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Comment Matrix Form for *TSO-CNPC Unmanned Aircraft Systems Control and Non-Payload Communications Terrestrial Link System Radios*

No.	Commenter	Paragraph No.	Comment	Change/Rationale	Disposition
1	Rockwell Collins	3	Why reference 2.2.1.1, 2.2.1.1b etc... while 2.2.1 as a whole must be met according to paragraph 3?	Delete reference to 2.2.1 if it is intended to only invoke the specified sub-sections.	Accepted. Action: Deleted reference to § 2.2.1.
2	Rockwell Collins	3.b(5)(b)	In the Note the equations do not have units specified.	Add the units of each parameter.	Accepted. Action: Revised the Note as follows: "…. It is given by the formula $\mathbf{V_t = (\sqrt{\ }[2W/(\rho * C_D * S)]) / 1.688}$, where $\mathbf{V_t}$ is terminal velocity in knots, **W** is the object's weight in lbs, **ρ** is air density in slugs/ft^3, $\mathbf{C_D}$ is the object's aerodynamic drag coefficient, and **S** is the object's cross-sectional area ("flat-plate" area perpendicular to direction of fall) in ft^2. Terminal velocity may also be determined experimentally and/or validated by testing. (Additional note: In English units of mass, one slug weighs 32.17 lb.)"
3	Rockwell Collins	5.a(5)(i)	The broad operational intent of this section is understood, and it is called out for notices in Operating Manual. However, some of these requirements (e.g. sighting distance from one manufacturers GRS to another's) are well beyond equipment level instructions typical of TSOs to which the equipment manufacturer has any control. This seems more appropriate for Advisory Circular or perhaps FCC licensing instructions.	Consider an alternate means to capture and maintain this high level operational limitations that are beyond the scope of equipment manufacturer activities.	Not accepted. Paragraph 5.a(5)(i) requires the TSOA applicant – C Band CNPC Link System radio manufacturer – to describe the requirements in 5.a(5)(i) in the operating instructions and system limitations, which are within the control and responsibility of the TSOA applicant. This is to ensure that the CNPC Link System, when installed and operated according to the operating instructions and

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					system limitations, still meets the minimum operational performance standards of this TSO. Note that paragraph 5.a(5)(i) is intended to ensure that the signal from an ARS will result in an Undesired-to-Desired (U/D) interference ratio below the maximum tolerable ratio of 44.5 dB at a GRS that is controlling another UA ARS at a maximum distance of 35 nautical miles (NM) from the GRS. The 10 NM separation requirement between GRS is one of the limitations necessary to accomplish this objective. It is within the control of TSO applicants to include this limitation in their operating manual for the UAS CNPC Link System equipment. Action: No change to paragraph 5.a(5)(i).
4	Rockwell Collins	Appendix 1. 2.1.17.1 / Section 3 (Figure 1)	Figure 1 in Section 3 gives the scope to which the TSO applies, specifically that the CNPC system includes ARS and GRS. The CNPC system must also comply with 2.1.17. But the second shall of 2.1.17.1 is a requirement for the UA FRMS which is only appearing in the correction appendix and does not show in the figure 1. Does the TSO only apply to ARS and GRS or does it also apply to the FRMS?	If the scope of TSO extends to FRMS, then the scope of applicability of the TSO described in figure 1 needs to be expanded to include it. This would of course be true of any other elements implied, but not currently depicted in Figure 1.	Accepted. As described in Section 3 and its Figure 1, the scope of TSO only covers the CNPC system ARS and GRS. Action: Changed the requirement statements of paragraph 2.1.17.1 of Appendix 1 so they only specify requirements for the ARS, and not for the UA FRMS.
5	Rockwell Collins	Appendix 1. Paragraph 2.2.1.2.2	The intent of this section is clear, reflecting anticipated near term frequency authorization planning, that is subject to potentially	Recommend the tuning limitations be kept at the full 5030 – 5091 MHz range	Not accepted. As stated in Appendix 1, added paragraph

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			numerous and frequent changes and expansions. However, stating a firm and narrow requirement to inhibit tuning outside the initially planned authorizations will create a significant cost for certification requalification each time this limit was expanded. This would be a cost both for the FAA (which would have to re-release the TSO) and manufacturers (who would have to then requalify equipment).	approved by WRC 2012. Operational controls rather than heavy handed recertification seem more appropriate, and cost effective.	2.2.1.2.2, the FAA's intent with respect to C Band spectrum use for UAS CNPC applications is to allocate a 10 MHz band (5040-5050 MHz) for use by Phase 1 CNPC Link Systems. This is to preserve as much of the 5030-5091 MHz frequency band as possible for eventual use by Phase 2 CNPC Link Systems. Action: No change to Appendix 1, Paragraph 2.2.1.2.2.
6	James Ziarno Harris Corp	Section 3, second paragraph	Page 2 Section 3 second paragraph, TSO references the requirements of DO-362 Section 2.2.2 apply, we believe this should reference 2.2.3 which are the Manufacturer Specific CNPC System Requirements whereas Section 2.2.2 are intended for the Baseline (Test Radio).	**From:** CNPC Link System radio classes are defined by the avionics system with C Band ARS and GRS radios with antennas and co-located / non-co-located with other avionics systems defined in Table 1. These CNPC Link System radio classes must meet the following requirements in RTCA/DO-362: §§ 2.1.17, 2.1.10, 2.1.12, 2.1.15, 2.1.16, 2.2.1, 2.2.1.1, 2.2.1.1.1.b—2.2.1.1.3, 2.2.1.3—2.2.1.8.2.2, 2.2.1.8.3, 2.2.1.9, 2.2.2, and 2.4. **To**: CNPC Link System radio classes are defined by the avionics system with C Band ARS and GRS radios with antennas and co-located / non-co-located with other avionics systems defined in	Not accepted. This TSO references the minimum performance requirements of RTCA/DO-362 § 2.2.2, Validation Baseline Radios. The TSO does not reference the requirements of § 2.2.3, Manufacturer Specific Radios. Simulations and flight tests were conducted to validate the minimum performance requirements of DO-362 § 2.2.2, Validation Baseline Radios. DO-362 § 2.2.3 – for alternative manufacturer specific radio designs – describes a range of radio RF requirements comparable to those of the Validation Baseline Radio requirements. This TSO does not reference § 2.2.3 since that section does not describe minimum performance requirements. Action: No change necessary.

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				Table 1. These CNPC Link System radio classes must meet the following requirements in RTCA/DO-362: §§ 2.1.17, 2.1.10, 2.1.12, 2.1.15, 2.1.16, 2.2.1, 2.2.1.1, 2.2.1.1.1.b—2.2.1.1.3, 2.2.1.3—2.2.1.8.2.2, 2.2.1.8.3, 2.2.1.9, 2.2.3, and 2.4.	
7	James Ziarno Harris Corp	Section 3 b. Failure Condition Classifications (3), (4) and (5)	This TSO is intended to address the Control and Non-Payload Communications (CNPC) terrestrial Link System radios, whereas the Failure Condition Classifications and the determination of Risk Class based on the calculation of predicted Kinetic Energy for the UA at ground impact is largely a function of the Mass of the UA and its impact velocity	CNPC Radio Manufacturers are seeking a specification directed only to the radio, which is independent of the UA it is installed. The mass (weight) of the CNPC is a contributor to the overall Kinetic Energy and Risk Class of the UA, but the CNPC radio should not be assigned a Rask Class as a result of its contribution to the overall UA Kinetic energy. This would be analogous to assigning the Risk Class of an "Aircraft in Flight" as a function of the size, weight of the installed Communications Transceiver. Suggest the FAA not assign Kinetic Energy Risk Classes to the CNPC, but assign the Risk Classifications to the UA in which the radio is installed.	Not accepted. The UAS risk classifications in paragraphs 3.b.(1) through 3.b.(4) define the starting point for the design assurance targets for the ARS and GRS. Per paragraph 3.b.(6)(a), UAS CNPC Link System functionality supporting DAA must meet the same design assurance levels regardless of UAS risk class, and Table 2 does not apply to such functionality. For all other CNPC Link System functionality, the intent of applying UAS risk classes as outlined in Table 2 is to allow design assurance to a lower DAL for equipment used only in correspondingly lower UAS risk classes (thereby decreasing the certification burden to the applicant), provided the applicant is willing to declare an installation limitation to limit installation of the equipment into the appropriate UAS risk class. Table 2 describes the relationship between UAS risk classes based on kinetic energy and the acceptable target DALs and probability of likely catastrophic failure conditions. Acceptable target DALs of the CNPC Link System equipment are proportional to UAS kinetic energy, with higher kinetic energy

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					dictating a higher design assurance and lower probability of failure. For applicants that wish to design equipment to a lower DAL, that is limited to installation in correspondingly lower risk class UAS, the DAL requirements of Table 2 are intended to be applied in place of the nominal hazardous/severe major Level B requirement of the CNPC Link System. An applicant that wishes to obtain approval for equipment that may be installed in any UAS must design the equipment to the nominal failure condition classifications specified by paragraphs 3.b.(1) through 3.b.(4), in accordance with paragraphs 3.b.(6)(a) (for functionality supporting DAA) and 3.b.(6)(b)(1) (for all other CNPC Link System functionality). Action: To clarify the intended **optional** application of Table 2 (to design certain functionality to lower DAL for use with lower risk class UAS) as per the above, we have changed paragraph 3.b(6)(b) of the TSO to read: **"(b)** For all other CNPC Link System functionality, develop the system to at least the following design assurance level: **(1)** The failure condition classification specified by paragraph **3.b(1)**, or, **(2)** If you limit the CNPC Link System equipment to be used with UAS Risk Class 4 or below as defined in paragraph **3.b.(5),** Table 2, the DAL specified for the highest

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					UAS risk class in paragraph **3.b.(5)**, Table 2, with which you intend the CNPC Link System equipment to be used. If you design the equipment to this DAL, include an installation limitation…"
8	Tony Boci Harris Corp	Section 5.a.3.(a)	The highest CNPC uplink and downlink data rates, CNPC ARS and GRS minimum transmitter RF output power minimum receiver sensitivity, minimum antenna gain, and maximum antenna RF connector and cable loss.	Suggest: minimum transmitter RF output power Change To: maximum transmitter RF output power	Not accepted. Minimum transmitter RF output power is the worst-case output power together with other RF parameters (worst-case) and the maximum data rates, as described in § 5.a.3.(a) will be used to show that the proposed CNPC Link System performance can be achieved. Action: No change to § 5.a.(3).(a).
9	Tony Boci Harris Corp	Section 5.a.3.(a)	The highest CNPC uplink and downlink data rates, CNPC ARS and GRS minimum transmitter RF output power minimum receiver sensitivity, minimum antenna gain, and maximum antenna RF connector and cable loss.	Suggest: minimum antenna gain, Change To: maximum antenna gain	Not accepted. Minimum antenna gain is the worst-case antenna gain together with other RF parameters (worst-case) and the maximum data rates, as described in § 5.a.3.(a) will be used to show that the proposed CNPC Link System performance can be achieved. Action: No change to § 5.a.(3).(a).
10	Tony Boci Harris Corp	Section 5.a.3.(a)	The highest CNPC uplink and downlink data rates, CNPC ARS and GRS minimum transmitter RF output power minimum receiver sensitivity, minimum antenna gain, and maximum antenna RF connector and	Question: For GRS, cable loss is site specific depending on cable length and type of RF cable. In the Installation Manual can we	Acknowledged. Applicants may include in the installation manual the maximum cable loss for a given cable length between the RF electronics and

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			cable loss.	provide the average cable loss based on the cable type and not to exceed cable loss?	antennas for the CNPC ARS and GRS installations. Action: No change to § 5.a.(3).(a).
11	Tony Boci Harris Corp	Section 5.a.3.(d)	Any unique aspects of the CNPC ARS and GRS antenna(s) such as antenna pattern performance characteristics. Aircraft antenna patterns must include free space patterns and patterns as modified by airframe obstruction at the intended installation location.	Question #1: Would providing vertical and horizontal antenna patterns in text format be sufficient to meet this requirement? Question #2: This type of analysis requires specialized software and modeling. Can the FAA provide recommendations on the software to be used, and the type artifacts required to satisfy this requirement?	Acknowledged. Providing vertical and horizontal antenna patterns in text format meets this installation limitation requirement. 2D or 3D analyses can be conducted to analyze the performance of aircraft antenna patterns including free space patterns and patterns as modified by airframe obstruction at the intended installation location. A safety margin may be applied when 2D analysis is conducted. As an example of 3D analysis, DO-362 Appendix K describes analysis of the installed antenna gains with airframe obstruction conducted using SAVANT, which is a specialized 3D CAD model Computational Electromagnetic simulation using Shooting and Bouncing rays with Geometric Optics extensions. Other acceptable software and modeling methods may also be available. Flight test may be performed to validate the analysis results. As with all certification projects, the FAA encourages applicants to obtain early agreement from their ACO Branch on proposals for use of specific modeling and software, deliverable artifacts, and other

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					means of compliance. AIR-6B0 can support discussions on these issues as needed. Action: No change to § 5.a.(3).(d).
12	James Ziarno Harris Corp	Section 5 (5) (c)	State in the installation limitations that for the CNPC Link System C Band Class installation a directional GRS antenna (as described in RTCA/DO-362) must be used.	There is no directional antenna described in RTCA DO-362, although Section 3.2.1.1 and Appendix L shows example Link Budgets with GRS Antenna Gains of 25 dBi. Rather than indicating a "directional GRS antenna must be used" and suggesting any particular antenna gain value, it is the CNPC Manufacturer's responsibility to recommend a GRS Antenna, including associated gain (if any) for a particular GRS operation. Suggest eliminating statement: "*State in the installation limitations that for the CNPC Link System C Band Class installation a directional GRS antenna (as described in RTCA/DO-362) must be used*"	Partially accepted. As per RTCA DO-362, §3.2.1.1 and Appendix L, for a CNPC Link System C Band Class installation a directional GRS antenna shall be used for operation at 35 NM or longer range to close the link. However, for shorter range operation (for example 10 NM or less) C Band CNPC Link GRS omnidirectional antennas may be used. Consideration of the off-axis effective isotropically radiated power spectral density will need to be given to ensure off-axis emissions do not cause unacceptable interference. Action: Clarified § 5.a.(5).(c) as follows: **(c)** State in the installation limitations that for the CNPC Link System C Band Class installation a directional GRS antenna (as specified in RTCA/DO-362 §3.2.1.1 and Appendix L) must be used, as applicable.
13	James Ziarno Harris Corp	Section 5.a.5.h.i.ii	One GRS is limited to support one ARS;	Why is this being restricted? The specified technology allows the GRS to support multiple ARSs.	Not accepted. The C Band operational limitations include the criteria of one GRS is limiting to support one ARS. The C Band operational limitation

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				Suggest eliminating statement: "*One GRS is limited to support one ARS;"*	is imposed to protect the UA ARS and GRS from interference from the "Undesired GRS" and "Undesired ARS" respectively. Action: No change to § 5.a.(5).(i).(ii).
14	James Ziarno Harris Corp	Section 5.a.5.h.i.iv	The CNPC ARS's must use automatic transmitter power control to switch to the low transmit power mode of 100 mW (see paragraph 2.2.1.6.1.3 of RTCA/DO-362) at or below 3,000 ft AGL.	Suggest Adding: If the UA is a small UA only certified to operate below 500', the ARS automatic transmitter power control should not be required since the UA must operate at or below 100mW at all times.	Not accepted. Small UASs that operate exclusively below 500 feet are outside the scope of RTCA/DO-362 and this TSO. Action: As a result of additional technical evaluations conducted after the draft TSO was released for public review, Paragraphs 5.a.(5).(i).(iii) and (iv) were revised as follows: (iii) The CNPC ARS must operate in high transmit power mode (see paragraph 2.2.1.6.1.2 of RTCA/DO-362); and, (iv) When the ARS is 9.5 NM or more from its GRS, the CNPC ARS must be operated at or above 3,000 ft AGL.
15	James Ziarno Harris Corp	Section 5.a.8	A summary of the test conditions used for environmental qualifications for each component of the system radios. For example, a form as described in RTCA/DO-160G, Environmental Conditions and Test Procedures for Airborne Equipment, Appendix A.	The referenced form provides information regarding which environmental tests were conducted, but it does not indicate which environmental tests are required for different class vehicles or operations. Suggest: Provide DO-160	Not accepted. Section 3.d of the TSO specifies the environmental qualification requirements for the equipment. These environmental qualification requirements apply to all CNPC Link System radios providing terrestrial point-to-point communication functionality and radio line-of-sight operation to support UAS operating in the National Airspace System.

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				environmental requirements for different class vehicles and various operations (Controlled airspace, sUAS etc.)	Action: No change to § 5.a.(8).
16	Tony Boci Harris Corp	Section 5.a.(5).(e)	State the UA minimum recommended operating enroute altitude (above ground level (AGL)) for the intended operational environment.	Question: Does this exclude clutter (e.g. clutter, manmade structures, and other obstacles)?	Acknowledged. Action: Clarified § 5.a.(5).(e) as follows: State the UA minimum recommended operating enroute altitude (above ground level (AGL)) for the intended operational environment, considering clutter, manmade structures, and other obstacles.
17	Tony Boci Harris Corp	Section 5.a.(5).(g).(i)	The greatest installed antenna gain reduction (antenna obstruction allowance) from maximum within the UA intended maneuvering envelope; and	Question: Please provide additional clarity on this requirement, an example would be very helpful.	Acknowledged. As per RTCA DO-362, example Appendix L, C Band CNPC Link ARS on-axis maximum antenna gain of 5 dBi and airframe loss of 12 dB were considered to close the link for operation at 35 NM range. Action: No change to § 5.a.(5).(g).(i).
18	Tony Boci Harris Corp	Section 5.a.(5).(g).(ii)	The maximum fade margin due to multipath and diffraction caused by terrain near the radio line of sight path between the two CNPC Link System antennas.	Question: Should clutter (e.g. trees, buildings, etc.) be excluded from such analysis? Does such analysis imply multipath along the radial path only, or is a full 3D multipath analysis is	Acknowledged. Clutter (e.g. trees, buildings, etc.) should be included in the multipath and diffraction analysis. A 3D multipath analysis is recommended. If

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				expected?	analysis of multipath along the radial path between the ARS and GRS only is done, flight test may be performed to validate the analysis results. Action: No change to § 5.a.(5).(g).(ii).
19	Tony Boci Harris Corp	Section 5.a.(5).(i).(i)	No GRS can operate within 10 NM of another GRS	Question: Does this only apply to GRSs of the same network?	Acknowledged. Paragraph 5.a.(5).(i).(i) is part of the C Band CNPC Link System Radio operating limitations to mitigate the Near-Far problem from the simultaneous operations of two CNPC Link System airborne and ground radios. This TSO addresses only non-network GRS. CNPC Link Systems intended to provide CNPC Link handover operations of one GRS to another GRS are outside the scope of this TSO. If an applicant proposes a CNPC Link System intended to conduct CNPC Link handover operation from one GRS to another GRS, and the GRSs and ARS are manufactured by the same manufacturer, the applicant may apply for deviation against this TSO. If the applicant proposes to operate two or more of their GRS within 10 NM of each another, then their deviation request must describe how they will mitigate the Near-Far problem. Action: No change to § 5.a.(5).(i).(i).

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20	James Ziarno Harris Corp With Spectrum edits	Section 5.a.(5).(h)	Include a note indicating that in order for an ARS operating in conjunction with any GRS, to be licensed by rule, the ARS must receive FCC Certification in addition to FAA TSO approval.	Question: Previously it was our understanding that the authority for licensing UAS Aviation Protected Spectrum (ARS or GRS) was the sole responsibility of the FAA UAS Spectrum Office. What is the authority of both the FCC and the FAA Offices in licensing the UAS Aviation Protected Spectrum for the ARS and the GRS?	Acknowledged. The Federal Communications Commission (FCC) issues frequency licenses (assignments) for UAS GRS and ARS communication operations. The FAA Spectrum Office assists the FCC in reviewing the license application and is the band manager for the 5030-5091 MHz band. Action: As a result of feedback received from the FCC on this TSO, paragraph 5.a(5)(h) has been changed to read: Include information on the FCC license and authorization requirements for the GRS, and include a note indicating that operations must stay within the specified geographic confines authorized to the operator. Include a note indicating that for an ARS operating in conjunction with any GRS, the GRS and the ARS must receive FCC Certification in addition to FAA TSOA approval.
21	Tony Boci Harris Corp	Section 5.a.(5).(i).(iv)	The CNPC ARS's must use automatic transmitter power control to switch to the low transmit power mode of 100 mW (see paragraph 2.2.1.6.1.3 of RTCA/DO-362) at or below 3,000 ft AGL.	Question: If by design the ARS transmits at low power only is the power switch still required?	Acknowledged. As a result of additional technical evaluations conducted after the draft TSO was released for public review, Paragraphs 5.a.(5).(i).(iii) and (iv) were revised to require the UA ARS to operate in high transmit power mode, and to operate at or above 3,000 ft AGL when the ARS is 9.5 NM or more from its GRS.. These additional technical evaluations determined that in order to avoid the

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					"near/far" undesired/desired interference problem, the ARS must transmit at high power at all times, and within the operating constraints defined by paragraphs 5.a(5)(i)(i) through (iv) in the final released version of the TSO. Therefore, no low power operation is allowed. Action: Paragraphs 5.a.(5).(i).(iii) and (iv) were revised as follows: (iii) The CNPC ARS must operate in high transmit power mode (see paragraph 2.2.1.6.1.2 of RTCA/DO-362); and, (iv) When the ARS is 9.5 NM or more from its GRS, the CNPC ARS must be operated at or above 3,000 ft AGL.
22	James Ziarno Harris Corp	Section 5.a.(5).(i).(iv) Note 1	Paragraphs 5.a.(5)(i)(i) to 5.a.(5)(i)(iv) are intended to ensure that the signal from an ARS flying at or below 3,000 ft AGL but above 500 ft AGL will result in an Undesired-to-Desired (U/D) interference ratio below the maximum tolerable ratio of 44.5 dB at the GRS, for a GRS that is controlling the ARS at a maximum distance of 35 nautical miles (NM) from the GRS. (See Appendix R, paragraph R.2.5.2 of RTCA/DO-362)	Question: While operationally ARS maintains a certain MSL level, there will be cases where traversing irregular terrain this requirement may be challenging to verify/validate. What altitude sensor sources for altitude are acceptable (i.e. pressure altitude, pressure altitude corrected, geometric altitude, laser altitude)?	Acknowledged. Various types of altitude sources such as geometric altitude or barometric altitude source can be used as defined in added paragraph 2.1.17 in Appendix 1 of this TSO. The altitude source will need to be able to operate properly over irregular terrain. Action: Paragraph 5.a.(5).(i).(iv) was revised as follows: (iv) When the ARS is 9.5 NM or more from its GRS, the CNPC ARS must be operated at or above 3,000 ft AGL.
23	EASA	Sec. 1 (Purpose),	The proposed TSO is for CNPC systems in C-band. It would be advisable to indicate it.	Indicate that this TSO is for CNPC systems in C-band.	Accepted.

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		page 1			Action: Revised the second sentence of the first paragraph of section 1 as follows: In it, we (the Federal Aviation Administration, (FAA)) tell you what minimum performance standards your Unmanned Aircraft Systems (UAS) Control and Non-Payload Communications (CNPC) terrestrial Link System radios operating in C Band, 5040-5050 megahertz (MHz) must meet for approval and identification with the applicable TSO marking.
24	EASA	Sec. 1 (Purpose), page 1	It should be clarified if this TSO addresses only non-network GRS.	Include clarification according to comment.	Accepted. Section 3 states that the TSO addresses CNPC Link System airborne and ground radios to achieve a terrestrial point-to-point communication functionality. Thus this TSO addresses only non-network GRS. Clarified section 1 as commented. Action: Revised the second sentence of the first paragraph of section 1 as follows: In it, we (the Federal Aviation Administration, (FAA)) tell you what minimum performance standards your Unmanned Aircraft Systems (UAS) terrestrial non-networked Control and Non-Payload Communications (CNPC) Link System radios operating in C Band, 5040-5050 megahertz (MHz) and must meet for approval and identification with the applicable TSO marking.

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25	EASA	Sec. 3 (Requirements) - Table 1, page 2	Table 1 is for "Class 1 — Validation Baseline Radio" but a definition of this radio is missing	Include a definition of "Class 1 — Validation Baseline Radio" and clarify scope	Accepted. Action: Added the following sentence as the second sentence of the first paragraph of section 3: RTCA/DO-362 § 2.2.2 defines Class 1 Validation Baseline Radios and describes their requirements.
26	EASA	Sec. 3 (Requirements), page 2	There is no § 2.1.17 section in DO-362	Replace by the correct section ID (2.1.7?)	Accepted. Section 3, first paragraph states that the CNPC Link System radios identified and manufactured on or after the effective date of this TSO must meet the requirements in Section 2 of RTCA Document DO-362 with Errata, with the corrections to the RTCA/DO-362 MOPS listed in TSO Appendix 1 which includes the added § 2.1.17. Action: Deleted § 2.1.17 from the second sentence of the second paragraph of section 3.
27	EASA	Sec. 3 (Requirements), page 2	Why is requirement in § 2.1.14 (CNPC Link System Service Derived Performance Requirements) of DO-362 not considered?	Consider including § 2.1.14 (CNPC Link System Service Derived Performance Requirements) of DO-362.	Not accepted. DO-362§ 2.1.14 describes CNPC Link System Service Derived Performance Requirements, which are installation requirements. The TSO addresses the stand-alone CNPC Link System. An upcoming Advisory Circular for UAS CNPC Link System installations will provide installation guidance for UAS CNPC Link Systems.

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					Action: No change to Section 3.
28	EASA	Sec. 3 (Requirements), page 2	Add 2.3 indicating "(alternative standard allowed, see d. Environmental Qualification below)"?	As per comment	Not accepted. Section 3.d, Environmental Qualification, of the TSO references RTCA/DO-362, section 2.3. This section further states that you may use a different standard environmental condition and test procedure than RTCA/DO-362, section 2.3, provided the standard is appropriate for the CNPC Link System radios. Action: No change to paragraph 3.
29	EASA	Sec. 3 (Requirements), page 3	(a) Functionality – (1): the meaning of "control" and "manage" should be clarified. Is "control" used in the way defined in DO-362 sec.1.1 (information exchanges needed to support the pilot in safely maneuvering the UA on the ground and in the air)? Is "manage" referring to other support functions (e.g. managing aircraft systems)?	Clarify the meaning of "control" and "manage" in 3.a(a)	Accepted. Action: Added the following sentences after the first sentence of § 3.a(1): Control includes the capability to set the UA headings, altitudes, and speeds consistent with the aircraft performance and Air Traffic Control clearances. Manage includes other support functions, for example manage UA control, engine, and inertial systems.
30	EASA	Sec. 3 (Requirements), page 3	(a) Functionality – (2): video. Since the TSO is on CNPC, it should be clarified that video here is intended for safety purposes (as indicated in DO-362 sec. 1.4.4.1)	Add "(for safety purposes)" after "video" in 3.a(2)	Accepted. Action: Replaced "video" with "video to support safety critical operations".

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31	EASA	Sec. 3 (Requirements), page 3	Is it this failure conditions classification assuming that the loss of a UA is not necessarily catastrophic? Is it assumed that there is a contingency strategy for loss of CNPC function? This should be clearly stated	Clarification needed and assumptions should be clearly stated.	Not accepted. The Lost Link failure condition classification is based on the following: the UA automatically executes the pre-programmed Lost CNPC Link function and features; the pilot will contact ATC and state the contingency trajectory; and the flight plan ensures that the UA has sufficient fuel to land to ensure risk to persons and property in the air or on the ground is properly mitigated if the CNPC Link is lost. The note in § 3.b(2) describes the mitigations for the Lost Link failure condition. Action: No change to § 3.b(2).
32	EASA	Sec. 3 (Requirements), page 3	b.(1) Failure Condition Classifications: Why are PITL and POTL introduced if those are not affecting the classification of the failure conditions?	Clarify the need for distinguishing between PITL and POTL in 3.b(1)	Not accepted. PITL and POTL are included in this section to define those command and control methods and to distinguish those levels of pilot control from a fully autonomous UAS. This TSO does not support a fully autonomous UAS system. The failure classification for PITL and POTL is identical. Action: No change to § 3.b(1).

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33	EASA	Sec. 3 (Requirements), page 3	3.b.1 Failure is identified as Hazardous/severe major. However, in landing or takeoff it may be even worse. For example, when a pilot in the loop is controlling the landing, undetected failure may lead to CAT conditions. In the case of pilot on the loop, it depends on the capabilities of the pilot which are commanded to the UA.	Revise classification for 3.b.1.	Not accepted. The hazardous/severe-major failure assessment is aligned with the safety assessment in DO-362 Appendix K, Section K.6.3.2, which states that for a Risk Class 5 and 6 large UAS, "The probability of an unannunciated failure of the CNPC Link System providing command and control function with minimum level of automation should be on the order of 10^{-7} or less, per flight hour." Action: No change to § 3.b(1).
34	EASA	Sec. 3 (Requirements), page 4	3.b(5) How is assessment with UAS Risk Class to be performed for lighter-than-air aircraft (airships/balloons)?	Clarify how to address lighter-than-air aircraft (airships/balloons) We suggest considering EASA policy E.Y01301, which includes a methodology involving calculation of kinetic energy at impact for the loss of control case, including velocity estimation for airships/balloons.	Not accepted. The FAA risk classification scheme for fixed wing UAS utilizing the impact kinetic energy of the UAS at design cruise speed accounts for the low cruise speed of airships/balloons as per the last sentence of § 3.b(5). Action: No change to § 3.b(5).
35	EASA	Sec. 3 (Requirements), page 5	Table 2 should include 2 more columns to indicate acceptable DALs and probabilities for HAZ and MAJ failure conditions. This would make it clearer and easier to apply point 3.b(6)	Expand Table 2 as per comment	Not accepted. In accordance with the FAA's safety continuum concepts for Part 23 and 27 aircraft, the intent of including Table 2 in this section is to allow design to a lower DAL for certain failure conditions than nominally specified in paragraph 3.b(1) for equipment that will be used only in UAS of lower risk

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					(based on UA kinetic energy at ground impact). Table 2 is aligned with guidance from the FAA Small Airplane Standards Staff that will be published in an upcoming AC on UAS type certification. Although the UAS risk class-based DAL structure in Table 2 is based on probability of catastrophic failure, for the purposes of establishing UAS risk-class-based DAL relief provisions in this TSO, Table 2 as structured provides an adequate framework for risk class-based DAL relief without introducing excessive complexity. Action: No change to Table 2 in § 3.b(5).
36	EASA	Sec. 5 (Application Data Requirements), page 9	5.a(5)(i) Proposed limitations are unabling technical solutions making use of ground networks (see comment 2). One GRS to support one ARS is misleading, as several remote pilot stations may make use of certain ground network for CNPC of several UAs. Besides, one GRS may support several ARSs even if not used simultaneously (e.g. the same control station may be able to control several UA, even if one at a time)	Limitations to be revised, and add notes to clarify the intentions of such limitations.	Not accepted. RTCA/DO-362, § 1.1.2, Scope of MOPS, states: "This MOPS does not include all CNPC Link System design characteristics, for example, support of multiple UAs communicating with one CNPC Link Ground Radio System (GRS), or support of one CNPC Link System GRS communicating with CNPC Link System Airborne Radio Systems (ARS) manufactured by different companies. These capabilities would require some interoperability between the GRS and ARS." This TSO addresses CNPC Link System airborne and ground radios to achieve a terrestrial point-to-point communication functionality. Thus this TSO addresses one GRS supporting one ARS. Paragraph 5.a.(5)(i) addresses an operating limitation necessary to mitigate the Near-Far

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					problem from the simultaneous operations of two CNPC Link System airborne and ground radios. This Near-Far problem is different from one GRS simultaneously supporting several ARSs. This Near-Far problem is also different from one GRS supporting several ARSs at different times. The cases of one GRS simultaneously supporting several ARSs, and one GRS supporting several ARSs at different times involve handover operations, which are outside the scope of RTCA/DO-362 and this TSO. Action: No change to section § 5.a(5)(i).
37	EASA	Appendix 1, Paragraph 2.1.17.2	Requirement "The ARS shall alert the pilot whenever the value of the AGL altitude input is less than 500 feet." The alerting functionality should be part of the HMI of the remote pilot station, not of the CNPC Link System.	Please clarify and amend as per comment	Partially accepted. Appendix 1, § 2.1.17.2 addresses an optional ARS configuration where the UA FRMS functions are integrated into the ARS. If the applicant elects to use this integrated ARS/UA FRMS configuration, the ARS must transmit a command to alert the pilot when the UA is below 3,000 ft AGL and the ARS is 9.5 NM or more from its GRS. Note that this requirement has been revised from the draft TSO released for public review, as a result of additional technical evaluations conducted after the draft TSO was released for public review that identified a need to revise the operating limitations as published in the draft TSO, and resulting revision of the associated operating limitations. Action:

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					Appendix 1, § 2.1.17.2 changed to read: "The ARS **shall** transmit a command to alert the pilot whenever the UA is below 3,000 ft AGL and the ARS is 9.5 NM or more from its GRS.".
38	EASA	3. e	For software qualification, we recommend to update the TSO template and TSO-CNPC to directly refer to the AC 20-115 at the latest revision.	Rationale: The AC covers all software aspects and includes the usage of supplements for specific software design technologies (e.g. Object Oriented Technics) and include guidance to use previous version of DO-178 for new developments. Suggested change: "**e. Software Qualification.** If the airborne/ground system radios include software, follow the guidance in AC 20-115 **(latest revision)**, Airborne Software Assurance. If the CNPC Link System GRS includes software, you may also develop the GRS software according to RTCA, Inc. document RTCA/DO-278A, *Software Integrity Assurance Considerations for Communication, Navigation, Surveillance and Air Traffic Management (CNS/ATM) Systems*, dated December 13, 2011."	Partially accepted. We currently reference the applicable standards in TSOs (e.g., RTCA DO-178B). While we may also include reference to an Advisory Circular (AC), as is the case for software, the AC reference is in addition to and not a replacement of the applicable standard document number (DO-178B). Action: Revised § 3.e as follows: **3.e. Software Qualification.** If the article includes software, develop the software in accordance with RTCA, Inc. document RTCA/DO-178C, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 13, 2011, including referenced supplements as applicable, to at least the software level consistent with the failure condition classification(s) defined in paragraph **3.b** of this TSO. You may also develop the software according to RTCA, Inc. document RTCA/DO-178B, dated December 1, 1992, if you follow the guidance in AC 20-115 (current version)~~C~~, *Airborne Software Development Assurance using EUROCAE ED 12() and RTCA DO-178()*~~, dated July 19, 2013~~.

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39	EASA	3.f	For Electronic Hardware Qualification, we recommend to update the TSO template and TSO-CNPC to directly refer to the AC 20-152 at the latest revision.	Suggested change: **"f. Electronic Hardware Qualification.** If the airborne and ground system radios include complex custom airborne/ground electronic hardware, follow the guidance in AC 20-152 **(latest revision)**, Airborne Software Assurance."	Not accepted. We currently reference the applicable standards in TSOs (e.g., RTCA DO-254). While we may also include reference to an Advisory Circular (AC), as is the case for software, the AC reference is in addition to and not a replacement of the applicable standard document number. The suggested change also does not address simple custom airborne/ground electronic hardware qualification. Action: No change to § 3.f.
40	Terry L. McVenes, Boeing	Page 21 Para: 2.4.3.1.6.1.1	*The proposed text states:* Note: L-Band Systems are not authorized *We recommend revising the text as follows:* Note: L-Band Systems for the terrestrial domain (including the L-Band Digital Aeronautical Communications System (LDACS) – http://www.ldacs.com) are under active development at the time of this writing. L-Band Systems for the terrestrial domain (including LDACS) are not authorized due to [*justification statement here*].	LDACS is an emerging standard for civil aviation that has support in some markets for deployment in the near future (e.g., 2020 timeframe). It should therefore be mentioned by-name the same as was done for AeroMACS in earlier sections. In addition, if L-Band systems including LDACS are not to be authorized for UAS CNPC communications there needs to be a supporting justification statement to be supplied by the authors.	Partially accepted. RTCA/DO-362 covers minimum operational performance standards for the CNPC terrestrial Link System radios operating in L Band, 1040–1080 MHz and 1104–1150 MHz, which does not include LDACS. LDACS systems don't comply with the RTCA/DO-362 minimum operational performance standards including the time-division duplexing and the radio masks requirements. Compatibility testing of the of the L Band, 1040-1080 and 1104-1150 MHz, CNPC Link Systems with the Tactical Air Navigation/Distance Measuring Equipment (TACAN / DME), Mode S, Automatic Dependent Surveillance – Broadcast system (ADS-B), and Traffic Collision Avoidance

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					System (TCAS) is not yet complete. Therefore, this TSO does not authorize L Band, 1040-1080 and 1104-1150 MHz, CNPC Link System radios. Once we have completed L Band compatibility testing and analyzed the results, we will evaluate the 1040-1080 and 1104-1150 MHz frequency bands for a revision of this TSO. We removed from Appendix 1 of the draft TSO the corrections to the minimum operational performance standards of RTCA/DO-362 §§ 2.2.1.7 – 2.4.3.2.2.2.4 including § 2.4.3.1.6.1.1, and referenced DO-362 with Errata, which describes corrections to DO-362 §§ 2.2.1.7 – 2.4.3.2.2.2.4. DO-362 with Errata covers both L Band and C Band CNPC terrestrial Link Systems. Action: Added the following note to the beginning of Appendix 1: **Note:** Compatibility testing of the of the L Band, 1040-1080 and 1104-1150 MHz, CNPC Link Systems with the Tactical Air Navigation/Distance Measuring Equipment (TACAN / DME), Mode S, Automatic Dependent Surveillance – Broadcast system (ADS-B), and Traffic Collision Avoidance System (TCAS) is not yet complete. Therefore, this TSO does not authorize L Band, 1040-1080 and 1104-1150 MHz, CNPC Link System radios. Once we have completed L Band compatibility testing and analyzed the results, we will evaluate the 1040-1080 and 1104-1150 MHz frequency bands for a revision of this TSO.

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					Only the Errata to RTCA/DO-362 for C Band system radios are referenced by this TSO.