



Reference material

Advanced train control Migration System (AMS) Specifications – Virtual Balise Cover Design Guideline

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AMS PROJECT SPECIFICATIONS

VIRTUAL BALISE COVER DESIGN GUIDELINE

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Foreword

This guideline forms a part of the TfNSW suite of railway signalling guidelines which detail the requirements for the implementation of ATP / AMS on the NSW rail network. This guideline specifically covers AMS Virtual Balise Cover function to allow commissioning of large areas, as part of the initial rollout plan, without affecting the operation of running trains equipped with on-board ETCS equipment active.

To gain a complete overview of ATP / AMS signalling design requirements, this document should be read in conjunction with the AMS suite of signalling design principle modules.

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1. Introduction

1.1. AMS Background

The ATP program was previously deploying a European Train Control System (ETCS) Level 1 'Full Supervision' system over the Transport network through various approval package rollouts.

In the Level 1 'Full Supervision' (FS) system all signals were to be fitted with an LEU and a balise group.

The ATP Program is now deploying the 'Advanced train control Migration System' (AMS) with the intent of facilitating accelerated trackside deployment, the fitment of additional rolling stock and the realisation of earlier safety benefits. AMS is essentially an ETCS Level 1 'Limited Supervision' (LS) system providing ceiling speed supervision and targeting high risk areas of the network e.g. signals without mechanical train stops, high risk junctions and buffer stops.

1.2. Purpose

This document describes the design process to deploy the VBC function in the project as part of the strategy to stage the commissioning of the ETCS equipped areas. It should be noted that this notion of staged commissioning implies that the strategy to commission the areas must be an input for the design for each defined phase or stage. The design proposed in this document considers the current ATP project approach to commissioning and ensures the required installation, testing and revenue service can be performed as planned.

Note that using the VBC function to update or modify an existing L1 area after the AMS rollout is out of the scope of this document. Future modifications to the areas will have to be studied case by case to determine the best solution according to the extension and complexity of the intended changes.

1.3. Application

This document applies to AEOs engaged to carry out signal design for new works.

2. Reference documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

AMS Project Specifications

[REF1] Trackside Sub-System Requirements Specifications DS#4250596

[REF2] System Requirements Specification, DS#4105522

[REF3]ERTMS/ETCS, SUBSET-026 v3.4.0- System Requirements Specification

3. Terms and definitions

The following terms and definitions apply in this document:

AEO Authorised engineering organisation; means a legal entity (which may include a Transport Agency as applicable) to whom the ASA has issued an ASA Authorisation

AMS Advanced train control Migration System

ASA Asset Standards Authority

ATP Automatic Train Protection; a system which supervises train speed and target speed, alerts the driver of the braking requirement, and enforces braking when necessary. The system may be intermittent, semi-continuous or continuous according to its track-to-train transmission updating characteristics.

BG Balise Group

ETCS European Train Control System; a four level, unified, modular automatic train protection specification to enhance interoperability across Europe

ERA European Railway Agency

LS Limited Supervision

LT Level Transition

SBI Service Break Intervention

T&C Test and Commissioning

TfNSW Transport for New South Wales

TSW Temporary Speed Warning

UN Unfitted

VBC Virtual Balise Cover

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4. Concept

As stated in the project requirements (AMS_SRS_154 in [REF2]) the on-board ETCS shall inhibit the information received from trackside areas not yet commissioned. Trackside equipment (balises) installed in areas not yet commissioned must not affect the running of trains with an active ETCS.

The rollout plan for the AMS project foresees the gradual commissioning of network areas, meaning that AMS areas in service will coexist with not yet commissioned areas, and ETCS equipped trains will run across them switching between L1 and L0 as required. The Virtual Balise Cover (VBC) is the standard ERA function (see [REF3]) used to allow the installation and commissioning of large sections of the network, without interfering with the on-board, complying with the requirement before mentioned.

The overall strategy to deploy the VBC function can be summarized as follows:

- Define VBC identities for all balises as part of the design.
- Store on-board VBC's for every train entering an area not yet commissioned. This will allow the trains to inhibit any information received from balises with a determined VBC identity.
- Delete on-board VBC's for every train entering a commissioned area. This will ensure the information from the defined VBC identity is no longer inhibited.

Storing and deleting VBC's on board is achieved by specific trackside equipment or configurations that transmit the appropriate order (set order / remove order).

This strategy implies the need for temporary stages or intermediate trackside designs. As the intention is for a staged trackside approach, trains will pass from commissioned areas into yet to be commissioned areas (and vice versa) during normal operations. Each stage will require a specific trackside and data design in relation to VBC functionality in order to maintain existing operation until the new area is commissioned. It should be noted that for each stage of the project, other functions such as level transitions will also need to be considered.

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5. VBC Identity

This chapter establishes the rules applied to define the VBC marker and region identity that constitute the VBC identity.

5.1. VBC country/region identity (NID_C)

A single country/region identity shall be used over the network. This single NID_C shall be set to 540.

([REF1]).

No further analysis is added on NID_C management since only one country/region code is foreseen in the AMS project.

Since only one country/region identity is considered (NID_C), VBC identities and VBC markers (NID_VBCMK) are the same. This document will refer indistinctively to VBC identities and VBC markers.

5.2. VBC marker (NID_VBCMK)

All balises shall be configured with a VBC Marker (packet #0) except for:

- Track Condition BMM in level 0
- TSW
- BG installed at yard exits to remove default VBC marker (refer to 9.1)

In these three exceptions no packet #0 shall be defined (no VBC identity defined) to ensure they cannot be inhibited by a stored VBC on board. As a reminder, BG's sending track conditions for BMM in any area operated in L0 shall be commissioned before the first AMS area is in service, or at least before a train with an on-board ETCS active runs in that particular area. BG's installed at yard exits are an additional mitigation measure to ensure that trains in passenger service do not leave the yard with a VBC stored.

The value of the default VBC marker shall be "1" (the value was chosen arbitrarily). It is important that a unique value is used across the AMS network to simplify the VBC management in the commissioning phase and any future modifications.

Note that packet #0 shall be defined in each of the balises of a BG.

A testing VBC marker may be defined for temporary balises to allow functional tests on areas not yet commissioned. The value of this marker shall be “63”. The use of this marker is further detailed in the following chapters. After the revenue service of all areas in the network (rollout completed) no testing marker shall remain in the configuration of trackside equipment.

6. VBC Order BG

VBC order refers to the transmission of packet #6 from a balise as defined in [REF3]. Within this package three parameters are defined:

- VBC identity (as defined in the previous section)
- Set or remove qualifier (order)
- Validity period

Transmission of packet #6 package orders the on-board to store (or delete) the specified VBC identity for the specified time. Note that the balises of the BG transmitting the order may have their own VBC identity. VBC identity of a balise, VBC identity transmitted by an order and VBC identity stored on-board are three different concepts that should be clear for each scenario, and special care is required to avoid misleading descriptions.

6.1. Set / Remove Order

BG's transmitting VBC orders (packet #6) shall not be configured with a VBC identity similar to the VBC identity of the order. This means that a BG ordering the inhibition of a VBC identity shall not be configured with that VBC identity. Obviously, a BG intending to delete a stored VBC (remove order) shall not be configured with that same VBC identity (since the on-board would inhibit the BG message).

BG's transmitting VBC orders shall consist of two balises. The rationale is that it will give a direction to the information in the BG when the train is in SR mode.

VBC orders shall be repeated by two consecutive BG's for redundancy purposes. The objective is to reduce the operational impact and mitigate the risk of losing the message.

A set order refers to package #6 with the correspondent order qualifier value “Q_VBCO=1”, while a remove order is packet #6 with the opposite value “Q_VBCO=0”.

Temporary VBC orders BG's will be configured with the order to set the VBC in one direction and the order to remove the VBC in the opposite direction. (.

As described in section 7 of this document, the VBC orders will be deployed to ensure that every entry or exit point of an area not yet commissioned is configured with an order to set the default VBC for trains entering the area and an order to remove the default VBC for trains leaving the area.

6.2. Validity Period

The validity period of every VBC order shall be 7 days (T_VBC).

This value is defined in the trackside subsystem requirements [REF1]. There are two risks related to the validity period of a VBC. The first one is that if a train leaves an area not yet commissioned in isolated mode, the VBC would remain stored on-board until the end of the validity period. The second would be that a train remaining inside the area not yet commissioned for longer than the validity period would no longer have the VBC stored and would react to the information read.

The first case mentioned will be further mitigated by the remove VBC order at the entrance of an AMS area in service. Both risks are additionally mitigated by operational procedures and network rules to manage the isolation mode and the stabling of trains.

6.3. Type of order and marker

VBC orders may be classified in two different groups:

- Permanent VBC orders
- Temporary VBC orders

6.3.1. Permanent VBC order

Currently the only permanent orders foreseen in the project are orders to remove the default VBC marker (project NID_C and default VBC marker). No other cases are foreseen.

Note that permanent VBC order does not refer to the validity period (which would not possible), but to the configuration after the rollout (refer to 9.1).

Balises transmitting permanent VBC orders (remove order at yard exits) shall not be configured with a VBC marker (packet #0), with the exception described in 9.1.2. This means, they shall not have a VBC identity.

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The rationale is that permanent orders will be used to ensure that trains cannot leave a maintenance area with a VBC identity stored therefore they should not have a VBC identity.

6.3.2. Temporary VBC order

These are the key components of the function in this project, and as the name indicates they will be part of a temporary configuration while areas of the network are progressively deployed and not yet commissioned. These VBC orders (packet #6) will be transmitted by dedicated BG's.

Temporary VBC orders transmitting the default VBC identity shall be configured with the testing VBC marker. The test marker (NID_VBCMK=63) will simplify testing on areas not yet commissioned.

The following figure shows an example of this configuration:

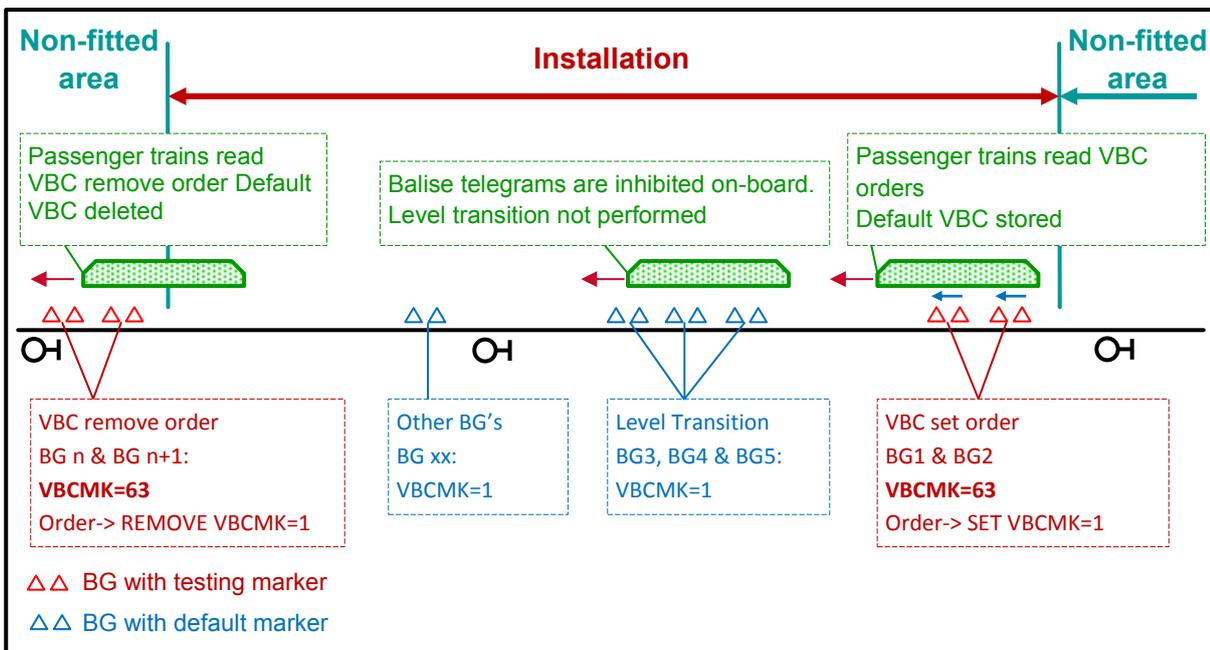


Figure 1.- Train in service and VBC

VBC markers in Figure 1 is described in 5.2. When an area is not in service, at every entrance and exit there will be BG's with the test marker and transmitting orders for the default VBC marker. When trains enter the area they will read the VBC set order and store the default VBC identity. While running inside the area, all newly installed balises will be inhibited since they will be configured with the default marker. When trains exit the area they will read the remove order and delete the stored VBC, and no other balises will be inhibited (refer to A.2 for detailed implementation example).

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6.3.3. Test VBC orders

To perform tests, the T&C teams will store on a test train the test marker by temporary arrangements. T&C may use special BG's configured with the set and remove orders for the test VBC (NID_C=540, NID_VBCMk=63). The following figure shows an example:

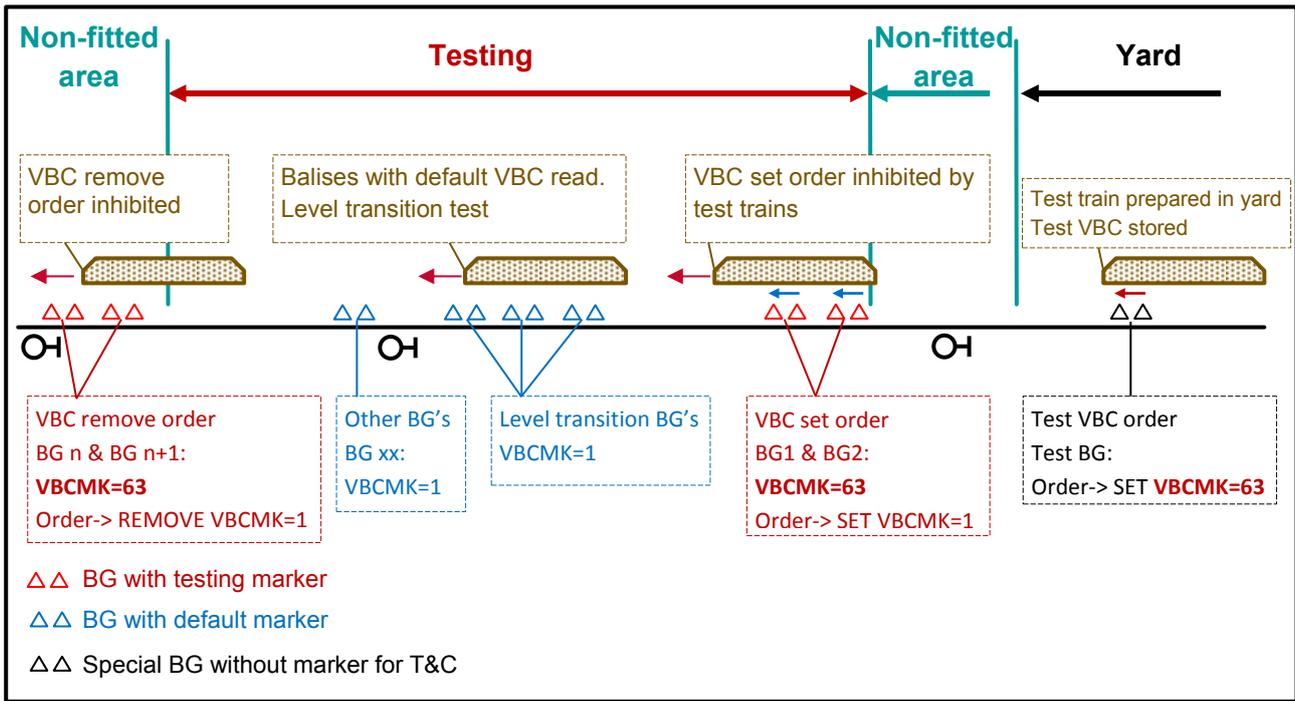


Figure 2.- Test trains and VBC

Note that Figure 2 does not depict the permanent orders to exit the yard, but the test VBC order used as a temporary arrangement for testing purposes (the BG's installed to exist the yard do not change the previous situation). The test VBC order will be transmitted to the test train outside the area to be tested, by the previously mentioned special BG's temporarily installed on the track. For example, at the yard where the test train will depart from or on a section of track before the area to test. Once the test VBC identity is stored on-board the VBC orders at the borders of the area are inhibited. Then the test train can perform functional tests reading the balises with the default VBC identity (refer to A.2 for detailed implementation example).

The T&C will ensure the test VBC is deleted from the test train after the test session, by transmitting a remove order with a special BG.

T&C procedures will define the conditions and precautions regarding the storage and deletion of the test VBC to mitigate the risks related to the management of the VBC function in test activities. Note that the

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configuration of marker and validity for test VBC orders shall be defined in test procedures and approved before the tests.

6.4. Linking strategy

BG's transmitting VBC orders should be preferably marked as linked. From a functional point of view the linking will not be relevant, and no linking information will be configured for them. The idea is that as the rollout moves forward VBC orders will be gradually removed and areas will be operated in L1 LS. Marking them as linked avoids that this particular balise configuration has any impact in AMS areas in service, therefore mitigating the risk of these balises being wrongfully re-installed during maintenance activities. However it should be noted that the benefit will be marginal during the rollout phase since in a number of cases balises will be read by trains in LO UN mode, and the information will be processed independently of linking marks.

Linking to BG's configured with testing VBC marker shall be avoided where possible. The test VBC marker is intended for functional testing by allowing a train to inhibited the marked balises, which will not be possible if they are linked; since the linking reaction would be triggered (second missed BG would necessarily trigger a SBI).

As a general rule linking arrangements will be required in the intermediate stages of the design. This means, linking may need to be modified in intermediate stages to have a particular behaviour for trains in commercial service and test trains. Linking examples are considered in the possible options described in chapter 7. In any case, the linking will require a configuration update as part of the design of the area under commissioning and its adjoining area in service.

7. Design Stages

This chapter describes the minimum necessary stages that shall be considered from the design perspective in one area, with consideration to the status of the adjoining areas. Every transition has first to be identified as planned to enter service before the adjoining area or after the adjoining area. This characteristic will determine the stages the design of the border will go through:

Area in service before the adjoining area

If the area is planned to enter service first the design will have to consider the following stages:

- Stage 1.1 – Installation and testing phase

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- Stage 1.2 – In service and next to an area not yet commissioned
- Stage 1.3 – In service next to an area in service

Area in service after the adjoining area

If the adjoining area will enter revenue service first, the design of the area will need to consider the following stages:

- Stage 2.1 – Installation and testing phase
- Stage 2.2 – In service next to an area in service

Note however that these design stages are described with respect to a border or transition to an adjoining area. Therefore, the number of interim designs in an area will depend on the number of adjoining areas and the phase planning of the revenue services for each area and those next to them.

This approach also assumes that areas will pass to revenue service at different times. If two adjoining areas will be commissioned at the same time, the VBC strategy in this section is not applicable and the particular transition should be designed as per the last configuration (Stages 1.3 and 2.2).

7.1. Area in service before the adjoining area

7.1.1. Stage 1.1 – Installation and testing phase

This first stage considers the status while the installation and testing of the new equipment is carried out in the area.

Exported constraint: It is important to notice that the BG's with VBC orders will have to be commissioned first before any other balise is installed on site. This is applicable for any area after the first ATP area is in service.

Stage 1.1 refers to a transition between areas where the reference area is not yet commissioned and the adjoining area is not fitted. The preferred solution will consist of placing temporary orders between the two areas, transmitting the default VBC and configured with a test VBC marker. By this means trains in service will store the default VBC when they move into the area and they will delete the default VBC when they move out of the area.

The principles in this design stage are:

- Dedicated BG's for VBC orders, with testing VBC marker and marked as linked.

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- No linking to/from VBC order BG's.
- Balises for LT with default VBC marker.
- Set order for direction into the area.
- Remove order for direction out of the area.

The following figure depicts the proposed solution:

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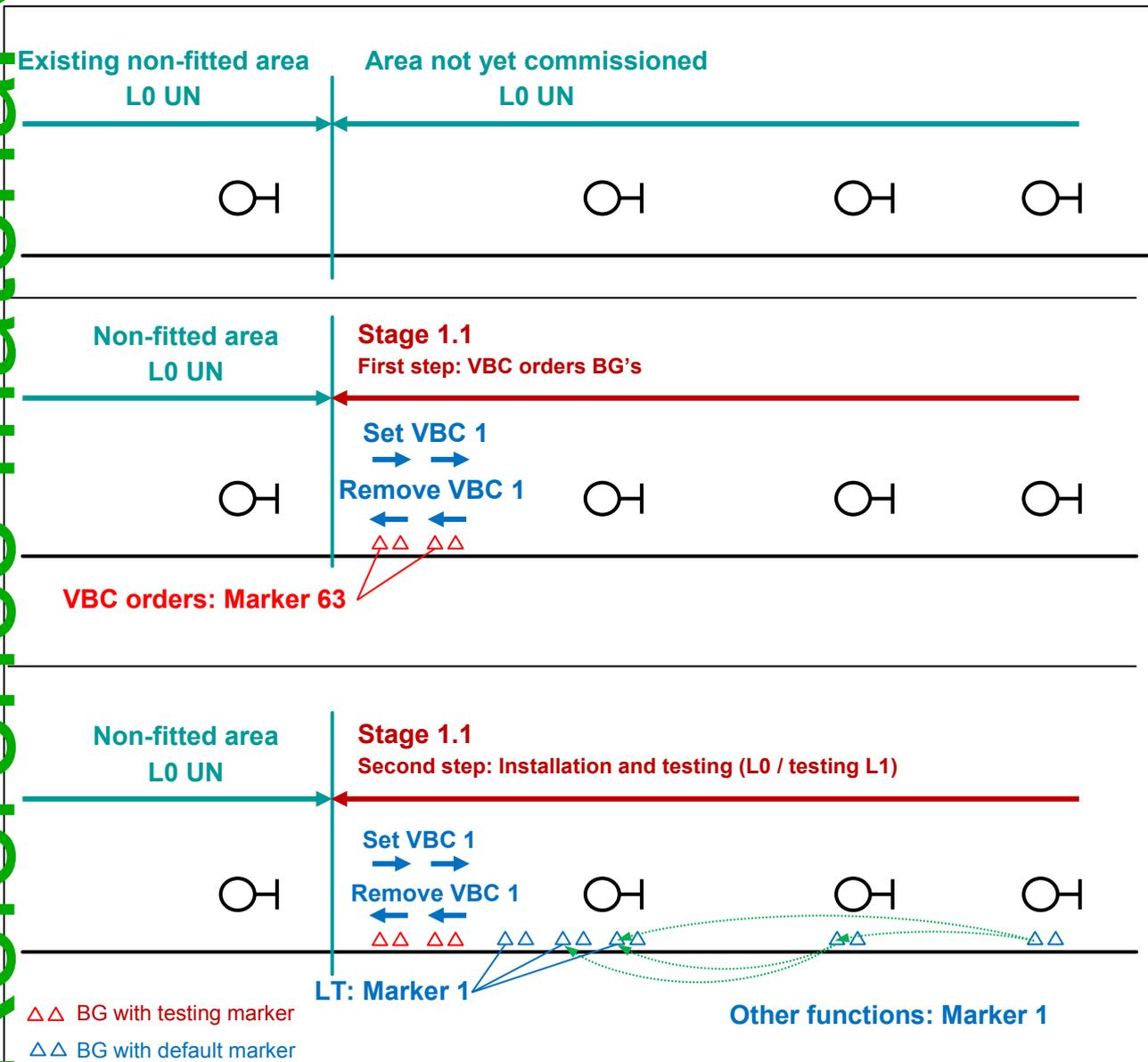


Figure 3.- Stage 1.1

This first step has been separated out as a reminder that the installation of the orders has to be carried out first. The BG's transmitting the Set/Remove order will store/delete on-board the VBC identity corresponding to the project VBC country/region and the default VBC marker. These BG's will have a different marker themselves: the testing marker. When trains enter the area (left to right in Figure 3) these BG's transmit the set order and the on-board will store the default VBC identity, and the rest of balises will be inhibited since they will be configured with the same default VBC identity.

When trains exit the area (right to left in Figure 3) these BG's transmit the order to delete the VBC on-board, to ensure that no further balises are inhibited.

The typical configuration will include LT BG's next to the VBC orders. At this stage, linking to LT may be configured although it will need to be updated at least in Stage 1.3.

7.1.2. Stage 1.2 – In service and next to an area not yet commissioned

This stage will follow Stage 1.1, as the area enters revenue service, but with a temporary configuration in this border, waiting for the installation and commissioning of the adjoining area to be performed at later date.

The preferred solution consists in removing the VBC orders defined in stage 1.1, (functional tests will be performed by means of physical covers or other temporary arrangements as required).

The following figure depicts the proposed solution:

Reference material only

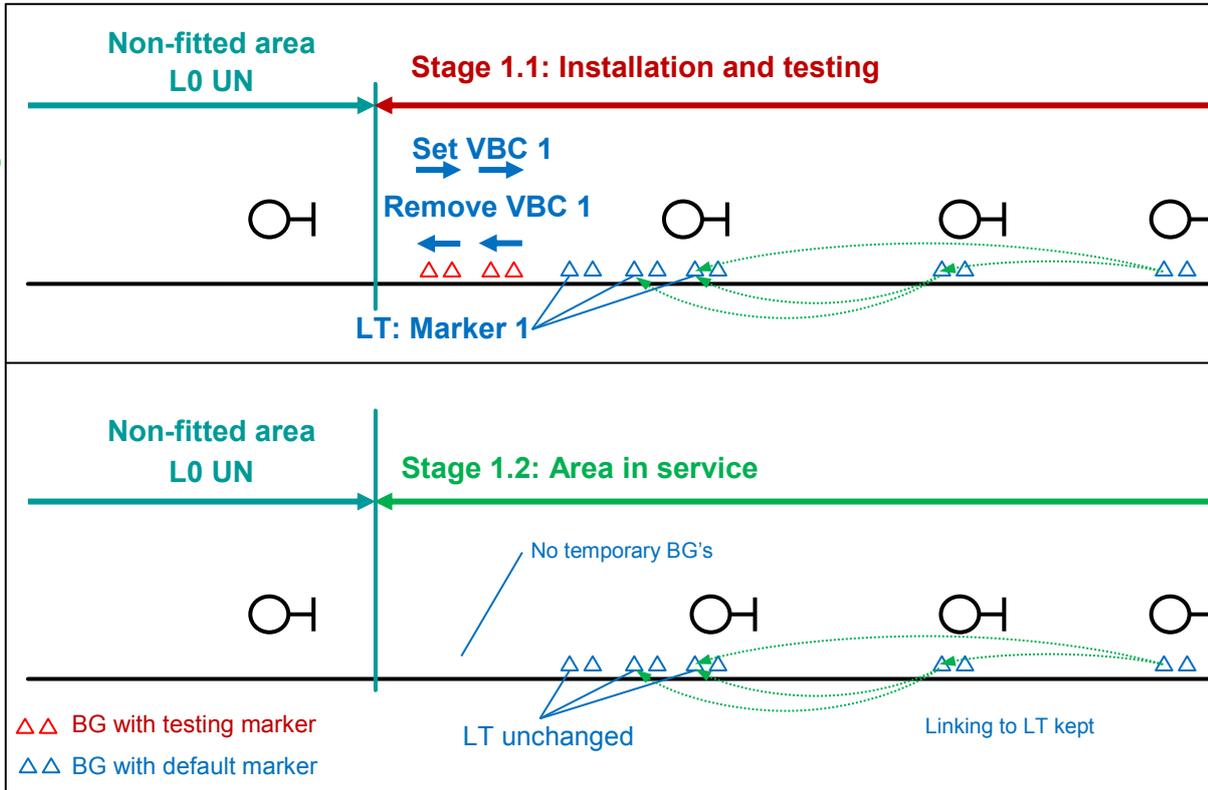


Figure 4.- Stage 1.2

This solution is the simplest from a technical point of view and it should be noted that relies on the correct configuration of VBC of other areas as explained in Stage 2.1.

Note that in any case the LT BG's in this stage are temporary in the sense that they will be eventually removed when the adjoining area enters commercial service.

Yards adjoining an AMS area are considered in separate section because of the particularities of this border (refer to 9.1).

7.1.3. Stage 1.3 – In service next to an area in service (area is in service first)

This stage refers to the configuration update required when both sides of the transition between areas enter revenue service. In this case it is more appropriate to refer to the required configuration changes:

- Linking update
- Functional update in area in service (Stage 1.2)

The following figure depicts the scenario:

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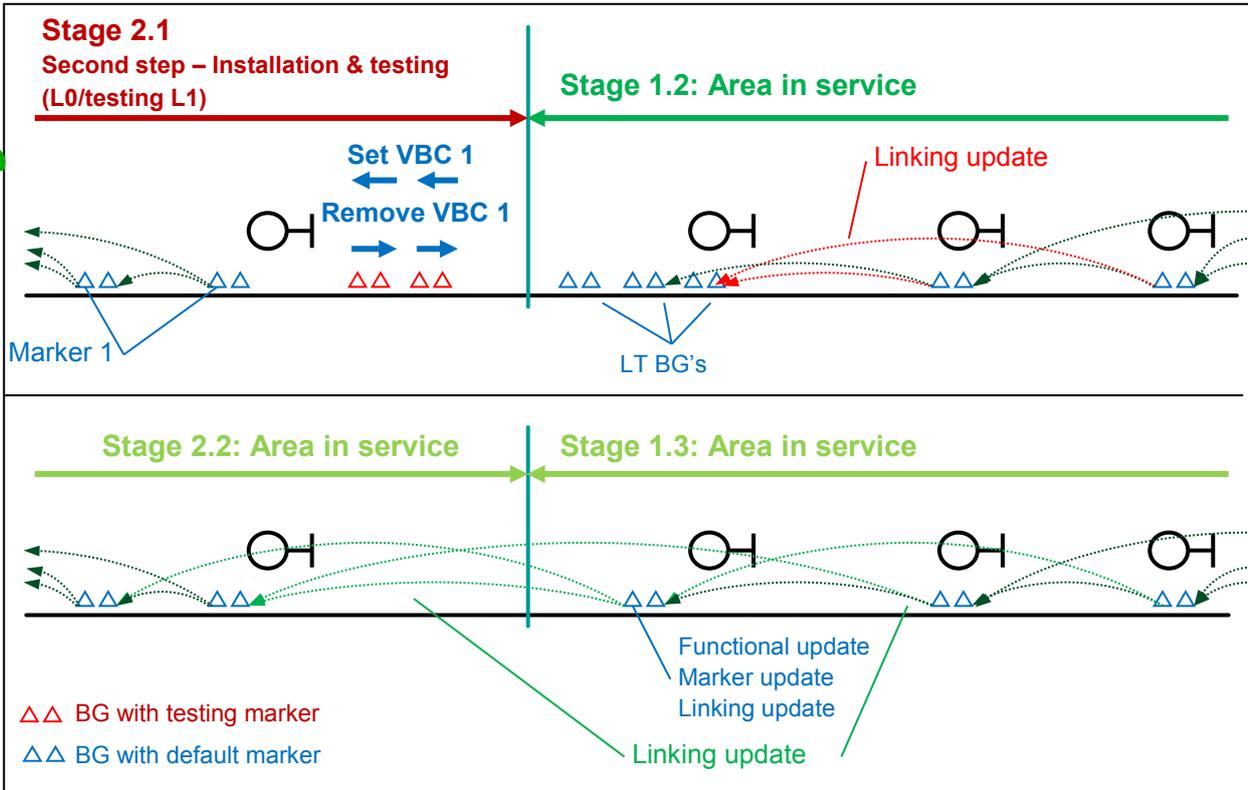


Figure 5.- Stage 1.3. Area in service (first)

It should be noted that the functional changes will depend on the actual transition. Apart from the elimination of the temporary level transition, other updates may be required for the rest of the functions and the corresponding cascading. Linking update may be required in both areas.

It should be noted that Stage 1.3 refers to the transition between two AMS areas. In the case of maintenance yards adjoining AMS areas the design will follow and specific staging (refer to 9.1).

7.2. Area in service after the adjoining area

7.2.1. Stage 2.1 – Installation and testing phase

In certain sections the installation will have to be carried out next to an area already in service. In those cases, it is expected that the adjoining area already in service is in the state proposed in Stage 1.2 [7.1.2]. The solution proposed for the VBC deployment is the same as in the previous section. The changes are not related to the VBC function itself but to the configuration of the adjoining area and the other functions.

Since the adjoining area is already in service it means that a temporary LT is already a part of the configuration in that area, and the new installation does not include a LT on this side of the border.

The principles in this design stage will be:

- Dedicated BG's for VBC orders, with testing VBC marker and marked as linked.
- No linking to/from VBC order BG's
- Set order for direction into the area
- Remove order for direction out of the area

The following figure shows the proposed solution:

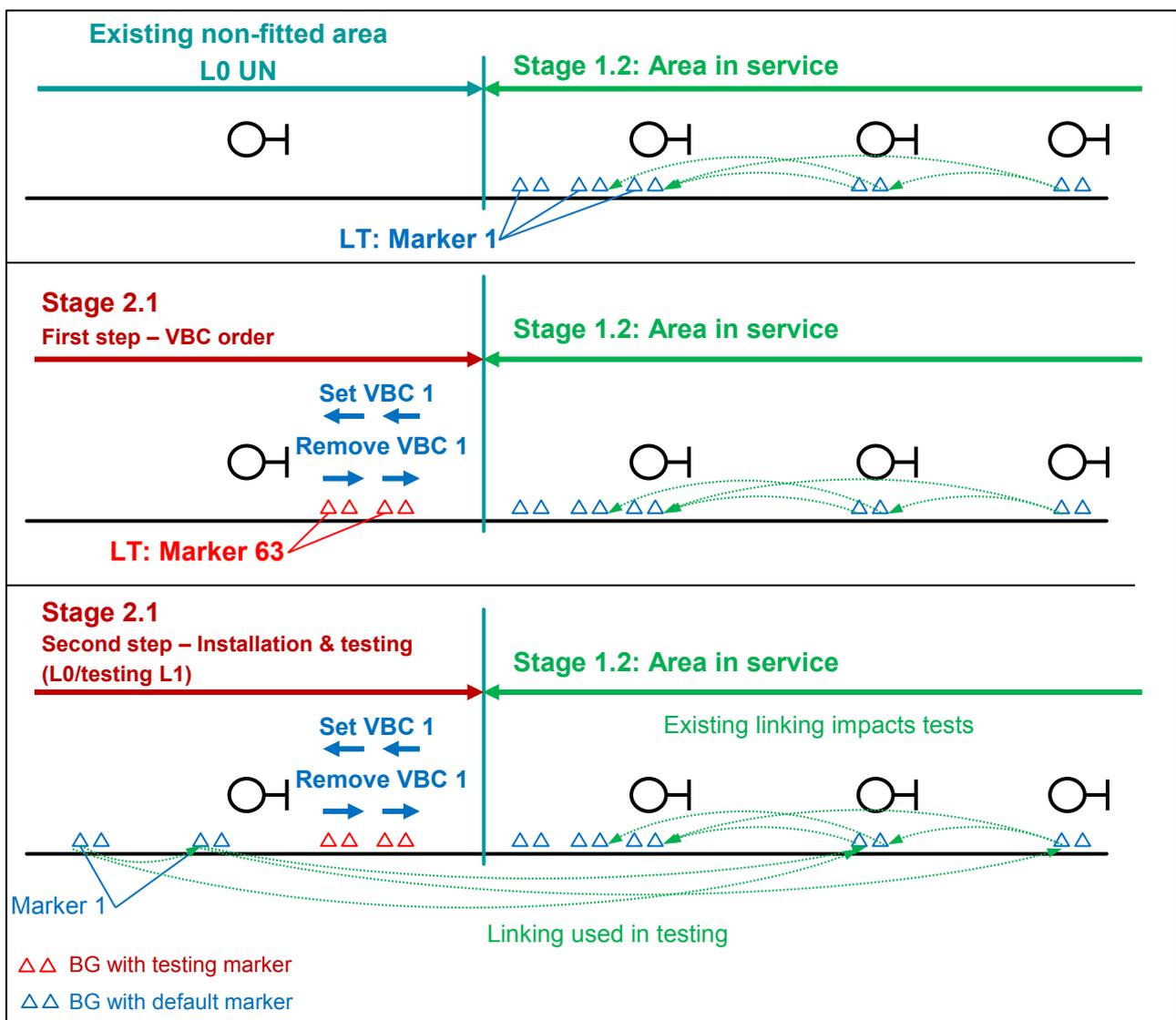


Figure 6.- Stage 2.1

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This solution is the simplest approach to the VBC function and maintains independency of areas until the last stage. As in Stage 1.1, VBC orders shall be commissioned first. Note that the VBC remove order is vital for the correct operation of the area in service.

Note that the permanent BG's in the new area could be configured with linking to the area in service, though it may not be worth it if the configuration has to be updated in the final stages 2.2 and 1.3.

There may be cases in which the installation works coexist in both areas. In terms of the stages defined this means that stages 1.1 and 2.1 coexist. The preferred option in these cases is to implement the stages as defined to maintain independency of areas even if this means that VBC orders will temporarily not provide any additional functionality.

The following figure shows an example:

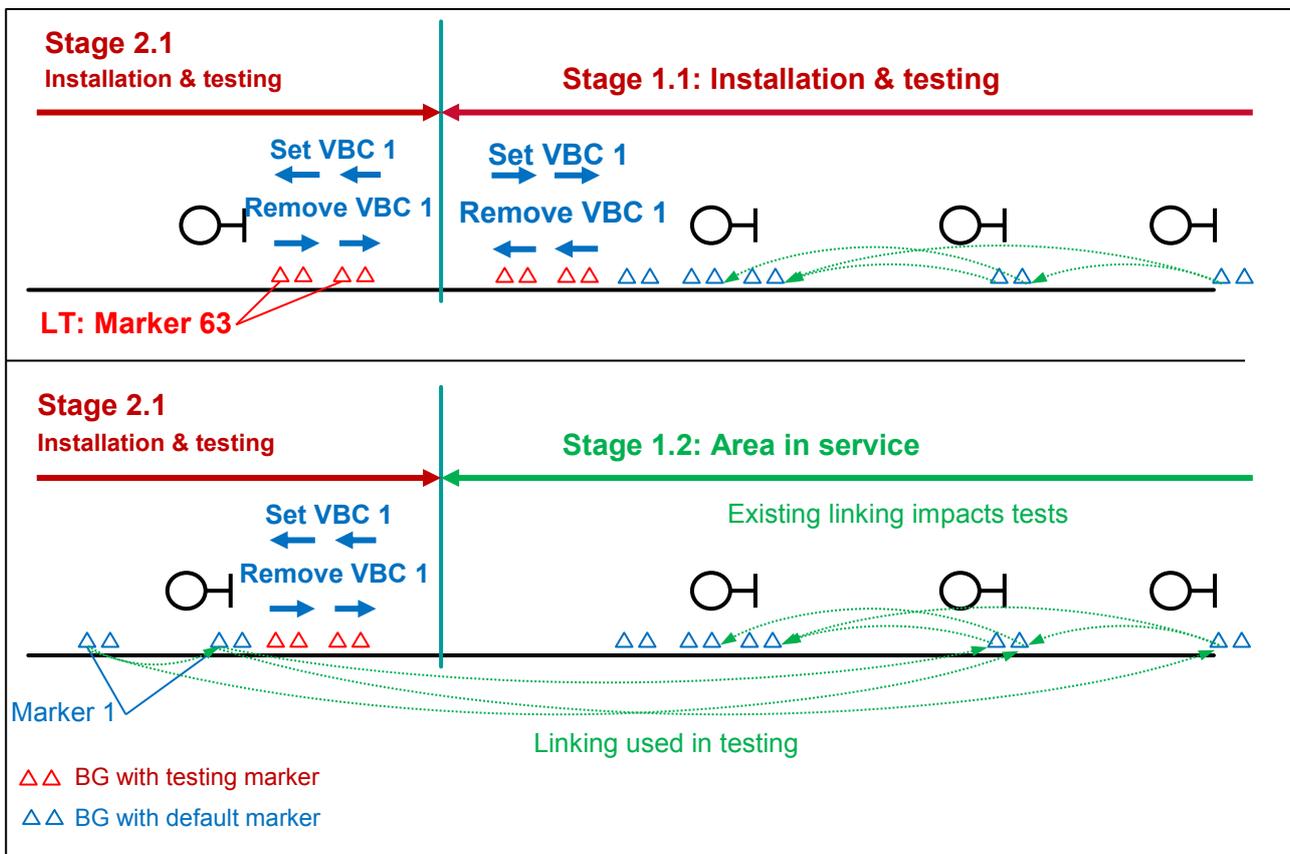


Figure 7._ Installation coexisting in two adjacent areas

7.2.2. Stage 2.2 – In service next to an area in service (area is second in service)

This stage refers to the configuration update required when both sides of the transition between areas enter revenue service from the point of view of the area that goes into service last. The most significant changes expected are:

- Linking update

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- VBC orders removed

The next figure depicts the scenario:

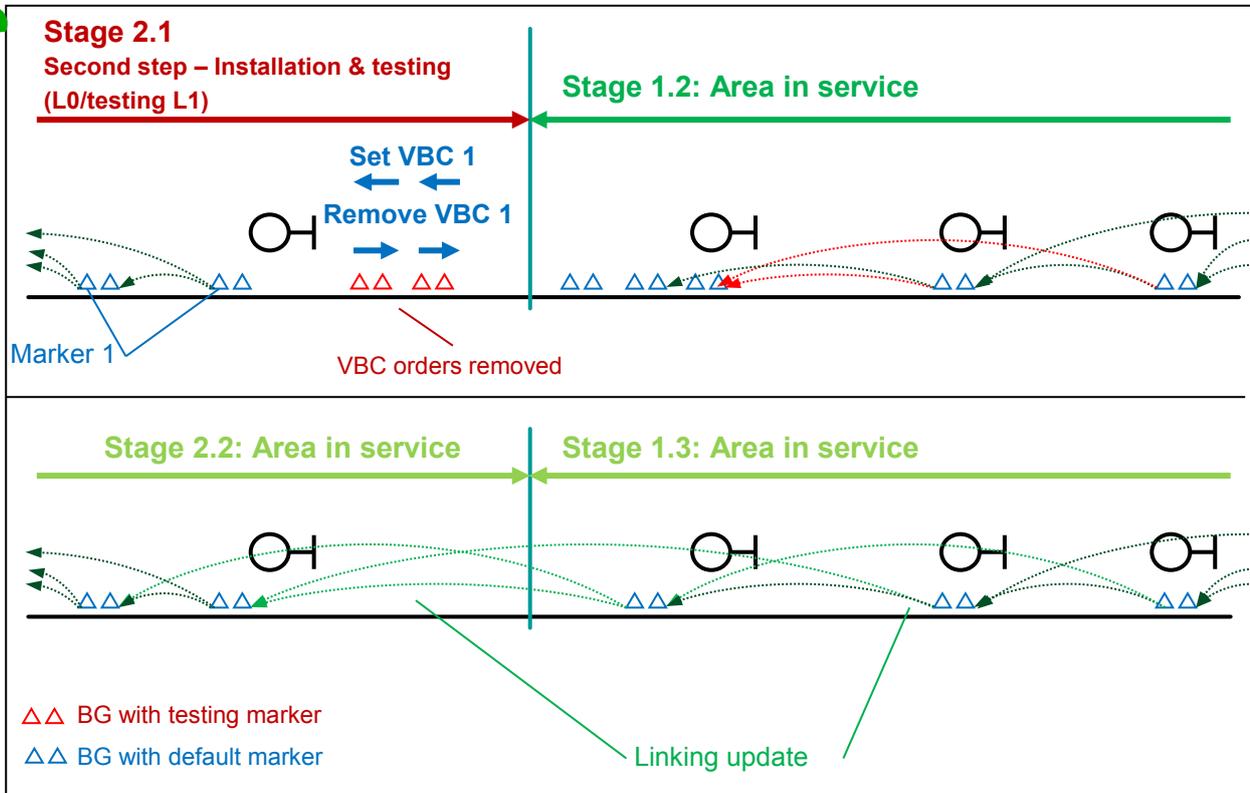


Figure 8.- Stage 2.2. Area in service (second)

Linking update may be required in both areas. The update in stage 2.2 will be coordinated with the update of stage 1.3, and executed in a same phase. As developed in the next chapter managing the change in both areas by one single entity should be evaluated.

8. Planning phases and design

From the definition of the stages in the previous chapters it can be deduced that in order to finalize the detailed design of an area the overall planning has to be known in order to define the phases the area will go through, and the stage of each border according the planned phase.

Even if stages 1.1 and 2.1 overlap in time, the design of each area will be performed according to the order they will move to revenue service.

This planning can also be used to define the scope of work of designers: The definition of the stages 1.1 and 1.2 described herein is assumed to be in the scope of work of the AEO of the given area. Also stages 2.1 and

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2.2 can be assumed to be in the scope of work of the AEO for the corresponding area. However the responsibility of stage 1.3 will be determined by the agreed scope of work (contractual scope of work). It should be considered that if the design of stages 2.2 and 1.3 is performed by a unique AEO, interfaces would be simplified.

It also seems that if stages 1.2 and 1.3 were separated significantly in time the most appropriate would be that the design of 1.3 is managed by the AEO responsible for stage 2.2, approaching the modification as an upgrade of an existing asset.

It is therefore recommended that the detailed design of an AEO considers as part of the scope of work the changes required in adjoining areas in service.

An example of how the planning impacts the design of the areas can be found in appendix A.1

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9. Additional design considerations

9.1. Permanent VBC remove orders in yards

A hazard related to yards and the VBC function is that after maintenance operations, it is possible that the train is wrongfully left with a stored VBC on-board. To mitigate the risk from this train leaving the yard with a stored VBC, an order to remove the default VBC shall be installed in the yard exit.

Note that this VBC order will be permanent and, as explained in 5.2, the related balises shall not have defined the VBC marker (no packet #0).

It is important to note that conditions and areas where a VBC may be stored on board shall be directly addressed in operational procedures and network rules. Storing any VBC for testing or maintenance purposes shall only be allowed in particular areas defined for that purpose. Test and maintenance procedures will need to ensure that the VBC is removed after the activity has been completed.

VBC orders at yard exits will be described as a separate case for clarity since the requirements are not exactly the same as for rest of transitions between areas. In the general case remove orders at yards will be defined by the following stages:

- VBC remove orders in yards adjoining a L0 area
- VBC remove order in yards adjoining a L1 not yet commissioned
- VBC remove order in yards adjoining a L1 in service

These stages will usually take place in that order. The characteristics are described in the following sections.

9.1.1. VBC remove orders in yards adjoining a L0 area

The most common initial scenario is considered to be when the adjoining area to the yard is operated as a L0 (UN mode) after the first AMS area is in service and the trains are running with the ETCS on-board operational. In these conditions, the connection with the line shall be equipped with VBC orders to remove the default VBC before trains leave the yard.

Trains running in L0 require also the transmission of the National Values before the train joins the main lines. Given the space constraints usually present in the area connecting the yard, the preferred option will be to combine the transmission of National values and the VBC remove order in the same groups.

The following figure depicts the situation:

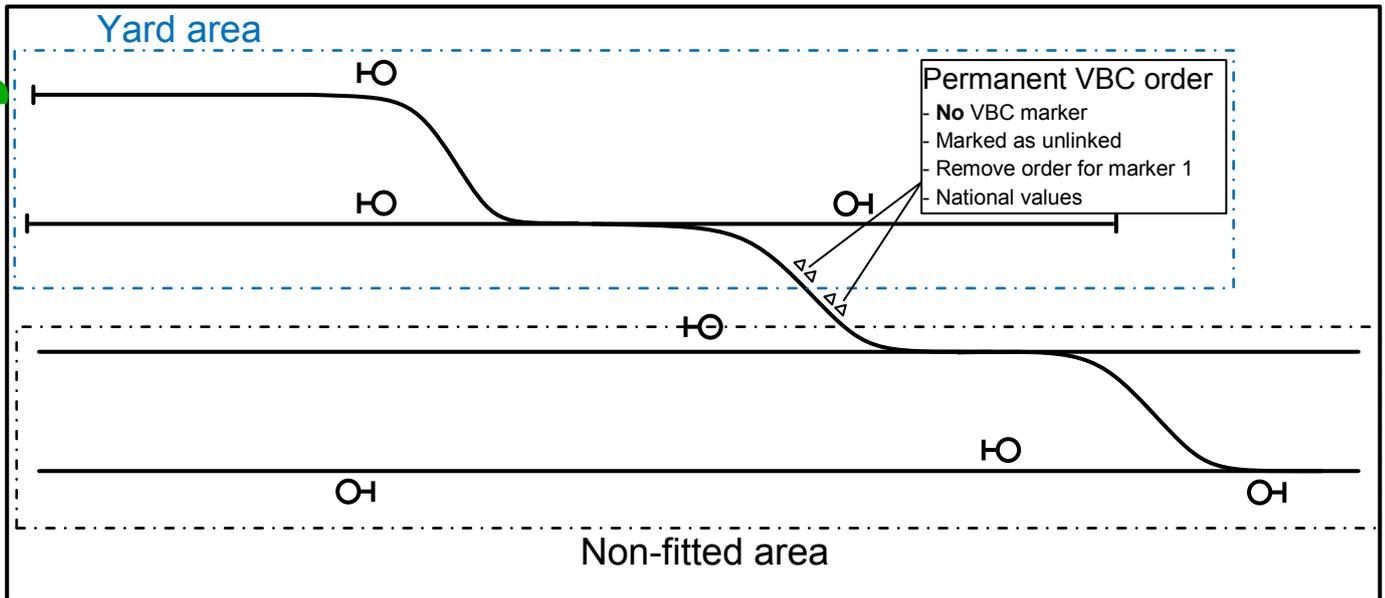


Figure 9.- VBC orders at yard exits after first AMS area in service

Note that these groups will have no VBC marker and they will be marked as unlinked. To mitigate the risk related to the VBC this must be the configuration of every yard after the first AMS area enters revenue service. From a detailed design point of view all AMS yards will be equipped with these groups. This stage is particular to yards and does not have an equivalent on the rest of area borders.

9.1.2. VBC remove order in yards adjoining a L1 not yet commissioned

In order to start the installation and commissioning phase in an area adjoining the yard a temporary configuration is required for the VBC orders. The proposed solution is to add BG's with temporary orders in the same way it is done for the installation phases (stages 1.1 and 2.1) and at the same time modify the configuration of the BG's present in the previous stage (if any).

Temporary VBC orders will be configured in the same way as for any area not yet commissioned: VBC marker 63 for testing purposes, marked as linked, sending set order for VBC marker 1 running from the yard into the line and sending remove order for VBC marker 1 running from the line into the yard.

These temporary BG's will be added in a point inside the yard so that all trains leaving the yard run over them before the BG's in the final configuration. If the connection to the line does not have enough length to install these BG's they shall be installed in a point before, ensuring that it is not physically possible for a train to avoid running over them to enter the line.

Reference material only

The following figure depicts an example:

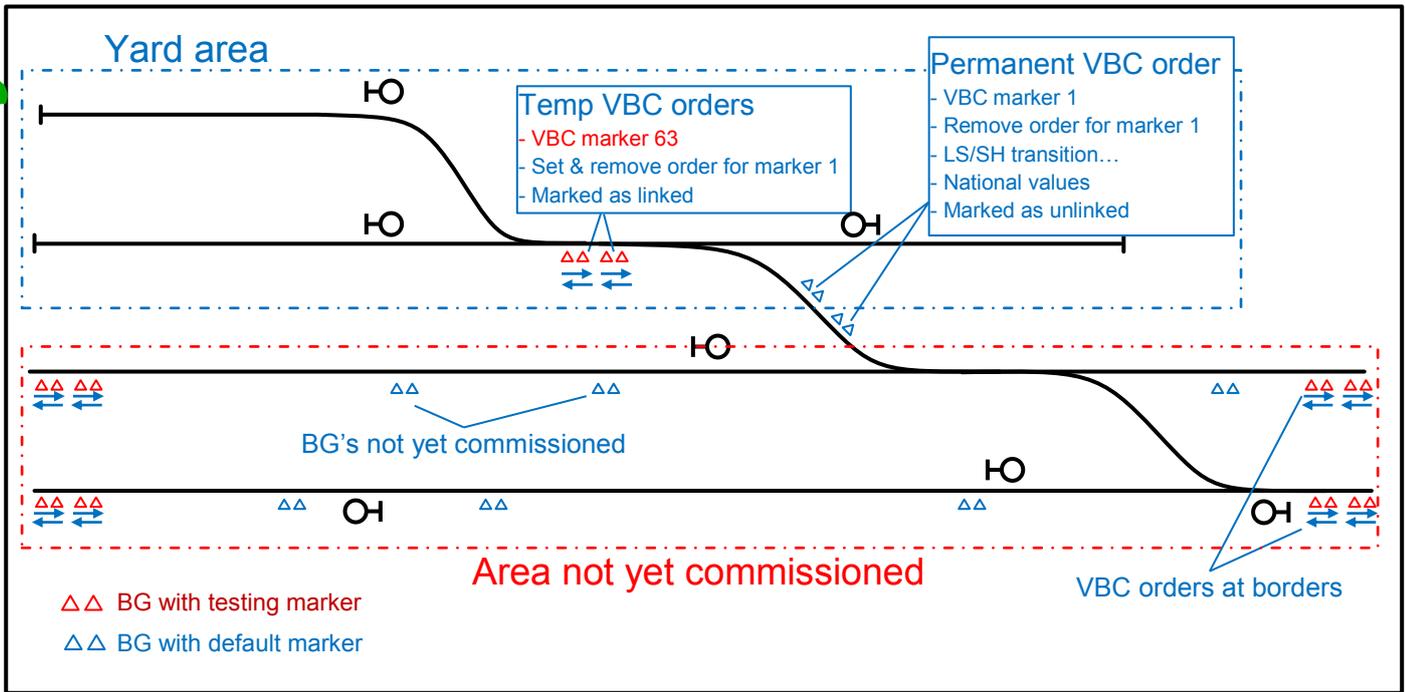


Figure 10.- VBC order at yard adjoining area not yet commissioned

The configuration of the existing BG's will be updated with the functionality required for the future level 1 but including the VBC marker 1 so that it is inhibited when the temporary VBC order is transmitted.

The configuration for L1 areas is described in the next section.

9.1.3. VBC remove order in yards adjoining a L1 in service

When an area adjoining a yard enters revenue service the configuration of the BG's at the border are updated to eliminate the temporary VBC orders, therefore the inhibition of the information received. This configuration is updated by uninstalling the temporary VBC orders BG's and by modifying the data of the BG's sending the level transition orders removing the VBC marker.

The following figure depicts the scenario:

Reference material only

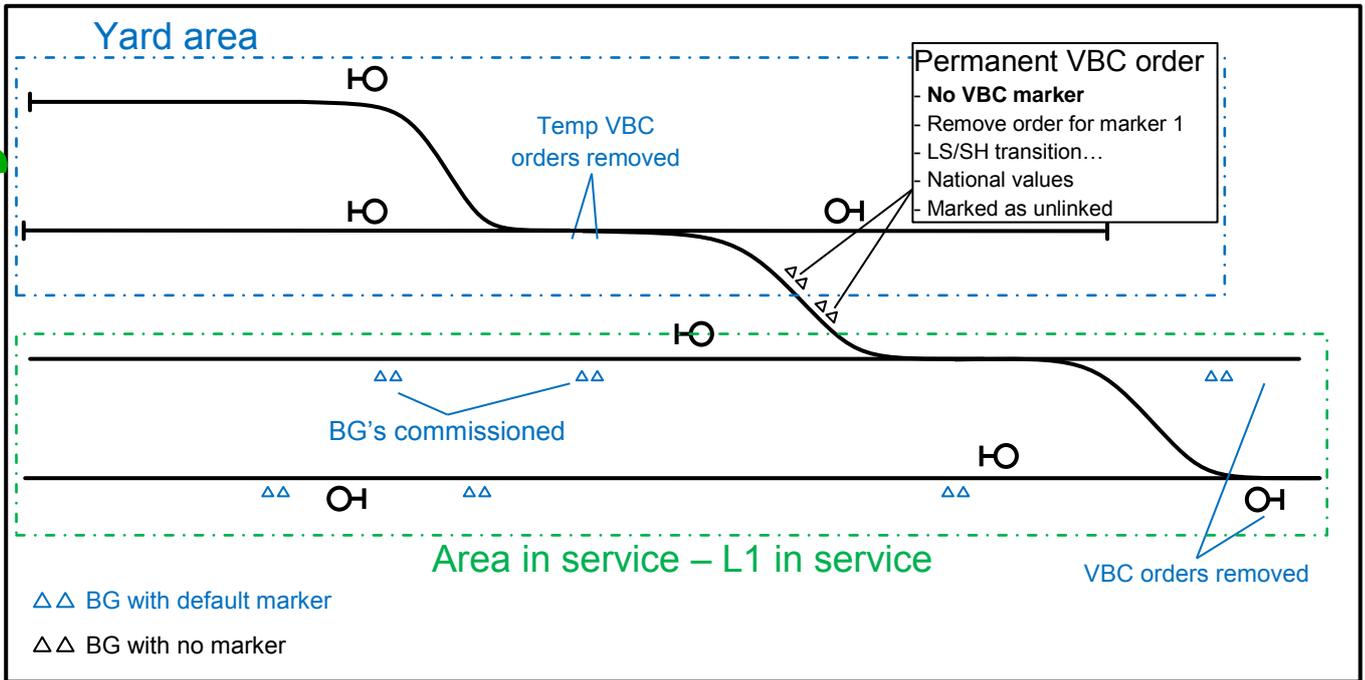


Figure 11.- VBC orders at yards adjoining a L1 area in service

The exact functionality of these BG's is out of the scope of this document, however the relevant aspect for the VBC is that the BG's at the yard exit will be used to combine the permanent VBC remove order with other ETCS functions. These BG's will necessarily be marked as unlinked and will have no VBC marker configured.

9.2. VBC orders at sidings within deployment areas

Sidings inside or adjoining an area not yet commissioned will not be considered as a border of the deployment area and will not be equipped with VBC orders. Trains in sidings could be exposed to two potential risks as a result of degraded modes or emergency procedures:

- Train is stabled in the siding for longer than the validity time for VBC, which is 7 days.
- Train loses the stored VBC as a result of maintenance procedures.

In these two cases, since the VBC order can only be received from trackside, the train cannot be allowed to leave the siding with the EVC operational (ATP bypass switch in normal position). In this situation, the train would react to BG's not commissioned.

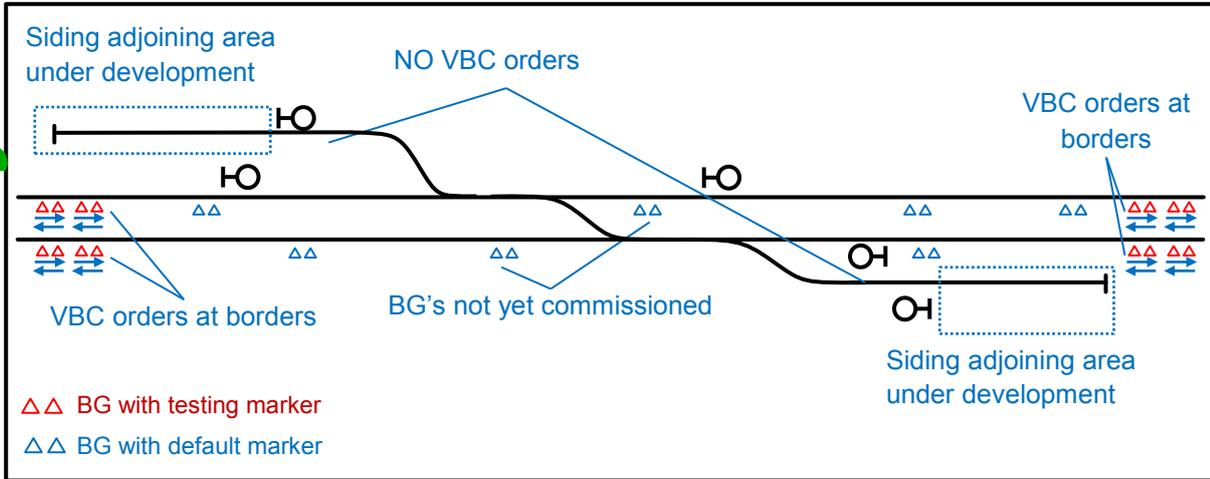


Figure 12.- Yard and siding adjoining area not yet commissioned

The operational procedures shall define the restrictions and requirements to perform any emergency procedure. For example, restrict on-board maintenance during the rollout phase, or prescribe the isolation mode after maintenance.

9.3. Physical space constraints

There are no special physical constraints for VBC order BG's as the general constraints applicable to all project balises apply. Only the logical order in terms of VBC orders and markers discussed in the document is relevant for the correct design of the function. Detailed physical location will respect the project requirements [REF1].

Reference material only

Appendix A

A.1. Example A - Phasing example

The below example presents a network with 4 areas that will be gradually commissioned, from area 1 to area 4.

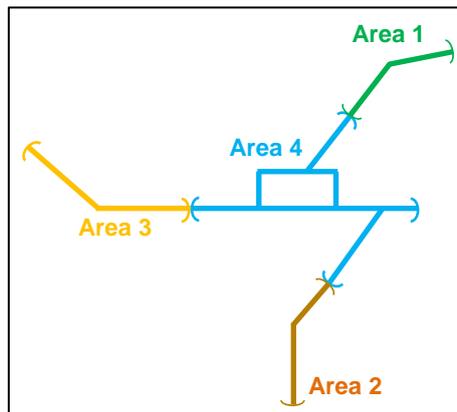


Figure 13.- Network example

In the figure it can be seen that areas 1 to 3 have only one adjoining area, while area 4 will have three adjoining areas. As explained in section 8, the phases planned in terms of which areas will be in revenue service at each phase, will determine the detailed design of the area and in particular the VBC configuration for each transition between areas.

For the present example we will assume that area 1 will be first in service. Installation works on Area 2 and 3 will start only after Area 1 is in service. Afterwards Area 2 will be in service followed by installation works on Area 3 and 4. Then Area 4 will be in service, and finally Area 3 will be in service.

Figure 14 shows the resulting phasing of this planning and the design stage of each area transition for each phase.

Reference material only

Reference material only

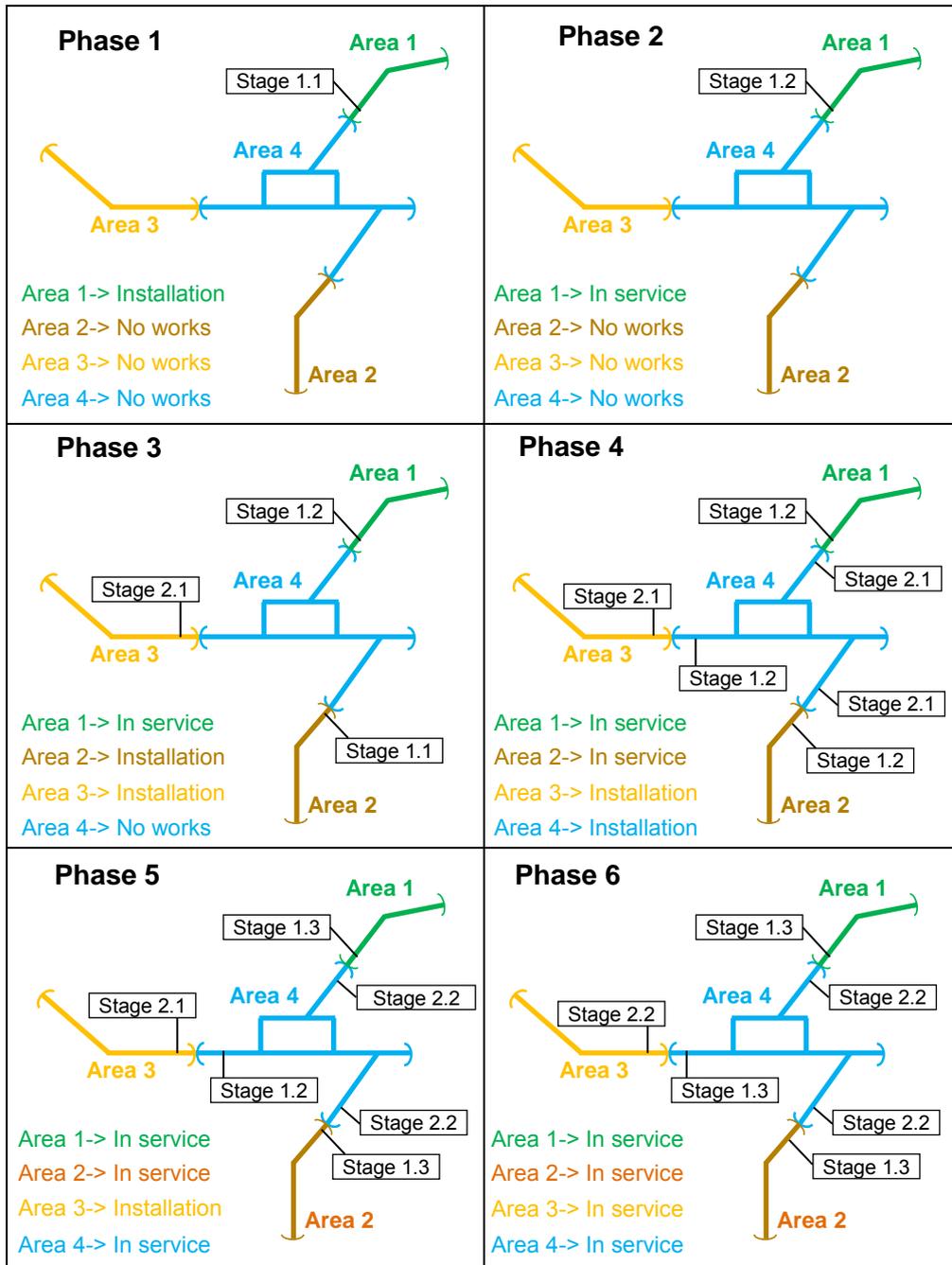


Figure 14.- Phasing example

Note that stages in area 4 borders will be different in general. Once an area is in service the stage of the borders may be 1.2 or 2.2 depending on the adjoining area. It can be inferred that the complexity and level of effort increases with the number of phases for areas with multiple adjoining areas (like Area 4 in the example).

A.2. Example B - Configuration of temporary VBC orders

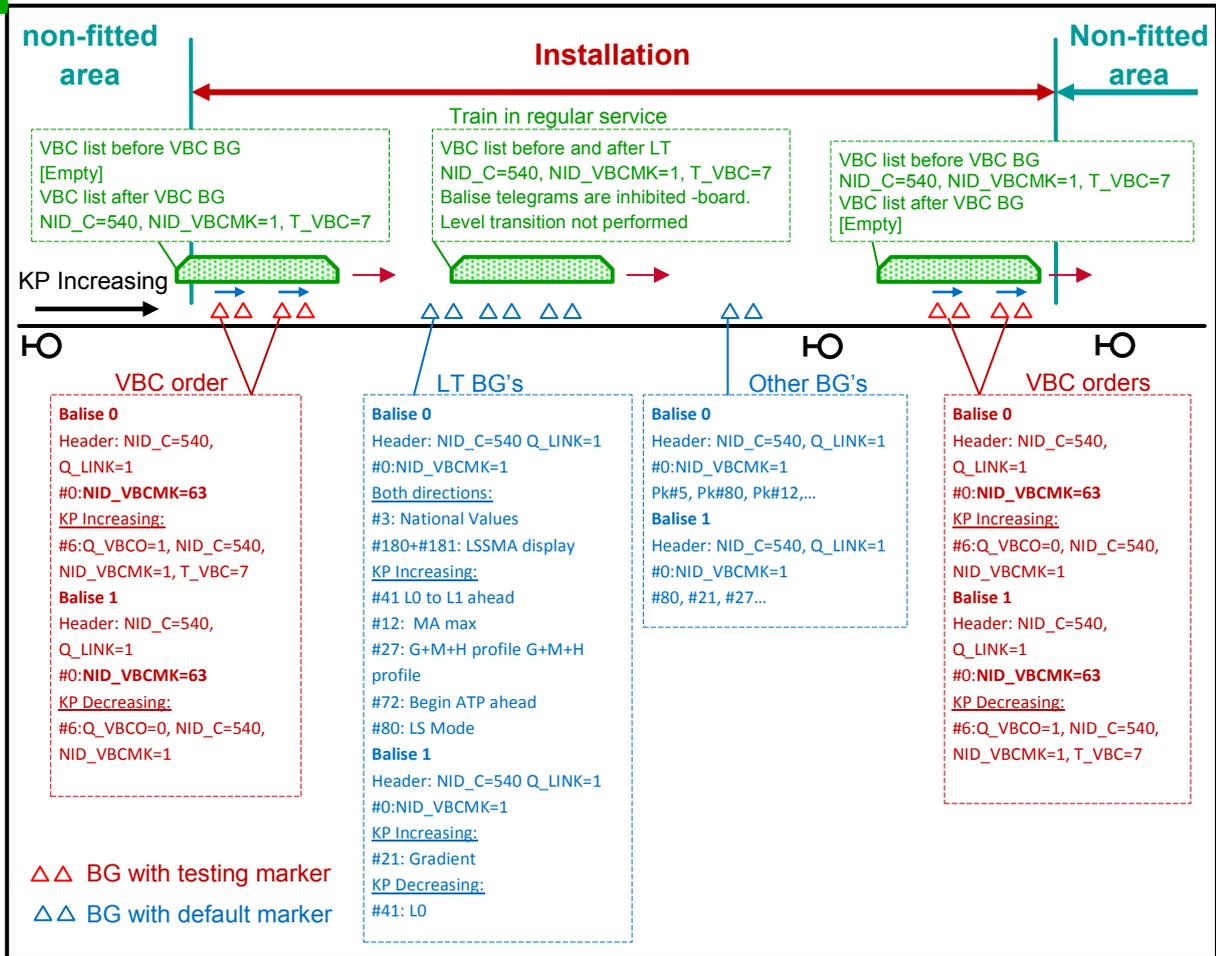


Figure 15.- Trains in service and VBC configuration in area not commissioned

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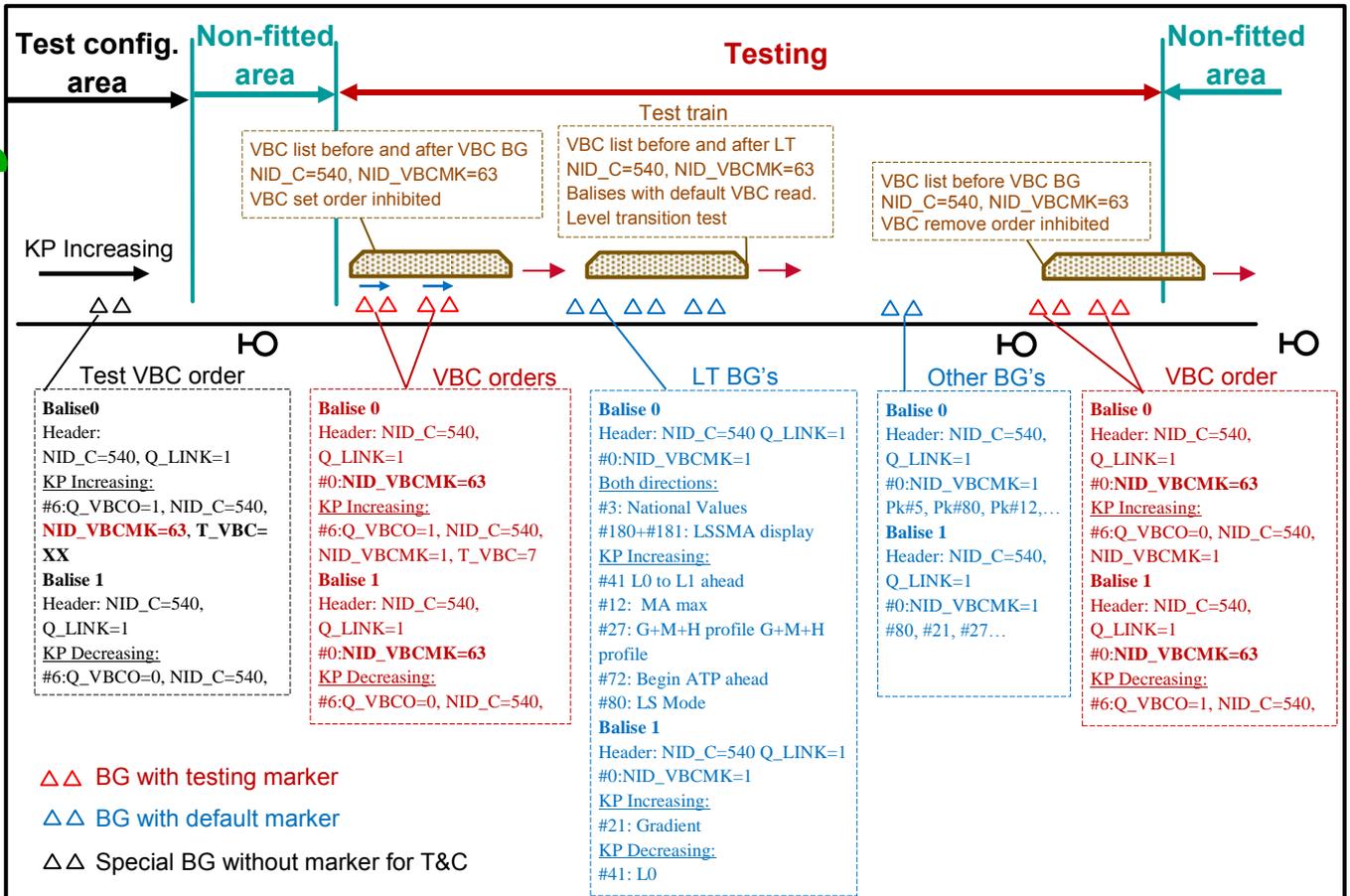


Figure 16.- Test train and VBC configuration in area not commissioned