**3GPP TSG-RAN WG4 Meeting #94-e R4-20xxxxx**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.7.3 & 8.7.3.1

**Source:** CATT

**Title:** Email discussion summary for RAN4#94e\_ #55\_NR\_UE\_pow\_sav\_RRM

**Document for:** Information

# Introduction

The documents in agenda items 8.7.3 and 8.7.3.1 contains the following topic and sub-topics under the topic:

* Topic #1: RRM measurement relaxation (AI 8.7.3.1)
  + RRM measurement relaxation
  + EMR impact in power saving mode
  + RRM impact due to cross-slot scheduling power saving technique
* Topic #2: Impact on demod requirement due to MIMO layer adaption

# Topic #1: RRM measurement relaxation

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000152 | Vivo | Proposal 1: Use option 1 for scenario 1 and 2  Proposal 2: Consider a scaling factor 6 to extend measurement interval when UE is at power saving mode.  Proposal 3: RRM relaxation on different inter frequency layers could be treated separately  Proposal 4: Reducing number of inter frequency layers is not considered within this WI  Proposal 5: Following current logic in specification, applying same measurement requirement (either at relaxed mode or normal mode) for all inter frequency layer, no matter its priority when Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ. |
| R4-2000157 | Vivo | **ACTION:** RAN4 kindly asks RAN2 to investigate the possibility of introducing thresholds particularly for inter-frequency RRM measurement relaxation for UE power saving purpose. |
| R4-2000157 | Vivo | Observation 1: No matter how TdeltasearchP and SdeltasearchP are configured, ‘low-mobility’ criterion is not able to precisely differentiate whether the handheld UE is actually in low-mobility or not.  Observation 2: If option 2 is adopted for ‘low-mobility’ scenario, there is some risk in UE paging reception and access ability after a valid paging, if power saving gain needs to be ensured.  Observation 3: Due to grip, gesture, random rotation and body shadowing, the RSRP fluctuation of handheld UEs is much more severe than that of NB-IoT UEs.  Observation 4: For ‘not-at-cell-edge’ scenario, if SintrasearchP and/or SnonintrasearchP are configured as more than 20dB, there is room and power saving gain for the second level RSRP thresholds. |
| R4-2000575 | CATT | Proposal 1: For scenario #1 and #2, option1 is proposed to define RRM measurement relaxation for UE power saving in NR.  Proposal 2: If the measurement relaxation criteria are met, the measurement period can be extended to 4 times to achieve power saving gain.  Proposal 3: When Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, if the relaxation criterions are fulfilled, no relaxation of the current measurement delay requirement is expected for inter-frequency measurement with higher priority.  Proposal 4: When Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, if the relaxation criterions are fulfilled, the relaxed requirement for the frequency layer of higher priority shall have the same Tmeasure,NR\_Inter\_relax as those for the frequency layer of equal/lower priority.  Proposal 5: Reducing the number of carriers to be measured cannot save power consumption.  Proposal 6: For overlapping carriers, it is up to UE implementation whether to relax RRM measurement for fast CA/DC setup.  Proposal 7: For non-overlapping carriers, there is no impact on EMR in power saving mode.  Proposal 8: When UE receives DCI command with the configuration of cross-slot scheduling and active BWP switch, the active BWP switch delay should be Max(TBWPswitchDelay, K0/K2), where K0/K2 is the configured scheduling offset for cross-slot scheduling.  Proposal 9: When UE receives DCI command with the configuration of cross-slot scheduling and TCI state switch, the TCI state switch delay should be Max(*timeDurationForQCL*, K0/K2), where K0/K2 is the configured scheduling offset for cross-slot scheduling. |
| R4-2000642 | CMCC | Proposal 1: It is proposed to adopt option 1 for scenario 1 and scenario 2 for RRM measurement relaxation  Proposal 2: It is proposed that the delay requirements in scenario 1 and 2 can be extended by 2 times for RRM measurement relaxation.  Proposal 3: It is proposed that UE is not allowed to relax the RRM measurement requirement for inter-frequency measurement with higher priority.  Proposal 4: if reducing number of frequency layer is considered in idle/inactive mode, it is proposed that UE only measure one carrier in each band. |
| R4-2000963 | LG Electronics Inc. | ***Proposal 1***: Define single relaxation method for scenario#1 and #2.  ***Proposal 2***: Use option 1 for scenario#1 and #2 to guarantee UE mobility  ***Observation 1***: Applying measurement relaxation to all neighbour cells or frequency layers could degrade UE mobility performance.  ***Observation 2***: The EMR frequency layer should be excluded from frequency layers using relaxed measurement mode.  ***Proposal 3***: Per-carrier based measurement relaxation should be considered to avoid UE mobility performance and EMR for power saving. |
| R4-2000989 | OPPO | Proposal 1: Do not introduce RRM measurement relaxation by reducing the number of frequency layer to be measured.  Proposal 2: Support Option 1 that RRM measurement by relaxing measurements period with longer intervals for UE power saving for all scenarios.  Proposal 3: Define a fixed scaling factor by N for RRM measurements with longer intervals for UE power saving in RRC\_idle/inactive state, e.g., N=2. |
| R4-2001343 | Nokia, Nokia Shanghai Bell | 1. RAN4 defines requirements for UE relaxation of UE measurements and reduction of the number of carriers the UE is required to monitor under the power saving WI. 2. Regard the option that UE is not required to meet the intra-frequency and inter-frequency neighbor cell measurement requirements as a special case of relaxed measurements. 3. Introduce RSRP/RSRQ serving cell measurement accuracy requirements for idle and inactive modes. 4. Option 3 can be applied for inter-frequency measurements, if Low Mobility and Not at Cell Edge conditions are fulfilled. 5. Option 3 can be applied for inter-frequency measurements if Not at Cell Edge condition is fulfilled. 6. Option 4 can be applied for inter-frequency measurement, if Low Mobility condition is fulfilled. 7. Option 5 can be applied for intra-frequency measurements for all power saving conditions. 8. UE power saving solution shall include a solution for flexible relaxation of UE inter-frequency measurements. 9. Introduce carrier specific search thresholds to facilitate better UE power savings. 10. Measurements on EMR carriers should not be relaxed if T331 is running. |
| R4-2001344 | Nokia, Nokia Shanghai Bell | **ACTION:** RAN4 kindly requests RAN2 to introduce carrier specific inter-frequency/RAT measurement search thresholds. |
| R4-2001654 | Huawei, HiSilicon | Proposal 1: UE is required to meet the relaxation measurement including serving cell and neighbour cells for scenario #1 and #2.  Proposal 2: The extension factor for relaxed measurement can be configured by network for scenario #1 and #2.  Proposal 3: Reducing the inter-frequency layers for measurement in idle mode can not bring power saving gain.  Proposal 4: In scenario #1 and #2, the measurement result derived from relaxation measurement can still be applied in EMR.  Proposal 5: In scenario #3, when UE is configured with EMR, UE will perform relaxation measurements. |
| R4-2001753 | Ericsson | **Observation:** The existing NR-DC interruption requirements related to DRX transitions, between active and non-active, and from non-DRX to DRX, can be reused when secondary DRX group is applied in NR CA operation involving FR1 and FR2. |
| R4-2001753 | Ericsson | **ACTION:** RAN4 respectfully asks RAN2 to take the above information into consideration in future work. |
| R4-2001754 | Ericsson | **Proposal #1:** UEs operating in scenarios 1 and 2 are not required to meet the existing intra-frequency and inter-frequency neighbour cell measurement requirements.  **Proposal #2:** If option 1 is selected, UEs operating in scenario 2 are less relaxed than in scenario 1 due to its high mobility.  **Observation #1:** Existing procedures already contains tools to configure the number of frequency layers to be measured.  **Proposal #3:** RAN4 shall not define new requirements for reducing the number of frequency layers to be measured.  **Proposal #4:** Measurements of higher priority carriers shall not be relaxed in high mobility scenarios (scenario #2).  **Proposal #5:** No RRM impact due to cross-slot scheduling using K0/K1 are received within the 1st three symbols. |
| R4-2001794 | MediaTek | Proposal 1: RAN4 to discuss the performance matrices and simulation assumptions that can be used to evaluate the scaling value of RRM measurement relaxation in IDLE mode, e.g., re-selection delay or serving cell quality before UE conducts the re-selection.  Observation 1: Power consumption per unit time will not be changed when number of frequency layer to be measured is reduced.  Proposal 2: For UE who supports both the IDLE mode RRM relaxation and EMR, UE shall also be allowed to relax the measurement period of the EMR carriers. |
| R4-2002137 | Qualcomm | Observation 1: Since UE must always monitor serving cell quality, there should not be any issue if UE stops performing intra-frequency and inter-frequency neighbour measurements if its mobility is low.  Proposal 1: Select option 2 for scenario #1, i.e., low mobility scenario. Select option 1 for scenario #2, i.e., away from cell edge and high mobility scenario.  Proposal 2: UE is not allowed to relax or enter any relaxed measurement modes, e.g. option 1 or option 2, if UE is configured with early measurement reporting (EMR) and T331 timer is running. |

## Open issues summary

### RRM measurement relaxation

**Issue 1-1: RRM measurement relaxation for scenario#1(Low mobility scenario)**

* Option 1: RRM measurement relaxation with longer intervals (Vivo, CATT, CMCC, LGE, OPPO, Huawei, Nokia)
* Option 2: UE is not required to meet the intra-frequency and inter-frequency measurement requirements (Ericsson, Qualcomm)
* Recommended WF
  + Agree option 1

**Issue 1-2: If option 1 agreed, how to extend the measurement interval for scenario#1?**

* Option 1: 2 times (CMCC, OPPO)
* Option 2: 4 times (CATT)
* Option 3: 6 times (Vivo)
* Option 4: Up to network configuration (Huawei)
* Option 5: System level simulation (MediaTek)
* Recommended WF
  + Need more discussion

**Issue 1-3: RRM measurement relaxation for scenario#2 (Not in cell-edge scenario)**

* Option 1: RRM measurement relaxation with longer intervals (Vivo, CATT, CMCC, LGE, OPPO, Huawei, Qualcomm)
* Option 1a: For intra-frequency measurement: option 1; for inter-frequency measurement: option 2 (Nokia)
* Option 2: UE is not required to meet the intra-frequency and inter-frequency measurement requirements (Ericsson)
* Recommended WF
  + Agree option 1

**Issue 1-4: If option 1 agreed, how to extend the measurement interval for scenario#2?**

* Option 1: 2 times (CMCC, OPPO)
* Option 2: 4 times (CATT)
* Option 3: 6 times (Vivo)
* Option 4: Up to network configuration (Huawei)
* Option 5: System level simulation (MediaTek)
* Recommended WF
  + Need more discussion

**Issue 1-5: RRM measurement relaxation threshold for inter-frequency measurement**

* Option 1: Introduce carrier specific search thresholds for measurement relaxation (Vivo, Nokia, LGE)
* Option 2: Up to RAN2’s decision (CATT)
* Recommended WF
  + Need more discussion

**Issue 1-6: RRM measurement relaxation for inter-frequency layer with higher priority**

* Option 1:
  + Option 1a (CATT, vivo, CMCC)
    - When Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, no relaxation of the current measurement delay requirement is expected for inter-frequency measurement with higher priority.
  + Option 1b (CATT, vivo)
    - When Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, if the relaxation criterions are fulfilled, the relaxed requirement for the frequency layer of higher priority shall use the same relaxed measurement requirement as those for the frequency layer of equal/lower priority.
* Option 2: Measurements of higher priority carriers shall not be relaxed in high mobility scenarios (scenario #2) (Ericsson)
* Recommended WF
  + Need more discussion

**Issue 1-7: RRM measurement relaxation by reducing the number of frequency layer to be measured**

* Option 1: Do not introduce RRM measurement relaxation by reducing the number of frequency layer to be measured. (Vivo, CATT, OPPO, Huawei, Ericsson, MediaTek)
  + Reducing number of inter frequency layers is not considered within this WI (Vivo)
  + Reducing the number of carriers to be measured cannot save power consumption (CATT)
  + Do not introduce RRM measurement relaxation by reducing the number of frequency layer to be measured. (OPPO)
  + Reducing the inter-frequency layers for measurement in idle mode can not bring power saving gain. (Huawei)
  + RAN4 shall not define new requirements for reducing the number of frequency layers to be measured. (Ericsson)
  + Power consumption per unit time will not be changed when number of frequency layer to be measured is reduced. (MediaTek)
* Option 2: if reducing number of frequency layer is considered in idle/inactive mode, it is proposed that UE only measure one carrier in each band. (CMCC)
* Option 3: RAN4 defines requirements for UE relaxation of UE measurements and reduction of the number of carriers the UE is required to monitor under the power saving WI. (Nokia)
* Recommended WF
  + Agree option 1.

### EMR impact in power saving mode

**Issue 2-1: EMR impact in power saving mode**

* Option 1: Whether EMR frequency layer shall be relaxed or not is up to UE’s implementation. (CATT)
  + For overlapping carriers, it is up to UE implementation whether to relax RRM measurement for fast CA/DC setup, for non-overlapping carriers, there is no impact on EMR in power saving mode.
* Option 2: EMR frequency layer shall not be relaxed. (LGE, Nokia, Qualcomm)
  + The EMR frequency layer should be excluded from frequency layers using relaxed measurement mode. (LGE)
  + Measurements on EMR carriers should not be relaxed if T331 is running. (Nokia)
  + UE is not allowed to relax or enter any relaxed measurement modes, e.g. option 1 or option 2, if UE is configured with early measurement reporting (EMR) and T331 timer is running. (Qualcomm)
* Option 3: EMR frequency layer shall be relaxed. (Huawei, MediaTek)
  + In scenario #1 and #2, the measurement result derived from relaxation measurement can still be applied in EMR. In scenario #3, when UE is configured with EMR, UE will perform relaxation measurements. (Huawei)
  + For UE who supports both the IDLE mode RRM relaxation and EMR, UE shall also be allowed to relax the measurement period of the EMR carriers. (MediaTek)
* Recommended WF
  + Need more discussion

### RRM impact due to cross-slot scheduling power saving technique

**Issue 3-1: RRM impact due to cross-slot scheduling power saving technique**

* Option 1: have RRM impact on DCI based delay requirement. (CATT)
  + When UE receives DCI command with the configuration of cross-slot scheduling and active BWP switch, the active BWP switch delay should be Max(TBWPswitchDelay, K0/K2), where K0/K2 is the configured scheduling offset for cross-slot scheduling.
  + When UE receives DCI command with the configuration of cross-slot scheduling and TCI state switch, the TCI state switch delay should be Max(timeDurationForQCL, K0/K2), where K0/K2 is the scheduling offset for cross-slot scheduling.
* Option 2: no RRM impact (Ericsson)
* Recommended WF
  + Need more discussion

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| CATT | Sub topic 2.2.1: RRM measurement relaxation  Issue 1-1: Support option1  Mobility performance is one of important aspect which should be considered for NR UEs. In some case, NR UEs in power saving mode may enter normal mode, UE can use the neighbor cell measurement measured during power saving mode for potential cell reselection. If UEs drop the neighbor cell measurement during power saving mode, the mobility performance will not be guaranteed when UEs enter from power saving mode to normal mode.  Issue 1-2: 4 times  4 times is proposed based on the outcome of evaluation captured in 38.840. Since in SI phase, the similar system level evaluation has been carried out by RAN1, so there is no need to have another system level simulation. In addition, there is no time to have system level simulation.  Issue 1-3: Support option1  The same reason as issue 1-1.  Issue 1-4: 4 times  The same reason as issue 1-2.  Issue 1-5: Up to RAN2’s decision  We think it is RAN2’s job, RAN4 can discuss and analysis whether there is power saving gain can be achieved by reducing frequency carrier to be measured, but cannot decide to introduce the carrier specific threshold for inter-frequency measurement.  Issue 1-6: Support option 1.  In good coverage, the higher priority frequency measurements are already at their lowest rate, i.e. every 60s for each frequency layer. And the power saving gain is limit to further relax the measurement interval from 60s to a larger value. Thus, there is no relaxation for the higher priority frequency layers.  In bad coverage case, since in Rel-15 legacy requirement, the measurement delay requirement for higher, equal and lower frequency layer are the same. So, in relaxation mode, we think the same relaxed requirements shall be have for higher, equal and lower frequency layer.  Issue 1-6: Support option 1.  Since the measurement requirements for inter-frequency layer are scaling with the number of carriers configured to be measured. And the UE power will not be increased with the same measurement interval for multiple carriers.  Sub topic 2.2.2: EMR impact in power saving mode  Issue 2-1: Support option 1.  Whether UE is allowed to enter power saving mode is up to UE implementation. According to the running CR 38.304, the UE may relax choose to perform relaxed measurements if RRM measurement relaxation criterion is met. It is not mandatory. Thus, it is up to UE implementation whether to relax RRM measurement for fast CA/DC setup. If the UE wants to achieve fast CA/DC setup, it will not relax RRM measurement for early measurement reporting. Otherwise, it can relax RRM measurement for power saving.  Sub topic 2.2.3: RRM impact due to cross-slot scheduling power saving technique  Issue 3-1: Support option 1.  Since the DCI decoding time can be longer to be parsed for power saving purpose, and the DCI decoding time is one part of delay requirements for BWP switching and TCI state switching. So the configurable value of K0/K2 will impact DCI based delay requirements, i.e. DCI based BWP switching delay and DCI based TCI switching delay. |

### 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.*

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

*Recommendations on WF/LS assignment*

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| --- | --- | --- |
|  | **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*

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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”* |

# Topic #2: Impact on demod requirement due to MIMO layer adaption

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000787 | Apple | **Proposal 1:** reuse the existing delay and interruption requirements of legacy BWP switching to case 2 (Only the number of maximum MIMO layer is changed in the BWP before and after MIMO layer adaption).  **Proposal 2:** RAN4 shall consider whether UE still needs to meet 4Rx demod requirement on those 4Rx-mandated bands when network configures the max\_MIMO\_layer\_num=2 to UE for power saving.  In our understanding, there might be three options to address this issue from standardization perspective,  **Option 1:** Add applicability for demod requirement to state that 4Rx demod requirement is not applicable for UE with max\_MIMO\_layer\_num =2; and so does the test case  **Option 2:** set the max\_MIMO\_layer\_num =4 in the all related test cases applied for 4Rx-mandated bands  **Option 3:** Do not recommend this max MIMO layer adaptation feature for power saving and still make 4Rx demod requirements applicable in all the cases irrespective of the configured number of MIMO layers. |

## Open issues summary

### Impact on demod requirement due to MIMO layer adaption

**Issue 1-1: Impact on 4Rx demod requirement due to MIMO layer adaption feature**

* Proposal from Apple:

RAN4 shall consider whether UE still needs to meet 4Rx demod requirement on those 4Rx-mandated bands when network configures the max\_MIMO\_layer\_num=2 to UE for power saving.

In our understanding, there might be three options to address this issue from standardization perspective,

* + Option 1: Add applicability for demod requirement to state that 4Rx demod requirement is not applicable for UE with max\_MIMO\_layer\_num =2; and so does the test case
  + Option 2: set the max\_MIMO\_layer\_num =4 in the all related test cases applied for 4Rx-mandated bands
  + Option 3: Do not recommend this max MIMO layer adaptation feature for power saving and still make 4Rx demod requirements applicable in all the cases irrespective of the configured number of MIMO layers.

We are open to discuss the above options or others to make the max MIMO layer adaptation feature useful in power saving scope.

* Recommended WF
  + Need more discussion

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 3.2.1: Impact on demod requirement due to MIMO layer adaption  Since this issue related to demod discussion, so it can be deferred to next meeting. |

### 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.*

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

*Recommendations on WF/LS assignment*

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|  | **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*

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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”* |