 1-5/8”.

**RFCA0150** The cable shall meet flame and fire retardant requirements according to IEC 60332-1 and IEC 60332-3.C

**RFCA0160** The cable shall meet requirements according to IEC 61034 (up to 2-1/4) for smoke emission test.
RFCA0170 The cable shall meet requirements according to UL 1581-1991 Sect. 1080 VW 1 Flame test, for a flame test on a single cable and UL 1581-1991 Sect. 1160 Vertical Tray Flame test, for a fire test on a bunched cable.

RFCA0180 The cable shall meet requirements according to IEC 60754-1 and IEC 60754-2 for gasses emitted during the combustion of material form cables.

RFCA0190 The cable weight shall not exceed 1.3 kg/m.

RFCA0200 The cable Minimum Bending Radius shall be equal or less than 200 mm for a single bend.

RFCA0210 The cable Minimum Bending Radius shall be less than 520 mm for repeated bends.

RFCA0220 The cable impedance shall be 50Ω.

RFCA0230 The declared cable Attenuation (dB/100m) shall be less than 0.85 dB/100m measured on a 150 MHz frequency (Standard conditions; VSWR 1.0, cable temperature 20˚C).

RFC00240 The cable operating temperature shall be at least in range -40˚C to 85˚C

2.3.7.3 RF Cable type 3

RFCA0250 The cable type shall be Foam-Dielectric, Corrugated.

RFCA0260 The cable size shall be 1/2".

RFCA0270 The cable shall meet flame and fire retardant requirements according to IEC 60332-1 and IEC 60332-3.C

RFCA0280 The cable shall meet requirements according to IEC 61034 (up to 2-1/4) for a smoke emission test.

RFCA0290 The cable shall meet requirements according to UL 1581-1991 Sect. 1080 VW 1 Flame test, for flame test on single cable and UL 1581-1991 Sect. 1160 Vertical Tray Flame test, for a fire test on a bunched cable.

RFCA0300 The cable shall meet requirements according to IEC 60754-1 and IEC 60754-2 for gasses emitted during the combustion of material form cables.

RFCA0310 The cable weight shall not exceed 0.22 kg/m.

RFCA0320 The cable Minimum Bending Radius shall be at least 70 mm for a single bend.

RFCA0330 The cable Minimum Bending Radius shall be less than 125 mm for repeated bends.

RFCA0340 The cable impedance shall be 50Ω.

RFCA0350 The declared cable Attenuation (dB/100m) shall be less than 2.67 dB/100m measured on a 150 MHz frequency (Standard conditions; VSWR 1.0, cable temperature 20˚C).

RFCA0360 The cable operating temperature shall be at least in a range -40˚C to 85˚C.
### 2.3.8 DC System Specification

**PSPR0010**  The DC power system shall be provided to support operation of radios in the absence of primary AC power. The changeover from AC to DC and reverse (after re-establishing an AC power source) shall be automatic and immediate and shall have no effect on the operation of the radios.

**PSPR0020**  The performance of the radios shall not be degraded for unlimited periods with the supply voltage variation as specified.

**PSPR0030**  Duplicated equipment elements shall be powered and fused separately.

**PSPR0040**  The DC backup power supply system shall provide the following autonomy of radios:

- **Sljeme Tx:** 24 hours,
  - with load of 3 frequencies with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC

- **Sljeme Rx:** 24 hours,
  - with load of 3 frequencies with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC

- **Japetić Tx:** 24 hours,
  - with load of 4 frequencies with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC

- **Japetić Rx:** 24 hours,
  - with load of 4 frequencies with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC

- **Kozjak Tx:** 24 hours,
  - with load of 4 frequencies with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC

- **Kozjak Rx:** 24 hours,
  - with load of 4 frequencies with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC

- **Northern Adriatic:** 24 hours,
  - with load of 3 frequencies with duty cycle of 30%, all the other radios on stby
- and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC
- V.Mlaka Tx: 12 hours,
  - with load of 2 frequencies with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W on nominal -48 VDC
- Mićevac Rx: 12 hours,
  - with load of 2 frequencies with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W on nominal -48 VDC
- Valtura: 12 hours,
  - with load of 2 frequencies with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W on nominal -48 VDC
- TWR Pula Rx: 8 hours,
  - with load of 2 frequencies with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC
- TWR Split Rx: 12 hours,
  - with load of 1 frequency with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC
- Čiovo: 12 hours,
  - with load of 1 frequency with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC
- Osijek GP: 8 hours,
  - with load of 1 frequency with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC
- Osijek LLZ: 8 hours,
  - with load of 1 frequency with duty cycle of 30%, all the other radios on stby
  - and additionally with load of 300 W (MW link, mux, etc.) on nominal -48 VDC

**PSPR0050** At following locations, exists DC backup power supply system at nominal voltage -48VDC:

- TWR Pula Tx
- TWR Split Tx
- TWR Lošinj
- TWR Brač

Duplicated DC/DC convertors with input voltage of -48 VDC shall be provided for insurance of nominal voltage stability for delivered equipment.
PSPR0060  The rectifier system shall have the same nominal voltage level as the radio equipment, with following characteristics:

- Duplicated rectifier block for full power
- Nominal input voltage: 230VAC ±15%, 50Hz
- Rack mountable rectifiers and batteries
- Minimum Two strings of batteries (2V, AGM VRLA, 15 years and longer - Long Life) each protected with battery fuse and LVBD contactor
- Rectifiers units, with following characteristics:
  - Input voltage 85 – 300VAC/DC (Nominal 200 – 250V)Input frequency 45 – 65Hz
  - Power factor >0.99 with load >1000W
  - Input protection: varistor for transients, fuse on both sides, shut down Uin>300V
  - Load sheering (current) ±5% max. current from 10 to 100%
  - Static voltage regulation ±0.5% for 10 – 100%
  - Dynamic voltage regulation ±5% for 10 – 90%
  - Output protection: Shut down in case of over voltage, protection for short circuit, high temperature, limitation of input current
  - Efficiency >90% for 30 – 70% load
- Isolation
  - 3.0kVAC- input to output
  - 1.5kVAC- input to earth
  - 0.5kVDC- output to earth
  - 3.0kVAC – CAN to next and previous unit
- Alarms:
  - Shutdown for low input voltage and high output voltage and high temperature, rectifier failure, ventilator failure, low voltage,
  - Warnings; shutdown for low temperature, rectifier in low power mode, limitation of battery charging current, input voltage out of tolerance
- LED indication
  - On, with no alarms and warnings (green)
  - Warning present (yellow)
  - Failure of rectifier (red)
- Temperature ranges:
  - Operating range: -40 °C to +75 °C
  - Storage range: -40 °C to +85 °C
- Cooling: Temperature regulated ventilator
- Relative humidity:
  - Operating range: 5 – 95%
  - Storage range: 0 – 99%
- Noise level: <65dBA
- Control unit, with following functions and characteristics:
  - System control functions
    - Output voltage measuring
    - Total load current measuring
    - Battery deep discharge protection
    - Alarm level setting
    - Alarm time table
    - Battery protected RTC (real time clock)
    - Site label
    - Reley outputs test
    - Measurements time table
• Energy time table (hour, day, week)

• Battery control functions
  • Battery current measuring
  • Battery temperature measuring
  • Battery test following discharge table or time table
  • Battery data settings
  • Battery quality indication
  • Boost charging
  • Charging temperature compensation
  • Temperature sonde failure protection

• Rectifier control functions
  • Information of connected rectifier units: serial number, inside temperature
  • Current measuring of each rectifier unit
  • Input voltage measuring of each rectifier unit
  • Unit efficiency measuring

• Remote control
  • Ethernet port 10/100 BASE-T
  • SNMP v1, v2, GET, SET i TRAP
  • Webpower, XHTML 1, java script, SSL

PSPR0070 Duplicated rectifier blocks shall not have elements that could cause the failure of both rectifier blocks in case of outage.

PSPR0080 Duplicated DC/DC converters shall be used for supply of -48 VDC (if the main voltage is different)

PSPR0090 The DC power supply system status shall be integrated in the RCMS with at least the following status monitoring:
  • AC main fail
  • DC rectifier alarm
  • DC on battery

2.3.9 Radio Equipment Interface Requirements

2.3.9.1 Analogue interfaces

Audio interfaces:

AUDI0010 The radios shall have the following audio interfaces:
  • Transmitter audio input,
  • Receiver audio output.

AUDI0020 Audio interfaces shall be wired to the Main Distribution Frame (MDF). CCL currently uses the KRONE type LSA Plus standard on all sites and locations.

AUDI0030 The line input on transmitters (AF input) shall be designed for a direct connection to communication lines – 600Ω balanced at a nominal level between -30dBm and +10dBm) adjustable by 1dBm steps.
AUDI0040 The line output on receivers (AF output) shall be designed for a direct connection to communication lines – 600Ω balanced at a nominal level between -30dBm and +10dBm) adjustable by 1dBm steps.

AUDI0050 For the purpose of legal recording each transmitter and receiver shall have a dedicated 600Ω recording output.

Contact signalling interfaces:

CONI0010 Radios shall be able to operate using contact signalling for PTT activation and Squelch indication.

CONI0020 Dedicated connections shall be used for contact signaling for PTT and Squelch activation operation.

CONI0030 Contact signaling interfaces shall be wired to the MDF.

CONI0040 The contact interfaces shall be over-voltage and over-current protected.

Push-to-talk (PTT) activation interfaces:

PTTI0010 Transmitters shall be capable of both local and remote keying. In order to enable remote keying, a PTT activation contact interface shall be available.

PTTI0020 The PTT activation signal shall be sent via:

- Copper cable (up to 2000m long, 0.6mm wire diameter) directly from the VCS system.
- Signaling lead of the E&M 4 wire analogue audio interface of the PCM multiplex equipment.
- Configurable tone keying from 1800 to 3000 Hz, an adjustable referent line level from -5 to -25 dBm

PTTI0030 A relay contact outside the transmitter closing a circuit to earth shall key the transmitter.

PTTI0040 The time delay between the activation of the relay and full power shall not exceed 20 ms.

PTTI0050 Spark suppression/overvoltage protection devices shall be provided in the transmitter.

PTTI0060 The load applied to the contact shall not exceed 50 V, 100 mA DC.

Squelch indication interfaces:

SQLI0010 Each receiver shall have a squelch indication interface, which shall enable systems connected to this interface to track when a squelch circuit on the receiver is closed.
SQLI0020 The squelch indication signal shall be available for the control of the frequency from external systems (multiplex equipment, VCS). Therefore, when the squelch opens, an insulated relay contact shall close a circuit to earth within 20msec.

SQLI0030 The squelch indication signal shall be transmitted to the VCS system via a single wire (a contact in the receiver closing a circuit to ground shall indicate squelch).

SQLI0040 The squelch indication signal shall be sent to VCS systems via:

- Copper cable (up to 2000 m long, 0.6 mm wire diameter) directly to VCS system.
- Signalling lead of the E&M 4 wire analogue audio interface of the PCM multiplex equipment.
- Configurable squelch tone signalling form 1800 to 3000 Hz, an adjustable referent line level from -5 to -25 dBm

2.3.9.2 Digital Interfaces

Serial Interfaces:

DATI0010 In order to enable monitoring and control of data exchange with the TMCS system, each radio shall have a dedicated RS232 or RS422 interface.

DATI0020 In order to enable local configuration of the radio equipment, each radio shall have a dedicated RS232 or USB interface.

DATI0030 It shall be possible to perform radio diagnostics and change radio equipment settings with the local PC/notebook maintenance software connected to the radio external connector(s).

E1 Interfaces:

DATI0040 In order to enable connection to the VCS system, each radio shall have a dedicated electrical E1 interface according to ITU-T G703.

DATI0050 The structure of an E1 frame shall be in accordance with ITU-T G704.

DATI0060 Time slot 16 of the E1 frame shall be used for signalling in order to enable transmission of squelch indication and the PTT signal between the radio equipment and VCS.

Ethernet Interfaces:

DATI0070 In order to enable connection to the VCS, each radio shall have a dedicated integral Ethernet interface for VoIP according to EUROCAE ED 137.

DATI0080 In order to enable RCMS connection between radio devices and the TMCS system, each radio shall have a dedicated integral Network interface with the SNMP protocol.

DATI0090 It shall be possible to configure the radio to support simultaneous audio (SIP/RTP) and remote control (RCMS) via IP.
DATI0100 In order to enable connection to the VCS via IP all the radios shall be connected to the dedicated IP network equipment.

**External Interfaces:**

DATI0110 In order to enable connection to the SWR monitor, each radio shall have a dedicated optoisolated interface or TTL interface.

DATI0120 In order to enable monitoring of the external devices (e.g. Power supply), each radio shall have a dedicated optoisolated interface or TTL interface.

DATI0130 In order to enable the Main/Standby antenna relay changeover, each radio shall have a dedicated relay interface.

**2.3.9.3 RF Interfaces**

RFIN0010 RF interfaces shall be used for connecting antennas to radios.

RFIN0020 The impedance of the RF interfaces shall be 50Ω, unbalanced.

RFIN0030 RF input and output connectors shall be a coaxial type N female.

RFIN0040 Transmitters shall not be damaged if the RF interface is open (Z=∞) or short circuited (Z=0).

RFIN0050 Protection against mismatch shall be provided and damage due to any type of mismatch shall be prevented.

**2.3.10 VHF/UHF Transmitter Requirements**

**2.3.10.1 Environmental Conditions**

ENVT0010 The transmitter shall operate according to specification across temperature range at least from -20 °C to +55 °C.

ENVT0020 The transmitter storage temperature range shall be at least from -30 °C to +70 °C.

ENVT0030 The Transmitter shall operate according to its specification at relative humidity in range at least between 10% and 90%.

ENVT0040 The Installation Altitude tolerance shall be from 0 to 2000 meters.
ENVT0050 The transmitter shall be capable of 100% duty cycle at full power and modulation across the full temperature range at least from -20 to +55°C, without any degradation of RF parameters (e.g. for ATIS and VOLMET usage).

### 2.3.10.2 Construction and Design

**CONT0010** The design and construction of the equipment shall be modern, based on the up-to-date technical conceptions related with such equipment. It shall be fully transistorized or/and fitted with integrated circuits (ICs).

**CONT0020** Modular construction shall be used to the maximum extent. All hardware modules shall be completely removable from the system without the requirement for any disassembly other than a simple disconnection of connectors or release of simple locking devices.

**CONT0030** All components shall be readily accessible to the maintenance personnel, easily disassembled and replaced.

**CONT0040** The equipment assembly shall be fitted with necessary circuits, which will permit the operation on any desirable frequency within the frequency range mentioned in the relevant paragraph.

**CONT0050** The equipment shall be of compact size, to the maximum practicable extent.

**CONT0060** Any special tools and special test equipment required shall be provided with the equipment.

**CONT0070** All radio equipment shall be housed in individual 19" rack enclosures.

**CONT0080** The reliability shall be the highest possible, warranting at least a 15,000 hours mean time between failures (MTBF) with normal periodic maintenance and a mean time to repair (MTTR) of at least 30 min.

**CONT0090** Remote site maintenance requirements shall in general be as minimal as possible. This particularly refers to the following:
- preventive maintenance inspections on site shall be required not more often than once per month;
- corrective maintenance on site shall be easy module replacement, without requiring complex skills or tools;
- repair of modules shall be possible by the personnel of the concerned ANSP or of a company different from the supplier.

**CONT0100** Each Transmitter shall be accompanied by a set of technical manuals. The technical instructions in manual provided shall be clear, concise and fully illustrated including circuit schematic diagrams. Any special technique shall be fully described. The aforesaid technical manuals shall include complete installation, operation and maintenance instructions.

**CONT0110** All fans shall be external or shall have possibility to be changed with minimal effort.
2.3.10.3 Electrical Characteristics

ELCT0010 The equipment shall be tunable over the range of 118 to 137 MHz for VHF and over the range of 225 to 400 MHz for UHF equipment without any change of elements. The equipment shall comply with all aspects of this specification within the specified frequency ranges.

ELCT0020 The transmitter shall have a multichannel feature allowing up to 20 frequency channels to be programmed, sorted and recalled by channel number.

ELCT0030 The frequency accuracy shall be at least 0.3 ppm within the temperature range at least from -20 °C to +55 °C.

ELCT0040 The type of emission shall be Double Side Band Amplitude Modulation, A3E for speech.

ELCT0050 The channel spacing shall be both 25 and 12.5 kHz for UHF. The channel spacing shall be both 25 and 8.33 kHz for VHF for all radio equipment.

ELCT0060 The carrier power delivered into a 50 Ohms load with a VSWR up to 2:1 shall be 25 W minimum for VHF TWR A/G Communications, 20 W minimum for UHF TWR A/G Communications, 50 W for VHF ACC and APP A/G communications and 30 W for UHF ACC and APP A/G communications.

ELCT0070 VHF Transmitters shall support at least 4 carrier frequency offset for 25 kHz spacing and at least 2 carrier frequency offset for 8.33 kHz spacing.

ELCT0080 There shall be a possibility of continuous adjustment of output power from 5 W to upper limit in 1W steps. This operation shall be easily performed by the Employer (from the device front panel or through RCMS software application, or by portable PC through an external dedicated port) at any time.

ELCT0090 Protection against mismatch shall be provided and any mismatch shall not cause damage.

ELCT0100 The audio input impedance shall be 600 Ohms, balanced.

ELCT0110 Special input accepting a suitable microphone, capable to modulate the transmitter up to 90% shall be available.

ELCT0120 The 3 dB AF bandwidth shall be 300 - 3400 Hz for 25 kHz channel spacing, as appropriate for 8.33 kHz, and as per ETSI EN 300676 Paragraph 7.4.4.3.

ELCT0130 The response shall be attenuated by at least 25 dB at 5 kHz, as per ETSI EN 300676 paragraph 7.4.4.4.

ELCT0140 The modulation depth should be adjustable up to 95 %.

ELCT0150 The VHF Total Harmonic Distortion (THD) shall be less than 10 % to be measured with a test tone 1000 kHz at modulation depths of 90 % and below.

ELCT0160 Local operation from the front-panel shall be provided by means of a Microphone modulation input, which is insulated from the telephone circuit input.
ELCT0170 A limiter shall limit the modulation depth to 95 %.

ELCT0180 The adjacent channel power shall not exceed the following values below the carrier power of the transmitter:
- 60 dB (for 8.33 kHz channel spacing); and
- 70 dB (for 25 kHz channel spacing)

ELCT0190 For the maintenance it shall be possible to download a radio configuration from a radio to a PC.

ELCT0200 For the maintenance it shall be possible to upload a radio configuration from a PC to a radio.

ELCT0210 It shall be possible to disconnect the Automatic Gain Control.

ELCT0220 For the purpose of recording the transmission, an output with demodulated signal shall be available.

ELCT0230 The carrier drop at 90 % modulation shall not exceed 5 %. Note: The carrier drop is defined as: Carrier Drop = (P_{tc}-P_{tr})/P_{tc}, where:
- P_{c} is ‘carrier power’,
- m is ‘modulation index’,
- P_{tc} is ‘total calculated power’, and
- P_{tr} is ‘total power read from measuring equipment’.

2.3.10.4 Radiation Characteristics

RADT0010 Harmonics of the carrier frequency shall not exceed 5 x 10^{-7} watts.

RADT0020 Any other radiation shall not exceed 5 x 10^{-7} watts. This radiation shall be measured at a 50-ohm load directly at the transmitter output up to 1,200 MHz.

RADT0030 The Cabinet Radiation shall not exceed 0.25 μW within a bandwidth of 1 kHz over the frequency range from 30 MHz to 1 GHz.

RADT0040 Shielding should be such that direct radiation of the transmitter housing and cabling does not produce the field strength of more than 30 μV/m at a distance of 30 m with cabinet doors open.

RADT0050 Intermodulation Products Emission shall be at least 40 dB below the carrier level for the 3rd order intermodulation product caused by a signal of a transmitter with the same output power decoupled 30 dB and with emitting frequency deviation within 50 to 100 kHz below the frequency of the transmitter under test.

RADT0060 Out Of-Band Noise shall be at least 150 dBc (1 Hz) below the carrier for frequencies separated more than 4 MHz from the carrier frequency.

RADT0070 The transmitter spurious emission shall be at least less than -46 dBm for frequencies separated more than 4 MHz from the carrier frequency.
2.3.10.5 Tuning

TUNT0010 The transmitter tuning shall be an easy and quick operation carried out by means of built-in monitoring devices.

TUNT0020 The application of a tuning procedure shall avoid the generation of any other frequency than the one on which the equipment is operating.

TUNT0030 The whole tuning procedure shall be briefly described and easily accessible when working on the transmitter.

TUNT0040 The spurious radiation requirements shall be met when the transmitter has been tuned in accordance with the procedure given in the manual.

2.3.10.6 Power Supply

PSPT0010 For AC supply the equipment shall be designed for a 220/230 V AC single phase.

PSPT0020 The frequency 50 Hz (48 - 62 Hz) shall be met.

PSPT0030 The AC Supply Voltage Variation tolerance - 10/+15 % shall be met.

PSPT0040 The 28 V DC operation shall be available for back-up purposes.

PSPT0050 The DC Supply Voltage Variation tolerance from - 20 % to + 12 % shall be met.

PSPT0060 The transmitter performance as specified above shall be met for unlimited periods, with the supply voltage variation as specified.

2.3.10.7 Control and Monitoring

CMMT0010 The front panel lamps shall indicate the following functions:
   a) Power on
   b) Equipment transmitting
   c) Alarm Indication

CMMT0020 The front panel controls shall include:
   a) Power on/off indication
   b) Local / Remote control switch

CMMT0030 One or several measuring instruments on the front panel should provide the following measurements:
   a) All AC and DC voltages necessary for fault location
   b) All RF levels necessary for tuning and fault location
   c) Output power / reflected power
   d) Modulation depth
   e) VSWR monitor
2.3.10.8 Remote Control

Overall remote control requirements are stated in chapter 2.3.8. Remote Control and Monitoring System (RCMS). On top of that all transmitters shall satisfy the following requirements:

REMT0010 Suitable Interfaces shall be available for remote operation and signaling via LAN or analogue or digital telephone lines. The following functions shall at least be performed:
   a) Tx ready
   b) Push-to-talk
   c) Power on/off signaling
   d) Power on/off switching
   e) General alarm signaling

REMT0020 Built-in-test facilities enabling immediate fault location in case of failure shall be available.

2.3.10.9 Safety Precautions

SAFT0010 Measures shall be taken to protect the equipment against the effects of over-current or over-voltage.

SAFT0020 The design and construction of the equipment shall not permit any significant change to its normal operation resulting from usual dust accumulation on its composing parts.

SAFT0030 In order to ensure normal operation, special precautions against dust, shall generally not be required at the equipment installation site.

SAFT0040 Special safety devices, such as protective covers, shall be provided.
2.3.11 VHF/UHF Receiver Requirements

2.3.11.1 Environmental Conditions

RENR0010 The Receiver shall operate according to specification across temperature range at least from -20 °C to +55 °C.

RENR0020 The Receiver storage temperature range shall be at least from -30 °C to +70 °C.

RENR0020 The Receiver shall operate according to its specification at relative humidity in range at least between 10% and 90%.

RENR0030 The Installation Altitude tolerance shall be from 0 to 2000 meters (above sea level).

2.3.11.2 Construction and Design

RCOR0010 The design and construction of the equipment shall be modern, based on the up-to-date technical conceptions related with such equipment. It shall be fully transistorised or/and fitted with integrated circuits (ICs).

RCOR0020 Modular construction shall be used to the maximum extent.

RCOR0030 All components shall be readily accessible to the maintenance personnel, easily disassembled and replaced.

RCOR0040 The equipment assembly shall be fitted with necessary circuits, which will permit the operation on any desirable frequency within the frequency range mentioned in the corresponding paragraph.

RCOR0050 The equipment shall be of compact size, to the maximum possible extent.

RCOR0060 Any special tools and special test equipment required shall be provided with the equipment.

RCOR0070 The reliability shall be the highest possible, warranting at least a 15,000 hours mean time between failures (MTBF) with normal periodic maintenance and a mean time to repair (MTTR) of at least 30 min..

RCOR0080 Remote site maintenance requirements shall in general be generally as minimal as possible. This particularly refers to the following:
- preventive maintenance inspections on site shall be required not more often than once per month
- corrective maintenance on site shall be easy module replacement, without requiring complex skills or tools
- repair of modules shall be possible by the personnel of the concerned ANSP or of a company different from the supplier

RCOR0090 Each Receiver shall be accompanied by a set of technical manuals. The technical instructions manual provided shall be clear, concise and fully illustrated including circuit schematic diagrams. Any special technique shall be fully described. The aforesaid technical manuals shall include complete installation, operation and maintenance instructions.
2.3.11.3 Electrical Characteristics

RELR0010 The equipment shall be tunable over the range of 118 to 137 MHz for VHF and over the range of 225 to 400 MHz for UHF equipment without any change of elements. The equipment shall comply with all aspects of this specification within the specified frequency ranges.

RELR0020 The receiver shall have a multichannel feature allowing up to 20 frequency channels to be programmed, sorted and recalled by channel number.

RELR0030 The type of reception shall be Double Side Band Amplitude Modulation, A3E for speech.

RELR0040 The channel spacing shall be 25 and 12.5 kHz for UHF. The channel spacing shall be 25 and 8.33 kHz for VHF.

RELR0050 The tuning of the receiver shall be an easy and quick operation. No measuring devices except a DC multimeter shall be required to tune the receiver with sufficient accuracy.

RELR0060 The spurious radiation requirements described below shall be met when applying the tuning procedure.

RELR0070 The receiver shall withstand continuous 24 hour uninterrupted reception (100 % duty cycle).

RELR0080 The frequency error shall be within $\pm 5 \times 10^{-6}$ over the whole range and under the above-mentioned environmental conditions.

RELR0090 The input impedance shall be 50 Ohms and the VSWR shall be better than 2:1 at the tuned frequency.

RELR0100 The Receiver sensitivity shall be at least -107 dBm (at 12dB SINAD ITU-T weighted)

RELR0110 The audio output level variation shall not exceed 3 dB for an input voltage between 1.5 $\mu$V and 200 mV.

RELR0120 The A.G.C. time constant shall be such that the recovery time from an instantaneous 60 dB signal level variation does not exceed 100 msec.

RELR0130 The receiver shall incorporate a means to suppress the noise at the 600 Ohms output by at least 70 dB in the absence of a wanted signal.

RELR0140 When the input signal exceeds the threshold by 3 dB, the squelch shall open at all RF inputs above 1 $\mu$V, and in less than 20 msec.

RELR0150 A pre-set squelch control which meets the requirements of ETSI EN 300676 Paragraph 8.11.3 shall be provided.

RELR0160 The squelch shall be independent of the audio output level control.

RELR0170 A failure of squelch circuit itself should not inhibit transmission of the audio signal to line.
RELR0180 Provisions shall be made to disconnect the squelch operation.

RELR0190 The squelch signal shall be available for the control of the frequency and channel distribution system. Therefore, when the squelch opens, an insulated relay contact shall close a circuit to earth within 20 msec.

RELR0200 The squelch characteristics shall be such that the receiver is effectively silenced after cessation of a signal without any noticeable rise of the noise level at the receiver output.

RELR0210 The squelch operation shall be accompanied by the illumination of a Front panel lamp or any other suitable indicator.

RELR0220 The squelch circuit shall be immune to false operation by impulsive interference without causing an operating delay of greater than 20 msec.

RELR0230 The squelch characteristics shall not involve an electrical backlash greater than 3 dB relative to the threshold setting at any level within the range of the squelch control. It shall also be independent of modulation depth.

RELR0240 The temperature stability of the squelch threshold shall be such that the variation of the threshold shall not exceed 3 dB for the temperature range defined above.

2.3.11.4 Overall Selectivity

RSLR0010 Spurious Response Rejection
The spurious response rejection is measured by the two signal generators method. Two input signals are applied to the receiver input as follows:
- Signal A (on channel), modulated 30 % at 1 % kHz to produce an S/N ratio of 10 dB.
- Signal B from 100 kHz to 2000 MHz, modulated by 60 % at 400 Hz. Then signal B shall be at least 80 dB above signal A to reduce the S+N/N by 3 dB.

RSLR0020 Image Response Rejection
The Image Response Rejection is measured by the two signal generators method. Two input signals are applied to the receiver input as follows:
- Signal A (on channel), modulated 30 % at 1 % kHz to produce an S/N ratio of 10 dB.
- Signal B (on image frequency), modulated by 60 % at 400 Hz.

Then signal B shall be at least 80 dB above signal A to reduce the S+N/N by 3 dB.

RSLR0030 IF Response Rejection
The IF Response Rejection is measured by the two signal generators method. Two input signals are applied to the receiver input as follows:
- Signal A (on channel), modulated 30 % at 1 % kHz to produce an S/N ratio of 10 dB.
- Signal B (on IF frequency), modulated by 60 % at 400 Hz.

Then signal B shall be at least 80 dB above signal A to reduce the S+N/N by 3 dB.
RSLR0040  **Adjacent Channel Selectivity**  
The selectivity is measured by the two signal generators method. Two input signals are applied to the receiver input as follows:
- Signal A (on channel), modulated 30% at 1 kHz to produce an S/N ratio of 10 dB.
- Signal B (adjacent channel), ± 25 kHz, modulated by 60% at 400 Hz.

Then signal B shall be at least 80 dB above signal A to reduce the S+N/N by 3 dB.

RSLR0050  **Cross-modulation**  
The cross-modulation shall be measured with two carriers A and B as follows:
- A is unmodulated and represents the wanted signal.
- B is modulated 60% at 400 Hz and spaced at ± 100 kHz from A, and represents the unwanted signal.

For a 10 dB S+N/N level at the receiver output, the unwanted signal level shall be at least 80 dB above the wanted signal.

RSLR0060  **Blocking (Desensitization)**  
The variation of the audio output power shall not exceed 3 dB for the following conditions:
- Wanted signal: 3 μV (EMF), modulated 30% at 1 kHz.
- Interfering signal: unmodulated, separated by ±1 MHz to ±10 MHz from the wanted signal and with a level 86 dB above the wanted signal.

RSLR0070  **Intermodulation**  
Intermodulation shall be measured by using three signal generators as follows:
- Signal Generator A (on channel) modulated 30% at 1 kHz, the Receiver adjusted to give a (S+N/N) ratio of 10 dB.
- Signal Generator B offset by ± 25 kHz from A, unmodulated.
- Signal Generator C offset by ± 50 kHz from A, modulated 60% at 400 Hz.

Then the equal signals B and C shall be at least 80 dB above signal A to reduce the (S+N/N) by 3 dB.

RSLR0080  **Effective Acceptance bandwith**  
Effective Acceptance bandwith shall be measured by using signal generator as follows:
- Signal Generator (on channel) modulated 30% at 1 kHz, Increase the signal level to achieve the SINAD ratio of 12 dB.
- Increase the signal level by 6 dB
- Vary the frequency by ±2.8 kHz and ±2.8 kHz for 8.33 kHz channel spacing, and ±8.5 kHz and ±8.5 kHz for 25 kHz channel spacing.

The SINAD level shall remain above 12 dB.
2.3.11.5 Audio Output

RAOR0010  The overall gain shall be sufficient to produce an audio output level of at least 1 mW into 600 ohms for a RF input of 1μV modulated to a depth of 60 % at 1 kHz.

RAOR0020  The audio output shall be provided by means of a balanced 600-ohm transformer suitable for direct connection to telephone lines.

RAOR0030  With a centre RF input frequency of 1 mV modulated 30 % and in the frequency band from 300 to 3400 Hz, the audio output level shall not vary by ± 3 dB with reference to the level at 1 kHz.

RAOR0040  The response shall be attenuated by at least 30 dB at 5 kHz.

RAOR0050  With the audio gain control set to a power output of 1 mW at the 600 ohm terminals for a RF input of 3 μV (EMF) modulated 60 % at 1000 Hz, any RF input between 1mV (EMF) and 100 mV (EMF) modulated 60 % (or 90%) at 1000 Hz shall not produce in excess of 5 % (or 10%) T.H.D. respectively at the 600 ohm output.

RAOR0060  With setting to a power output of 1 mW at the 600 ohm terminals for an r.f. input of 3 μV (EMF) modulated 60 % at 1000 Hz, any r.f. input between 1mV (EMF) and 100 mV (EMF) modulated or 90% at 1000 Hz the ratio (S/S+N) shall be better (higher) than 50 dB.

RAOR0070  If the receiver includes a noise limiter, it shall be efficient with 100% modulation. The operation of the noise limiting circuits should not involve a noticeable depression of the wanted audio output. The distortion of audio signals whose peaks modulate up to 100 % should be minimum.

2.3.11.6 Radiation Characteristics

RRDR0010  The receiver shall be adequately screened to permit operation of any number of receivers at one location and co-location with transmitters.

RRDR0020  The oscillator radiation shall not exceed 2 nW (10 μV/50 Ohms) within a bandwidth of 1 kHz when measured at the 50 ohm antenna input over the frequency range from 9 kHz to 1 GHz.

RRDR0030  The receiver shall meet the relevant international requirements for screening and direct radiation.
2.3.11.7 Power Supply

RPSR0010 For AC supply the equipment shall be designed for a 220/230 V AC single phase.

RPSR0020 The frequency 50 Hz ± 2 % shall be met.

RPSR0030 The AC Supply Voltage Variation tolerance - 10/+15 % shall be met.

RPSR0040 The 28 V DC operation shall be available for back-up purposes.

RPSR0050 The DC Supply Voltage Variation tolerance shall be from - 20 % to + 12 %

RPSR0060 The receiver performance as specified above shall be met for unlimited periods with the supply voltage variation as specified.

2.3.11.8 Control and Monitoring

RCMR0010 The front panel lamps have to indicate the following functions:
   a) Power on
   b) Equipment receiving
   c) Squelch indication
   d) Alarm indication

RCMR0020 The front panel controls shall include:
   a) Power on/off indication
   b) Local / Remote control switch
   c) A jack for headset connection

RCMR0030 One or several measuring instruments shall provide the following measurements:
   a) All AC and DC voltages necessary for fault location
   b) Received signal level
2.3.11.9 Remote Control

Overall remote control requirements are stated in chapter 2.3.8. *Remote Control and Monitoring System (RCMS)*. On top of that all, receivers shall satisfy the following requirements:

RCMR0040 Suitable Interfaces shall be available for remote operation and signalling via LAN or analogue or digital telephone lines. The following functions shall at least be performed:
   a) Rx-ready indication
   b) Squelch
   c) Power on/off switching
   d) Power on/off signalling
   e) General alarm signalling

RCMR0050 Built-in-test facilities enabling immediate fault location in case of failure shall be available.

2.3.11.10 Safety Precautions

RSFR0010 Measures shall be taken to protect the equipment against the effects of over-current or over-voltage.

RSFR0020 The permissible input voltage without causing damage shall be 5 V at least independently of the signal frequency. On the system level the receiver station shall be protected against at least 15V.

RSFR0030 The design and construction of the equipment shall not permit any significant change to its normal operation resulting from usual dust accumulation on its composing parts.

RSFR0040 In order to protect normal operation, special precautions against dust shall generally not be required at the equipment installation site.

RSFR0050 Special safety devices, such as protective covers, shall be provided.
2.3.12 VHF Transciever Requirements

TRAR0010 Unless otherwise stated, VHF transceivers shall satisfy all requirements specified for VHF transmitters and receivers (VHF transceivers shall comply both with requirements for VHF transmitters and with requirements for VHF receivers).

TRAR0020 The transceiver shall have a multichannel feature allowing up to 20 frequency channels to be programed, sorted and recalled by channel number.

TRAR0030 VHF transceivers shall have dedicated recording output (600Ω impedance). When connected to this output Digital Voice Recording and Playback system shall record both directions of communication (transmitter input and receiver output) simultaneously.

2.3.12.1 Radio control position requirements

TRAR0040 A radio control position shall be equipped with a separate microphone, headset, footwitch and panel for interfacing VHF transceivers. The panel shall enable access to all transceiver controls (radio channels programming and selection etc.)

TRAR0050 Panels used on the radio control position shall be fully compatible with VHF transceivers. The Contractor shall provide all necessary cables for connecting these panels with transceivers.

TRAR0060 Panels shall be delivered as desktop versions (ready to be installed in CWP desks).

TRAR0070 Panels shall be powered via 230V AC ± 10%, 50Hz and provided DC back-up system.

TRAR0080 Panels shall have a multichannel feature.

TRAR0090 Radio control positions shall enable main/standby switching between transceivers.

TRAR0100 Radio control positions shall have a dedicated analogue recording interface.

TRAR0110 Radio control positions shall be VoIP based and shall be connected to the dedicated radio equipment via VoIP.

TRAR0120 Radio control positions shall be capable of controlling at least 8 radios.
2.3.13 VHF/UHF Receiver Multicoupler Requirements

2.3.13.1 General

MCGR0010 The Antenna Multicoupler shall serve to feed several (up to 16) receivers from a single antenna.

MCGR0020 The Antenna Multicoupler shall be installed in receiver equipment cabinets.

MCGR0030 It shall be possible to connect two or more multicouplers in series.

2.3.13.2 Environmental Conditions

MCER0010 The Ambient Air Temperature tolerance shall be from -10 °C to +50 °C

MCER0020 The Radio equipment shall operate according to its specification at relative humidity in range at least between 10% and 90%.

MCER0030 The Installation Altitude tolerance shall be from 0 to 2000 meters

2.3.13.3 Construction and Design

MCCR0010 The design and construction of the equipment shall be modern, based on the up-to-date technical conceptions related with such equipment.

MCCR0020 Modular construction shall be used to the maximum extent.

MCCR0030 All components shall be readily accessible to the maintenance personnel, easily disassembled and replaced.

MCCR0040 The equipment assembly shall be equipped with the necessary circuits, which will permit the operation on any desirable frequency within the frequency range mentioned in the relevant paragraph.

MCCR0050 The equipment shall be of compact size, to the maximum possible extent.

MCCR0060 Any special tools and special test equipment required shall be provided with the equipment.

MCCR0070 Each multicoupler will be accompanied by a set of technical manuals. The technical instructions manual provided shall be clear, concise and fully illustrated including circuit schematic diagrams. Any special technique shall be fully described. The aforesaid technical manuals shall include complete installation, operation and maintenance instructions.

MCCR0080 The reliability shall be the highest possible, warranting at least a 15.000 hours mean time between failures (MTBF) with normal periodic maintenance and a Mean Time To Repair (MTTR) of at least 30 min.
Remote site maintenance requirements shall in general be as minimal as possible. This particularly refers to the following:

- preventive maintenance inspections on site shall be required not more often than once per month
- corrective maintenance on site shall be easy module replacement, without requiring complex skills or tools
- repair of modules shall be possible by the personnel of the concerned ANSP or of a company different from the supplier

The multicoupler shall operate over the band 118-137 MHz for VHF Multicouplers and 225-400 MHz for UHF Multicouplers without resorting to any serious component changes. The multicoupler shall be broadband, in case of active types, or field tuneable, in case of selective filter type MC.

The multicoupler shall be fully field-tuneable.

The input and output impedance shall be 50 ohms.

The input and output VSWR shall be better than 1.5:1 for VHF Multicouplers and 1.7:1 for UHF Multicouplers.

In case of a passive multicoupler, the insertion loss on the tune frequency between an input port and any output to a receiver port shall be less than 2dB.

In case of a passive multicoupler, the rejection at any output port of frequencies more than ±1 MHz from the tune frequency shall be at least 15 dB.

In case of a passive multicoupler, the 3rd order intermodulation product resulting from the input of two in-band signals of +20 dBm shall be less than -50dBm.

### 2.3.13.4 Power Supply

For AC supply the equipment shall be designed for a 220/230 V AC single phase.

The frequency 50 Hz ± 2 % shall be met.

The AC Supply Voltage Variation tolerance + 10/-15 % shall be met.

The 28 V DC operation shall be available for back-up purposes.

The DC Supply Voltage Variation tolerance shall be from - 20 % to + 12 %

The receiver performance as specified above shall be met for unlimited periods with the supply voltage variation as specified.
2.3.13.5 Safety Precautions

MCSR0010  Measures shall be taken to protect the equipment against the effects of over-current or over-voltage.

MCSR0020  The permissible input voltage without causing damage shall be 5 V at least independently of the signal frequency. On the system level the receiver station shall be protected against at least 15V.

MCSR0030  The design and construction of the equipment shall not permit any significant change to its normal operation resulting from usual dust accumulation on its composing parts.

MCSR0040  In order to protect normal operation, special precautions against dust, shall generally not be required at the equipment installation site.

MCSR0050  Special safety devices, such as protective covers, shall be provided.

2.4 TMCS

2.4.1 General

The TMS shall meet the following general requirements:

GETM0010  A general approach to a solution of the Remote Control and Monitoring System - RCMS of the TX and RX radio centers and the supervision rooms in Zagreb, Pula, Split and other sites according to the RCMS principal schematics diagram in chapter 10.4 TMCS system architecture; shall be based on the following requirements:

a)  Automatic switchover of radio equipment in the case of failure based on an alarm signal derived from the BIT information,

b)  Manual switchover of radio equipment in the case of failure or maintenance/reconfiguration purposes available locally or from the supervision room/centre,

c)  Various remote control and monitoring interfaces embedded in the system.

GETM0020  In order to monitor and control the operation of radio equipment at the TX and RX radio centers, an appropriate RCMS application shall enable communication between all TX and RX centers and the supervision rooms in Zagreb.

Additionally, in order to monitor locally TX and RX radio centers Northern Adriatic, TWR Pula, Valtura and TWR Lošinj an appropriate RCM system shall be installed at Pula supervision room.

Additionally, in order to monitor locally TX and RX radio centers TWR Split, TWR Brač, Čiovo and Kozjak an appropriate RCM system shall be installed at Split supervision room.

Additionally, in order to monitor locally TX/RX radio center TWR Osijek an appropriate RCM system shall be installed at Osijek supervision room.

An RCMS distribution principal diagram is shown in chapter 10.4
GETM0030 The TMCS subsystem shall be designed to avoid a single point of failure. Any equipment malfunction shall not have impact on the operational system functionality.

GETM0040 The TMCS subsystem on all TX and RX sites shall be based on a standard LAN network interface.

GETM0050 The TMCS subsystem shall be designed with following architecture:
- A LAN for connecting all main radios
- B LAN for connecting all standby radios

GETM0060 The TMCS system, due to different possibilities of existing CCL transmission system, and in order not to limit possible changes in the connection type depending on the current and future situation at TX and RX sites, shall allow the use of all following connection types:
  - Serial (RS 232 or RS 422),
  - E1 according to ITU-T G.703/G704,
  - Ethernet 10/100 Base-T using SNMP protocol.

GETM0070 The RCMS application shall be implemented through client/server architecture. Server and workstation machines will be located in Technical Room (OTE) and with KVM extenders will be connected to the monitors, keyboard and mouse physically located in Control Technical Monitoring Room (CNU).

Note:
CCL will provide only following infrastructure by the site regarding TMCS Ethernet connections:
- Sljeme TX, Japetić TX, Kozjak RX, Valtura TX/RX, Čiovo TX/RX: Multiplexer with Ethernet connection to CCL
- Sljeme RX: only copper wire cable to Sljeme TX exists
- Japetić RX: only copper wire cable to Japetić TX exists
- Kozjak TX: Multiplexer with Ethernet connection to Kozjak RX
- V. Mlaka TX and Mićevac RX: only copper wire cable to CCL exists
- TWR Pula TX: Ethernet connection to Pula LAN which has IP connection to Zagreb and Pula servers
- TWR Pula RX: copper wire and fiber-optic cable connection to Pula LAN
- TWR Split TX: Ethernet connection to Split LAN which has IP connection to Zagreb and Split servers
- TWR Split RX: copper wire and fiber-optic cable connection to Pula LAN
- TWR Osijek: only fiber-optic cable from Osijek LLZ and Osijek GP to Osijek TWR exists. Osijek TWR has multiplexer with IP connection to CCL.
- TWR Lošinj: Ethernet connection to CCL
- TWR Brač: Ethernet connection to CCL
- Northern Adriatic TX/RX: TBD

### 2.4.2 RCMS application

**RCMS0010** The RCMS application shall monitor all receivers and transmitters in the system (based on BIT) and indicate failures.

**RCMS0020** The RCMS shall monitor all remote/control units in the system (based on BIT) and indicate failures.

**RCMS0030** The RCMS shall monitor all data links in the system and indicate failures.

**RCMS0040** The RCMS shall monitor all connected external equipment and indicate its status/failures.

**RCMS0050** The RCMS shall monitor the AC and DC supply at all sites.

**RCMS0060** The RCMS shall provide manual and automatic switching between main and standby radios.

**RCMS0070** The RCMS shall provide user-initiated switching between main and standby radios at any predefined time or time periods (e.g. specific time, specific date, periodically...).

**RCMS0080** The RCMS shall provide an interruptive BIT test to be performed on any selected individual radio in the system.

**RCMS0090** The RCMS shall allow the user to perform the initiated interruptive BIT test on any selected (individual/group/all) radio(s) in the system, at any predefined time or time periods (e.g. specific time, specific date, periodically...).

**RCMS0100** The RCMS shall provide a possibility for the connected external equipment to be switched on or off from the supervision room PC.

**RCMS0110** The RCMS shall provide the user-defined multiple I/O ports (contacts or opto isolated) for control and monitoring of additional equipment (such as alarms and auxiliary switching), at least 4 input and 4 output functions for each VHF/UHF telecommunication cabinet.

**RCMS0120** The Transmitter RCMS shall meet the following requirements:

- display of radio's current overall state,
- display of status of current continuous built-in test (CBIT),
- transmitter activation indication,
- operating frequency monitoring and setting,
- frequency channel set/memory/recall,
- display of frequency,
- display of radio URI,
- display of date and time
• display and setting of AM modulation depth,
• channel spacing (8.33 kHz or 25 kHz) monitoring and setting,
• frequency carrier offset monitoring and setting,
• RF output power monitoring and setting,
• VSWR status monitoring
• radio stand-by mode setting (on/off),
• RF output inhibit on/off,
• PTT monitoring and setting (on/off),
• AC / DC status.
• local and Remote PTT setting (on/off),
• audio line input level setting,
• audio signal AGC setting (on/off),
• initiation and result display of built-in test (BIT).

RCMS0130 The Receiver RCMS shall meet the following requirements:
• radio's current overall state
• Rx receiving status indication,
• status of current continuous built-in test (CBIT),
• operating frequency monitoring and setting,
• frequency channel set/memory/recall,
• channel spacing (8.33 kHz or 25 kHz) monitoring and setting,
• receiver sensitivity monitoring and current level value,
• radio stand-by mode setting (on/off),
• squelch status monitoring and display of current receive level value,
• AC / DC status.
• Squelch output polarity setting (Normal/Inverse),
• Initiation and result display of built-in test (BIT),
• Setting of RX squelch,
• Squelch carrier override setting (on/off),
• Squelch defeat setting (on/off),
• Squelch noise compensation (on/off),
• Audio line output level setting.

RCMS0140 RCM System shall support the following functions:
• Configuration and parameter settings,
• Monitoring and Control of all fundamental parameters,
• Security and access management.

RCMS0150 RCMS application shall provide management of all system configuration and parameter settings, including security management, appropriate indications of alarm conditions, and appropriate recovery management tool.
An alarm indication through shall be given in case of failure of the equipment or any of the sub-units. The alarm shall be both visual and audible. Remote indication of alarms shall be possible.

Alarms and management feedback must be provided via a built-in RCMS application allowing an easy and straightforward reporting via SNMP commands to central SNMP management system.

System shall monitor and report of status and health of all system components, especially including:

- Disk drives and RAID controllers in server computers,
- TX/RX equipment hardware and modules itself,
- Power supplies, when applicable,
- Client and server RCMS applications.

All alarms and events displayed in the system shall be possible to forward to central management system using SNMP. Filtering of alarms to be forwarded using SNMP shall be supported.

VHF system equipment shall include built-in tests that automatically monitor the status initiating audible, visual, and network alarms in the event of a failure. Employer’s Technical staff must have the option of silencing the alarm indicators.

All system messages shall be active until a user with corresponding user rights acknowledges the message. Time of message and time of acknowledgement must be stored together with the message in the system log management.

The VHF RCMS application shall record all system messages, status reports, warnings and error messages into database. Full range of facilities to retrieve, query, analyse and report listed events shall be provided. In addition all user actions have to be logged. The system shall provide a direct access for the administrator to the log files with the possibility to export the log files.

A system wide audit trail shall be provided to register all maintenance activity with detail information.

Remote diagnostics shall be possible to allow system faults to be diagnosed to at least module level.

The Contractor shall clearly specify the module level on component basis.

2.4.3 RCMS Data Presentation

Critical operational alarms shall be presented on an RCMS alarm message window. The alarm data shall contain all alarm details, e.g. date, time, alarm description, equipment location, etc.

The screens shall be organized in depth levels. There shall be at least three levels:
- Level 1 which displays all radio monitored sites,
- Level 2, which presents all radio equipment on selected radio site,
- Level 3, which presents single selected radio equipment.

RCMS0280 The user shall be allowed to change and organize content of the screen in data and graphical form, e.g. sites, radios, ancillary equipment, etc.

RCMS0290 At the supervision rooms, the control and monitoring of remote operating equipment shall be indicated (visually and by audible alarms in critical cases).

Combined color alarm signals from radios and sites shall be used to present the current operational status of system elements. For example, the following color palette is desirable:
- No fault - Green color,
- Fault - Red color,
- Warning - Yellow color,
- Unknown state - Blue color.

RCMS0300 The RCMS application shall allow maintenance mode to be selected for the radio equipment under maintenance.

RCMS0310 The RCMS SW application shall facilitate the generation of various reports according to the user selection (visible on the screen and/or printed on paper).

Reports shall cover the current and past statuses in several combined or divided forms:
- Radio equipment status and alarms,
- Transmission and ancillary equipment status and alarms,
- Radio equipment configuration (operational parameters and settings) for each unit and/or system.

RCMS0320 All reports and configurations from requirement RCMS0310 shall be made possible to archive and recall in the RCMS application with a version date/number.

RCMS0330 A full range of features shall be provided within the database application to perform a statistical analysis in characters and graphical form (for longer time periods).

RCMS0340 All collected events and data shall be logged for a period of minimum 30 days.

RCMS0350 It shall be possible to create a report of listed logs between two specified dates/times.

RCMS0360 A full range of facilities shall be provided to retrieve, query, analyze and report on logged data through the dedicated database.

RCMS0370 It shall be made possible for the Employer to configure the access levels for each RCMS site and to transfer these level rules between them.

At least following security/access levels shall be possible:
- test access – limited control functions,
- control access – all control functions,
- administrator access – system configuration possibilities.

RCMS0380 It shall be possible to configure a password for each individual user.
RCMS0390  It shall be possible to save (back-up) the RCMS configuration parameters of radio and ancillary equipment on external media (CD, USB) and restore the previous (saved) configuration at any time, if needed.

2.4.4 TMCS Built-in Test Equipment (BITE)

BITE0010  The system shall provide the BITE (built-in test equipment). The system shall monitor the condition of system components and communication systems, and shall provide alarms and diagnostic information on a failed system component.

BITE0020  The Tenderer shall describe the functioning and BITE Data protocol of the proposed BITE in detail.

BITE0030  The BITE information shall be available locally on each radio unit with an appropriate error code.

BITE0040  The BITE information shall be presented by the alarm indicators on the radio unit front panel for each failure registered by BITE.

BITE0050  The BITE information shall be available at the supervision room and fitted with highly organized presentations of maintenance information that enable instantaneous assessment of the entire system status.

BITE0060  The background running BITE diagnostic functions shall be designed to monitor correct operation of the radio system in real time.

BITE0070  The time-programmable BITE self-test functions shall be available. If any failure has been detected, an appropriate message with the error description shall be stored in the RCMS database.

BITE0080  All messages stored in the RCMS database shall be displayed on the screen when retrieved, and available for printing on a dedicated selected printer.

BITE0090  Each BITE interface implemented in a radio device shall be connected over a data BUS to the RCMS Unit.

BITE0100  The BITE interface on the radio shall be RS232, RS422, Ethernet, E1 or similar.

BITE0110  The Transmitter BITE shall be able to perform at least the following tests:
  - AC Power Supply,
  - DC Power Supply,
  - Actual level of Supply voltage,
  - RF Level of transmitter power,
  - Modulation depth of output RF power,
  - VSWR current level value,
  - Synthesizer lock,
  - Audio input,
  - PTT functionality,
  - Radio equipment temperature status.

BITE0120  The Receiver BITE shall be able to perform at least the following tests:
  - AC Power Supply,
2.4.5 TMCS Hardware

The Tenderer is, because of CCL’s current maintenance contract with HP, encouraged to offer HP products.

2.4.5.1 TMCS Server Specification

HRPS0010 The Servers shall at least support dual processor platform based on Intel® Xeon® processor E5-2600 family supporting at least 1600MHz memory speeds.

HRPS0020 Memory capacity shall be at least 16GB DDR3/DDR4 RDIMM.

HRPS0030 The Servers shall have redundant gigabit LAN connections (IPv4 and IPv6 compatible). Each server shall be connected to both stacked LAN switches with network interfaces in teaming mode.

HRPS0040 The Servers shall have an integrated SATA/SAS Hot plug hardware RAID controller to support RAID 0/1/5/6 configuration, with 512 MB or more integrated memory. Servers shall have DVD drive.

HRPS0050 The Servers storage configuration shall be derived in RAID 5 configuration with 3 or more Hot plug LFF SATA 3.5-inch disk drives. Configurations RAID 6 with 4 drives or RAID 5 with 3 online and 1 spare drive are preferable.

HRPS0060 The Servers storage configuration shall be derived using three logical disk partitions:
- **System** storage partition: used for operating system and software application.
- **Operational** storage partition: capacity shall be calculated to archive for a period of 45 days assuming 24H duty-cycle.
- **Image** storage partition: used to store system images, installation and configuration files.

**HRPS0070** The Servers shall provide SmartStorage feature to enhance system performance for real-time application.

**HRPS0080** The Servers shall support agentless hardware monitoring and alerting capability management.

**HRPS0090** The Servers shall provide integrated easy-to-view panel with LED signalisation for critical HW components including system overall status; power supplies, network interfaces, CPUs, fans and disk statuses.

**HRPS0100** The Servers shall be 19” rack mountable.

**HRPS0110** The Servers shall be based on dual hot plug power supplies with load balancing mode. Fans inside server shall be redundant.

**HRPS0120** In order to unify computer equipment and therefor to reduce maintenance cost, the Tenderer is encouraged for all server computers to offer COTS server equipment - the HP ProLiant ML350p Gen8 Server series or better.

### 2.4.5.2 TMCS Client computers specification

**HRPC0010** The client workstation machine shall have redundant gigabit LAN connections (IPv4 and IPv6 compatible). Each client computer shall be connected to both stacked LAN switches with network interfaces in teaming mode.

**HRPC0020** The client workstation machine shall be based on Intel® Xeon® Processor family, with 8 MB cache.

**HRPC0030** The client workstation machine shall be delivered with DDR3/DDR4, UDIMM memory type with minimum memory speed of 1333MHz and 8GB capacity.

**HRPC0040** The client workstation machine shall have an integrated SATA RAID controller to support RAID 1 configuration. Client computers shall have DVD read/write drive.

**HRPC0050** The client workstation machine shall have minimum 250GB capacity in RAID 1 configuration.

**HRPC0060** The client workstation machine shall have a professional 2D graphic card with support up to two displays. Graphic card shall have integrated min one DVI digital output with supported resolutions at least 1920x1200.

**HRPC0070** All monitors shall be 22 inches widescreen LCD with native resolution not smaller than or equal to 1920x1200 and shall be equipped with suitable mounting hardware for installation on the consoles.

**HRPC0080** All monitors shall support standard VESA mount.

**HRPC0090** All provided mice shall be equipped with optical sensor. All provided keyboards shall have English locale. A keyboard and mouse shall be robust and user-friendly.
Due to limited available space on the consoles at operational positions, selected monitor models to be utilized for RCMS systems shall be approved by the Employer.

In order to unify WS equipment and therefor to reduce maintenance cost, the Tenderer is encouraged for all client computers to offer COTS workstation equipment that is already in major use by Employer (HP Z420 or better).

### 2.4.5.3 TMCS KVM equipment specification

**HRKV0010** KVM extenders shall provide connection between computers and remotely installed peripheral devices (monitor, mouse, keyboard, speakers and microphone), using single UTP CAT 5E cable, to allow for remote operation of the computer.

**HRKV0020** KVM extenders shall consist of computer modules (for connection to computers) and user modules (for connection of peripheral devices).

**HRKV0030** Extenders shall provide connectivity between computer and user modules at maximum resolution over UTP CAT 5E cables on distances over 120 m.

**HRKV0040** Extenders shall transport following signals:
- Single video channel,
- Keyboard and mouse (USB and PS/2, mixed operation allowed),
- Bidirectional stereo audio,
- Bidirectional serial RS232,
- Transparent USB 1.1 with support for devices requiring 500 mA power.

**HRKV0050** Extenders shall transport single link video channel with supported resolutions at least 1920x1200, with 24-bit colour and transparent forwarding of E-DDC information. Connecting both analogue and digital monitors shall be supported, at both sides of the connection (at computer and at user modules). Video interface on both modules shall be DVI connector, with DVI-to-VGA adapters provided when necessary.

**HRKV0060** Computer module shall provide connection for local console (display, keyboard and mouse), which shall be connected to provided KVM drawer via KVM switch.

**HRKV0070** For safety and reliability purposes KVM extenders shall have SNMP monitoring capability.

**HRKV0080** Extenders shall provide transparent transport of bidirectional stereo audio with 96 kHz sampling rate and 24 bit digital resolution. Modules shall provide 2×3.5 mm jack plug (line in, line out) interfaces.

**HRKV0090** Extenders shall provide transparent transport of bidirectional serial RS232 connection with supported bitrates up to 115,200 bit/s. Transmittable signals shall include RxD, TxD, RTS, CTS, DTR, DSR and DCD. Modules shall provide 1 × DB9 interface.

**HRKV0100** Only one UTP CAT 5E cable shall be used to transport all required signals. Interface on both modules shall be RJ-45.

**HRKV0110** The computer, which is connected to the computer module, shall be possible to operate from both remote peripherals (connected to user module) and local peripherals (connected to computer module).

Local and remote user shall both be able to use the computer. For the duration of one user's usage of keyboard or mouse, other user's keyboard and mouse shall be temporarily locked out.
There shall be possibility for local user to use the computer's keyboard and mouse exclusively.

HRKV0120 Extender modules shall provide OSD and serial console (maintenance) interfaces. Using those it shall be possible to view status and information of both local and remote modules, of transmission cable and to change configuration of local module.

HRKV0130 Modules shall provide BITE functions, with continuous self-monitoring, error detection and status (problem) reporting functionality. All key components and functions shall be monitored (including temperature inside of the module), and device status displayed using built-in LED signalisation and accessible on maintenance connection.

HRKV0140 Modules shall be powered by internal AC power supply. Modules shall support redundant 12 VDC power input. Power consumption of modules shall be less than 30 W.

HRKV0150 Extender modules shall be provided with 19” rack mounting kits. Multiple computer modules shall be installed into single RU, to save space in 19” rack. User modules shall be possible to install on the desk and into 19” rack.

### 2.4.6 TMCS Software

SWGE0010 RCMS software system architecture shall be designed on a server/client computing model.

SWGE0020 The software architecture shall have ability to provide clean, organized and intuitive user interface with appropriate error messaging.

SWGE0030 The software architecture shall offer secure integration and tight interoperability across multiple TX/RX centers and to distribute exact and trustworthy data information.

SWGE0040 The software architecture shall be characterized by the ability to be scalable, secure, provide high performance and guarantee modernization in the smooth upgrade path.

SWGE0050 Complete software package shall be available on installation CD/DVDs.

SWGE0060 Specific Document – software release notes shall be issued for each software release or upgrade.

SWGE0070 Database technology - flow of the algorithm used for implementation of RCMS software application shall be properly described and documented.

SWGE0080 After successful operational acceptance test all software configurations with in RCMS shall be properly back up and stored on internal RAID or external USB disks.

### 2.4.7 TMCS Time code system
The system shall be capable to synchronize to UTC using NTPv4 or NTPv3 (NTPv4 is preferred), over UDP/IPv4 protocol.

System servers, on each of operational and auxiliary/test environment, shall be synchronized to Employer NTP servers (stratum 1). System servers shall be capable to use at least three Employer NTP servers. These system servers shall then be used as stratum 2 for the rest of the VHF system.

2.4.8 TMCS Security Facilities

The system shall be provided with sophisticated security facilities to prevent any unauthorized use.

In any case, it shall be demonstrated that the RCM system is secured against any tampering.

RCM system shall provide access control through user authentication.

Different user groups shall be defined for different levels of user rights. User groups shall be associated with specific rights for accessing, using, modifying and controlling VHF system. User groups shall be defined for particular system positions (e.g. Technical, Administrator…).

Rights for accessing, using, modifying, controlling or any other access regulated activity shall be individually defined (i.e. per right).

Users shall log on the RCM system using user credentials – username and password. Users shall be joined into user groups.

Number of users which can be created on the system shall not be limited.

Users, user groups and rights definition shall be definable by Employer (user with Administrator rights) without Contractor’s support.

Users in Technical group shall have limited access rights to change VHF configuration.

Only the members of the Administrator group shall be able to configure and alter the system configuration, without restrictions.

System shall provide security logging facilities. Security log shall be accessible only to Administration user group.

All security related actions performed by users shall be recorded into security log. At minimum, following activities shall be recorded:

- User login and logout,
- User forcing system variable to fault or to specific value,
- Manual failover (within redundant TX/RX pair),
- System configuration change,
- Other security related events.

For each recorded activity, security log shall provide username of user which performed activity, time, date and name/description of activity performed.
2.4.9 TMCS Maintenance Provisions

TMMP0010 The system shall be of a modular design, with sufficient built in redundancy to allow major components to be replaced without having any detrimental effect upon the current operational status.

TMMP0020 The TMCS server and client and LAN switching components shall consist of high quality commercial off the shelf products (COTS).

TMMP0030 The equipment design shall be such as to ensure easy servicing and replacement of units and sub units.

TMMP0040 As a design goal, identical units and sub units shall be interchangeable without readjustment.

TMMP0050 Mechanical and electrical systems shall be designed for easy maintenance and fault diagnosis by a single person – trained technical staff.

TMMP0060 Dismounting of the stand-by unit or any other duplicated part shall have no influence on the operating unit. The failure or removal of any duplicated component shall not interrupt the operational service.

TMMP0070 Performing configuration changes or restarting services on client workstation shall not have any effect on the rest of the system.

TMMP0080 Built-in test (BITE) facilities shall be available enabling immediate fault location in case of failure. Software routines shall constantly check for proper system operation.

TMMP0090 Measurement data messages sent from radio equipment (with required BITE functionality) shall include detailed status of it. Status reported by the radio equipment shall be received, decoded and used by RCMS application, and displayed in TMCS screens/positions.

TMMP0100 It shall be possible to view data sent from VHF’s interfaces to TMCS servers (for maintenance purposes).

It shall be possible to remotely connect (VNC, RDP) to server from TMCS clients, to perform maintenance tasks from control and/or central room/location.

TMMP0110 System image shall be provided, containing OS, drivers, RCMS applications and all necessary configuration files. It shall be possible to restore both client and server computers to full working condition by restoring system image, without other configuration tasks required.

Multiple system images independent for each computer can be provided or one common image for all roles (client or server roles and positions) can be provided, with selection of computer role during restoration.

It shall be possible to restore image using DVD drive and over LAN from one of the servers.

TMMP0120 Installation media for OS, drivers and any other required applications shall be provided, to enable installation if client or server HW is changed in the further long-term operation and maintenance of the system, when availability of the COTS HW could be limited.

RCMS and other applications required for specified functions shall have scripted (automated), easy, fast and well documented installation process.
2.5 Accessories and instrumentation

**FTAI0010** The Tenderer shall offer three sets of tools and service kits (e.g. cable connector adapters, etc.) for efficient maintenance, control/monitoring and repair of delivered equipment.

**FTAI0020** For maintenance and measuring purposes, the Tenderer shall offer Radiocommunications service instrument with similar or better characteristics than Aeroflex 2945B Communications Service Monitor which CCL currently uses.

**FTAI0030** The Radiocommunications service instrument shall have at least the following functions/specifications:

- Transmitter and receiver testing
- Spectrum monitor
- SSB testing
- Cable fault testing
- Tracking generator with full offset tracking
- Accurate power measurement to 150W
- Transient and Harmonic analysis
- RF frequency counter
- S/N meter
- Oscilloscope
- RF synthesizer
- Modulation meter
- Memory for storing complete instrument setups
- CCITT filter

**FTAI0040** With VHF system three (3) laptop computers shall be delivered. This computers shall be used for maintenance tasks and installed with RCMS application as well. Computers shall provide following:

- Windows OS with same version as TMCS clients,
- Multicore CPU,
- 8GB of more of RAM minimum,
- 15.4" LCD display minimum,
- 10/100/1000 Mbit/s Ethernet interface,
- RS-232 interface with included RS232 to RS422/485 adapter. This adapter shall not require additional power supply,
- Carrying backpack.

In order to unify computer equipment and to reduce maintenance cost, because of CCL’s current maintenance contract with HP, the Tenderer is encouraged for all laptop computers to offer COTS equipment by HP.
2.6 Interoperability

The role of the Supplier, or its authorised representative established in the Community (in this case: the Tenderer), is to ensure and declare compliance of its EATMN constituent with the essential requirements, specific requirements contained within the relevant implementing rules for interoperability and other relevant technical specifications (e.g. Community specifications, standards).

The purpose of the following requirements is to ensure that the procured and implemented system is compliant by all means with the requirements laid down in The Interoperability Regulation: REGULATION (EC) No 552/2004 + 1070/2009 on the interoperability of the European Air Traffic Management network.

Instruction to tenderers:

The Tenderer's disability to comply with the regulatory requirements, directives and applicable standards shall lead to the immediate rejection of the offer.

FTIO0010 The Tenderer shall attach with the tender documentation the EC Declaration of Conformity for all parts of the equipment/system (the Constituents) that is part of the offer and future delivery.

FTIO0020 The Tenderer shall prepare and attach with the system documentation the EC Declaration of Suitability for use for the delivered radio system.

FTIO0030 The Tenderer shall offer radio equipment and systems which comply with EC Regulation 1079/2012 + 657/2013 laying down requirements on air-ground voice channel spacing for the single European sky.

2.7 RAM (Reliability, Availability, Maintainability)

2.7.1 General

Reliability, Maintainability and Availability are characteristics of the overall system which shall be specified, designed, implemented, tested, validated and documented.

The quality of equipment can be considered as its ability to satisfy the user needs for the specified period of time and can be expressed with its operational availability. Two major contributors to the quality are:

a) Reliability, and
b) Maintainability.

FTRG0010 The methodology, techniques, processes and tools the Tenderer intends to use to achieve the specified RAM objectives shall be described or referenced in specific plans addressing architecture, hardware and software aspects.

2.7.2 Reliability

Reliability is defined as a probability that equipment will perform its intended function without error, under stated conditions, for a specified period of time.

FTRR0010 The Tenderer shall provide in the tender documentation a reliability model consisting of reliability block diagrams covering all functions of the system.

FTRR0020 The MTBF and MTTR in hours and the availability shall be clearly shown in either a block diagram or a list showing the equipment breakdown to the functional unit level, with the identification of a specific common failure mode (e.g. switch over equipment).
The Tenderer shall provide in the tender documentation reliability predictions and analysis as per standard MIL-HDBK-217 or other commonly used and accepted method which shall be clearly stated.

### 2.7.3 Maintainability

Maintainability is the measure of the ability of an item to be retained in or restored to a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair. MTTR is the sum of corrective maintenance times at any specified level of repair, divided by the total number of failures within an item repaired at that level, during a particular interval under stated conditions.

The Tenderer shall provide in its response the MTTR estimates and prediction for each of the following:

- Line Replaceable Unit (LRU);
- Each major equipment group;
- Each single channel of the system.

The Tenderer shall state in its response the average turn-around time (TAT) for a Line Replaceable Unit (LRU).

### 2.7.4 Availability

For the purpose of this specification, Availability is defined as a ratio of the total time the system is capable of performing its mission, against the time for which it is required to perform that mission, expressed as a percentage. The availability calculation excludes all planned downtimes.

The figures for Availability quoted in this Specification are for Operational Availability (Ao) and shall be calculated using the following equation:

\[
Ao = \frac{MTBF}{MTBF + MTTR + MRT}
\]

- **MTBF** = Mean Time Between Failures in hours.
- **MTTR** = Mean Time To Repair in hours.
- **MRT** = Mean Response Time in hours (i.e. the average time from a notification of failure for a technician to be ready to commence a repair action).

The proposed Radio System shall be considered as failed or unavailable when one or more radio frequencies are not available per radio site.

The lifetime of the Radio System shall be not less than 15 years or 130,000 hours operation.

The estimated value of Operational Availability of the Radio System shall be not less than 99.998%.

The estimated value of MTBCF of the System shall be not less than 40,000 h.

All calculation shall be provided to indicate the system ability to meet the requirements with full explanation of all assumptions.
3 Logistic Support

3.1 Maintenance Concept

Maintenance of this system and associated environmental features will be efficient and responsive to operational needs and the requirements of aviation safety.

There are two levels of maintenance:

- "Level one": on-site, where the staff will isolate and replace faulty LRUs and SRUs, and
- "Level two": performed either in the Repair Workshop (at the Contractor's premises or at any other site agreed between the Contractor and the Employer) or, exceptionally, on-site. Faulty LRUs and SRUs will be repaired down to the component level, to a maximum possible extent.

LSMC0010 The Tenderer shall propose his own vision and concept of the most appropriate and the most efficient maintenance approach (especially corrective maintenance).

LSMC0020 The Contractor shall guarantee the shortest possible MTTR (Mean Time to Repair), which shall be less than 0,25 hours.

LSMC0030 The Contractor shall support the establishment of a support and, if necessary, service agreement with local companies covering the repair/replacement of COTS items by the original suppliers.

LSMC0040 The Contractor shall guarantee support and repair/replacement of all hardware, software and documentation (including COTS products as well), including the supply of spare parts for a period corresponding to the expected life of the unit, but not less than 10 years. In case the Contractor cancels the hardware service agreement, the Supplier shall be obliged to continue the support by his own means.

3.2 Spares and Support

3.2.1 General

LSSU0010 The offered initial set of spare parts shall be specified in a tender documentation, in a form of the Mandatory Spare Parts List, which shall contain all spare parts (LRUs, SRUs, consumables), with the price for each individual item.

LSSU0020 A Spare Parts List shall, for each spare part, include:

- Contractor/Manufacturer Name,
- Part Number (P/N),
- Spare Part Description,
- Recommended Quantity of Spare Parts to be delivered,
- Quantity of parts to be installed in the system,
- MTBF, MTTR, TAT, DT of each part,
- Category: repairable (repair/replace on site, repair in repair workshop) or non-repairable (discard on failure),
- Warranty period (only in case of specifically defined warranty period for certain parts).
LSSU0030 If at the end of the warranty period it is proven that the measured spares consumption and/or MTBF is not within the limits as defined in the Contract, the Contractor shall review its spares calculations, as well as upgrade and supply the spares package at its own cost.

LSSU0040 The Contractor shall guarantee the shortest possible TAT (turn-around time) for parts sent to the Repair Workshop for repair or exchange, which shall be less than 30 calendar days.

LSSU0050 The Contractor shall guarantee the shortest possible DT (delivery time) for parts that will be additionally ordered by the Employer, which shall be less than 60 calendar days.

LSSU0060 The Contractor shall deliver all spare parts to the Employer, in the quantity and quality which is in accordance with the Contract requirements, at the latest 7 calendar days before the start of commissioning. These spare parts shall be inspected and tested (except consumables) during the Operational Acceptance Test (Guarantee Test).

LSSU0070 The Contractor shall notify the Employer if the delivery of a particular type of spares is becoming difficult or if the manufacturing of that part has stopped. Such notification accompanied by a spare parts replacement proposal shall be given at least 6 months in advance.

LSSU0080 The above stated requirement (LSSU 0070) shall be valid for parts procured from the Contractor or any of the suppliers involved in the procurement of spare parts for this system.

LSSU0090 The Contractor shall include 24/7 technical customer support maintenance by a professional/specialist ATC radio engineer, based in the Contractor’s premises. Upon contract signature, the Contractor shall provide the contact details (Name/Surname, Title, Position/Department, Telephone, Fax, E-mail address, Office Working time) for the entitled professional mentioned above.

LSSU0100 Upon contract signature, the Contractor shall, provide the contact details for a substitute of the entitled professional mentioned above in case of his/her absence (or a Help Desk).

3.2.2 Mandatory Spare Parts List

LSSL0010 The Tenderer shall include in its offer a mandatory set of spare parts to enable the efficient five (5) years’ maintenance of all parts of the system, and for each site separately. The Employer reserves the right to procure an additional set of spares.

LSSL0020 The offered initial set of mandatory spare parts shall be based on the RAM calculation, but not less than:

- Eight (8) VHF transmitters
- Eight (8) VHF receivers
- Two (2) UHF transmitters
- Two (2) UHF receivers
- Six (6) pcs of RCMS site equipment
- Three (3) VHF transceivers
- Three (3) CWP panels for transceivers
- One (1) antenna type 1
- One (1) antenna type 2
- One (1) antenna type 3
- One (1) antenna type 4
- One (1) antenna type 5
- Four (4) SWR monitors
- Four (4) Rx VHF Multicouplers
- Two (2) Rx UHF Multicouplers
- Six (6) Lightning protectors
- Two (2) DC rectifiers
- Three (3) RCMS PC client computers
- One (1) RCMS Server
- Five (5) ethernet switches

LSSL0030 The offered mandatory set of spares shall be of the same type/model/version as the equipment installed.

3.2.3 Recommended spare parts

LSSL0040 The Tenderer is encouraged to propose an additional set of spare parts according to its own experience and maintenance concept, which should be useful. This list should be clearly divided from a Mandatory Spares Part list from para 3.2.2.

3.3 Warranty

3.3.1 General

Warranty is the firm and written obligation of the Contractor to fix, at its costs and over an agreed period, the defects and deficiencies occurring on the accepted deliverables (hardware, software, documentation, etc.).

This obligation does not apply when the Contractor can prove that such defect or deficiencies fall outside the warranty coverage.

LSWG0010 The entire costs, including the costs for analysis of the reported problems, for possible shipment of the defective goods back to Factory and for the correction of deficiencies falling under warranty shall be borne by the Contractor.

LSWG0020 The warranty shall be applicable to all the System and ancillary deliverables developed and/or delivered by the Contractor (hardware, software, documents).
The warranty shall not extend to any damage arising in consequence of proven negligence or improper manipulation/repair of the equipment by CCL or by a third party, nor to consumable parts of the product.

Services such as installation, setting-up and tuning shall be covered by warranty while the others (training, support) are not covered by any warranty clause.

Under the warranty conditions, the Contractor shall ensure that the operational downtime is compatible with the Availability, MTTR and MTBF, as specified in Para 2.7 of this Specification.

The Contractor shall warrant the COTS HW as well as special developments which might be required.

The Contractor shall interface with the COTS HW and FW vendors for solving any problems occurring during the warranty period.

The Contractor shall warrant the delivery of SW developed by itself or by its Sub-Contractors.

The Contractor shall defend the CCL interests in face of COTS SW vendors for solving any problems occurring during the warranty period.

The contents, presentation, accuracy, correctness and completeness of all documentation provided to satisfy the contract requirements shall be covered by the warranty (whether or not originating directly from the Contractor).

The Tenderer shall specify a detailed scope of warranty.

The Tenderer shall include in the tender documentation a description of warranty repair eligibility conditions, i.e.:

- Fault reporting procedures;
- Procedures for sending hardware for repairs;
- Software repairing/upgrading procedures;
- the Help-Desk (On Call 24/7 expert technical assistance) service scope and conditions.

The Tenderer shall specify defect elimination times:

- Hardware repairs at the manufacturing plant;
- Interventions on the radio systems installation site;
- Phone, fax, e-mail assistance;
- Other options, if any.

The Tenderer shall include in the response a description of the method of providing post-warranty maintenance services.

The Tenderer shall include in the response a declaration of availability of spare parts for at least 10 years from the date of Operational Acceptance.

The Tenderer shall include in the response a declaration of availability of higher software versions that can be used to upgrade the equipment functionality.
3.3.2 Warranty Period

LSWP0010 The warranty periods for all HW and SW mentioned above shall be at least 24 months from the date the Operational Acceptance is approved (signing the Operational Acceptance Certificate).

LSWP0020 The Contractor’s obligation to correct defects and deficiencies shall apply until all the reported and pending defects and deficiencies from the Operational Acceptance, as well as from the warranty reporting period, have been corrected in a satisfactory way.

LSWP0030 The warranty reporting period for the HW/SW items and documentation shall automatically be extended by the period during which the Radio System (per site) is not operationally available (DOWN TIME).

LSWP0040 After the warranty reporting period, any newly detected deficiencies shall not fall under the warranty any longer.

3.3.3 Obligations of the Contractor

LSWO0010 If defects and deficiencies affecting the contractually agreed supplies and services arise during the appropriate warranty period, the Contractor shall begin to rectify such defects in compliance with the provisions listed hereinafter:

LSWO0020 Where the warranty period is concerned, it is generally agreed that, in case of the Contractor receiving a notification in the time from Monday to Friday, 8:00 to 16:00 hours, rectification of the defects shall begin within 5 working days after the receipt of the Contractor’s notification.

LSWO0030 In this respect the Contractor shall guarantee a support service for the above mentioned periods. Based on a detailed description of the fault, an appropriate system specialist shall, without delay, contact by telephone the CCL personnel who have given the notification of the fault.

LSWO0040 Should the CCL personnel be unable to take a remedial action at short notice, yet the fault appears rectifiable by a systems specialist locally, the systems specialist shall travel to such location without delay in accordance with the above time stipulations and begin to rectify the fault.

LSWO0050 Where complex system faults are identified, the project managers shall reach an agreement regarding the suitable location for troubleshooting and regarding deadlines.

LSWO0060 Upon expiry of the above deadlines CCL may rectify the fault by itself, or have it rectified at the Contractor's expense. The Contractor's warranty obligation shall thereby remain unaffected if the work has been performed properly and CCL has informed the Contractor thereof without delay.

LSWO0070 The rectification of faults and any other work performed on accepted or operational systems shall be carried out in compliance with the CCL’s internal work instructions; where applicable, special arrangements will be made in individual cases.

LSWO0080 After completion of the repair or modification the Contractor shall demonstrate the compliance with the specification of the HW/SW and Documentation.
LSWO0090  A report (including a Version Description Document for SW items) describing the nature of the deficiency/defect, the cause and the corrective measures taken, shall be prepared by the Contractor and submitted to CCL with the correction.

LSWO0100  Replacement parts already delivered to CCL may be used by the Contractor during the warranty period.

LSWO0110  The Contractor shall provide replacements, at no expense to CCL, for defective parts during the warranty period.

LSWO0120  The Contractor shall correct, at no expense to CCL, all defects in the design of hardware or software during the warranty period, where these defects cause the system not to meet specified performance requirements.

LSWO0130  Fixes to the software shall undergo regression testing.

LSWO0140  The documentation shall be updated as required to reflect the HW/SW deficiencies corrected under the warranty.

LSWO0150  During the warranty period, the Contractor shall provide support to CCL in solving any problem arising from the license arrangements that the Contractor has negotiated with the vendors in place and name of CCL.
4 Technical System Documentation

**TSDO0010** The documentation shall be compliant by all means with the requirements laid down in The Interoperability Regulation (EC) No 552/2004.

**TSDO0020** The documentation shall be in English.

**TSDO0030** The system documentation for each site shall consist of:
- Hardware documentation,
- Software documentation,
- Operational user manual,
- Training documentation
- Site installation documentation

**TSDO0040** The final versions of the system documentation shall consist of 3 hard copies per site and 1 copy on CD media.

**TSDO0050** The system documentation shall be written and printed in accordance with either ISO A4 or ISO A3 format standards. All drawings shall be documented in a commonly available CAD utility.

**TSDO0060** The Tenderer shall specify a list of all system documentation specifying reference numbers (if applicable at the time of tender procurement), description of documentation, delivery milestones in relation to project milestones (Contract Signature, FAT, OAT, etc.)

**TSDO0070** The Tenderer shall also supply for each site the COTS documentation i.e. a set of technical documents of the system hardware and software units, provided by the manufacturer of COTS products (such as PCs, workstations, modems, network equipment). These documents shall be delivered in the same quantity as the system documentation.

**TSDO0080** Defects, misunderstandings, inadequate or incomplete descriptions and other findings in the documentation, which compromise the quality of the documentation and/or influence the usability of the documentation for the planned purposes, shall be corrected without any extra costs to the Employer.

**TSDO0090** All documentation to be delivered shall be issued in a final version and provided to the Employer, prior to the Operational Acceptance.

**TSDO0100** The documentation shall include the following:
- Equipment description;
- Equipment block diagram;
- Unit layout in cabinets and cabinet wiring;
- Detailed description and purpose of each unit;
- Interconnections within units;
- Wiring and assembly diagrams down to the LRU/SRU level;
- Fault finding diagrams;
- Setting-up and operating procedures;
- Preventive maintenance and its procedures;
- Corrective maintenance and its procedures;
- Specification of all equipment units with part number, serial number and manufacturer;
- Other information necessary to perform regular and preventive maintenance.

**TSDO0110** The software documentation (e.g. the Software User Manual or equivalent and the Version Description Document or equivalent) shall contain a description of the system software and shall comprise sufficient details to permit full understanding and maintenance of the system.

**TSDO0120** The documentation shall provide guidelines for the technical staff to:
- Understand the equipment function in detail;
- Perform preventive and corrective maintenance of the equipment;
- Troubleshoot the system down to the LRU/SRU level;
- Install and configure any LRU/SRU in case of complete equipment failure or malfunction of that LRU/SRU;
- Perform all necessary measurements and adjustments.
5 Training

The System HW +SW training consists of Factory training and on-the-job-training. The factory training consists of Basic Factory technical staff training and IP environment training. CCL’s intention is to send 10 participants on that training.

Additionally, DC system maintenance training (3 day training) shall be organized (TRNG0210, TRNG0220, TRNG0230) for 6 participants.

TRNG0010 The following personnel training is required:
- System hardware and software training of technical staff

TRNG0020 The Tenderer shall submit in its offer an initial version of the Training Plan. The Training Plan shall be discussed in detail with the Contractor and approved by the Employer in accordance with the agreed schedule.

TRNG0030 The Tenderer shall suggest a maximum number of trainees in one group. The number of trainees in one group shall not be less than six.

TRNG0040 The technical staff shall be trained to:
- Understand equipment architecture and configuration,
- Understand operational functions and features of all equipment units,
- Understand and use system software application(s) which are part of delivered equipment,
- Perform preventive maintenance of the equipment,
- Perform corrective maintenance, i.e. troubleshoot the system down to the LRU and SRU (where applicable) levels,
- Perform system test and alignment procedures for LRU/SRUs,
- Perform required measurements and adjustments and to be able to use all necessary tools and instruments,
- Understand the diagnostic and test utilities and procedures.

TRNG0050 The Training shall address all of the hardware and software delivered in the scope of the Contract, which means that the training for installation, maintenance and operation of COTS products shall be included in the Tender Documentation and in the Training Plan, as well.

TRNG0060 The training language shall be English or Croatian. The Contractor shall provide necessary training on all products delivered within the project.

TRNG0070 All instructors engaged in the training shall be fluent in English, qualified, skilled, shall have excellent knowledge of the system and shall be experienced trainers.

TRNG0080 The content of the training course(s) shall be included in the Training Plan and shall be approved by the Employer.

TRNG0090 The training material in electronic form (on CD) shall be made available for the trainees at least 1 week before the course begins. Paper copies of the training material shall be available for the trainees at the time the course begins.

TRNG0100 The Employer shall have the right to use such material for further courses within its own organisation.

TRNG0110 The Training shall include theoretical education together with the elements of practical training.

TRNG0120 A schedule for the training course(s) shall be defined after contract signature.
TRNG0130 The Tenderer shall conduct a final written and practical exam for each trainee (student) at the end of the training. A Trainee shall be considered as competent ("A trainee successfully completed the course.") for system maintenance and operation if he passes a practical exam with a score of at least 70% and a theoretical (written) exam of at least 70%.

TRNG0140 After the completion of each course, the following reports shall be provided to the Employer:

- Each student's performance;
- A summary report for each examination;
- An attendance report;
- Certificate of competence for each student who successfully completed a course with a score of at least 70% for each exam.

TRNG0150 The technical staff shall be trained in several parts:

- Prior to FAT (Factory Acceptance Test) to be able to take part in Factory Acceptance Tests, held in the Contractor’s training facilities (Factory Training)
- During the system installation, which will be considered as an on-the-job-training, as it is intended that trainees participate in installation activities as much as possible, while the Contractor will make the supervision and have the responsibility of correct system installation. The Contractor is encouraged to perform a day or two of pre-installation training in order that the Employer’s technical staff will be able to actively participate in the system installation.

TRNG0160 The Tenderer shall offer the level of Factory training intended for the system and maintenance engineers experienced with similar systems. The technical staff training should last 7 working days at least.

TRNG0170 A Factory training programme shall at least consist of:

- Radio device training (Tx, Rx, TxCB): theory of operation, block-schemes, front and back panels, functions, menus, adjustments, connections/integration/installation, practical tips etc. Practical “hands-on” training is required.
- Dividers, multicouplers, filters, VSWR meters training: theory of operation, block-schemes, functions, adjustments, connections/integration/installation, practical tips… etc. Practical “hands-on training” is required.
- RCMS sub-system training: installation (HW & SW), troubleshooting, functions, menus, applications, site/equipment management, user/password management etc.
- 19” equipment cabinets: cabling installation, wiring and cabling, equipment fitting and connecting, AC/DC power distribution and cabling, grounding and fusing, EMP protection, etc.

TRNG0180 Additionally, the Tenderer shall offer within factory training program the VHF/UHF radio migration to IP environment training:

- Design of IP LAN VHF/UHF at Tx and Rx radio center;
- Configuration the IP related parameters on RCMS
- VoIP control messages between VCS and radio
- Configuration of IP LAN equipment at radio site
- Principle of sharing the resources with more VCSs

**TRNG0190** The Training from TRNG0180 shall be provided by the expert trainer in IP network (preferably IP integrator manufacturer staff). The Contractor shall prepare all necessary training documentation, practical exercises, as well as the tools and instruments for the practical hands-on training.

**TRNG0200** The IP migration training should last at least 3 working days.

**TRNG0210** Additionally, the Tenderer shall offer within factory training program the DC system maintenance training:
- DC Power System Overview
- Proper use of schematic drawings, adjustments, hands-on training, and the theory of operation of a DC power system
- Circuit Card Description
- DC system Documentation

**TRNG0220** The Training from TRNG0200 shall be provided by the expert trainer in DC system (preferably DC system manufacturer staff). The Contractor shall prepare all necessary training documentation, practical exercises, as well as the tools and instruments for the practical hands-on training.

**TRNG0230** The DC system maintenance training should last at least 3 working days.
6 Safety and Quality Assurance

6.1 Safety

6.1.1 General

SARQ0010 When creating the safety documentation, including a safety plan and safety reports, the Supplier shall take into account:

- Requirements from EC regulations EC 552/2004, EC 1070/2009, with related Implementing Rules (IR) and Community Specifications (CS),
- Requirements from EC regulation EC 482/2008,
- The Supplier shall follow Eurocontrol’s Safety Assessment Methodology as much as practicable,
- All comments provided by CCL (when updating this documentation),
- Safety reports shall include the safety recommendations to CCL, as a possible means for risk mitigation. This shall include procedural and human mitigations, e.g. training, shift management, maintenance procedures, operational procedures etc.

SARQ0020 The safety documentation shall be provided to the Employer for review and approval in accordance with the milestones specified in the Documentation Plan.

6.1.2 Safety Audit

SASA0010 The safety audit shall be conducted by The Employer in duration of approximately one working day according to the Employer’s safety audit plan previously delivered, subject to mutual agreement.

SASA0020 The safety assurance process shall be audited and the Contractor shall provide full support to the Employer’s safety audit team including access to evidence and arguments.

6.1.3 Safety Plan

SASP0010 The Contractor shall provide a Safety Plan which shall include all activities to be performed by the Contractor to meet the requirements related to safety, in such a way that the delivered technical system is safe for operation and minimises the risks which may contribute to aircraft accidents as far as reasonably practicable.

SASP0020 A preliminary version of the Safety Plan shall be delivered at the latest 30 days after contract signature, and shall be reviewed and approved by the Employer.

SASP0030 Safety activities to be specified in the Safety Plan shall be carried out to cover:

- All hardware and software to be delivered (components to be developed, procured, modified, or re-used), up to external interfaces of the system,
- Safety related procedures and training of the CCL staff,
• The whole time span of the Project and all activities with safety significance, i.e. the system specification, design, development, integration, installation, acceptance, commissioning, transition to operation and maintenance of the system.

SASP0040 The Contractor will produce updates of the Safety Plan, if necessary.

6.1.4 Safety Reports

SASR0010 Safety reports will cover the Safety Assessment process, containing as a minimum, the following:

• Hazards identification and analysis for each system function, including the determination of hazard likelihood and severity, and possible effect on operation,
• Identification of possible effect on operation for each hazard,
• Identification of risk mitigation measures for each hazard.

SASR0020 Safety Reports will be produced in accordance with the Safety Plan.

SASR0030 Safety Reports shall include, as a minimum, the following set of documents and due dates:

• Functional Hazard Assessment Report (FHAR), due date: 30 days after contract signature;
• Preliminary System Safety Assessment Report (PSSAR), due date: 2 calendar weeks before the FAT starting date;
• System Safety Assessment Report (SSAR), due date: 1 calendar week before installation of the target system;
• Safety Issue Log (SIL). The document shall contain all safety critical issues which should be mitigated in a procedural or human related matter. Due date: Start of the equipment installation;

6.1.5 Safety Objectives

SASO0010 The likelihood of total loss of transmitting function for one frequency channel from one site shall be less than 10\(^{-4}\) per operating hour (once a year).

SASO0020 The likelihood of degradation, RF interference or partial loss of transmitting function for one frequency channel from one site shall be less than 10\(^{-4}\) per operating hour (once a year).

SASO0030 The likelihood of total loss of receiving function for one frequency channel from one site shall be less than 10\(^{-4}\) per operating hour (once a year).

SASO0040 The likelihood of detected degradation, RF interference or partial loss of receiving function for one frequency channel from one site shall be less than 10\(^{-4}\) per operating hour (once a year).
SASO0050 The likelihood of non-detected degradation or partial loss of receiving function for one frequency channel from one site shall be less than $10^{exp-5}$ per operating hour (once every 10 years).

SASO0060 The likelihood of total loss of antenna system function for all frequency channels on site shall be less than $10^{exp-4}$ per operating hour (once a year).

SASO0070 The likelihood of detected degradation or partial loss of antenna system function for frequency channels on site shall be less than $10^{exp-4}$ per operating hour (once a year).

SASO0080 The likelihood of non-detected degradation or partial loss of antenna system function for frequency channels on site shall be less than $10^{exp-5}$ per operating hour (once every 10 years).

SASO0090 The likelihood of interference with other antenna systems shall be less than $10^{exp-5}$ per operating hour (once every 10 years).

SASO0100 The likelihood of loss of or inadequate SWR monitor function shall be less than $10^{exp-3}$ per operating hour (once a month).

SASO0110 The likelihood of loss or degradation of monitoring and remote control of Tx/Rx site shall be less than $10^{exp-3}$ per operating hour (once a month).

SASO0120 The likelihood of loss or degradation of connector interface panel causing loss of A/G voice transmission/reception function for Tx/Rx site shall be less than $10^{exp-4}$ per operating hour (once a year).

SASO0130 The likelihood of loss or poor intelligibility of A/G voice transmission/reception function for all/some frequency channels caused by RF signal interference within cables or non-adequate signal and poor cables routing shall be less than $10^{exp-5}$ per operating hour (once every 10 years).

SASO0140 The likelihood of partial loss of A/G voice transmission/reception function caused by excessive vibration of equipment cabinets/racks shall be less than $10^{exp-5}$ per operating hour (once every 10 years).

SASO0150 The likelihood of partial loss of A/G voice transmission/reception function caused by overheating of equipment (ventilation of equipment within cabinet) shall be less than $10^{exp-5}$ per operating hour (once every 10 years).

SASO0160 The likelihood of loss of or inadequate overvoltage protection function shall be less than $10^{exp-4}$ per operating hour (once a year).

SASO0170 The likelihood of total loss of DC system function shall be less than $10^{exp-3}$ per operating hour (once a month).

### 6.1.6 Software Safety Requirements

SASS0010 The Tenderer shall produce evidence and arguments demonstrating that:

- the software safety requirements correctly state what is required by the software, in order to meet safety objectives and requirements, as identified by the risk assessment and mitigation process;
- traceability is addressed in respect of all software safety requirements;
• the software implementation contains no functions which adversely affect safety, particularly there must not be the CSCI whose single failure would induce the effect with severity class 1 as per ESARR 4;

• the software satisfies its requirements with a level of confidence which is consistent with the software criticality;

• assurances are provided confirming that the general safety requirements set out in the previous points are satisfied, and the arguments that demonstrate the required assurances are at all times derived from:
  (i) a known executable version of the software;
  (ii) a known range of configuration data;
  (iii) a known set of software products and descriptions, including specifications that have been used in the production of that version.

SASS0020 The Contractor shall allocate software assurance levels (SWAL) to all operational software, in compliance with the following:

• The software assurance level shall relate the rigour of the software assurances to the software criticality by using the severity classification scheme set out in Section 3.2.4 of Annex II to Regulation (EC) No 2096/2005, combined with the likelihood of occurrence of a certain adverse effect. A minimum of four software assurance levels shall be identified, with software assurance level 1 indicating the most critical level (if such software exists);

• An allocated software assurance level shall be commensurate with the most severe effect that software malfunctions or failures may cause, as referred to in Section 3.2.4 of Annex II to Regulation (EC) No 2096/2005. This shall, in particular, take into account the risks associated with software malfunctions or failures and the architectural and/or procedural defences identified.

• Software components that cannot be shown to be independent of one another shall be allocated the software assurance level of the most critical of the dependent components.

SASS0030 To assure software safety requirements validity, the Contractor shall describe the functional behaviour of software in nominal and downgraded modes, timing performances, capacity, accuracy, software resource usage on the target hardware, robustness to abnormal operating conditions and overload tolerance, as appropriate. Software safety requirements shall be complete and correct, and compliant with the system safety requirements.

SASS0040 To assure the software safety requirements verification, the Contractor shall ensure that:

• The software functional behaviour, timing performances, capacity, accuracy, software resource usage on the target hardware, robustness to abnormal operating conditions and overload tolerance, shall comply with the software requirements.
• The software shall be adequately verified by analysis and/or testing and/or equivalent means.

• The software verification shall be correct, complete and documented.

**SASS0050** To assure the software configuration management, the Contractor shall ensure that:

• Configuration identification, traceability and status accounting facilitate that the software life cycle data is shown to be under configuration control throughout the software life cycle.

• Problem reporting, tracking and corrective actions facilitate that safety related problems associated with the software are shown to have been mitigated.

• Retrieval and release procedures facilitate that the software life cycle data is regenerated and delivered throughout the software life cycle.

**SASS0060** To assure the software safety requirements traceability, the Contractor shall ensure that:

• Each software safety requirement is traced to the same level of design at which its satisfaction is demonstrated.

• Each software safety requirement, at each level in the design at which its satisfaction is demonstrated, is traced to a system safety requirement.

**SASS0070** The assurances shall include the rigour for each software assurance level which shall increase as the software increases in criticality. For that purpose:

• the variation in rigour of the assurances per software assurance level must include the following criteria:
  - required to be achieved with independence;
  - required to be achieved;
  - not required;

• the assurances corresponding to each software assurance level must give sufficient confidence that the software can be operated tolerably safely;

**SASS0080** For any software (such as COTS, non-developmental software or previously used software, etc.), for which some of the requirements cannot be applied, the Contractor shall provide, through other means, the same level of confidence as the relevant software assurance level whenever defined. Those means must give sufficient confidence that the software meets the safety objectives and requirements, as identified by the safety risk assessment and mitigation process.
6.2 Quality

6.2.1 General

QGEN0010 The Tenderer shall be certificated, holding a valid ISO 9001:2015 or equivalent Quality Management System Certificate.

QGEN0020 The Tenderer shall submit documentary evidence in the Tender establishing to the Employer satisfaction that the Tenderer has a valid Quality Management System certificate.

6.2.2 Quality Assurance Plan

QAAP0010 The Contractor shall develop a Quality Assurance Plan, subject to the approval by the Employer.

QAAP0020 The Quality Assurance Plan shall describe the organisation, processes, tasks and responsibilities with respect to quality assurance.

QAAP0030 The Quality Assurance Plan shall identify the documents to be produced in appropriate phases of the lifecycle (see also the Project Management Plan), and shall state how these documents are checked for adequacy.

QAAP0040 The Quality Assurance Plan shall identify the standards, practices, conventions, and metrics to be applied and shall state how compliance with these items is to be monitored and assured.

QAAP0050 The project applicable and referenced documents and standards shall be listed in the Quality Assurance Plan, with their title and version number.

QAAP0060 The Preliminary Quality Assurance Plan shall be available at contract signature.

QAAP0070 The final version of the Quality Assurance Plan shall be available within 60 days from contract signature.

6.2.3 Quality Audit

QAQA0010 The Quality Assurance processes, technical documentation and products produced shall be subject to quality audit. The date, schedule and scope shall be mutually agreed.

QAQA0020 The duration of quality audit shall be approximately one working day.

QAQA0030 The Contractor shall provide full support to the Employer’s quality audit team including access to evidence and arguments.
7 Project Management

7.1 General

PMGE0010  The Contractor shall be responsible for the management, performance, monitoring and coordination of the whole project from the project kick-off until the completion of the contract.

PMGE0020  The Contractor shall establish a project organization in accordance with the requirements included herein, having necessary resources, qualification and experience to fulfill all of its obligations.

PMGE0030  The Tenderer shall define and describe the part of its organization which will manage or be involved in the project.

PMGE0040  The Contractor shall appoint the Contractor's Representative, who will be an interface to the Employer's Project Manager, and be at the Employer's disposal for all matters relating to contract execution.

PMGE0050  In case another person will act as his substitute, the Employer shall be notified at least 2 weeks in advance of the other person proposed to substitute him.

PMGE0060  The Contractor's Representative (or his substitute) shall be present at all meetings during the contract execution.

PMGE0070  The Contractor's Representative shall be responsible for project co-ordination and will take all necessary actions to ensure the project progress according to the agreed schedule.

PMGE0080  Communication between the Contractor and the Employer shall be in accordance with the Employer's practice. Details of a Communication Procedure between the Contractor and the Employer will be proposed by the Employer and mutually agreed after contract signature.

PMGE0090  If deemed necessary during contract execution, the Employer or the Contractor can propose progress meetings.

PMGE0100  The agenda for this meeting(s) shall be mutually agreed and prepared at least 3 working days prior the date of a meeting.

PMGE0110  The following persons shall be present at progress meetings:
  - The Contractor's Representative,
  - The Employer's Project Manager,
  - Any other persons who the above representatives consider important to be present.

PMGE0120  The venue of meetings will be mutually agreed.

PMGE0130  The Contractor shall prepare minutes of the meetings and submit them for approval to the Employer not later than 3 working days after the meeting finishes.

PMGE0140  The Contractor shall issue and manage a Progress Chart (Master Time Schedule). The contract shall be executed in accordance with the progress chart. This chart will be set out in the form of a linear timetable (preferably using the MS Project). The starting date is to be the date of entering the contract into force.

PMGE0150  The Progress Chart will specify dates of all major actions and decisions to be taken by both the Employer and the Contractor. Any alterations to this chart need to be examined and mutually agreed.

PMGE0160  The initial progress chart shall be included in the tender documentation.
PMGE0170 The progress chart shall be agreed between the Contractor and the Employer and shall be kept updated during contract execution. The version control of an electronic file of the Progress Chart shall be established.

PMGE0180 The Contractor shall establish close coordination with the Employer for the development of all planning activities related to the project, forwarding relevant plans, procedures, etc. for review and approval, prior to putting them into force.

PMGE0190 The Contractor shall prepare at least the following Project Plans at the appropriate stage in the project for review and approval by the Employer:
- Project Management Plan (PMP),
- Logistic Support Plan (LSP),
- Documentation Plan (DP),
- Safety Assurance Plan (SAP),
- Quality Assurance Plan (QAP),
- Training Plan (TP),
- Installation, Migration and Commissioning Plan (IP),
- FAT Plan and Procedures,
- Operational Acceptance Plan and Procedures.

7.2 Project Management Plan

PMPM0010 The Contractor shall prepare a Project Management Plan (PMP) in accordance with the requirements included in the present chapter.

PMPM0020 A draft version of the PMP shall be provided as part of the tender documentation. An initial official version of the PMP shall be issued on the date of contract signature at the latest.

PMPM0030 The Project Management Plan shall include at least the following:
- Project scope and overview,
- Project deliverables (shall also include a Documentation List),
- Work Breakdown Structure (Shall define the scope of work and resources necessary to meet the Contract requirements. The work breakdown shall also include the work to be performed by the Employer, e.g. participation in reviews and tests, preparation of data.),
- Project organisation and responsibilities,
- Master Time Schedule (Progress Chart),
- Quality assurance activities to be performed in the project by the Contractor,
- Configuration management activities (regarding hardware, software and documentation version changes).

PMPM0040 Any change to the PMP or to the processes outlined in it will be subject to the formal Employer’s approval. The PMP shall be kept up-to-date.

PMPM0050 The PMP shall normally include at least the following aspects:
- Management procedures and practices;
- Work breakdown structure (WBS);
- Master time schedule, showing dates and deliverables;
7.3 Documentation Plan

PMDP0010 A Documentation Plan shall specify the list of all documents to be delivered to the Employer during contract execution.

PMDP0020 A draft version of the Documentation Plan shall be provided by the Tenderer in the tender documentation. An initial official version of the Documentation Plan shall be issued on the date of contract signature at the latest.

PMDP0030 The Documentation Plan shall include at least the following:

- Title of document,
- The Contractor,
- Applicability of the document (e.g. entire system, a certain subsystem or a particular COTS product, hardware documentation, software documentation, etc.),
- Reference and version number of the document,
- Dates of each document delivery.

7.4 Logistic Support Plan

PMLS0010 The Contractor shall prepare a Logistic Support Plan (or equivalent) which shall specify in more detail logistic aspects of the Contract. The Logistic Support Plan shall include:

- Maintenance concept of the system,
- Maintenance activities, levels and responsibilities (maintenance flows overview),
- Overview of the technical documentation to be provided, especially stating the manuals with maintenance procedures,
- Spare Parts List which shall meet the requirements of this Technical Specification,
- Relation of maintenance activities with the skills obtained at technical training,
- Tools and test equipment list to be provided and/or required,
- All aspects of warranty support including a detailed description of the scope of warranty support,
- Possible post-warranty support arrangements regarding the system maintenance,
- Overview of recommended preventive maintenance actions.

PMLS0020 A draft version of the Logistic Support Plan shall be issued on the date of contract signature at the latest.
7.5 Installation, Migration and Commissioning Plan

PMIM0010 On each site where installation is going to take place, the Supplier shall prepare an Installation, Migration and Commissioning Plan comprising:

- The Contractor’s scope of work,
- Sub-contractors involved and their scope of work (if applicable),
- The Employer’s scope of work,
- Tasks to be performed and the person(s) responsible for each task,
- Timing of the tasks,
- Documentation (e.g. instructions, specifications, drawings, interconnection diagrams and other relevant information for installation),
- Other information important for the final installation.

PMIM0020 An initial (draft) version of the Installation, Migration and Commissioning Plan shall be provided in the tender documentation.

PMIM0030 The final Installation, Migration and Commissioning Plan plan shall be submitted at least 4 weeks and approved by the Employer at least 3 weeks before the start of installation/migration activities.

7.6 Acceptance Test Plans and Procedures

PMAP0010 The Contractor shall provide acceptance test plans and procedures (test specifications) for Factory Acceptance and Operational Acceptance, including a detailed description of the proposed test techniques and procedures to verify all equipment parameters, together with a schedule for such tests. The following documents shall be provided:

- Factory Acceptance Test Plan and Procedures,
- Operational Acceptance Test Plan and Procedures.

PMAP0020 These acceptance test plans and procedures (test specifications) shall at least contain the following:

- A schedule of the actions to be taken in the testing of various parts of the equipment,
- The forms of documentation of test results,
- The condition under which the tests shall be conducted and approved,
- A detailed description of the tests to be performed.

PMAP0030 The FAT Plan and Procedures shall be submitted to the Employer at latest 4 weeks before the FAT. The document shall be reviewed by Employer and shall be amended or changed if necessary, and approved by both parties 2 weeks before the FAT at the latest.

PMAP0040 The Operational Acceptance Test Plan and Procedures shall be submitted to the Employer at latest 4 weeks before the OAT. The document shall be reviewed by Employer and shall be amended or changed if necessary, and approved by both parties 2 weeks before the OAT at the latest.
8 Installation and Commissioning/Transition

8.1 Installation

INST0010 The planning of the system installation and setting up shall be developed in close cooperation with the Employer.

INST0020 The Installation, Migration and Commissioning Plan, specifying all installation and transition activities, shall be approved by the Employer prior to the installation.

INST0030 The Contractor can perform a site survey before the installation takes place in order to identify necessary works to be performed, if deemed necessary.

INST0040 The Employer will perform, prior to the installation, a complete physical check of the goods received (equipment, accessories, spare parts, documentation, etc. – all according to the Contract specification), and will notify the Contractor if the delivery does not fulfill the requirements listed in the Contract Specification.

INST0050 The Contractor shall have full responsibility for the system installation and setting up.

INST0060 The Contractor shall produce, procure and supply all necessary equipment, tools, etc., consumable as well as non-consumable, needed for the installation and setting-up.

INST0070 Installation on the site shall be conducted by Contractor’s skilled staff with support of the Employer’s technical staff under close Contractor’s supervision. These activities shall form On-the-Job Training of the Employer’s staff that shall be carried out during the installation in accordance with the agreed conditions given in the Training Plan.

INST0080 The installation shall take into consideration all applicable local legislation rules and procedures.

INST0090 The Contractor shall prepare a list of staff (for non-Croatian residents) to conduct the installation activities, as well as all necessary documents early enough in order to obtain their working permits in the Republic of Croatia (local legislation rules and procedures).

INST0100 The Contractor shall state in the Installation, Migration and Commissioning Plan the aspects of the installation to be included in the documentation concerning:

- Co-location aspects (where applicable);
- Cabling arrangements, routing, identification;
- EMC compatibility, Interference, susceptibility to foreign radio frequencies;
- Earthing arrangements;
- Equipment mounting, cooling, etc.

INST0110 The Contractor shall specify all the facilities and procedures the Employer has to provide for test purposes.
8.2 Pre-Commissioning and Completion

TCOM0010 The Contractor shall issue a written notice to the Employer when the installation within the site is finished and commissioning may commence.

TCOM0020 The Employer shall conduct an inspection of the site and the installation itself.

TCOM0030 After successful completion of the site inspection, the Employer shall issue a Completion Certificate and grant the commissioning within fourteen (14) days from receipt of the Contractor’s site completion notice.

TCOM0040 If some defects or deficiencies are found during the site inspection, the Employer’s Project Manager shall notify the Contractor’s representative and list all of them in a Completion Report. The Contractor shall take necessary remedial actions at its own expense, and the procedure shall be repeated.

8.3 Commissioning and Transition (Migration)

TTRA0010 The Contractor shall be responsible for the commissioning and transition to the new system. Transition (migration) activities shall be performed in accordance with the final Installation and Migration Plan.

TTRA0020 Transition to the new system shall be performed in a way that the functionality of the existing equipment is not significantly endangered at any moment in order to avoid/minimise the interruption of operational service.

TTRA0030 The Contractor shall conduct the transition activities according to the local rules, procedures and current situation (unexpected problems or issues: complex air situation, degradation of connected systems, etc.) as well as according to the conclusions stressed out in the dedicated CCL’s transition safety assessment document. This can sometimes affect the working time and transition duration as well.
9 Testing and Acceptance

9.1 Factory Acceptance

**TFAT0010** Factory acceptance shall be performed to verify that the equipment fully complies with the specification requirements. Non-complying equipment will be rejected.

**TFAT0020** Factory acceptance shall be normally witnessed by the Employer's representative(s), if not decided otherwise.

**TFAT0030** If the Employer's representative(s) does/do not witness the Factory acceptance testing, the Contractor shall perform Factory Acceptance Tests without the presence of the Employer's technical staff, issue a FAT Report (results and protocols) and send it to the Employer via official communication procedure.

**TFAT0040** All factory acceptance tests shall be normally carried out before the system installation and on the basis of a test specification submitted to Employer by the Contractor at least 4 weeks before the FAT.

**TFAT0050** The Contractor shall provide a test specification (FAT Plan and Procedures) including a detailed description of the proposed test techniques and procedures to verify all equipment parameters, conditions under which the tests shall be conducted and approved, the forms of documenting test results, together with a schedule for such tests.

**TFAT0060** All equipment and sub-units shall be fully interconnected and built up into a complete system configuration. Specific tests considered as impracticable within the given system configuration will be performed using simulated inputs/outputs or a test bench when specifically approved by the Employer.

**TFAT0070** All FAT procedures shall comply with and be performed according to the applicable standard documents, recommended practices or procedures (ICAO, ETSI, ITU, EUROCAE, CEI…).

**TFAT0080** The Employer reserves the right to request some further tests to be performed (which are not listed in the FAT specification) if deemed necessary. These tests shall be also noted in the FAT report.

**TFAT0090** If a failure occurs during acceptance testing, the Contractor shall take necessary remedial actions at its own expense, and all relevant tests shall be repeated unless the Employer decides otherwise.

**TFAT0100** After successful completion or unsuccessful attempt of the FAT, the FAT Report shall be immediately prepared and issued by the Contractor. The FAT report shall be signed by both the Contractor’s and Employer’s FAT representatives.

**TFAT0110** After successful completion of the FAT, the FAT Certificate shall be issued by CCL. The FAT Certificate shall be prepared and signed by CCL’s Project Manager not later than 10 days after FAT completion and sent to the Contractor’s Representative according to the official communication procedure.
9.2 Operational Acceptance

TOAT0010 The purpose of an Operational Acceptance Test (Guarantee Test) is to demonstrate conformity of the delivered equipment and proper functioning of the system after commissioning, specified in the Contract.

TOAT0020 The OAT shall be carried out after the system installation on each site, followed by issuing a Completion Certificate and on the basis of a test specification (OAT Plan and Procedures).

TOAT0030 The Employer reserves the right to request some further tests (site specific) to be performed (which are not listed in the OAT specification) if deemed necessary. These tests shall be also noted in the Operational Acceptance Report.

TOAT0040 The Operational Acceptance testing (Guarantee Test) shall be witnessed by the Employer's representative(s).

TOAT0050 If a failure occurs during acceptance testing, the Contractor shall take necessary remedial actions at its own expense, and all relevant tests will be repeated unless the Employer decides otherwise.

TOAT0060 The Contractor is responsible for providing all test equipment (hardware and/or software) necessary for the tests. The test facilities provided by the Contractor are not part of the delivery.

TOAT0070 All delivered spare parts shall be tested in real operation during the Operational Acceptance Test.

TOAT0080 The possibility of quick replacement of line replaceable units (LRUs) shall be demonstrated on the Operational Acceptance Test (as a part of the On-the-Job training).

TOAT0090 After successful completion or unsuccessful attempt of each Operational Acceptance, an Operational Acceptance Report shall be prepared and issued by the Contractor as soon as possible, but no longer than 7 days. The Operational Acceptance Report shall be signed both by the Contractor’s and Employer’s Operational Acceptance representatives and approved by the Employer’s Operational Acceptance representative appointed.

TOAT0100 Following satisfactory completion of all Operational Acceptance Tests (Guarantee Test) the Contractor shall offer the System for formal acceptance by the Employer.
Authorized CCL representatives shall grant the Operational Acceptance if the following conditions are satisfied:

- The inventory and a complete physical check of the goods received have shown that the delivery in all aspects fulfills the requirements listed in the Contract Specification;
- The system has been installed correctly;
- The documentation has been supplied and is in conformity with the Contract Specification;
- Training of the CCL staff has been carried out in accordance with the agreed conditions;
- Spare parts have been delivered according to the Contract Specification and have been tested in real operation;
- Operational acceptance tests have successfully been completed;
- Signed and approved Operational Acceptance Report has been issued.

All Operational Acceptance Report problems and observations shall be closed or a relevant action assigned and agreed.

All Certificates of Conformance and Suitability for use shall be provided by the Contractor for all deliverable items (including software).

The Operational Acceptance shall be granted by issuing an Operational Acceptance Certificate by the Employer. The Operational Acceptance Certificate shall be prepared and signed by CCL’s Project Manager not later than 7 days after completion of Operational Acceptance and sent to the Contractor’s Representative according to the official communication procedure.

If any kind of certificate regarding the equipment will be requested by Civil Aviation Authority such document shall be provided by Contractor at no cost for the Employer.
10 Drawings

10.1 Principal Positioning

10.1.1 Principal positioning of antennas, site Japetić

Drawing: Japetić site principal diagram
10.1.2 Principal positioning of antennas, site Sljeme

**TX**

- VHF x3
- UHF x3

**RX**

- VHF x2
- UHF x1

~7 m

~6 m

~5 m

Drawing: Sljeme site principal diagram
10.1.3 Principal positioning of antennas, site Kozjak

Drawing: Kozjak site principal diagram
10.1.4 Principal positioning of antennas, site Northern Adriatic

Drawing: Northern Adriatic site principal diagram
10.1.5 Principal positioning of antennas, site Valtura

Drawing; Valtura site principal diagram
10.1.6 Principal positioning of antennas, site V.Mlaka/Mićevec

TX

20 m

Velika Mlaka

2.35 km

RX

20 m

Mičevec

~3 m

VHF x2

VHF x1

~3 m

VHF x2

VHF x1

Drawing: V.Mlaka/Mićevec principal diagram
10.1.7 Principal positioning of antennas, site Čiovo

![Diagram of Čiovo principal diagram]

10.1.8 Principal positioning of antennas, site TWR Pula

![Diagram of TWR Pula principal diagram]
10.1.9 Principal positioning of antennas, site TWR Split

![Diagram of TWR Split principal positioning](Diagram.png)

10.1.10 Principal positioning of antennas, site TWR Osijek

![Diagram of TWR Osijek principal positioning](Diagram.png)
10.1.11 Principal positioning of antennas, TWR Lošinj

![Diagram of TWR Lošinj principal diagram]

10.1.12 Principal positioning of antennas, site TWR Brač

![Diagram of TWR Brač principal diagram]
10.2 Positioning of Equipment Inside the Objects

10.2.1 Position of telecommunication cabinets; site Japetić

Drawing: Site Japetić TX room layout
Drawing: Site Japetić RX room layout
10.2.2 Position of telecommunication cabinets; site Sljeme

Drawing: Site Sljeme Tx room layout
Drawing: Site Sljeme Rx room layout
10.2.3 Position of telecommunication cabinets; site Kozjak

Drawing: Site Kozjak Tx room layout
Drawing: Site Kozjak Rx room layout
10.2.4 Position of telecommunication cabinets; site Northern Adriatic

TBD
10.2.5 Position of telecommunication cabinets; site Valtura

Drawing: Site Valtura room layout
10.2.6 Position of telecommunication cabinets; site V.Mlaka/Mićevec

Drawing: V.Mlaka/Mićevec TX room layout

Drawing: V.Mlaka/Mićevec RX room layout
10.2.7 Position of telecommunication cabinets; site Čiovo

Drawing: ČiovoTX/RX room layout
10.2.8 Position of telecommunication cabinets; site TWR Pula

Drawing: TWR Pula TX room layout

Drawing: TWR Pula RX room layout
10.2.9 Position of telecommunication cabinets; site TWR Split

Drawing: TWR Split TX room layout

Drawing: TWR Split RX room layout
10.2.10 Position of telecommunication cabinets; site TWR Osijek

Drawing: TWR Osijek, location GP room layout
10.2.11 Position of telecommunication cabinets; site TWR Lošinj
10.2.12 Position of telecommunication cabinets; site TWR Brač
10.3 RF Diagrams

10.3.1 Japetić RF diagrams

Diagram: Japetić VHF Tx system principal RF diagram
Drawing: Japetić UHF Tx system principal RF diagram
Drawing: Japetić Rx system principal RF diagram
10.3.2 Sljeme RF diagrams

Drawing: Sljeme Tx system principal RF diagram
Drawing: Sljeme Rx system principal RF diagram
10.3.3 Kozjak RF diagrams

Drawing: Kozjak VHF Tx system principal RF diagram

Drawing: Kozjak UHF Tx system principal RF diagram
Multicoupler

Lightning Protection

VHF Antenna

UHF Antenna

Spare VHF Antenna

Rx system principal RF diagram

Drawing: Kozjak
10.3.4 Northern Adriatic RF diagrams

Drawing: Northern Adriatic Tx system principal RF diagram
Drawing: Northern Adriatic Rx system principal RF diagram
10.3.5 Valtura RF diagrams

Drawing: Valtura Tx system principal RF diagram
Drawing: Valtura Rx system principal RF diagram
10.3.6 V.Mlaka/Mićevec RF diagram

Drawing: V.Mlaka/Mićevec Tx system principal RF diagram

Drawing: V.Mlaka/Mićevec Rx system principal RF diagram
10.3.7 Čiovo RF diagram

Drawing: Čiovo system principal diagram

10.3.8 TWR Pula RF diagram

Drawing: TWR Pula Tx system principal RF diagram
10.3.9 TWR Split RF diagram
Drawing: TWR Split Rx system principal RF diagram
10.3.10 TWR Osijek RF diagram

Drawing: TWR Osijek system principal RF diagram
10.3.11 TWR Lošinj RF diagram

Drawing: TWR Lošinj system principal RF diagram

10.3.12 TWR Brač RF diagram

Drawing: TWR Brač system principal RF diagram
10.4 RCMS System Principal Diagram

Drawing: Zagreb Central Site
Drawing: Split Regional Site
Drawing: Pula Regional Site
10.5 RDR Kozjak mast