**3GPP TSG-RAN WG4 Meeting # 98-e R4-21xxxxx**

**Electronic Meeting, Jan. 25-Feb. 5, 2021**

**Agenda item:** 11.11.2 and 11.11.3

**Source:** Moderator (CMCC)

**Title:** Email discussion summary for [98e][313] NR\_Repeater\_RF

**Document for:** Information

# Introduction

RAN#90e approved a new “New WID on NR Repeaters” with RAN4 as the responsible WG, which includes development of FR1 FDD specifications as well as TDD specifications for FR1 and FR2. The scope of this email discussion focuses on RF core requirements, which is separated by radiated and conducted requirements, the same as the agenda for current meeting. As the first meeting, this email discussion aims to conclude which requirements could be defined for NR repeater and all the associated aspects would be listed for further study.

List of candidate target of email discussion for 1st round and 2nd round

* 1st round: discuss the open issues and strive to minimize the open issues
* 2nd round: according to 1st round discussion, discuss left open issues for 2nd round, and strive to minimize the open issues, and strive to approve WF.

# Topic #1: Common issues for conducted and radiated requirements

NR repeater classes are discussed in this thread.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2100376 | CATT | Proposal 1: NR repeater output power requirement follows LTE repeater output power approach including the ALC requirements, i.e. no class is defined.Proposal 2: For the NR repeater in FR1 FDD bands, we think following LTE FDD repeater requirements is ok.Proposal 3: TDD repeaters downlink Tx power requirements follow FDD repeaters’ requirements.Proposal 4: TDD repeater uplink requirements are be defined as following,Table 1: TDD Repeater uplink output power; normal conditions

|  |  |
| --- | --- |
| Rated output power | Limit |
| P ≤ 31 dBm | +3 dB and -3 dB |

Table 2: Repeater uplink output power; extreme conditions

|  |  |
| --- | --- |
| Rated output power | Limit |
| P ≤ 31 dBm | +4 dB and -4 dB |

Proposal 5: ALC requirement is defined for NR repeater for both FDD and TDD, the requirements are defined to follow LTE repeaters. |
| R4-2100378 | CATT | Proposal 1: EVM requirements for NR repeater downlink and uplink are defined as 6%. The proposal applies to both FR1 and FR2.Proposal 2: Frequency stability requirement for NR repeater reuse BS approach and define the requirement as ± 0.01 ppm. The proposal applies to both FR1 and FR2. |
| R4-2100828 | CMCC | Observation 1: NR repeater could be deployed inside the high-speed train to provide blanket inside coverage for UE in the high-speed train considering the large penetrate loss generated by carriages.Observation 2: There are two methods of defining repeater classes. One is IAB-like definition that using the terminologies in the set of MA/MR/LA with some modification and the other is LTE repeater-like definition that is based on manufactures declarations of the minimum donor couple loss for flexible deployment. Observation 3: IAB power related requirements include output power, output power dynamics and power control related requirements while LTE repeater only has the power accuracy requirements.Proposal 1: 1-C type is the only option for FDD repeater to reduce testing complexity.Proposal 2: TDD repeater is suggested to support all the four types 1-C, 1-O, 1-H, 2-O. Proposal 3: it is suggested to define MA/MR/LA classes for NR repeaters.Proposal 4: maximum output power limit should be designed to avoid harmful interference to neighbouring cells. |
| R4-2102109 | Ericsson | Observation 1: For wide area deployment scenarios and downlink transmission, the repeater specification applies the same approach as the BS specification.Observation 2: For downlink, unlike the BS specifications, the repeater does not ensure protection of other operators’ channels in other frequency layers for heterogeneous deployments of medium range/local area repeaters.Observation 3: Unlike the UE specification, the repeater specification does not regulate losses to victim networks due to receiver blocking and adjacent channel selectivity in neighbor networks. |
| R4-2102110 | Ericsson | Observation 1: Applying only the wide area OBUE mask in downlink means that repeaters create more adjacent channel interference than basestations by 2dB for Category B mask, 10dB for category B mask in 10MHz.Observation 2: Applying only the wide area OBUE mask in uplink can lead to performance degradation for adjacent operators, especially in regions where the category A mask is applicable. The UL ACLR degradation may be 17dB.Observation 3: If a relay would have 32dBm or lower power and meet the medium range BS OBUE then in downlink the same protection would be achieved as for a gNB. In UL, the UE spectrum emissions mask would be met, but adjacent channel power would still be 10dB greater than a UE meeting ACLR.Observation 4: A local area repeater meeting local area BS OBUE requirements would protect DL co-existence. In UL, adjacent channel emissions could be degraded by around 3dB or more.To avoid degradation of the co-existence performance, the following could be considered:• For repeaters in medium range and local area scenarios, the OBUE mask corresponding to those environments could be applied. This would reduce but not eliminate the ACLR degradation compared to BS• The repeater could be required to meet the BS absolute ACLR requirement of -13dBm/MHz. This would mostly eliminate the emissions increase in downlink, but not fully in uplink.• The repeater could be required to meet an adjacent channel emissions limit set by considering the ACLR for a PC3 UE (regardless of repeater power). This would eliminate the DL and UL emissions increase. |

## Open issues summary

Before the definition of RF conducted and radiated requirements, some common issues should be discussed at first, e.g. distinguishing repeater classes, about which there are several proposals that are discussed as below.

### Sub-topic 1-1

NR repeater class definition.

**Issue 1-1: Whether to explicitly distinguish repeater classes in the specification?**

* Proposals
	+ Option 1: Yes
		- Option 1-1: selection from the set of MA/MR/LA with some modification, if needed, e.g. similar as IAB-MT classes definition. (CMCC, Ericsson)
	+ Option 2: No class is defined. (CATT)
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | As discussed in our paper, for FR1 there are power limits for different classes, which is related to ensuring DL co-existence for heterogeneous network deployment. Also as pointed out by CMCC, if some kind of simple RX functionality is needed (to detect SSB for example) then RX sensitivity is class based. |
| ZTE | Issue 1-1:Fine with option 1 since maximum DL output power will have impact on co-channel coexistence |
| CMCC | we prefer option 1 to define MA/MR/LA cell scenarios for NR repeater, considering the more flexible deployment scenarios. |
| CATT | We propose no class definition but there would be some requirements differences for different output power capability as we shown in our contribution. If companies would like to open the class discussion, we would also be ok. But we’re not sure if repeater coverage will be the same as BS especially WA BS because the same output power for repeater as BS will need very high gain for repeater. That may not be feasible. The class definition discussion may finally be very similar with IAB-MT that the description is very general and not very useful for the deployment or requirements from my understanding. There’s no class definition for LTE repeater, I’m not very familiar with that discussion. But let’s see the future discussion for NR repeater. |
| Huawei | Class definitions affect only a few parameters, the issue here appears to be output power limitations and associated emissions masks. We are not against classes but are not sure they apply in the same way to repeaters as they do to BS. Repeater performance is limited by the available gain it can provide without oscillating, if this gain is limited then higher output power requires higher input power. For example existing repeater isolation estimates use 105dB, which means a max gain of 90dB. If a wide area power of >38dBm were required the input would need to be at least -52dBm, which is quite a big input signal? |
| Docomo | **Issue 1-1: Whether to explicitly distinguish repeater classes in the specification?**We are fine with Option 1. The assumption of each scenario for WA/MR/LA needs to be further discussed. |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Conducted requirements

NR repeater conducted related requirements are discussed in this thread, including transmit power related requirements, emission requirements and the others.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2100376 | CATT | Proposal 1: NR repeater output power requirement follows LTE repeater output power approach including the ALC requirements, i.e. no class is defined.Proposal 2: For the NR repeater in FR1 FDD bands, we think following LTE FDD repeater requirements is ok.Proposal 3: TDD repeaters downlink Tx power requirements follow FDD repeaters’ requirements.Proposal 4: TDD repeater uplink requirements are be defined as following,Table 1: TDD Repeater uplink output power; normal conditions

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| P ≤ 31 dBm | +4 dB and -4 dB |

Proposal 5: ALC requirement is defined for NR repeater for both FDD and TDD, the requirements are defined to follow LTE repeaters. |
| R4-2100377 | CATT | Observation: ACLR with NR adjacent channel may be omitted. ACLR with LTE adjacent channel needs some discussion for the decision.Proposal: Reuse BS operating band unwanted emissions and transmitter spurious emissions requirements for NR repeater. |
| R4-2100378 | CATT | Proposal 1: EVM requirements for NR repeater downlink and uplink are defined as 6%. The proposal applies to both FR1 and FR2.Proposal 2: Frequency stability requirement for NR repeater reuse BS approach and define the requirement as ± 0.01 ppm. The proposal applies to both FR1 and FR2. |
| R4-2100828 | CMCC | Observation 1: NR repeater could be deployed inside the high-speed train to provide blanket inside coverage for UE in the high-speed train considering the large penetrate loss generated by carriages.Observation 2: There are two methods of defining repeater classes. One is IAB-like definition that using the terminologies in the set of MA/MR/LA with some modification and the other is LTE repeater-like definition that is based on manufactures declarations of the minimum donor couple loss for flexible deployment. Observation 3: IAB power related requirements include output power, output power dynamics and power control related requirements while LTE repeater only has the power accuracy requirements.Proposal 1: 1-C type is the only option for FDD repeater to reduce testing complexity.Proposal 2: TDD repeater is suggested to support all the four types 1-C, 1-O, 1-H, 2-O. Proposal 3: it is suggested to define MA/MR/LA classes for NR repeaters.Proposal 4: maximum output power limit should be designed to avoid harmful interference to neighbouring cells. |
| R4-2100830 | CMCC | Proposal 1: we suggest to involve the following emission requirements for repeater as the start point. It is noted all the regulatory requirements of BS could be reused.* Transmitted signal quality, including Frequency error and EVM while IBE and EVM equalizer spectrum flatness requirements could be eliminated.
* Unwanted emissions, including ACPR, Out of band gain, Operating band unwanted emissions
* Transmitter spurious emissions, including mandatory requirements, Protection of the BS receiver of own or different BS, Additional spurious and Co-location requirements with other BS/repeaters
* output intermodulation
* input intermodulation
 |
| R4-2102109 | Ericsson | Conducted requirementsObservation 1: For wide area deployment scenarios and downlink transmission, the repeater specification applies the same approach as the BS specification.Observation 2: For downlink, unlike the BS specifications, the repeater does not ensure protection of other operators’ channels in other frequency layers for heterogeneous deployments of medium range/local area repeaters.Observation 3: Unlike the UE specification, the repeater specification does not regulate losses to victim networks due to receiver blocking and adjacent channel selectivity in neighbour networks. |
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| R4-2102111 | Ericsson | Observation 1: The requirement on frequency stability in the E-UTRA repeater specification is likely to be sufficientObservation 2: For the out of band gain requirement to be sufficient, the gain must be lower than the coupling loss to any radio transmitter from the repeater, not just the donor. Observation 3: The behavior of the repeater if it is situated close to another node that is transmitting on an adjacent channel should be further considered (it may amplify the signal from the adjacent channel node)Observation 4: The EVM definition in the E-UTRA repeater specification is not the same as the EVM defined in the BS and UE specifications.Observation 5: The EVM is probably not sufficient for 256QAM operation.Observation 6: The input intermodulation requirements cover UL passband repeat and co-existence/co-location to other bands and seem to be sufficient. Observation 7: The output intermodulation requirements in the E-UTRA repeater specification are sufficient.Observation 8: It is not obvious that an ACRR requirement is needed, but further consideration should be given to the behavior of the repeater if there is another node close by that either creates emissions on an adjacent channel or actually uses an adjacent channel.Observation 9: A TDD switching time requirement may be applicable for a repeater. |
| R4-2102418 | Huawei | Many of the requirements are the same or at least follow the same principle of using the BS limits. Requirements on emissions are broadly in line with the equivalent BS requirements, requirements limiting gain to prevent repeater oscillation are the same across all variants and would likely be similar for an NR repeater.There are a number of interesting requirements however which have implications on repeater design and possible implication of a NR TDD repeater:Frequency Stability: The allowable value is so small that any up/down conversion and demodulation seems improbable to implement.Modulation accuracy: The EVM requirement is assuming a “clean” input signal, the allocation to the repeater is hence added to the BS/UE EVM when considering the link. Current requirements are very high and possibly only suitable for QPSK or 16QAM links. For NR it is possible this value needs to be improved.Timing accuracy: As NR is considering TDD a similar timing accuracy requirement may be needed. The current requirement is based on the chip rate and only for low chip rate UTRA, this will need further study if it is applied to NR.In addition existing repeater variants are designed for networks which do not have AAS, whilst the repeater itself may not use AAS beam forming, the BS and UE it communicates between may, this should further be investigated. |
| R4-2102831 | Qualcomm Incorporated | This paper discusses some conducted requirements specified for LTE and comments on inclusion for NR FR1, including maximum output power for FR1, out of band gain, unwanted and spurious emissions, coexistence with co-located base stations, EVM, repeater gain control, repeater delay and frequency error.  |
| R4-2100635 | CommScope Technologies AG | Proposal: Adopt these requirements as necessary and sufficient for specifying the radio transmission and reception requirements for a NR repeater. |

## Open issues summary

As the first meeting, conducted requirements are discussed based on the legacy EUTRAN/UTRAN repeater specs with comments on inclusion in FR1 NR. There are several proposals that are listed below.

Agenda 11.11.2.

### Sub-topic 2-1

The principle for FR1 FDD and TDD

**Issue 2-1-1: the principle for defining NR FDD requirements**

* Proposals
	+ Option 1: Following LTE FDD repeater requirements is OK. (CATT)
	+ Option 2: at least the following requirements need further discussion
		- Option 2-1: EVM (Huawei)
		- Option 2-2: OBUE and whether there is a need to consider ACLR or something equivalent (Ericsson)
		- Option 2-3: maximum output power (Ericsson, CMCC)
		- Option 2-4: out of band gain
* Recommended WF
	+ NR FDD requirements could follow LTE FDD requirements. However, at least following requirements should be further discussed.
		- EVM, OBUE & adjacent channel emissions, maximum output power, out of band gain

**Issue 2-1-2: extra requirements only for TDD rather than FDD, following aspects could be taken into account:**

* Proposals
	+ Option 1: Time accuracy (Huawei)
	+ Option 2: TDD switching requirements (Ericsson)
	+ Option 3: REFSENSE (CMCC in R4-2100827)
	+ Option 4: transmit off requirements (CATT in R4-2100375)
	+ Option 5: transient period requirements (CATT in R4-2100375)
* Recommended WF
	+ Candidate TDD specific requirements for further discussion: time accuracy, TDD switching, REFSENSE, transmit off requirements and transient period requirements.
		1. Sub-topic 2-2

Output power related conducted requirements for both FDD and TDD.

**Issue 2-2-1: Whether/how to set maximum output power upper limits, following approaches could be taken into account:**

* Proposals
	+ Option 1: BS-like approach of constraining the maximum output power for MR and LA repeaters for coexistence in heterogeneous network deployment (CMCC, Ericsson)
	+ Option 2: Differentiating DL and UL with separate approaches (CATT)
		- power of Repeater not exceeding any UE power class defined in the band
		- LTE FDD-like approach based on manufacture’s declaration
* Recommended WF
	+ TBA

**Issue 2-2-2: whether to assume and/or set a requirement for fixed gain:**

* Proposals
	+ Option 1: for further study (Ericsson)
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 2-2-3: ALC/AGC capability is maintained or not?**

* Proposals
	+ Option 1: Yes, the requirements are defined to follow LTE repeaters. (CATT)
	+ Option 2: Yes, further discussion on how to regulate this requirement to ensure satisfactory radio link performance with following aspects
		- Option 2-1: Self-oscillation impact (Huawei, Qualcomm)
		- Option 2-2: AGC should be a slow adjustment compared to the symbol rates (Qualcomm)
* Recommended WF
	+ From moderator’s point of view, ALC and AGC play the same role. They are only the different names to regulate repeater’s gain control capability.
	+ ALC/AGC capability should be maintained with further discussion on how to regulate this requirement to ensure satisfactory radio link performance
		1. Sub-topic 2-3

Signal quality related requirements for both FDD and TDD, including EVM, frequency error.

**Issue 2-3-1: EVM definition, following aspects should be taken into account**

* Proposals
	+ Option 1: Whether/how to consider 256QAM? (Ericsson)
	+ Option 2: EVM needs to be improved taking both the extra noise in repeater and the received signal quality into consideration, (CATT 6%，Huawei)

$$EVM\_{total}=\sqrt{EVM\_{received\\_signal}^{2}+EVM\_{repeater}^{2}}$$

* + Option 3: Whether to define EVM in the same way as BS/UE specs (assuming channel estimation/equalization as defined in the spec at the TE) (Ericsson)
* Recommended WF
	+ TBA

**Issue 2-3-2: frequency error**

* Proposals
	+ Option 1: ±0.01ppm
	+ Option 2: TBA
* Recommended WF
	+ ±0.01ppm
		1. Sub-topic 2-4

Unwanted emission related conducted requirements including ACLR, OBUE, spurious emission, out of band gain, and ACRR for both FDD and TDD.

**Issue 2-4-1: ACLR definition, following aspects should be considered**

* Proposals
	+ Option 1: more stringent requirement for adjacent channel emission/absolute ACLR could be considered to avoid degradation of the co-existence performance. (Ericsson)
	+ Option 2: ACLR with NR adjacent channel may be omitted. ACLR with LTE adjacent channel needs some discussion for the decision. (CATT)
* Recommended WF
	+ TBA

**Issue 2-4-2: OBUE definition, following aspects should be considered**

* Proposals
	+ Option 1: follows BS specification for the appreciate requirements, following aspects should be considered. (CATT, Huawei, CMCC)
		- Option 1-1: whether including addition requirements, e.g.(DTT)
		- Option 1-2: whether including Protection of the BS receiver in the operating band requirements
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 2-4-3: spurious emission**

* Proposals
	+ Option 1: follows BS specification for the appreciate requirements, following aspects should be considered. (CATT, Huawei, CMCC)
		- Option 1-1: whether all the requirements of BS still apply for repeater, including the mandatory requirements, the coexistence with other system, the Protection of the BS receiver of own or different BS and the co-location with base stations
		- Option 1-2: Whether include all the classes or implicitly refer to one class. (CMCC)
* Recommended WF
	+ NR repeaters spurious requirements should follow BS specification for the appreciate requirements. Further discussion on whether to include all the spurious requirements for all classes.

**Issue 2-4-4: out of band gain, following aspects should be considered**

* Proposals
	+ Option 1: minimum coupling loss to donor BS (Huawei)
	+ Option 2: minimum coupling loss to any radio transmitter from the repeater, not just the donor (Ericsson)
* Recommended WF
	+ TBA

**Issue 2-4-5: ACRR requirements, following aspects should be considered**

* Proposals
	+ Option 1: the behaviour of the repeater if there is another node close by that either creates emissions on an adjacent channel or actually uses an adjacent channel. (Ericsson)
	+ Option 2: co-existence with UTRA/EUTRA rather than NR operating on an adjacent channel
* Recommended WF
	+ TBA
		1. Sub-topic 2-5

others

**Issue 2-5-1: output intermodulation**

* Proposals
	+ Option 1: Referring to BS Rx intermodulation requirements.
	+ Option 2: TBA
* Recommended WF
	+ The same requirements as BS Rx intermodulation could still apply for FR1 NR repeater

**Issue 2-5-2: input intermodulation, may cover following scenarios**

* Proposals
	+ Option 1: passband repeater. (Ericsson)
	+ Option 2: co-location repeaters. (Ericsson)
	+ Option 3: co-existence repeaters. (Ericsson)
* Recommended WF
	+ TBA

**Issue 2-5-3: whether include repeater delay requirements**

* Proposals
	+ Option 1: Further discussion is necessary. (Qualcomm)
	+ Option 2: TBA
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |

|  |  |
| --- | --- |
| Ericsson | **Issue 2-1-1: the principle for defining NR FDD requirements** The recommended WF seems OK; we should continue discussions on the mentioned requirements. We also point out in our contribution that EVM needs further discussion as the LTE repeater spec does not define EVM in the same way as BS and UE specs and also the value is out of date, so we agree that EVM needs consideration too.**Issue 2-2-1: Whether/how to set maximum output power upper limits, following approaches could be taken into account**We think CATT have a point that if the UL power exceeds UE power classes then there may be co-existence issues. There was some study of UL for IAB, but this was for TDD mid-bands and with beamforming rather than FDD low bands. **Issue 2-2-2: whether to assume and/or set a requirement for fixed gain:**The point here is whether it can be assumed that UE TX power control directly impacts repeater TX power or not.**Issue 2-3-1: EVM definition, following aspects should be taken into account**One additional consideration with EVM as well as the issues listed in options 1-3 is that the total EVM experienced at the receiver is additive. i.e., in downlink the TX EVM will be sqrt ( (BS EVM)^2 + (repeater EVM)^2). The total link EVM would be sqrt ( (BS EVM)^2 + (repeater EVM)^2 + (receiver EVM)^2)So if e.g. the repeater EVM would be 6% and the BS EVM 8% (64QAM) then the total TX EVM for both the BS trasnsmitter and repeater would be 10%.Same principles apply for UL.**Issue 2-3-2: frequency error**The proposed WF is OK**Issue 2-4-1: ACLR definition, following aspects should be considered** Regarding option 2; we don’t follow why the interference towards an LTE adjacent channel would need to be regulated with an ACLR like requirement but the interference towards an NR channel would not need to ?**Issue 2-4-3: spurious emission** One question here; since spurious emissions are related to regulation… is it clear that a repeater is treated like a BS from a regulatory point of view ?**Issue 2-4-4: out of band gain, following aspects should be considered**To clarify option 2; it is possible that there could be another transmitter closer to the repeater than the donor and the repeater could amplify it’s unwanted emissions. This would cause greater interference than amplifying the donor emissions. Of course it is not possible to know what is nearby for any deployment. What would be needed would be an assumption on minimum coupling loss. So should the assumed minimum coupling loss to another source of out of band emissions (that may be amplified) be based on the distance to the donor or something smaller ?**Issue 2-5-1: output intermodulation** For output intermodulation, shouldn’t the requirement be based on the BS **TX** intermodulation ? (i.e. for conducted, output power -30dB) ?**Issue 2-5-2: input intermodulation, may cover following scenarios**Actually our view is that the requirements defined for the LTE repeater cover scenarios relating to other network signals within the band, co-existence to other systems and co-location and so seem to be sufficient. |
| ZTE | **Issue 2-1-1: the principle for defining NR FDD requirements** Fine with recommended WF;**Issue 2-2-1: Whether/how to set maximum output power upper limits, following approaches could be taken into account**Both option 1 and option 2 should be considered as option 1 only considered DL, however uplink should also been considered.**Issue 2-2-2: whether to assume and/or set a requirement for fixed gain:**Option 1, need further study.**Issue 2-2-3: ALC/AGC capability is maintained or not?** Fine with recommended WF**Issue 2-3-1: EVM definition, following aspects should be taken into account** Option 2**Issue 2-3-2: frequency error**Fine with recommended WF.**Issue 2-4-1: ACLR definition, following aspects should be considered** Both option 1/2 could be considered in the future meeting, it’s not necessary to conclude at this meeting.**Issue 2-4-2: OBUE definition, following aspects should be considered** Option 1 to have more stringent requirement.**Issue 2-4-3: spurious emission**Fine with option 1**Issue 2-4-4: out of band gain, following aspects should be considered** Both option 1 and option 2 should be considered, however it’s difficult to identity the coupling loss between adjacent node and repeater.**Issue 2-4-5: ACRR requirements, following aspects should be considered** Both option 1 and option 2 should be considered,**Issue 2-5-1/2:****More study is needed.****Issue 2-5-3: whether include repeater delay requirements** |
| CMCC | Sub topic 2-1: Issue 2-1-1: we support option 2, NR FDD requirements could follow LTE FDD requirements. However, at least following requirements should be further discussed, including EVM, OBUE & adjacent channel emissions, maximum output power, out of band gainIssue 2-1-2: if in thread [312], It is agreed that the repeater could be aware of the DL/UL configuration, we suggest to include the REFSENSE for the baseband processor used to decode the control information.Sub topic 2-2:Issue 2-2-1: we suggest BS-like approach of constraining the maximum output power for MR and LA repeaters. It should be noted that if we limit the output power of repeater not exceeding any UE power class, the deployment scenarios would be limited.Issue 2-2-2: at first, it is noted that the repeater could perform with fixed gain only when the amplified output power is lower than the maximum output power limit. Once the output power is larger than the maximum limit, auto gain control could perform to make sure output power is lower than the limit. Before defining requirements for fixed gain, we should analyze the impact of repeater without fixed gain. For UL, this could make the received power at donor BS not equal to the target power. Therefore, requirement for fixed gain is necessary.Issue 2-2-3: ALC/AGC requirements should be regulated to avoid self-oscillation.Sub topic 2-3:Issue 2-3-1: we support option 2Issue 2-3-2: we support option 1Sub topic 2-4:Issue 2-4-1: we support option 1 and option 2.Issue 2-4-2: OBUE requirements could follow BS requirements, including addition requirements (option 1-1).Issue 2-4-3: spurious emission should be categorized by different class. Issue 2-4-4: option 2Issue 2-4-5: option 1Sub topic 2-5:Issue 2-5-1: option 1Issue 2-5-2: option 1, 2 and 3Issue 2-5-3: only for TDD not FDD |
| CATT | **Issue 2-1-1: the principle for defining NR FDD requirements** Ok with the recommended WF.**Issue 2-1-2: extra requirements only for TDD rather than FDD, following aspects could be taken into account:** Ok with the recommended WF.**Issue 2-2-1: Whether/how to set maximum output power upper limits, following approaches could be taken into account:**We proposed option 2 because there’s UL power restriction in WID. Maybe we need to align this understanding firstly to continue the discussion.**Issue 2-2-2: whether to assume and/or set a requirement for fixed gain:**We need more thinking on this.**Issue 2-2-3: ALC/AGC capability is maintained or not?** Ok with the recommended WF.**Issue 2-3-1: EVM definition, following aspects should be taken into account** Option 2.**Issue 2-3-2: frequency error** Support the recommended WF.**Issue 2-4-1: ACLR definition, following aspects should be considered** We provided option 2 to follow LTE FDD approach. The ACLR requirement may not be measured as the thermal noise floor after the repeater’s gain is higher than the ACLR noise. For LTE ACLR, actually we think it can also be omitted because the ACLR capability still can’t be measured.**Issue 2-4-2: OBUE definition, following aspects should be considered** Option 1.**Issue 2-4-3: spurious emission** Ok with the recommended WF.**Issue 2-4-5: ACRR requirements, following aspects should be considered** We may need some discussion if this capability can be measured or just define a relaxed requirement.**Issue 2-5-1 to Issue 2-5-3**Need more study. |
| Huawei | Issue 2-1-1: The recommended WF is ok, we should consider the highlighted requirements. Also it should be noted that if requirements begin to differ from the previous repeater scenarios then co-existence simulation may be needed to verify that network performance is not further degraded.Issue 2-1-2: Recommended WF is ok, we should further study timing requirementsIssue 2-2-1: Previous repeater simulation were done with repeater output power of 33dBm, we should consider a) what scenarios require more power, as the repeater gain is limited to ~90dB then increasing the output power does not improve the link only changes the optimum location for the repeater. b) if the repeater uses higher output power than previous simulations we should carry out co-existence with the new parameters.Issue 2-2-2: Existing repeaters have AGC to prevent oscillation during set up, this seems a necessary function also gain is reduced to prevent compression if the input power + gain exceeds the output power capability. The existing agc explicitly states it is slow so as not to interfere with the network power control so the repeater appears transparent, for an RF repeater this seems sufficient.Issue 2-2-3: This seems related to 2-2-2 but we are ok with recommended WF.Issue 2-3-1: Option 2 is ok, we need to decide how much degradation is acceptable to the link EVM and if it is possible to use for higher modulation orders (and what to do if it is not)Issue 2-3-2: Recommended WF okIssue 2-4-1: Its ok to consider both options, but repeaters are currently specified with an operating band and a passband, the passband is a concept unique to repeaters, outside the pass band it is expected the gain is lower, and OBUE are specified wrt the passband not the carrier. This distinction has not been discussed, if a similar approach is used for NR repeater we should consider ow it affects these discussions.Issue 2-4-2: The repeater should offer the same protection as other nodes, these should be included.Issue 2-4-3: As with 2-4-2 the repeater should not interfere with outer systems so these should be included.Issue 2-4-4: minimum coupling losses to adjacent systems should be considered but can only be used as deployment instruction as we have no way of knowing what real values will be. Loss to donor is of course consolable if the repeater is installed by operator.Issue 2-4-5: ACCR only currently applies for UTRA adjacent carriers so is perhaps not so relevant for NR. Option 1 is fine for studyIssue 2-5-1: This should be Tx intermodulation. That is effectively a co-location requirement with other systems in same band and of same class/Pout. It is perhaps arguable that a repeater would not be deployed in this scenario so we should discuss further. Issue 2-5-2: Not sure what the options really mean, but the 3 input intermodulation requirements are probably needed.Issue 2-5-3: Certainly needs more study, why are they not included in existing repeater requirements? Pulse timing has been discussed separately but delay could be a separate issue additional delay will be similar to UE’s being further away, this type of delay is relevant for FDD and TDD? |
| Docomo | **Issue 2-1-1: the principle for defining NR FDD requirements**We are OK with the recommended WF.**Issue 2-1-2: extra requirements only for TDD rather than FDD, following aspects could be taken into account:**Option 4 and 5 are needed for TDD requirements. OK with the recommended WF.**Issue 2-2-1: Whether/how to set maximum output power upper limits, following approaches could be taken into account:**We prefer Option 1.**Issue 2-2-2: whether to assume and/or set a requirement for fixed gain:**Option 1.**Issue 2-2-3: ALC/AGC capability is maintained or not?**As mentioned in recommended WF, in order to prevent self-oscillation, ALC capability is needed.**Issue 2-3-1: EVM definition, following aspects should be taken into account**We are fine with Option 1 and 2.**Issue 2-3-2: frequency error** OK with Option 1.**Issue 2-4-1: ACLR definition, following aspects should be considered**OK with Option 1. If RAN4 does not define ACLR requirements, then alternate tests are needed.**Issue 2-4-2: OBUE definition, following aspects should be considered** If RAN4 does not define ACLR requirements, Option 2 is preferable.**Issue 2-4-3: spurious emission** OK with the recommended WF.**Issue 2-5-1: output intermodulation**Output intermodulation should refer BS “Tx” intermodulation requirements. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
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|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
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### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

1. Topic #3: Radiated requirements

NR repeater radiated related requirements are discussed in this thread, including transmit power related requirements, emission requirements and the others.

It is noted that the topic about how to split the conducted and radiated requirements would be discussed in email discussion [312] NR\_repeater\_general rather than in [313] scope. Therefore, in [313], there is no assumption about the applicable frequency range for radiated requirements. Companies are suggested to indicate whether their comment is applicable for FR1, FR2 or both.

Agenda 11.11.3

* 1. Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2100377 | CATT | Observation: ACLR with NR adjacent channel may be omitted. ACLR with LTE adjacent channel needs some discussion for the decision.Proposal: Reuse BS operating band unwanted emissions and transmitter spurious emissions requirements for NR repeater. |
| R4-2100379 | CATT | Proposal 1: NR FR2 repeater Tx power requirements follow BS approach.Observation: The beam forming assumption of the received signal for FR2 Tx power requirement needs to be discussed.Proposal 2: No ALC requirement is defined for NR FR2 repeater. |
| R4-2100829 | CMCC | Observation 1: IAB power related requirements include radiated transmit power, output power, output power dynamics and power control related requirements, which are referred from both BS and UE requirements while LTE repeater has no radiated requirements.Observation 2: To achieve blanket coverage, both the network node, IAB and LTE repeaters are allowed to transmit power exceeding any UE classes. Proposal 1: Radiated transmit power requirement is required for blanket and reliable connection.Proposal 2: to achieve blanket coverage and avoid interference, it is reasonable to set maximum output power upper limit for repeater but not exceeding any UE power class seems too stringent. Proposal 3: repeater’s output power per connector and scaling factor should be redefined, if needed.Proposal 4: RE dynamic range, total dynamic range and UE power control requirements doesn’t apply for NR repeaters. |
| R4-2100831 | CMCC | Proposal 1: For FR1 OTA, we should focus on conducted requirement as the start point and then identify whether the same scaling factor of IAB could be reused. For FR2, new analysis is necessary for requirements except regulatory requirements. The following lists all the potential requirements for OTA emission requirements* Transmitted signal quality, including Frequency error, EVM
* Unwanted emissions, including ACPR, Out of band gain, Operating band unwanted emissions
* Transmitter spurious emissions
	+ including mandatory spurious, additional spurious, Co-location spurious with other BS/repeater for FR1
	+ including mandatory spurious and additional spurious for FR2
* output intermodulation
* input intermodulation
 |
| R4-2102112 | Ericsson | Radiated transmit power is considered in this contribution. |
| R4-2102113 | Ericsson | Radiated requirements:Observation 1: For repeaters with TX power in the range 31-39dBm, the ACLR is more stringent close to the carrier than the emissions mask.Observation 2: To provide the same amount of DL adjacent channel protection as a BS or IAB, a repeater must comply to at least the absolute BS ACLR requirement (with adjustment if the maximum power is >31dBm). |
| R4-2102114 | Ericsson | Radiated requirementsObservation 1: To avoid significant impact of the repeater to the link, the frequency error needs to be specified to be a fraction of the UE and BS frequency error.Observation 2: EVM should be based on either the definition in the BS or the UE spec. Further discussion should take place on whether the EVM should be aligned to 256QAM or 64QAM.Observation 3: No need for TX intermodulation requirements for FR2Observation 4: In place of receiver requirements, a requirement on out of carrier gain should be defined. This should be based on the UE blocking requirement level within the band and the BS out of band blocking levels for out of band.Observation 5: A requirement on input intermodulation should be created, with levels based on the BS RX intermodulation requirement. |

* 1. Open issues summary

As the first meeting, radiated requirements are discussed based on the legacy BS/IAB specs with comments on inclusion in NR radiated requirements. There are several proposals that are listed below*.*

* + 1. Sub-topic 3-1

*Beam related requirements:*

**Issue 3-1: beam related requirements, following aspects should be taken into account**

* Proposals
	+ Option 1: discussion in core requirements/ conformance test stages
	+ Option 2: Beam forming assumption of the received signals (CATT)
* Recommended WF
	+ TBA
		1. Sub-topic 3-2

*Output power related requirements:*

**Issue 3-2-1: Tx power**

* Proposals
	+ Option 1: following BS approach (CATT)
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 3-2-2: ALC requirements**

* Proposals
	+ Option 1: No ALC requirements (CATT)
	+ Option 2: TBA
* Recommended WF
	+ TBA
		1. Sub-topic 3-3

*Signal quality related requirements:*

**Issue 3-3-1: Frequency error requirements**

* Proposals
	+ Option 1: A fraction of the UE and the BS frequency error (Ericsson)
	+ Option 2: ± 0.01 ppm (CATT)
* Recommended WF
	+ TBA

**Issue 3-3-2: EVM, following aspects should be considered**

* Proposals
	+ Option 1: Based on BS or UE spec (Ericsson)
	+ Option 2: Aligned to 256 QAM or 64 QAM (Ericsson)
	+ Option 3: EVM equals to 6% (CATT)
* Recommended WF
	+ TBA
		1. Sub-topic 3-4

*Unwanted emission related requirements including OBUE and out of carrier gain:*

**Issue 3-4-1: emission including OBUE and spurious, considering the following aspects**

* Proposals
	+ Option 1: To provide the same amount of DL adjacent channel protection as a BS or IAB, a repeater must comply to at least the absolute BS ACLR requirement (with adjustment if the maximum power is >31dBm) (Ericsson)
	+ Option 2: Reuse BS operating band unwanted emissions and transmitter spurious emissions requirements for NR repeater. (CATT)
	+ Option 3: TBA
* Recommended WF
	+ TBA

**Issue 3-4-2: Out of carrier gain, considering the following aspects**

* Proposals
	+ Option 1: UE blocking requirement level within the band and the BS out of band blocking levels for out of band (Ericsson)
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 3-4-3: ACLR, considering the following aspects**

* Proposals
	+ Option 1: ACLR with NR adjacent channel may be omitted. ACLR with LTE adjacent channel needs some discussion for the decision. (CATT)
	+ Option 2: TBA
* Recommended WF
	+ TBA
		1. Sub-topic 3-5

*Others including Tx/output intermodulation requirements and input intermodulation:*

**Issue 3-5-1: Whether to define Tx/output intermodulation requirements**

* Proposals
	+ Option 1: No for FR2 (Ericsson)
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 3-5-2: whether/how to define input intermodulation, considering the following aspects**

* Proposals
	+ Option 1: based on the BS RX intermodulation requirement (Ericsson)
	+ Option 2: TBA
* Recommended WF
	+ TBA
	1. Companies views’ collection for 1st round

For radiated requirements, companies are suggested to indicate whether their comment is applicable for FR1, FR2 or both. If we resolve the question about the frequency range for radiated requirements in thread [312], then we could update afterwards.

* + 1. Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Issue 3-1: beam related requirements, following aspects should be taken into account**The scope of the WI excludes adaptive beamforming between the repeater and UE**Issue 3-3-1: Frequency error requirements**Option 2 is OK (for FR1 and FR2)**Issue 3-3-2: EVM, following aspects should be considered**Similarly to conducted, it is worth to bear in mind that the total TX EVM is the root square sum of both BS EVM and repeater EVM. So if e.g. the repeater EVM would be 6% and the BS EVM 8% (64QAM) then the total TX EVM for both the BS transmitter and repeater would be 10%.**Issue 3-4-1: emission including OBUE and spurious, considering the following aspects**Note that this proposal is only applicable for FR2. For FR1 there should also be a consideration that unless ACLR is considered in some way then adjacent channel protection may not be maintained only with OBUE, though.**Issue 3-4-2: Out of carrier gain, considering the following aspects**Note that the proposal is for FR2.**Issue 3-4-3: ACLR, considering the following aspects**For FR2, there is of course no LTE channel. We note in our contributions that if ACLR is not considered then in general the protection towards adjacent systems is not as good as BS and UE; in some cases by a significant amount.**Issue 3-5-1: Whether to define Tx/output intermodulation requirements**Requirements are needed for FR1.**Issue 3-5-2: whether/how to define input intermodulation, considering the following aspects**The proposal is for FR2. For FR1, a similar approach to the conducted should be adopted. |
| ZTE | **Issue 3-1: beam related requirements, following aspects should be taken into account**More study is needed.**Issue 3-2-1: Tx power**Similar as FR1 conducted, not only DL coexistence, but also uplink coexistence should be considered.**Issue 3-3-1: Frequency error requirements**Option 2 is fine**Issue 3-3-2: EVM, following aspects should be considered**Similar as conducted part.**Issue 3-4-1: emission including OBUE and spurious, considering the following aspects**Option 2 is more preferred, however as mentioned in the conducted part, UL emission should also been considered.**Issue 3-5-1: Whether to define Tx/output intermodulation requirements**This might be not needed for output intermodulation.**Issue 3-5-2: whether/how to define input intermodulation, considering the following aspects**Similar as BS RX intermodulation requirements |
| CMCC | Issue 3-1: option 2 for FR2Issue 3-2-1: Tx power should follow BS requirements for both FR1 and FR2Issue 3-2-2: ALC is necessary for FR1 and FR2Issue 3-3-1: option 2 for FR1 and FR2Issue 3-3-2: option 3 for FR1Issue 3-4-1: option 1 and 2 for both FR1 and FR2Issue 3-4-2: option 1 for both FR1 and FR2Issue 3-4-3: option 1 for both FR1 and FR2Issue 3-5-1: option 1 for FR2Issue 3-5-2: option 1 for both FR1 and FR2 |
| CATT | **Issue 3-1: beam related requirements, following aspects should be taken into account**We see some aspects such as option 2, but that may not be the only aspect we need to consider. We need to be clear that the defined the requirements are reasonable then discuss the test details in the test stage.**Issue 3-2-1: Tx power**As the BS radiated Tx output power is based on declaration, we think option 1 should be ok.**Issue 3-2-2: ALC requirements**We still think ALC may not be needed for FR2, but it’s the first meeting to discuss this. We can decide it in future meetings.**Issue 3-3-1: Frequency error requirements**Option 2.**Issue 3-3-2: EVM, following aspects should be considered**Option 3 which is the same as FR1.**Issue 3-4-1: emission including OBUE and spurious, considering the following aspects**Option 2.**Issue 3-4-2: Out of carrier gain, considering the following aspects**Need more study.**Issue 3-4-3: ACLR, considering the following aspects**Our proposal applies to both FR1 and FR2. As Ericsson commented, no LTE adjacent channel for FR2. So just no ACLR is defined for FR2. |
| Huawei | Issue 3-1: The WI excludes repeater to UE beam forming, it is possible that the “UE side” coverage could be adaptable without being UE specific beam forming. The same could apply to the “BS side”. However deployment and isolation to prevent repeater oscillation are very important things, if the antennas pattern is adaptable then it would have to be checked for isolation under all conditions. This may not be a good approach.Issue 3-2-1: Similar issue was discussed for conducted, performance is dominated by gain which is in turn dominate by isolation rather than just output power. Output power will change the optimum location for the repeater but not necessarily the link budget. The optimum power for FR2 should be discussed further along with any possible need for co-existence simulationsIssue 3-2-2: ALC as defined in current repeater spec is to prevent oscillation (depending on deployment isolation) and compression, as such it seems it is also necessary for OTA/FR2Issue 3-3-1: option 2 is okIssue 3-3-2: As with conducted the EVM link budget should be considered and possible performance and capability should be considered.Issue 3-4-1: option 2 seems ok, Issue 3-4-2: need to study furtherIssue 3-4-3: probably ok for FR2Issue 3-5-1: option 1 okIssue 3-5-2: option 1 ok |
| Docomo | **Issue 3-1: beam related requirements, following aspects should be taken into account**Based on the scope of the WID, adaptive beamforming between UE and repeater is excluded, but it needs to be further discussed on beam related requirements between BS and repeater.**Issue 3-2-1: Tx power**OK with Option 1.**Issue 3-2-2: ALC requirements**As mentioned in conducted part, ALC function is needed.**Issue 3-3-1: Frequency error requirements**Option 2.**Issue 3-3-2: EVM, following aspects should be considered**Similar as conducted part.**Issue 3-4-1: emission including OBUE and spurious, considering the following aspects**OK with both of Option 1 and Option 2.**Issue 3-4-3: ACLR, considering the following aspects**Some criteria for ACLR is needed. If it is difficult to measure ACLR, alternative test requirement should be considered.**Issue 3-5-1: Whether to define Tx/output intermodulation requirements**OK with Option 1.**Issue 3-5-2: whether/how to define input intermodulation, considering the following aspects**OK with Option 1. |

* + 1. CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
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| YYY | Company A |
| Company B |
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* 1. Summary for 1st round
		1. Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
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|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

* + 1. CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

* 1. Discussion on 2nd round (if applicable)
	2. Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |