Reference material

Advanced train control Migration System (AMS) Specifications – AMS Look-Ahead Design Guideline

This document is published as reference material to support the implementation of Automatic Train Protection as part of the roll out of the Advanced Train Control Migration System project.

The content described might be of assistance to individuals and organisations performing work on Transport for NSW Rail Assets.

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AMS PROJECT SPECIFICATIONS

AMS LOOK-AHEAD DESIGN GUIDELINE

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Foreword

This design guideline forms a part of the AMS suite of documents which detail the design requirements for the AMS Project. This guideline specifically covers the probable scenarios that would require Look-ahead information and the possible ways to implement this based on the existing signalling system, availability of trackside infrastructure and the associated complexity that may impact the time frame, risks etc.

To gain a complete understanding of the signalling design requirements, this document should be read in conjunction with the suite of AMS project documents.

1. Background

The term 'Look-ahead' refers to the concept where the locally available aspects of a signal cannot provide enough information to its connected LEU in order for it to select a telegram unambiguously and as a result, additional aspect information from the signal/s ahead is required to be brought back to the LEU location.

Under AMS, a designated high risk location (e.g. a diverging route at a high risk Turnout) is protected by a controlled BG transmitting the target speed for the location. The on-board equipment will then use the received target speed along with the train braking parameters and other trackside data to calculate the train braking curve and enforce the train speed consistently, collectively known as Target Speed Monitoring (TSM).

In order to minimise operational disruption, the controlled BG should be located just before the beginning of the train braking curve, also known as the 'P location'. In other words, the 'P location' is the point where braking from line speed needs to start in order to achieve the target speed at the designated high risk location. When the protection is not required (e.g. the straight route is set at a high risk turnout location, a Proceed aspect is shown on the signal protecting an overlap deficiency), the controlled BG will not transmit the target speed and the on-board equipment will not enter the TSM. As the line speed becomes higher or the target speed becomes lower, the 'P location' shifts further in rear of the target location, i.e. a higher approach speed leads to an earlier brake intervention.

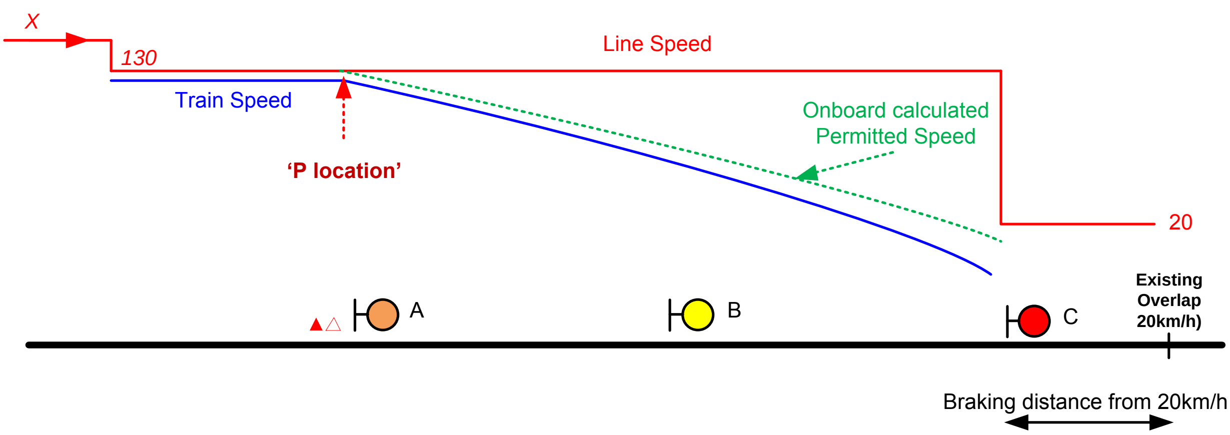

Figure 1 – 'P location' under AMS context

In some cases, the 'P location' occurs prior to the first signal warning the Driver to start reducing the train speed. This is due to the following two restrictions given by ETCS:

1) The on-board ETCS equipment calculates longer braking distances due to the train position uncertainty (confidence interval), the use of worst case braking parameters and the application of safely rounded gradient profiles received from trackside (i.e. more conservative than the real gradient).

2) The on-board ETCS equipment can receive the updates only when the train reaches the BG, while the Driver can adapt the train speed as soon as the signal is in sight.

As a result, depending on the position of the 'P location' and a cost-efficiency evaluation, the LEU associated with the controlled BG protecting the high risk location could be connected at a signal prior to the first warning signal and would therefore may require Look-ahead information.

2. Purpose

This guideline presents possible scenarios that would require provision of Look-ahead information and describes the associated technical design solutions for both Contact Sensing and Current Sensing configurations under Section 5. The scenarios presented under this section are based on the cases discussed in the AMS Circuit Design Standard with some additional cases included in Appendix A for further clarification. The purpose of Appendix A is to present a variety of the most commonly occurring cases that further clarifies the intent of Look-ahead design. Therefore Appendix A should not be treated as an increase from the original scope.

Depending upon the existing trackside signalling system and availability of signalling infrastructure, there might be various construction options available for implementation as described under Section 6.

2.1. Scope

The Look-ahead concept refers to various scenarios where the aspect information of a signal ahead needs to be brought back to an LEU connected to a given signal which has insufficient information to prevent an early ATP brake intervention at a designated high risk location or at an intermediate low risk turnout. The aspect information from the signal/s ahead is required to unambiguously identify the following conditions:

- When the speed restrictions due to the associated high risk hazard can be inhibited (single TSM scenario).
- When the speed restrictions due to the associated high risk hazard can be inhibited as well as when any of the less restrictive speed information applicable to the hazard location can be sent (multiple TSM scenario).
- When the speed restrictions due to the associated high risk hazard can be inhibited at an intermediate low risk turnout (i.e. a low risk turnout protected by an intermediate signal within the signal connected to the TSM initiating LEU / BG and the high risk hazard) where the speed restrictions impose an unacceptable operational restriction.

Various examples covering all the above scenarios have been described under Section 5.

This guideline identifies three basic Look-ahead scenarios based on the aspect of the signal connected to the TSM initiating LEU/BG and the AMS functionality:

i) Protection of a high risk turnout at a signal displaying a Medium aspect (refer to Section 5.1).

ii) Protection of a high risk turnout at a signal displaying a Clear aspect (refer to Section 5.2).

iii) Protection of a high risk overlap deficiency at a signal displaying a Medium aspect (refer to Section 5.3).

Note: Although the primary purposes of providing Look-ahead are to improve the Operations and to avoid Driver confusion, in some cases the operational benefits are either simply insignificant or it is too complex to assess. In such cases, necessary direction needs to be sought from the AMS Systems Integrator before a decision is made whether or not to implement the Look-ahead design.

This guideline also covers the three different options to implement Look-ahead as described under Section 6 depending upon the type of existing trackside infrastructure within the proposed AMS fitment area:

i) Ethernet communications,

ii) CBI data change,

iii) Hardwired copper cable.

2.2. Application

This guideline applies to the AEOs engaged to carry out the signalling design for new works and provide guidance to help identify various Look-ahead scenarios that may exist under AMS context.

Note: The examples presented in this guideline are case specific analysis, some of which have direct reference to the AMS Circuit Design Standard relating to Look-ahead. These examples cover various scenarios where Look-ahead need or need not to be provided under AMS context but do not form an exhaustive list.

3. Reference documents

The following documents should be read in conjunction with this guideline. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

i) AMS Circuit Design Standards

ii) AMS Signal Design Principles

iii) Approach Balise Group Selection and Position Design Guideline

4. 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; a set of 1 to 8 balises

CBI Computer Based Interlocking

Contact Sensing LEU inputs are from contacts of the relays driving the signal aspects

Current Sensing LEU inputs are directly from the signal lamps

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

LEU Lineside Electronic Unit; equipment that controls the balise output based on the state of the signalling inputs

LEU Table A Table that records the intended AMS outputs in relation to the possible states of the LEU inputs associated to the valid aspects of its connected signal

LSSMA Lowest Supervised Speed within the Movement Authority

SSI type Solid State Interlocking or later equivalents, such as Smartlock, Westrace and Westlock

TFM Trackside Functional Module; controls individual trackside equipment e.g. signal, point etc.

TfNSW Transport for New South Wales

TSM Target Speed Monitoring

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5. Typical Look-ahead scenarios

The following scenarios have been identified as typical situations where an early ATP brake intervention would occur without the implementation of Look-ahead under AMS. Additional aspect information that needs to be brought back for each of these scenarios has also been identified.

Under both contact and current sensing configurations, Look-ahead information that needs to be brought back should be able to distinguish:

a) All different routes at the TSM initiating BG for the purpose of sending the applicable turnout speeds due to the high risk junction as well as to apply the post turnout speeds for these lines. Refer to Sections 5.1 and 5.2.

   For some specific layouts, the amount of Look-ahead information may be reduced when an Approach BG is present where the Approach BG can update the turnout speeds as well as the related post turnout speed information based on the route set at the high risk junction. Refer to Appendix A.2.

b) A Proceed aspect from the Stop aspect of the signal protecting a high risk overlap deficiency at the TSM initiating BG for the purpose of sending Line speed. Refer to Section 5.3.

c) If a diverging route is set over an intermediate low risk turnout (i.e. a low risk turnout situated between a TSM initiating BG and its corresponding high risk hazard) for the purpose of revoking the TSM with the sole intention of not imposing any operational restriction. Refer to Section 5.4

5.1. Turnout Protection at a signal displaying a Medium aspect

5.1.1. Single Light and Double Light signals

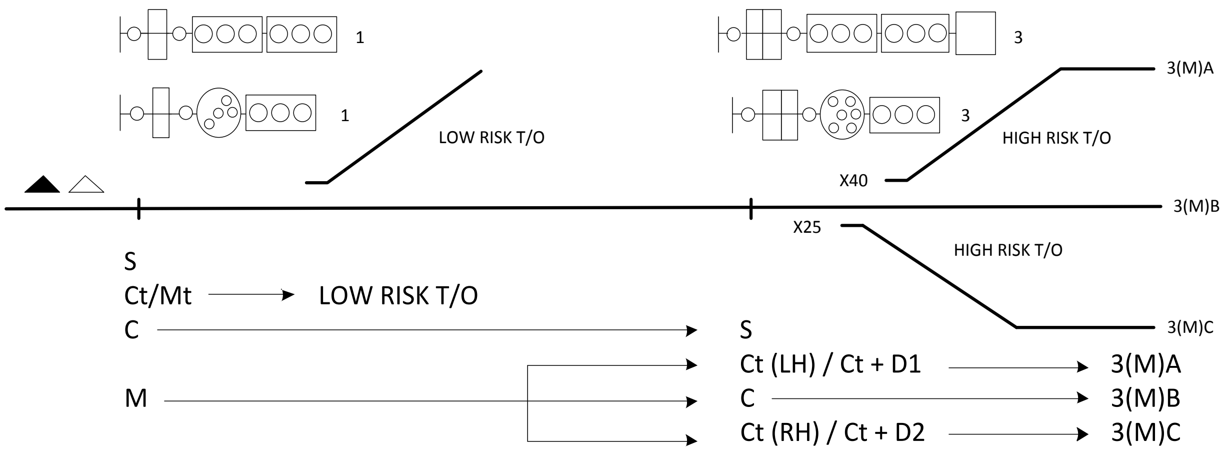

Figure 2 – Turnout Protection at a signal showing a 'Medium' aspect – Single or Double Light

In the above example, Signal 1 displays a medium aspect when the junction signal (Signal 3) shows a Proceed aspect for either the straight or the turnout routes.

Signal 1 does not have sufficient information to confirm if the Junction Signal (Signal 3) is set for the straight or any of the diverging routes. Without Look-ahead, the BG would have to send the most restrictive speed at the junction with Signal 1 displaying a Medium aspect and thus would result in an operational penalty for the straight route and the higher speed diverging route. In order to apply the correct speed restriction for the diverging routes (i.e. the turnout speeds for 3(M)A and 3(M)C routes as well as the speed beyond the respective turnouts) and to inhibit any ATP brake intervention for the straight route, aspect information from the Junction Signal needs to be brought back to Signal 1 location.

Refer to Standard Circuit 6 and its related LEU Table. Under contact sensing arrangements, the existing signalling circuits require modification to create 'Medium' aspect control relays for Signal 1 based on the route set at Signal 3 and the corresponding inputs need to be provided to the LEU.

A similar scenario is considered below but on a different layout under current sensing arrangements. Refer to Standard Circuit 13 and its corresponding LEU Table.

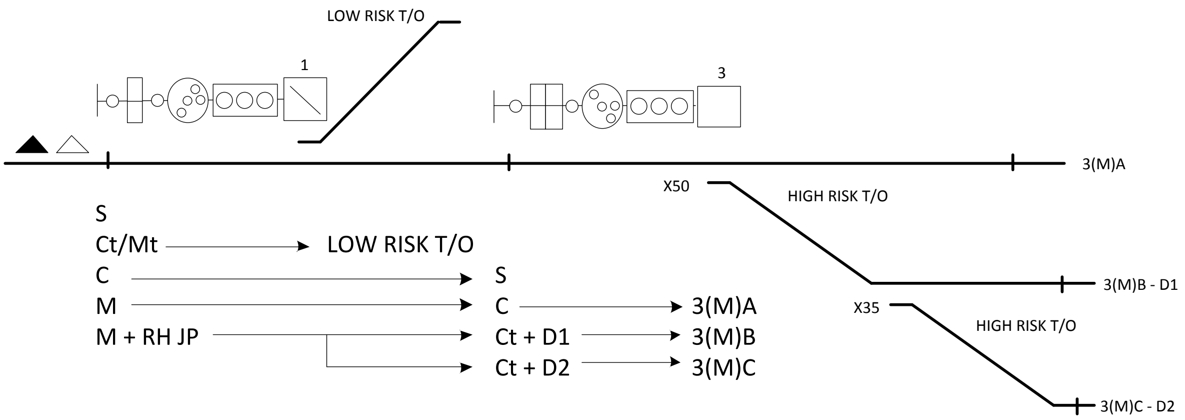

Figure 3 – Turnout Protection at a signal showing a 'Medium' aspect – Single Light

In this case, Signal 1 displays a medium aspect (Pulsating Yellow) for straight route while an additional turnout repeater applies to the turnout routes from Signal 3. The layout has two consecutive turnouts at the high risk junction with 3(M)B route having higher turnout speed than that of 3(M)C route. Although Signal 1 has sufficient information to differentiate between the straight and diverging routes at the junction, it does not have sufficient information to differentiate between the two diverging routes.

Without Look-ahead inputs, the BG would have to send the most restrictive speed of the junction (due to the x35 turnout leading to 3(M)C route) when any of the diverging routes are set. In order to apply the correct speed restriction and to inhibit any ATP brake intervention for the straight route, aspect information from the Junction Signal needs to be brought back to Signal 1 location. In this case, lamp monitoring input from the lesser restrictive Route Indicator (i.e. D1 for 3(M)B route) is sufficient to be provided to the LEU. If the Route Indicators are relay driven, contact sensing input should be used instead, in order to mitigate the impact of lamp failures as the LEU will receive the state of the driving relay.

5.1.2. Double Light signals

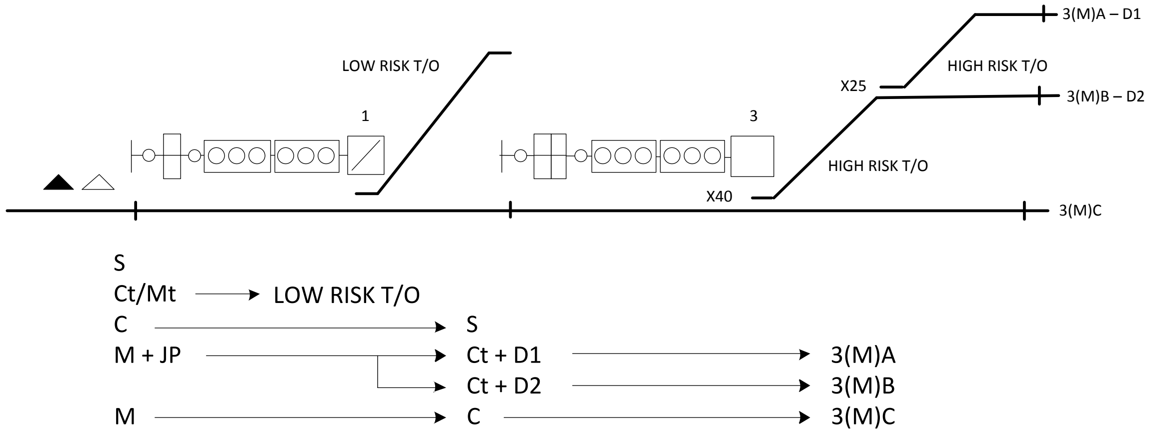

Figure 4 – Turnout Protection at a signal showing a 'Medium' aspect – Double Light

The above example is similar to the scenario explained in Figure 3 but is for a double light signal using the current sensing arrangements. Refer to Standard Circuit 16 and its corresponding LEU Table. In this case, the lamp monitoring input from the lesser restrictive Route Indicator (i.e. D2 for 3(M)B route) of the junction signal (Signal 3) is sufficient to be provided to the LEU. If the Route Indicators are relay driven, contact sensing inputs should be used instead, in order to mitigate the impact of lamp failures as the LEU will receive the state of the driving relay.

Refer to Appendix A which covers various layouts with varying Look-ahead requirements and hence provides further insight on Look-ahead design. These examples are based on high risk turnout protection at a signal displaying Medium aspect which is the base for Section 5.1. The same layouts could be applicable for high risk turnout protection at a signal displaying Clear aspect where the TSM initiating BG is provided at a signal in rear of the outer signal used in these examples but these have not been repeated as the basic philosophy for Look-ahead would remain the same.

5.2. Turnout Protection at a signal a displaying Clear aspect

5.2.1. Single Light signals

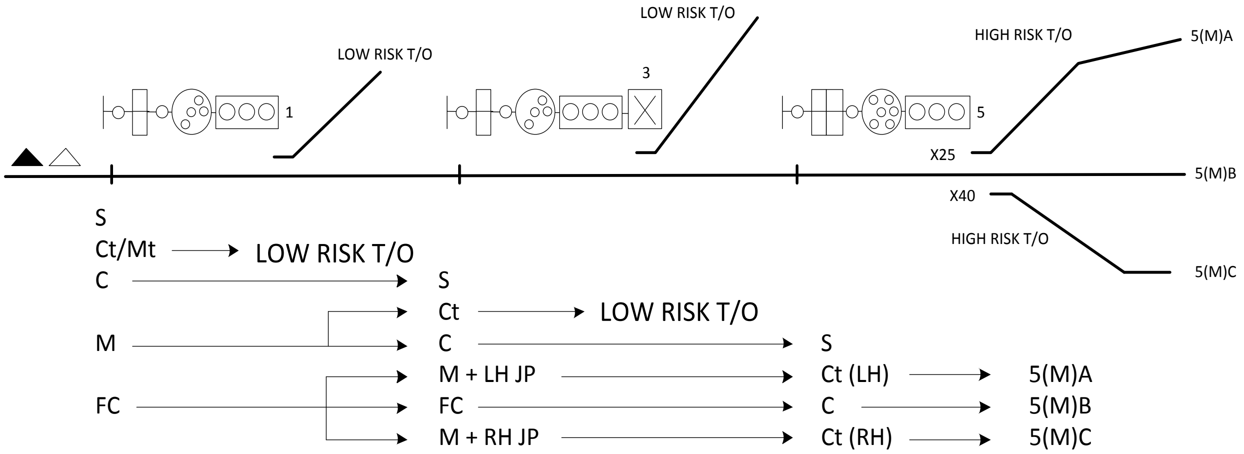

Figure 5 – Turnout Protection at a signal showing a 'Clear' aspect – Single Light

In the above example, the 'P location' falls at or ahead of Signal 1 which shows a Full Clear aspect when the junction signal (Signal 5) shows a Proceed aspect for either the straight route or any of the diverging routes at the high risk junction. Therefore, Signal 1 does not have sufficient information to confirm if the junction signal is set for the straight route or any of the diverging routes.

Without Look-ahead, the BG would have to send the most restrictive speed at the junction (because of the x25 turnout speed for 5(M)A route) with Signal 1 displaying a Clear aspect and thus would result in an operational penalty for both 5(M)B and 5(M)C routes. In order to apply the correct speed restriction and to inhibit any ATP brake intervention for the straight route, aspect information from Signal 3 needs to be brought back to Signal 1 location.

Refer to Standard Circuit 8 and its related LEU Table for the solution under contact sensing arrangements where three additional relays need to be created at Signal 1 location based on 3JP(LH) HDR, 3JP(RH) HDR and 3 DR relay information.

Under current sensing arrangements, lamp monitoring inputs from the Green aspect and the right hand Turnout Repeater of Signal 3 need to be brought back (physically or via network inputs) to Signal 1 location

5.2.2. Double Light signals

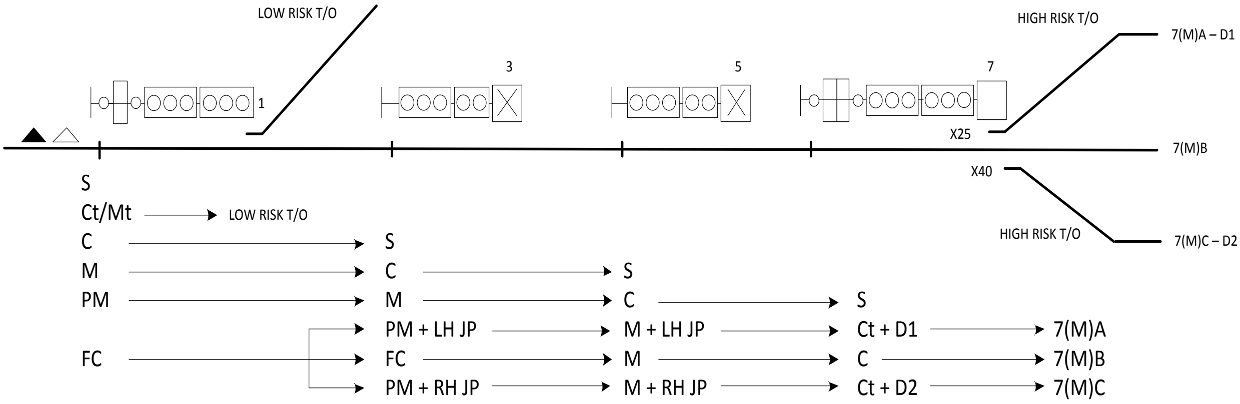

Figure 6 – Turnout Protection at a signal showing a 'Clear' aspect – Double Light

In the above example, the 'P location' falls at or ahead of Signal 1, which shows a G/G aspect when the junction signal (Signal 7) shows a Proceed aspect for either the straight route or any of the diverging routes at the high risk junction. Therefore, Signal 1 does not have sufficient information to confirm if the junction signal is set for the straight or any of the diverging routes.

Without Look-ahead, the BG would have to send the most restrictive speed at the junction (because of the x25 turnout speed for 7(M)A route) with Signal 1 displaying a Clear aspect and thus would result in an operational penalty for 7(M)B and 7(M)C routes. In order to apply the correct speed restriction and to inhibit any ATP brake intervention when the straight route is set, aspect information from Signal 3 needs to be brought back to Signal 1 location.

Refer to Standard Circuit 9 and its related LEU Table for the solution under contact sensing arrangements where three additional relays need to be created at Signal 1 location based on 3JP(LH) HDR, 3JP(RH) HDR and 3 DR relay information.

Under current sensing arrangements, refer to Standard Circuits 17 & 18 and its corresponding LEU Table. Lamp monitoring inputs from the Bottom Green lamp and the right hand Turnout Repeater of Signal 3 need to be brought back (physically or via network inputs) to Signal 1 location.

5.3. Overlap Deficiency Protection at a signal displaying a Medium aspect

While AMS enforces a speed restriction in order to protect the infrastructure hazards based on the most restrictive signal aspect sequence up to a signal at stop ahead, the aspect sequences can change depending on local conditions and legacy design practices. Successive Medium aspects are present in various parts of TfNSW's network where not enough information is locally available to unambiguously determine which signal ahead is at Stop. In these cases, when an overlap deficiency is required to be protected at a signal displaying a Medium aspect, additional signal aspect information needs to be brought back from the location/s ahead to ensure that the speed restriction can be inhibited when it is safe to do so.

5.3.1. Successive Medium aspects – Single Light signals

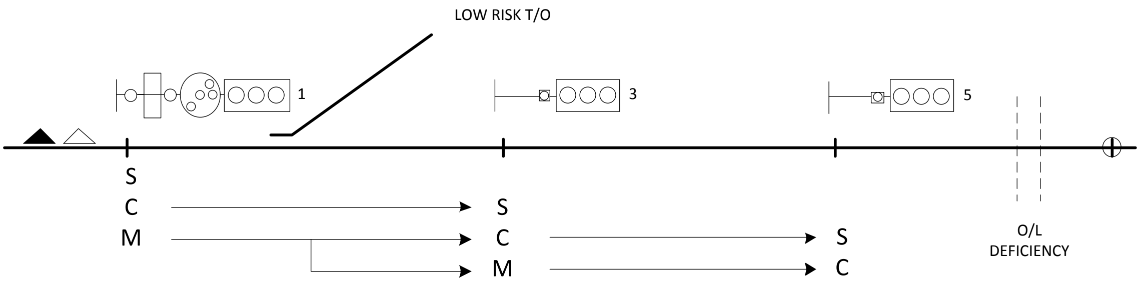

Figure 7 – Successive 'Medium' aspects – Single Light

In the above example, Signal 1 shows a Pulsating Yellow with Signal 3 displaying either a Caution or a Medium aspect. With Signal 1 not having sufficient information to determine which signal is at Stop (Signal 5 or beyond), without Look-ahead, the BG would have to apply the most restrictive speed due to the overlap deficiency at Signal 5 (assuming it is at Stop) and thus resulting in an operational penalty. In order to inhibit the speed restriction when Signal 5 shows a Proceed aspect, information from Signal 3 needs to be brought back to Signal 1 location.

Refer to Standard Circuits 25 (Contact Sensing) & 31 (Current Sensing) and their corresponding LEU Tables. The existing signalling circuits need to be modified to create the 'Medium' aspect control relays for Signal 1 based on 3HR and 3HDR relay information under contact sensing arrangements.

Under current sensing arrangements, lamp monitoring input from the Yellow aspect of Signal 3 needs to be brought back to Signal 1 location.

5.3.2. Successive Preliminary Medium aspects – Double Light signals

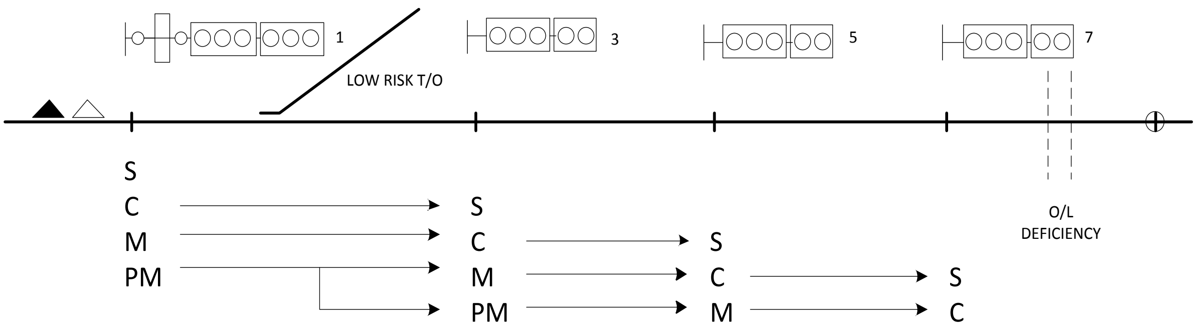

Figure 8 – Successive 'Preliminary Medium' aspects – Double Light

In the above example, Signal 1, a double light signal, shows a Preliminary Medium aspect (G/PY) with Signal 3 displaying either a Medium (G/Y) or a Preliminary Medium (G/PY) aspect. With Signal 1 not having sufficient information to determine which signal is at Stop (Signal 7 or beyond), without Look-ahead, the BG would have to apply the most restrictive speed due to the overlap deficiency at Signal 7 (assuming it at Stop) and thus resulting in an operational penalty. In order to apply the speed restriction correctly and to inhibit any ATP brake intervention when Signal 7 shows a Proceed aspect, information from Signal 3 needs to be brought back to Signal 1 location.

Refer to Standard Circuits 28 (Contact Sensing) & 34 (Current Sensing) and their corresponding LEU Tables. Under contact sensing arrangements, additional 'Preliminary Medium' aspect control relays for Signal 1 need to be created based on 3HDR and 3PHDR while under current sensing arrangements lamp monitoring input of Signal 3 Bottom Yellow needs to be brought back to Signal 1 location.

5.4. Intermediate Low Risk Turnout

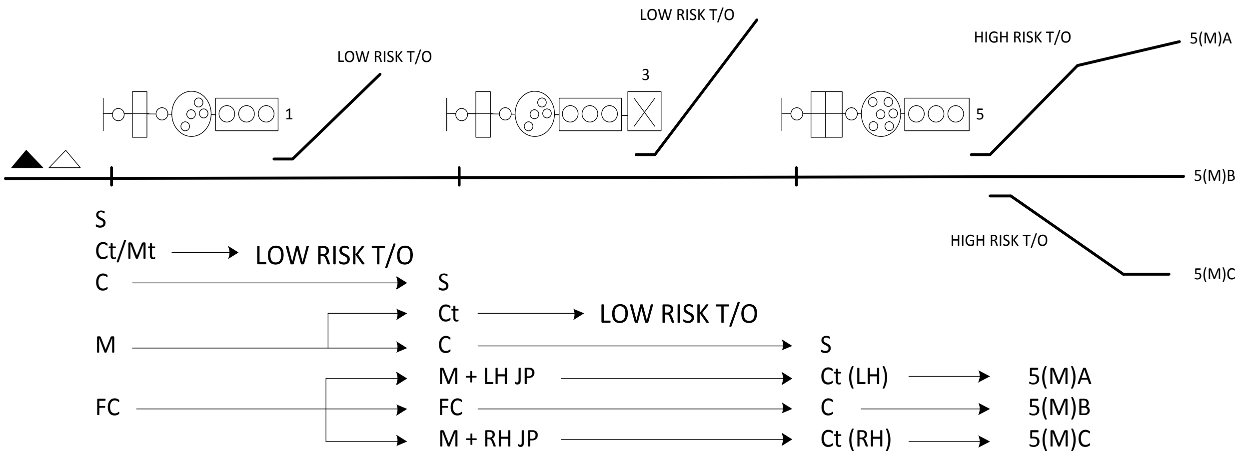

Figure 9 – Intermediate Low Risk Turnout

In the above example, the TSM initiating BG is situated 2 blocks away from the high risk turnouts. As shown through the aspect sequence between these signals, Signal 1 shows a Medium aspect for both 3(M)A (diverging through the low risk turnout) and 3(M)B routes. The fact that the most restrictive speed profile of the high risk junction (Signal 5) will be applied in this situation, it is highly likely that the braking curve would start much earlier than Signal 3 and hence it would impose operational restrictions on the Train movements involving 3(M)A route. If this becomes an issue for Operations, the speed restriction being applied on 3(M)A route needs to be revoked and additional information from Signal 3 needs to be brought back so that 3(M)A and 3(M)B routes can be identified at Signal 1.

Under contact sensing configurations, additional Medium aspect control relays for Signal 1 need to be created based on 3(M)A HR and 3(M)B HR relay information while in current sensing configurations, Signal 3 LH BOL aspect information needs to be brought back to Signal 1 and provided to the LEU as Look-ahead input.

6. Look-ahead implementation options

The possible Look-ahead scenarios discussed in the above section have been presented either in contact or in current sensing context through their corresponding Standard Circuits and LEU Tables.

There are three construction/implementation options for bringing back Look-ahead aspect information from signal/s ahead, based on the existing signalling systems and trackside signalling infrastructure. These options are described below.

6.1. Option 1: Ethernet communications

This option requires a new optical cable (Ethernet communication) connecting the LEUs directly from the Look-ahead location to the receiving location. This option may be the optimum solution when the Look-ahead information is or can be made available at an existing LEU at the Look-ahead location without requiring the installation of new relays. Diagrams SS2, SR2, RR2 and RS2 are examples of this option.

6.2. Option 2: CBI data change

This option utilises the existing communications link between CBI locations, and requires the installation of a new relay at the receiving location to include the Look-ahead information as a new contact sensing input to the LEU. This option may be preferred at locations where an LEU is not otherwise required at the Look-ahead location. Diagram SS1 is an example of this option.

Note that modifying existing data might be a legitimate option but would involve a data re-commissioning. A case by case analysis needs to be carried out in order to ascertain the overall impact of any proposed option. Overall, the cost effectiveness will dictate the final outcome so long as it doesn't have a major impact on the project and lead to other risks.

6.3. Option 3: Hardwired copper cable

This option requires new relays to be created at the receiving location based on routes set at the Look-ahead location. This option is normally preferred when there is not an existing LEU at the Look-ahead location and there are no CBI COMMS between the two locations (i.e. option 2 is not possible). If spare copper cores are not available in the existing lineside cabling, option 1 and the installation of a new LEU at the Look-ahead location should be considered.

Diagrams SR1, RR1 and RS1 are examples of this option.

6.4. Location type permutations

From a Look-ahead perspective, there are two types of locations; 'SSI type' locations (including Westlock and Westrace), which normally use current sensing arrangements, and 'relay type' locations, which normally use contact sensing arrangements. Microlok locations fall into the relay type location category, as relays are used to drive the signal aspects in this type of signalling. The following sections describe the four different permutations between SSI type and relay type locations.

Note: For the purpose of presentation, the following sections assume that an LEU is provided at LOC B (i.e. the Look-ahead location) for other AMS functionalities.

6.4.1. SSI type location to SSI type location (SS)

Summary of Options:

- If the required TFM-B output(s) are to be wired into LEU B, then Scenario SS2 (Ethernet network) may be the optimal solution.
- If the required output(s) are available from TFM-B, but not wired into LEU B, then the solution may be to wire them into LEU B and then implement SS2.
- If the required output(s) are not available from TFM-B, then the likely solution will be to implement SS1.

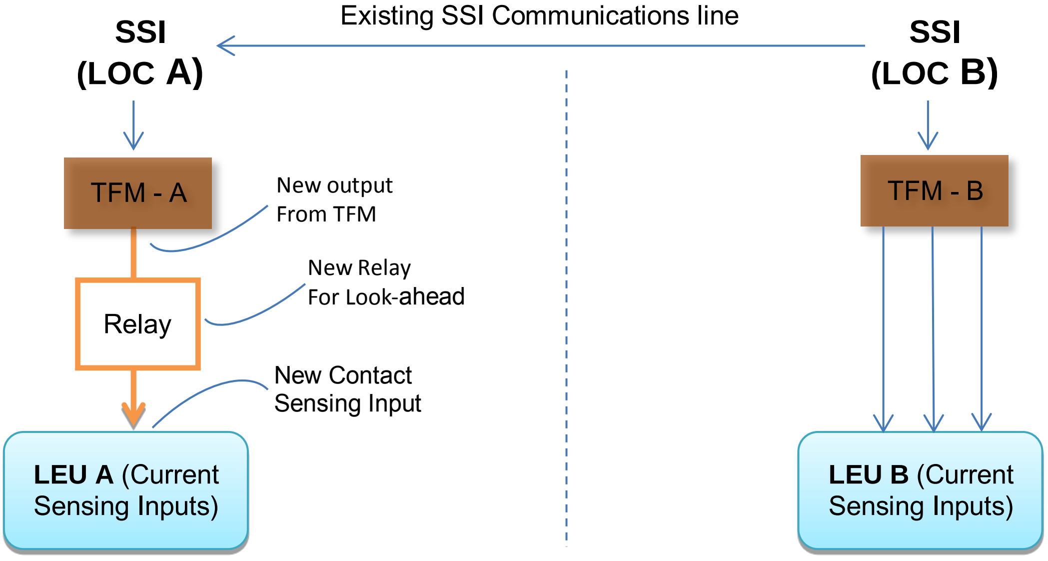

Figure 10 – Relay output from TFM and Contact Sensing input to LEU (SS1)

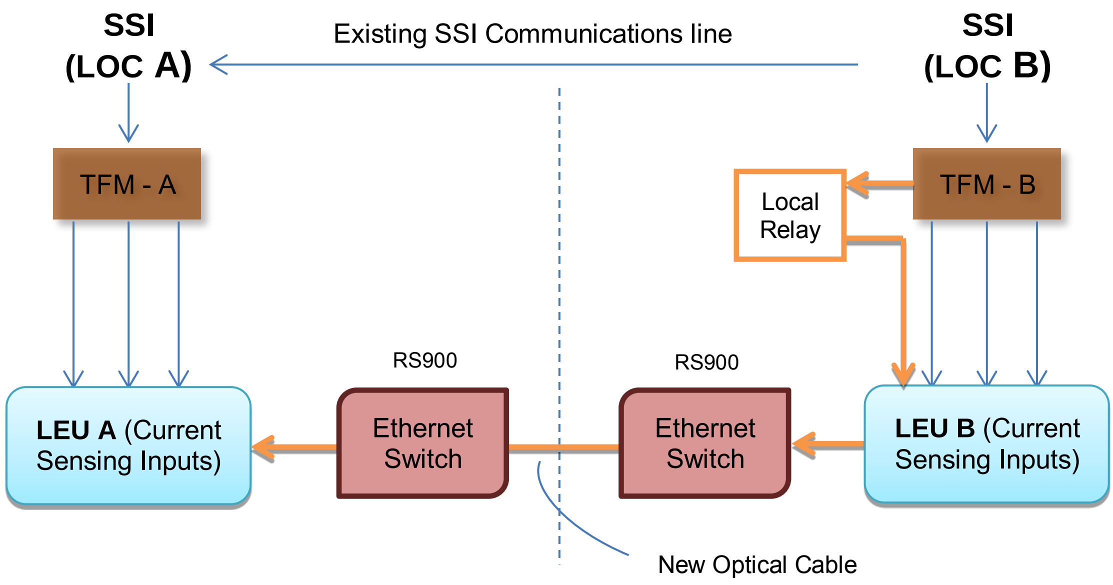

Figure 11 – Look-ahead using LEU Networking (SS2)

6.4.2. SSI type location to Relay type location (SR)

Summary of Options:

- If the required TFM output(s) are to be wired into LEU B, then Scenario SR2 (Ethernet network) may be the optimal solution.
- If the required output(s) are available from the TFM, but not wired into LEU B, then the solution will be to implement either SR1 or SR2.
- If the required output(s) are not available from the TFM, then the solution will be implementation of either SR1 or SR2 with the preference for SR1.

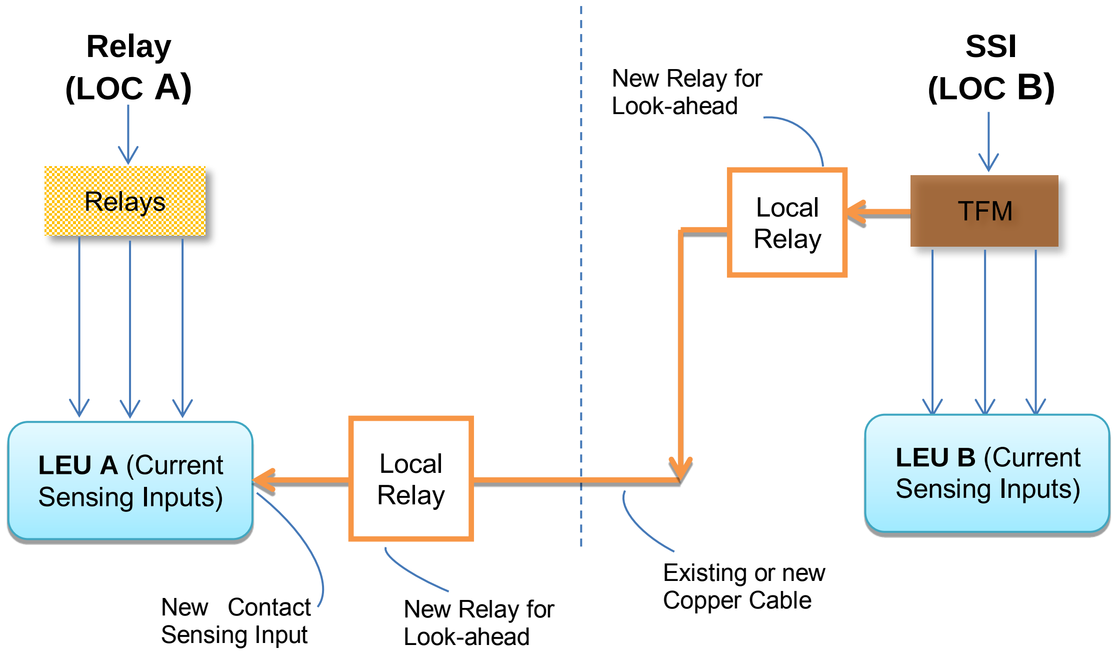

Figure 12 – Relay output from TFM and Contact Sensing input to LEU (SR1)

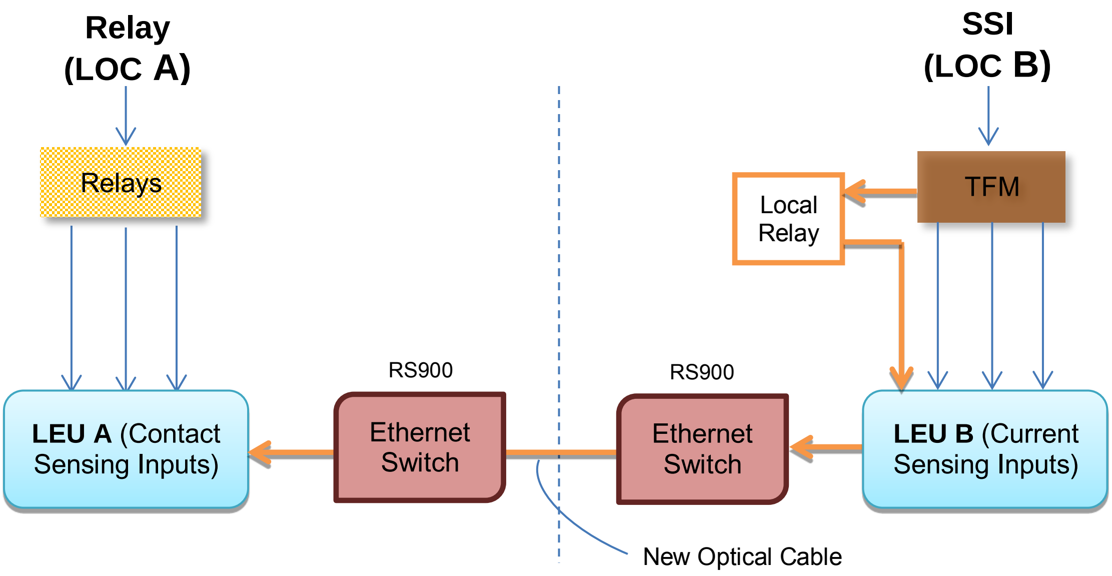

Figure 13 – Look-ahead using LEU Networking (SR2)

6.4.3. Relay type location to Relay type location (RR)

Summary of Options:

- If the required relay input(s) are to be wired into LEU B (provided for other AMS functionalities), then Scenario RR2 (Ethernet network) may be the optimal solution.
- If the required input(s) are not wired into LEU B or the required relays do not presently exist, then the solution could be either RR1 or RR2 depending on cost and availability of resources. Note: It is likely that scenario RR1 will be the most cost effective depending on whether spare viable copper cores exist.

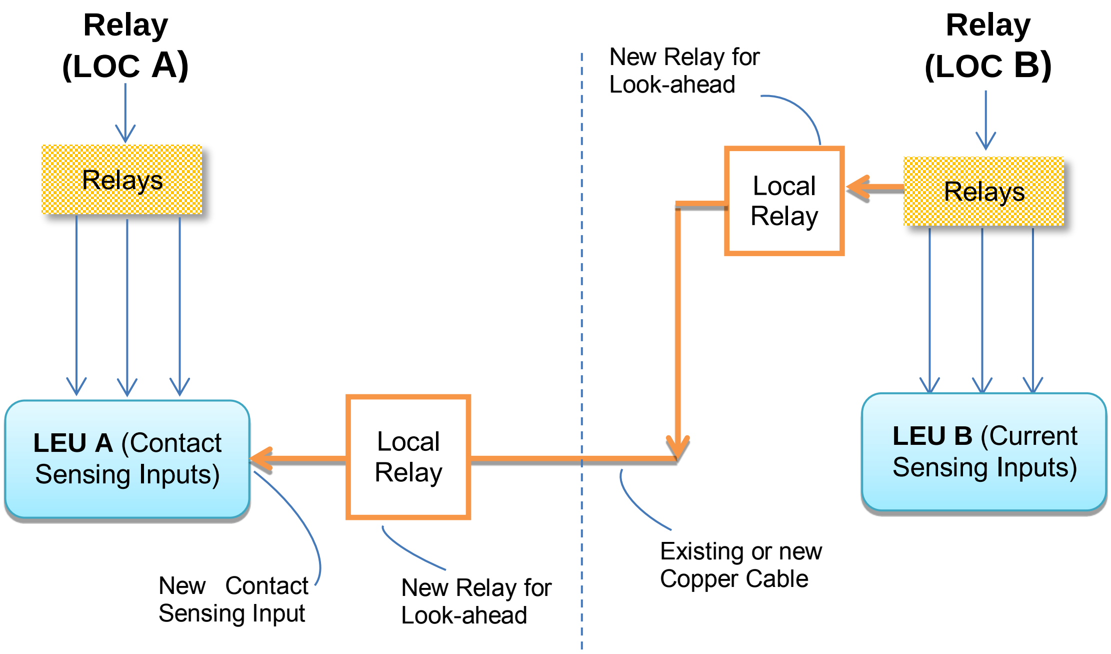

Figure 14 – Contact Sensing input to LEU (RR1)

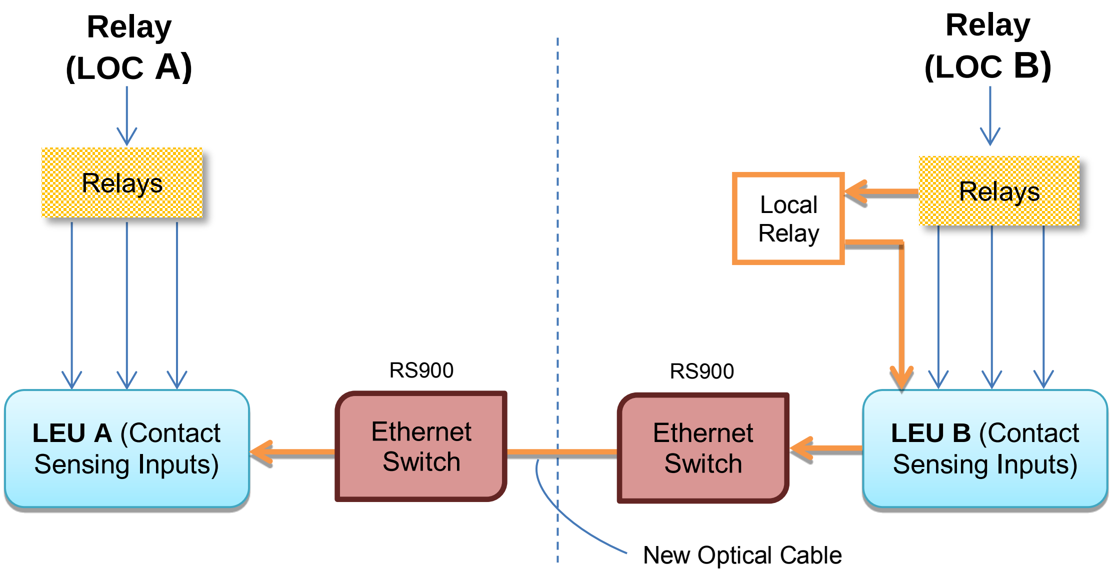

Figure 15 – Look-ahead using LEU Networking (RR2)

6.4.4. Relay type location to SSI type location (RS)

Summary of Options:

- If the required relay input(s) are to be wired into LEU B (provided for other AMS functionality), then Scenario RS2 (Ethernet network) may be the optimal solution.
- If the required input(s) are not wired into LEU B or the required relays do not presently exist, then the solution could be either RS1 or RS2 depending on cost and availability of resources. Note: It is likely that scenario RS1 will be the most cost effective depending on whether spare viable copper cores exist.

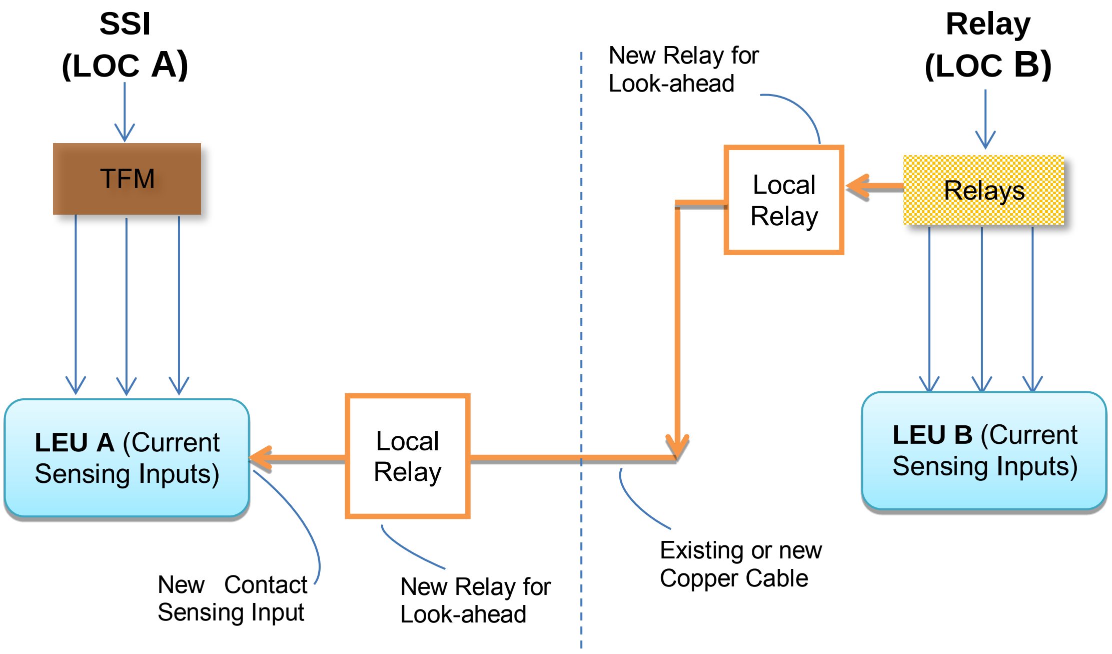

Figure 16 – Contact Sensing input to LEU (RS1)

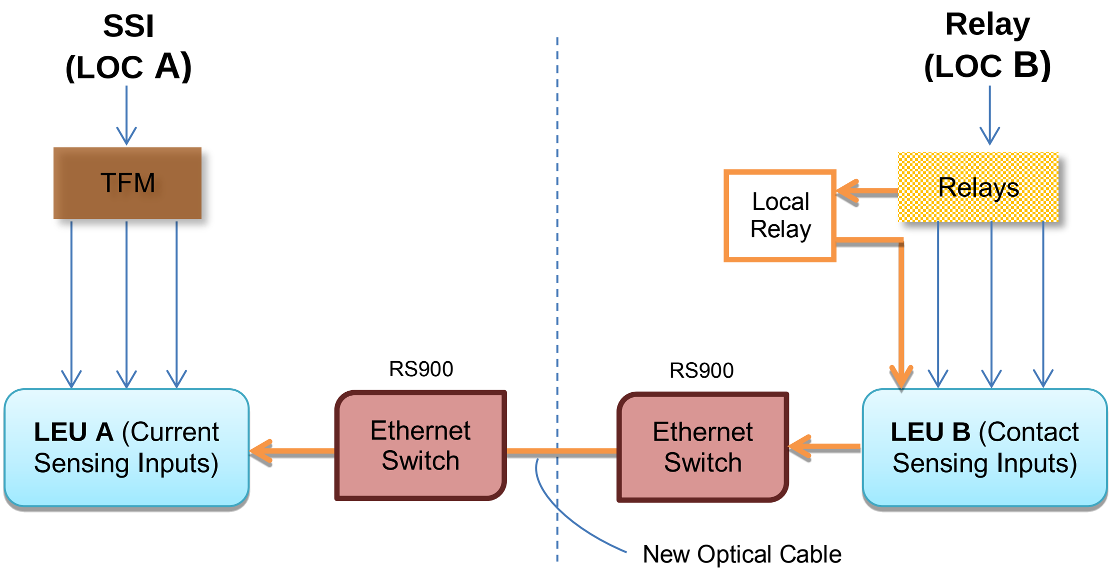

Figure 17 – Look-ahead using LEU Networking (RS2)

Appendix A

This section captures various layouts expected to be found within the AMS fitment area where Look-ahead needs to apply for the purpose of high risk turnout protection. In line with the purpose of Look-ahead, as stated in Section 5, each example derives the Look-ahead inputs required to cater for that particular scenario for both Contact and Current Sensing configurations.

Additionally, this section discusses if any of these inputs can be rationalised where an Approach BG is present (as per the Approach Balise Group Selection and Position Design Guideline) for each of these layouts. This can be possible where the turnout speeds does not need to be differentiated and also due to the fact that inputs for all main electrified routes originating from the signal connected to the Approach BG are provided to its LEU so that the appropriate speed updates can happen from the Approach BG. However, turnout speeds may still need to be differentiated in order to avoid any Driver confusion, (through alignment of LSSMA information with the corresponding turnout route set ahead) and presence of an Approach BG won't help in reducing any Look-ahead inputs.

In contact sensing configurations, where external circuits need to be modified to create additional relays based on signal controls from the Look-ahead location, inputs from all these relays are provided to the LEU.

In current sensing configurations, Look-ahead input requirements are based on the below mentioned fail-safe design principles:

- Input related to the route leading over the most restrictive speed profile of a high risk junction is not provided to the LEU. This is due to the fact that absence of all the Look-ahead inputs (either due to that particular route being set or due to failure) will enforce the most restrictive speed profile of the junction through the LEU Masks.
- BOL (single light signals) and Top Yellow (double light signals) aspect of a junction signal has not been considered in addition to the Route Indicators for Look-ahead inputs. This is due to the fact that an SSI controlled signal is held at its first Proceed aspect during any of the lamp failures related to the signal ahead (except the route indicators) and accordingly the most restrictive speed profile of the junction is sent.

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A.1 Single Turnout

A.1.1 No Approach BG

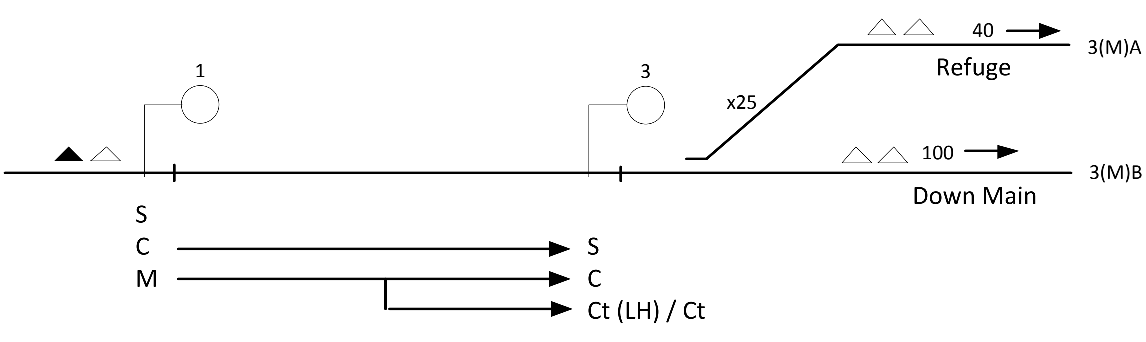

Figure 18 – Single Turnout

A.1.1.1 Contact Sensing Configuration (Single and Double light signals):

3(M)A HR and 3(M)B HR relay information needs to be brought back to Signal 1 location. Two additional Medium aspect control relays for Signal 1 need to be created based on this information and contacts from both these relays need to be provided to the LEU.

A.1.1.2 Current Sensing Configuration:

Single light signals: Yellow lamp monitoring input of Signal 3 needs to be brought back and provided to the LEU along with the aspects of Signal 1.

Double light signals: Top Green lamp monitoring input of Signal 3 needs to be brought back and provided to the LEU along with the aspects of Signal 1.

A.1.2 With Approach BG (connected to Signal 3)

A.1.2.1 Contact Sensing Configurations (Single and Double light signals):

Presence of an Approach BG doesn't help rationalise the inputs further. Look-ahead design follows the same as described in A.1.1.1.

A.1.2.2 Current Sensing Configurations:

Single and Double Light signals: Look-ahead inputs provided to the LEU are as discussed in A.1.1.2. Further rationalisation of inputs is not possible.

A.2 Multiple Turnouts – towards both directions

A.2.1 No Approach BG

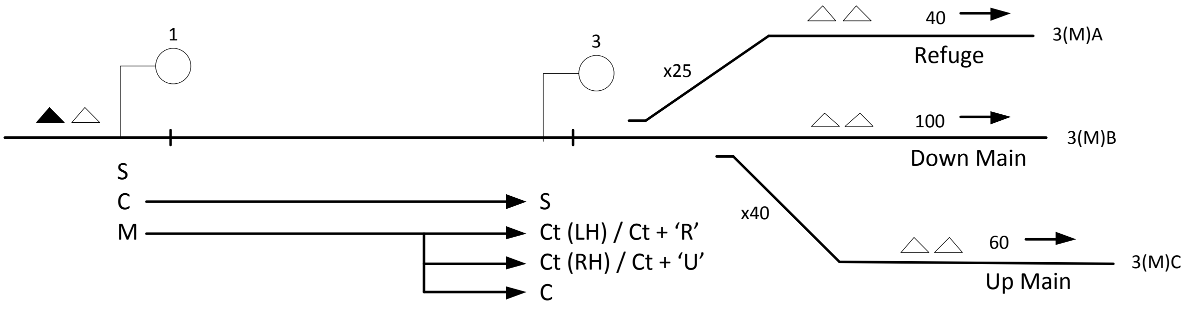

Figure 19 – Multiple Turnouts (1)

A.2.1.1 Contact Sensing Configuration (Single and Double light signals):

3(M)A HR, 3(M)B HR and 3(M)C HR relay information needs to be brought back to Signal 1 location. Three additional Medium aspect control relays for Signal 1 need to be created based on this information and contacts from all of them need to be provided to the LEU.

A.2.1.2 Current Sensing Configuration:

Single light signals: Yellow and 'RH BOL' lamp monitoring inputs of Signal 3 need to be brought back and provided to the LEU along with the aspects of Signal 1.

Double light signals: Lamp monitoring inputs from the Top Green lamp and 'U' route indicator of Signal 3 need to be brought back and provided to the LEU along with the aspects of Signal 1.

A.2.2 With Approach BG (connected to Signal 3)

A.2.2.1 Contact Sensing Configuration (Single and Double light signals):

Presence of an Approach BG doesn't help rationalise the inputs further. Look-ahead design follows the same as described in A.2.1.1.

A.2.2.2 Current Sensing Configuration:

Single and Double Light signals: Look-ahead inputs provided to the LEU are as discussed in A.2.1.2. Further rationalisation of inputs is not possible.

A.3 Multiple Turnouts – towards the same direction

A.3.1 No Approach BG

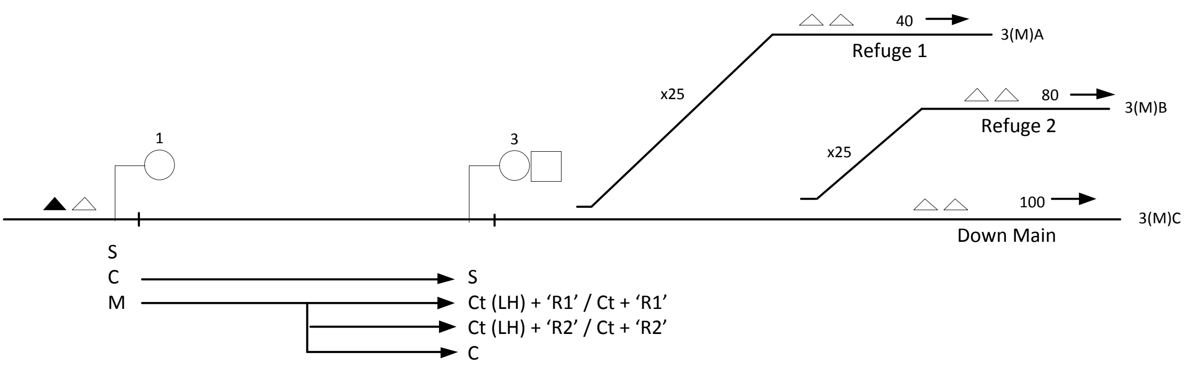

Figure 20 – Multiple Turnouts (2)

A.3.1.1 Contact Sensing Configuration (Single and Double light signals):

3(M)A HR, 3(M)B HR and 3(M)C HR relay information needs to be brought back to Signal 1 location. Three additional Medium aspect control relays for Signal 1 needs to be created based on this information and contacts from all of them need to be provided to the LEU.

A.3.1.2 Current Sensing Configuration:

Single light signals: Lamp monitoring inputs from the Yellow aspect and 'R2' route indicator of Signal 3 need to be brought back and provided to the LEU along with the aspects of Signal 1.

Double light signals: Top Green and 'R2' route indicator lamp monitoring inputs of Signal 3 need to be brought back and provided to the LEU along with the aspects of Signal 1.

Note:

Although the turnout speeds are the same in this case, the main objective of providing Look-ahead is to send the correct post turnout speed for a particular line and thus not to depend on the repositioning BG for that purpose. Also, if the distance between the turnouts becomes long and accordingly the operational restriction on Refuge 2 becomes unacceptable, Look-ahead will be required irrespective of the post turnout speeds.

A.3.2 With Approach BG (connected to Signal 3)

A.3.2.1 Contact Sensing Configuration (Single and Double light signals):

Since the turnout speeds are same and the correct post turnout speeds can be applied from the Approach BG, 3(M)A HR and 3(M)B HR relay information can be combined into one single relay while 3(M)C HR relay information needs to be brought separately to Signal 1 location. Therefore presence of the Approach BG will save usage of an external relay and running of two cores from Signal 3 to Signal 1 location. With 3(M)A or 3(M)B route set at the junction, the TSM initiating BG will only send the turnout speed and apply for the turnout related to 3(M)A route being the most restrictive.

A.3.2.2 Current Sensing Configuration:

Single Light signals: In line with the philosophy of contact sensing, the only lamp monitoring input required from Signal 3 is the Yellow aspect.

Double Light signals: In line with the philosophy of contact sensing, only the Top Green lamp monitoring input of Signal 3 is required.

In both cases, input from the 'R2' route indicator is not required due to presence of an Approach BG connected to Signal 3.

Note:

If a significant distance between the turnouts leads to an unacceptable operational restriction for 3(M)B route and accordingly 3(M)A and 3(M)B routes need to be differentiated, then three additional relays need to be created for Look-ahead purposes anyway and inputs from all these relays need to be provided to the LEU. And thus presence of an Approach BG won't help rationalise the Look-ahead design in that case.

A.4 Consecutive Turnouts – Higher Speed followed by Lower Speed

A.4.1 No Approach BG

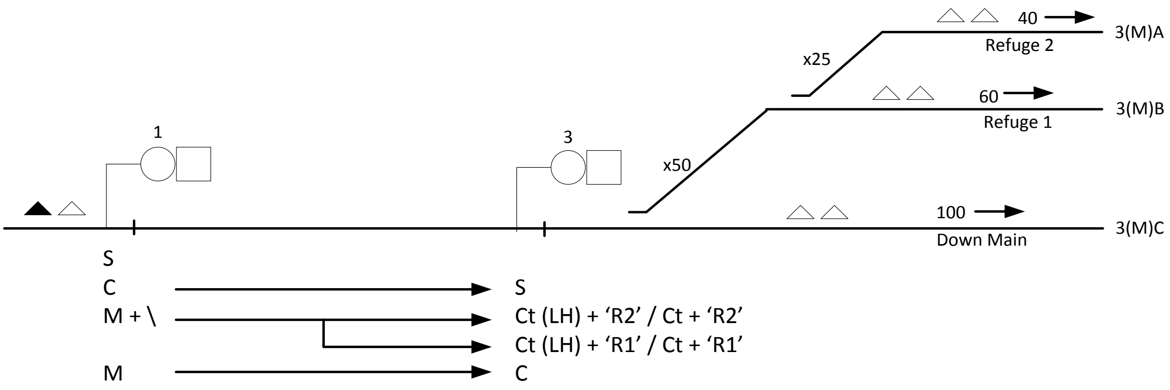

Figure 21 – Consecutive Turnouts (1)

A.4.1.1 Contact Sensing Configuration (Single and Double light signals):

In this case Signal 1 is fitted with a Left hand Turnout Repeater that is valid for both 3(M)A and 3(M)B routes and hence 3(M)A HR and 3(M)B HR relay information needs to be brought back to Signal 1 location separately. The existing Turnout Repeater control relay for Signal 1 needs to be separated into two relays based on this information and contacts from these relays need to be provided to the LEU.

Note: In this case, Look-ahead provides an operational benefit by providing the correct speed profile according to the route set. This may not be significant because of the layout; however the main objective in providing Look-ahead in this scenario is to avoid Driver confusion since provision of Look-ahead enables the displayed LSSMA information to be aligned with the posted speeds of the route set.

A.4.1.2 Current Sensing Configuration:

Single light signals: Lamp monitoring input from 'R1' route indicator of Signal 3 needs to be brought back and provided to the LEU along with the aspects of Signal 1 including the Turnout Repeater.

Double light signals: Lamp monitoring input from 'R1' route indicator of Signal 3 needs to be brought back and provided to the LEU along with the aspects of Signal 1 including the Turnout Repeater.

In both cases, 'R1' input is required as it belongs to the lesser restrictive route 3(M)B.

A.4.2 With Approach BG (connected to Signal 3)

A.4.2.1 Contact Sensing Configuration (Single and Double light signals):

Since the turnout speeds for 3(M)A and 3(M)B routes need to be differentiated in this case, presence of an Approach BG doesn't help rationalise the Look-ahead design further and it follows the same as described in A.4.1.1.

A.4.2.2 Current Sensing Configuration:

Single and Double Light signals: Look-ahead inputs provided to the LEU are as discussed in A.4.1.2. Further rationalisation of inputs is not possible.

A.5 Consecutive Turnouts – Lower Speed followed by Higher Speed

A.5.1 No Approach BG

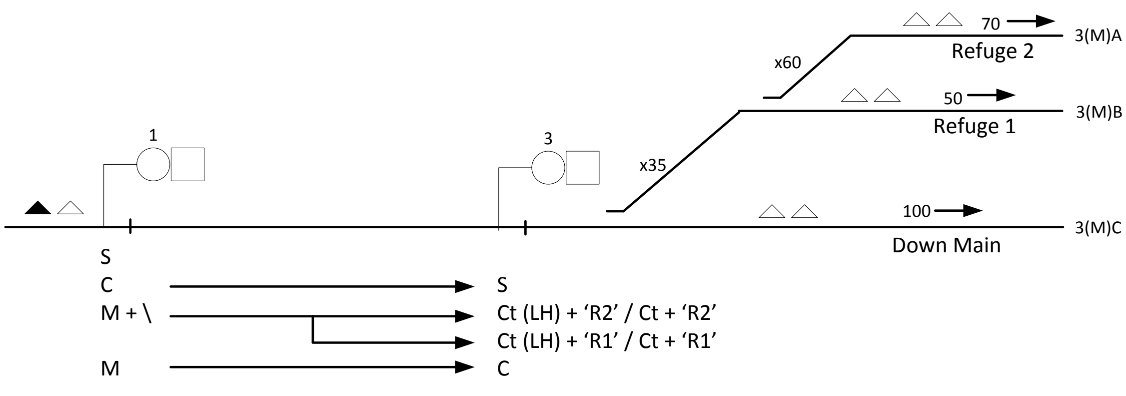

Figure 22 – Consecutive Turnouts (2)

A.5.1.1 Contact Sensing Configuration (Single and Double light signals):

Similar to the previous example, Signal 1 is fitted with a Left Hand Turnout Repeater that is valid for 3(M)A and 3(M)B routes. 3(M)A HR and 3(M)B HR relay information needs to be brought back to Signal 1 location separately. The existing Turnout Repeater control relay for

Signal 1 needs to be separated into two relays based on this information and contacts from these relays need to be provided to the LEU.

Note: Because of the presence of the lower speed turnout before a higher speed turnout, the LSSMA will always display a speed of 35km/h in this case irrespective of 3(M)A or 3(M)B route being set and hence the issue of Driver confusion doesn't arise even without the provision of Look-ahead. However, the main benefit lies in the ability to apply the correct post turnout speed profile according to the route set instead of depending upon the repositioning balise group for that purpose.

A.5.1.2 Current Sensing Configuration:

Single light signals: Lamp monitoring input from the 'R1' route indicator of Signal 3 needs to be brought back and provided to the LEU along with the aspects of Signal 1 including the Turnout Repeater.

Double light signals: Lamp monitoring input from 'R1' route indicator of Signal 3 needs to be brought back and provided to the LEU along with the aspects of Signal 1 including the Turnout Repeater.

In both cases, 'R1' input is required as it belongs to the lesser restrictive route 3(M)B.

A.5.2 With Approach BG (connected to Signal 3)

A.5.2.1 Contact Sensing Configuration (Single and Double light signals):

Because of the specific nature of this layout (refer 'Note' under Section A.5.1.1), there is no benefit in identifying the different turnout speeds. Therefore, the turnout repeater fitted to Signal 1 is sufficient to distinguish between the straight and any of the divergent routes set and accordingly Look-ahead is not required. With 3(M)A or 3(M)B route set at the junction, the TSM initiating BG will only send the turnout speeds of 35 and 60 and will apply at the corresponding turnouts while the correct post turnout speed will be updated from the Approach BG according to the route set at the junction signal.

A.5.2.2 Current Sensing Configuration:

Single and Double Light signals: In line with the philosophy of contact sensing, input from the 'R1' route indicator is not required and therefore there is no need for Look-ahead.

A.6 Combination of Multiple and Consecutive Turnouts

A.6.1 No Approach BG

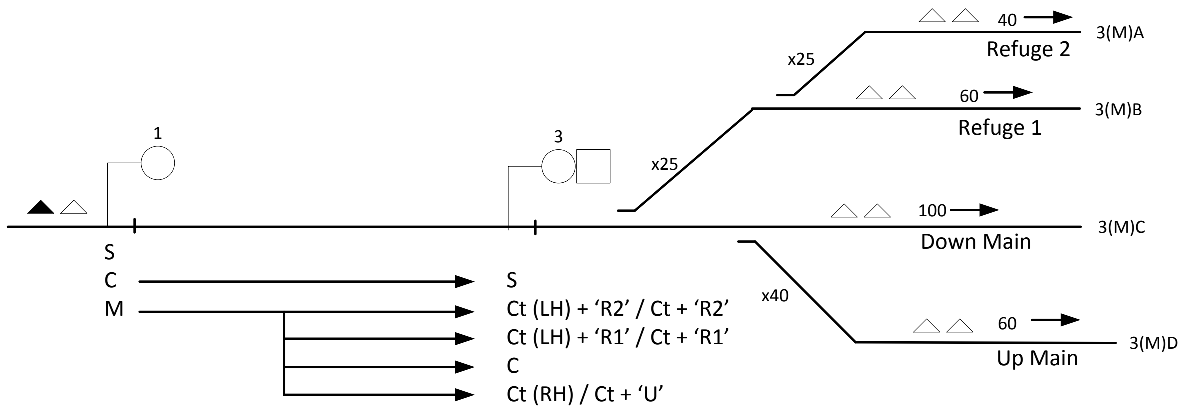

Figure 23 – Combination of Multiple and Consecutive Turnouts

A.6.1.1 Contact Sensing Configuration:

3(M)A HR, 3(M)B HR, 3(M)C HR and 3(M)D HR relay information needs to be brought back to Signal 1 location. Four additional Medium aspect control relays for Signal 1 need to be created based on this information and contacts from these relays need to be provided to the LEU for both single light and double light signals.

Note: Since the Turnout speeds for both Refuge roads are same in this case, the issue of Driver confusion (due to LSSMA information shown on DMI) doesn't arise here. However, the main objective of bringing the information separately is to apply the correct post turnout speed for each Refuge road. Therefore, 3(M)A HR and 3(M)B HR could be combined at Signal 3 location and brought as a single relay to Signal 1 location only if the post turnout speeds for both Refuge roads are the same.

A.6.1.2 Current Sensing Configuration:

Single light signals: Lamp monitoring inputs from Yellow and RH BOL aspects and the 'R1' route indicator of Signal 3 need to be brought back and provided to the LEU along with the aspects of Signal 1.

Double light signals: Lamp monitoring inputs from the Top Green lamp as well as 'R1' and 'U' route indicators of Signal 3 need to be brought back and provided to the LEU along with the aspects of Signal 1.

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Note: In the cases where the post turnout speeds for both the Refuge roads are the same, lamp monitoring input from the 'R1' route indicator becomes redundant for both single and double light signals.

A.6.2 With Approach BG (connected to Signal 3)

A.6.2.1 Contact Sensing Configuration (Single and Double light signals):

Since the turnout speeds for Refuge Roads are same, there is no need to differentiate them and accordingly 3(M)A HR and 3(M)B HR relay information can be combined into one single relay at Signal 3 location while 3(M)C HR and 3(M)D HR relay information need to be brought separately to Signal 1 location. Therefore presence of the Approach BG will save usage of an external relay and running of two cores from Signal 3 to Signal 1 location. With 3(M)A or 3(M)B route set at the junction, the TSM initiating BG will only send the turnout speed of 25 for both the turnouts while the route specific speed profile will be updated from the Approach BG.

A.6.2.2 Current Sensing Configuration:

Single Light signals: Lamp monitoring inputs from the Yellow and RH BOL aspects of Signal 3 need to be brought back and provided to the LEU along with the aspects of Signal 1.

Double Light signals: Lamp monitoring inputs from the Top Green lamp and 'U' route indicator of Signal 3 need to be brought back and provided to the LEU along with the aspects of Signal 1.

In both cases, input from the 'R1' route indicator is not required.