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Technical Note - TN 010: 2016

Issued date: 20 April 2016

Effective date: 20 April 2016

Subject: Update to EGG 1656 *Balise Placement and Metal Mass Assessment Guide*

This technical note is issued by the Asset Standards Authority to notify the changes to EGG 1656 *Balise Placement and Metal Mass Assessment Guide*, Version 1.0.

The following changes have been made to EGG 1656:

Section 6.1 Big metal mass announcement balise group: the last paragraph and the formula are replaced with the following content:

The BMM announcement balise group is placed at least 75 m but no more than 500 m ('D_BMM') from the beginning of the BMM (refer to ESG 100.31). See **Equation 1.**

Maximum Line Speed (V_MAXTRAIN) = 160km/h (45m/s) for the RailCorp network.

To process balise information and act on it, the on-board T_Reaction_Time is <1.5 seconds (sub-clause 5.2.1.3 Subset-041).

D_BMM (m) = (1.5s * 45m/s) = 67.5m (rounded up to 75m).

Equation 1 – Balise placed between the minimum and maximum distance from beginning of BMM

Note: This distance applies to ETCS Level 0, Level 1 and Level 2.

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Section 6.2 Balise in the vicinity of a big metal mass: the last paragraph and the formula are replaced with the following content:

Where a balise is placed close to a BMM, the distance between the BMM and the balise is calculated as shown in **Equation 2**.

At a maximum track speed of 160 km/h, the balise exclusion zone = 2 * (5% * distance from last relevant balise group (m) + 5(m)) + (2 * Q_LOCACC (m)).

Equation 2 – Balise placed close to a BMM

The balise exclusion zone is based on the BMM announcement balise group at between 75 m and 500 m from the BMM.

The following sections are deleted:

~~**Section 6.2.1 Uni-directional track**~~

~~**Section 6.2.2 Bi-directional track**~~

Add the following new Section 6.4 after Section 6.3:

6.4 BMM optimisation

Where there are several BMMs in sequence and the distance between any of the BMMs is less than 80 m then, only one BMM announcement balise group is placed before the first BMM in the group. This BMM announcement balise group announces all BMMs. See **Figure 1**.

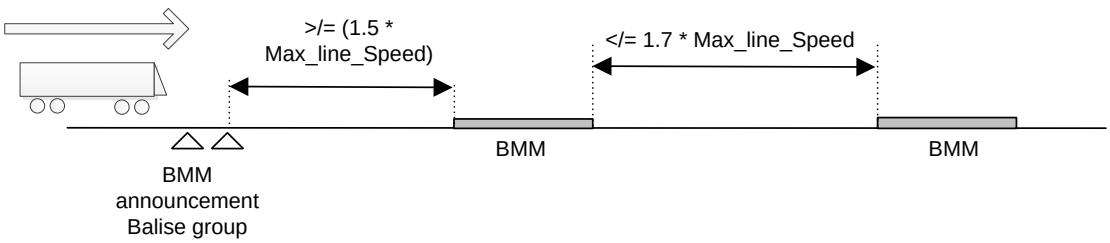

Figure 1 – Management of multiple BMM's in close proximity on a unidirectional line

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Add the following new Section 6.5 after Section 6.4:

6.5 BMM bi-directional track optimisation

With bi-directional track and several BMM, where the distance between any of the BMMs is less than 135 m, then only one BMM announcement balise group is placed before and after the group of BMMs. See **Figure 2**.

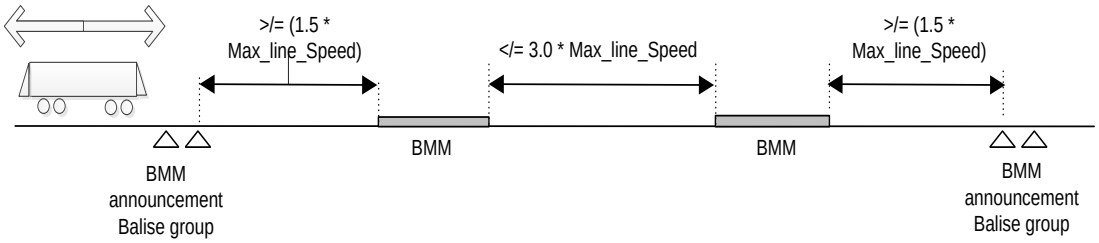

Figure 2 – Management of multiple BMM's in close proximity on a bi-directional line

Section 7 Balises close to a metal mass object other than a BMM: the last sentence, shown below, is deleted.

~~Note: By keeping balises at least 10 m away from any metal mass, the clearances for the above categories 1 to 3 can be accommodated.~~

Section 8 Survey: the first paragraph is replaced by the following content:

A geographic survey is carried out to identify and record BMM locations.

Section 8.2 Initial identification of metal mass: the title is replaced by the following:

8.2 Initial identification of big metal mass

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Engineering Guideline
Signals
Design

EGG 1656

BALISE PLACEMENT AND METAL MASS ASSESSMENT GUIDE

Version 1.0

Issued March 2013

Reconfirmed 02 July 2019

Engineering Guideline

Owner:	Chief Engineer, Signals & Control Systems		
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Document control

Version	Date	Summary of change
1.0	21/03/2013	First issue.

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1 Introduction

A Big Metal Mass (BMM) is a metallic object considered outside an allowed metallic mask, as defined in section 6.5 of the European Railway Agency (ERA) Specification Subset-036 for the European Train Control System (ETCS).

A metal mass in the four foot of the track can obstruct the ability of the on-board transmission equipment to function correctly. If a BMM is detected, the on-board system might report a malfunction (system failure) of the on-board transmission (antenna) function (Subset-026 clause 3.15.7.1), and an alarm may be triggered, resulting in an emergency brake intervention.

To avoid this alarm, a BMM must be announced beforehand by a balise group. This BMM announcement will suppress the on-board alarm for the specified length of the BMM. A detected BMM persisting for a distance longer than the announced length will still result in an emergency brake intervention.

An emergency brake intervention will require a system power down and reset, to recover for normal operations.

In order to guarantee interoperability, Subset-036 rules shall be applied. In addition, any particular constraints from ETCS suppliers must also be considered.

It will therefore be necessary to identify all BMM's on the RailCorp network, to determine where BMM announcements are required, and if additional balises are required for BMM announcement purposes. The lengths of these BMM's must be measured to ensure alarm suppression occurs for the full length of each BMM.

2 Scope

The scope of this document is limited to the trackside design process and construction activities for the RailCorp Automatic Train Protection (ATP) ETCS project.

This guideline:

- summarises BMM criteria,
- defines the specifications for placement of balises announcing BMM's, and
- defines the process for identifying and measuring BMM's.

2.1 Purpose

The primary purpose of this document is to define the requirements and methodology for assessing metal mass with consideration for ‘Big Metal Mass’ announcement and balise placement, such that on-board antenna alarms are avoided.

A secondary purpose is to provide guidelines to enable consistency of the design of trackside ETCS systems.

2.2 Application

This guideline is applicable to Level 0, Level 1 and Level 2.

3 Reference documents

Reference	Description
ERA/ETCS Subset-026 Version 3.3.0	*System Requirements Specification*

EGG 1544	*Measurement of Geographic Data for ATP*
ERA/ETCS Subset-036 Version 3.0.0	*Installation Rules for Balise*
ERA/ETCS Subset-040 Version 3.2.0	*Dimensioning and Engineering Rules*
ERA/ETCS Subset-041 Version 3.1.0	*Performance Requirements for Interoperability*
SPG 0706	*Installation of Trackside Equipment*
ESG 100.31	*Signal Design Principles*
ATP Construction Drawings	*M05-500 series for ATP*

4 Terms and definitions

The following definitions apply in this document:

ATP	Automatic Train Protection
BMM	Big Metal Mass
ERA	European Railway Agency
ETCS	European Train Control System
Level 2	ETCS application level that uses radio to transmit movement authorities to trains
Level 1	ETCS fitted lines that use balises to transmit movement authorities to trains
Level 0	ETCS un-fitted lines (minimal track to train transmission)
MTP	Mechanised Track Patrol
STM	Specific Transmission Module
TOR	Top of Rail. In the context of this guideline, the term TOR refers to top of plane of new rail heads.

5 Big Metal Mass Definitions

5.1 Level 1 & Level 2 Areas

In Level 1 and 2 areas, BMM's need to be announced to avoid alarms and undue braking of trains.

A balise group before a BMM shall command the on-board to inhibit integrity alarms for the length of the BMM.

There is no need for a balise group after the BMM to enable the onboard antenna self-test again, as the length of the BMM is part of the BMM announcement (refer to section 6).

5.2 Level 0 Areas

In Level 0 areas, BMM's need to be announced to avoid alarms and undue braking of trains. The on-board ETCS system has been preconfigured to suppress alarms due to BMM's in Level 0 (and Level STM) for BMM's, up to a certain length.

For the current ETCS version this pre-configured length ('D_Metal') is presently selected (default) at 300m. This means that BMM's need announcement balises in Level 0 territory only if they are 300m or longer.

5.3 Big Metal Mass Infrastructure

Subset-036 (section 6.5) classifies metallic objects in the vicinity of balises into categories 1, 2 or 3.

Category 1, 2 or 3 objects do not require BMM announcements.

Objects complying with categories, 1, 2 and 3 will be tolerated by the on-board system (i.e. no BMM alarm will be generated).

Note 1: Width measurement of the metallic object is taken at the highest point.

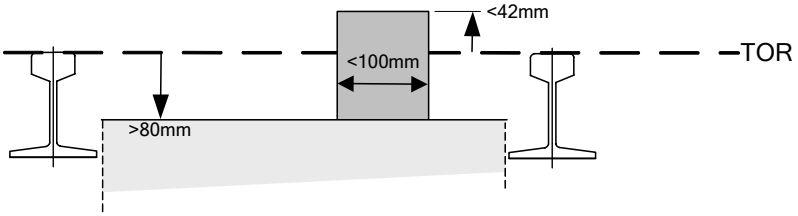
Note 2: All distances between the balise group and the metal mass are considered from the centre of the balise closest to the metal mass.

A BMM alarm should not be generated if the metallic object is located within the following summarised dimensional and positional constraints:

Category 3 Objects:

Top of surface shall be:

- < 100mm in total combined width and top of object less than 42mm above TOR, or
- >80mm below TOR (any width).

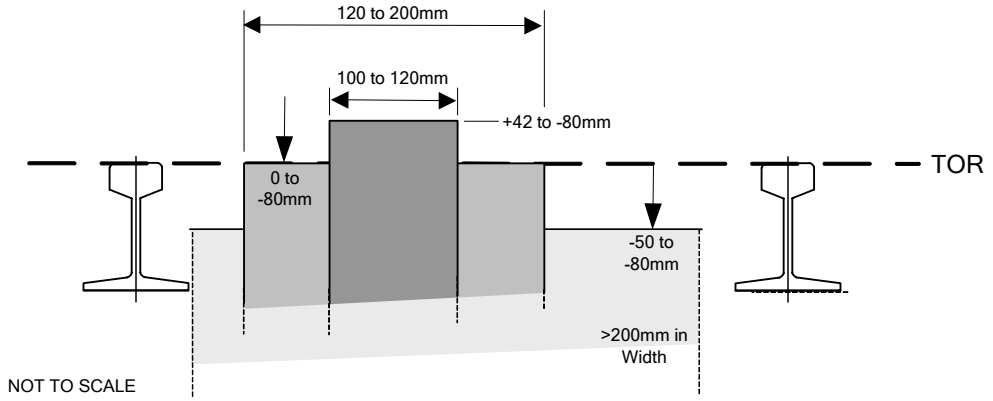


NOT TO SCALE

Category 2 Objects:

Objects belonging to this category are wider than 100mm and have no restriction on length. Top of surface shall be:

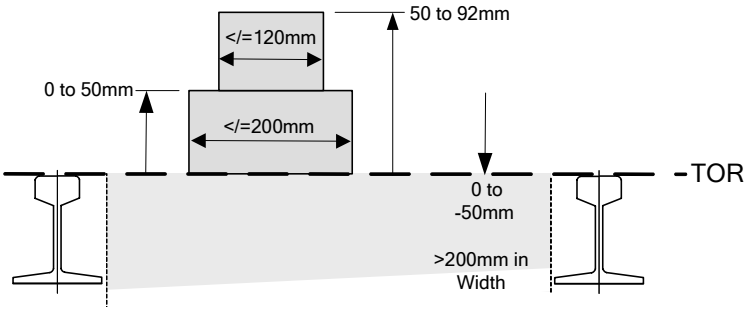
- 100 to 120mm wide (no length restriction) between 42mm above TOR and 80mm below TOR, or
- 120 to 200mm wide (no length restriction) between 0mm above TOR and 80mm below TOR, or
- >200mm wide (no length restriction) between 50mm and 80mm below TOR.



Category 1 Objects:

Category 1 objects have a length restriction of 10m. Top of surface shall be:

- </=120mm wide between 50mm and 92mm above TOR, or
- </=200mm wide between 0 and 50mm above TOR, or
- >200mm wide between 0mm above TOR and 50mm below TOR.



Where an overlap occurs in categories, the most restrictive case shall apply.

5.3.1 Check-Rail/Points/Crossovers:

Check-rails, long (e.g. high speed) points blades and crossovers are unlikely to exceed 25 to 30mm in height above TOR and as such, will be category 1, 2 or 3 objects. Within the RailCorp track environment the assumption is that there will be no metal above TOR or at least none more than 30mm in the form of thin (<200mm) check-rails and the like.

5.3.2 Guard-Rail:

Guard-rails formed from standard running rail are dealt with as a separate category in Subset-036 and are not a BMM.

Note 1: The metal thickness of the steel angle-iron guard rails used on the Harbour Bridge and at other restricted locations in the Sydney CBD, is within the allowable mask and is not a BMM.

Note 2: Rails temporarily stored in the four foot and overlapped could possibly be read by the on-board system as a BMM. The likelihood of the stored rails being observed by the on-board system as a BMM is considered low, providing that not more than two rails are

located in the four foot and are not overlapped for more than 10m. These should present a similar metal mass profile as a pair of standard guard rails.

Stored rails must not encroach within 1m of a balise.

5.3.3 Derailment Plinth:

A concrete derailment plinth may be found in the four foot on some bridges or tunnels and which takes the place of steel guard rails. It will contain metallic reinforcing which is normally at least 50mm below the surface.

Some plinths are located above TOR and depending on the profile, could present as being outside of the allowable mask (i.e. a BMM).

Note: In order to install a balise at a concrete derailment plinth, it is likely that a section of that plinth will need to be removed. If a balise group is required to be installed within a derailment plinth which is also a BMM, then a significant section of plinth may need to be removed or other options considered.

Options for removal and re-instatement of the integrity of a cut derailment plinth will need to be agreed by Chief Engineers Signals, Track and Civil, on a case by case basis.

Note: Some derailment plinths (also known as ‘up-stands’) such as in the ECRL tunnels may also form part of a track anti-vibration dampening system and it may not be feasible to remove significant sections of the plinth.

5.3.4 Road/Rail Level Crossings:

A concrete road/rail level crossing including hi-rail access and emergency access track crossings etc will contain metallic reinforcing and will generally be a category 2 object as the steel will normally lie at least 50mm below TOR.

A road/rail level crossing (concrete or otherwise) will usually contain steel check rails and which usually extend before and after the crossing. Check rails will generally be a category 2 object.

5.3.5 Slab Track:

Concrete slab track will contain metallic reinforcing normally at least 50mm below the surface. This is often found in tunnels, and it is recommended to check the available tunnel guides for the type of formation used.

Concrete slab track will generally be a category 3 object, as the steel will normally lie well below 80mm from TOR.

5.3.6 Steel Bridges:

Timber transom topped steel bridges will generally be a category 3 object as the steel will normally lie well below 80mm from TOR.

The Sydney Harbour Bridge for example, might appear to be a BMM (and there are signals on it which will require balises), however, as the timber transoms (sleepers) vary in thickness from 160mm upwards, the metal bridge structure in this example is not a BMM under the definition of Subset-036.

5.3.7 Other Metallic Objects:

Other metallic objects may exist in the four foot such as metal walkways or old style metal cover plates over signal branch EP point layouts.

If for example, the top of a metal mesh (or solid) walkway deck (longer than 10m) is located (vertically) between zero and 50mm below TOR, it will highly likely be classified as a BMM. Options might be to: lower the walkway, replace it with an approved glass fibre decking or remove it. Most metal walkways will be on top of the sleepers/transoms which will place it as a category 2 or 3 object.

6 Big Metal Mass Balise Group Placement

Standard balise group placement clearances are based on a line speed of 160km/hr. At locations where infrastructure constraints do not permit the standard placement, a line speed less than 160km/hr but greater than actual maximum line speed may be used in the following calculations with agreement from the Chief Engineer Signals.

6.1 Big Metal Mass Announcement Balise Group

It is a requirement to minimise the number of balises to be installed, and existing balise groups should be used for BMM announcement, wherever practical.

The BMM announcement balise group shall be placed at least 70 ('D_BMM') metres from the beginning of the BMM (refer to ESG 100.31 clause 31.11.1.1). See calculation below.

Calculation:

Maximum Line Speed (V_MAXTRAIN) = 160km/h (45m/s) for the RailCorp network.

To process balise information and act on it, the on-board T_Reaction_Time is <1.5 seconds (sub-clause 5.2.1.3 Subset-041).

D_BMM (m) = 1.5s * 45m/s = 68m (rounded up to 70m).

Note: This distance applies to ETCS Levels 0, 1 and 2.

6.2 Balises in the vicinity of a Big Metal Mass

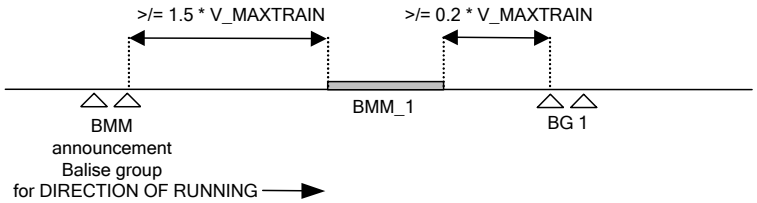
The on-board system requires at least 0.2 seconds to recover the ability to detect and read balises once the influence from the metal mass has disappeared (sub-clause 6.2.1.7 Subset-036).

Where a balise is to be placed close to a BMM, the distance between the BMM and the balise shall be >/= 10m. See calculation and sketch below.

Calculation:

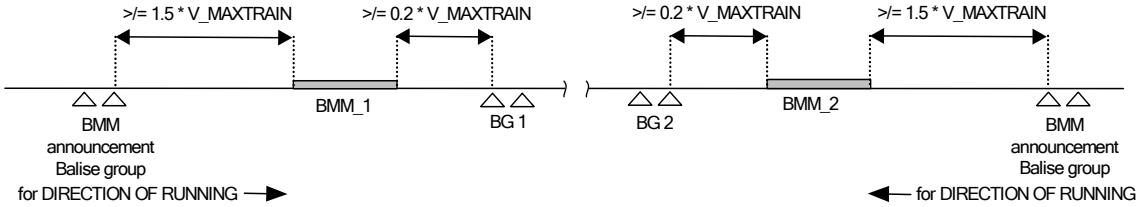
At a maximum track speed of 160km/h, this equates to a minimum distance of 9m (rounded up to 10m) (T_Reaction_Time (0.2s) * V_MAXTRAIN (45m/s).

6.2.1 Uni-directional Track



6.2.2 Bi-directional Track

A BMM announcement balise group shall be provided for each direction.



6.3 Adjacent Big Metal Mass's

Where BMM's are close to each other (i.e. where several sequential BMM's exist), one BMM announcement balise group may be used to announce all of them. The BMM announcement balise group shall announce all BMM's separately.

Where the distance between BMM's is >80m (see calculation below) a separate BMM announcement balise group can be installed, but in order to reduce the number of balises this is generally not done unless the distance is >300m.

Calculation:

T_Reaction_Time (1.5s + 0.2s) * V_MAXTRAIN (45m/s) = 77m (rounded up to 80m).

7 Balises close to a Metal Mass Object other than a BMM

In addition to the normal balise installation constraints defined on M05-500 series construction drawings, the following sub-clause 6.2.18 Subset-036 clearances from a balise and a metal mass object shall apply where it is required to place a balise group close to a metal mass belonging to the categories as specified in section 5.3:

Category 1 Object:

- >/= 0.35*√(length of object) + 1.1m

Category 2 Object:

- >/= 1.1m

Category 3 Object:

- Normal balise installation rules for metal mass and cable exclusion zones according to the M05-500 series construction drawings.

Note: By keeping balises at least 10m away from any metal mass, the clearances for the above categories 1 to 3 can be accommodated.

8 Survey

A geographic survey must be carried out to identify and record metal mass locations.

The following structures/objects (but not limited to) will likely contain metallic elements located within the four foot and will require a survey to determine metal mass category (1, 2 or 3) or if outside the allowable mask (i.e. classified as BMM and which will require prior announcement):

- Bridges,
- Slab track,
- Concrete level crossings,
- Concrete maintenance access crossings,
- Concrete up-stands,
- Check rails, and
- Other metallic objects in the four-foot (such as walkways).

8.1 Process

The metal mass survey and assessment process is shown as a flow chart in Appendix 1.

8.2 Initial Identification of Metal Mass

Possible BMM objects may be initially identified by means of a desktop viewing of video footage taken of the track. The Mechanised Track Patrol (MTP) video footage for example, should provide sufficient accuracy to permit an initial assessment.

The location and brief description of all objects identified as possible metal mass shall be recorded and will then require a site survey to accurately measure the object.

After the initial identification, infrastructure requiring a detailed survey shall be determined in accordance with the parameters in this guideline.

Note: Additional local knowledge from regional staff and surveyors may be of assistance.

8.3 Geographic Survey Requirements

Each object identified (from the video viewing or other information sources) as a possible metal mass shall be dimensionally measured. The following minimum parameters need to be measured on site and recorded for each identified object:

- Length (required to be able to discriminate between the constraints for fitted and unfitted areas) +/-1m or better where practical,
- Metal mass sectional dimensions +/-5mm, and
- Distance of metal mass above or below TOR +/-5mm.

The surveyor shall record the above-listed measurements (including location and distance from closest signal) and provide a dimensioned cross section sketch on the ETCS Metal Mass Recording Form shown in Appendix 2, clearly indicating the relationships with the top of the plane of the rail heads. The surveyor and a checker shall sign for correctness.

Once completed, the ETCS Metal Mass Recording Form containing the dimensional information shall be scanned and submitted to Signal Design for BMM assessment.

9 Signalling Design Assessment

Signal Design shall identify potential infrastructure for BMM assessment and possible further investigation.

The Signal Design assessor shall refer to the flow chart shown in Appendix 1 to assist with the identification of BMM.

The assessment of a BMM on a particular section of line should be formally recorded and presented on the signalling design as part of the design package.

Following the survey of metal mass, Signal Design shall analyse the recorded information for BMM. Where BMM is determined:

- Show the start and finish BMM on the Signalling Plan (see ESG 100.31), and
- Include details in the Signalling Functional Specification.

Sign off of the analysis shall be completed by the Designer and a Checker.

Applicable BMM announcement and fitment of balise shall be provided as necessary.

Refer to Signal Design Principles ESG 100.31 for further information on metal masses.

ETCS on-board alarm system suppression shall be minimised, as antenna failures will not be detected in a BMM area (safety issue).

Any alarms as a result of a BMM not being identified during the survey and in the signalling design shall be rectified (as detected) during commissioning and on-board functional testing.

Note: Any agreed remedial actions to existing infrastructure shall be incorporated in accordance with standard construction specifications.

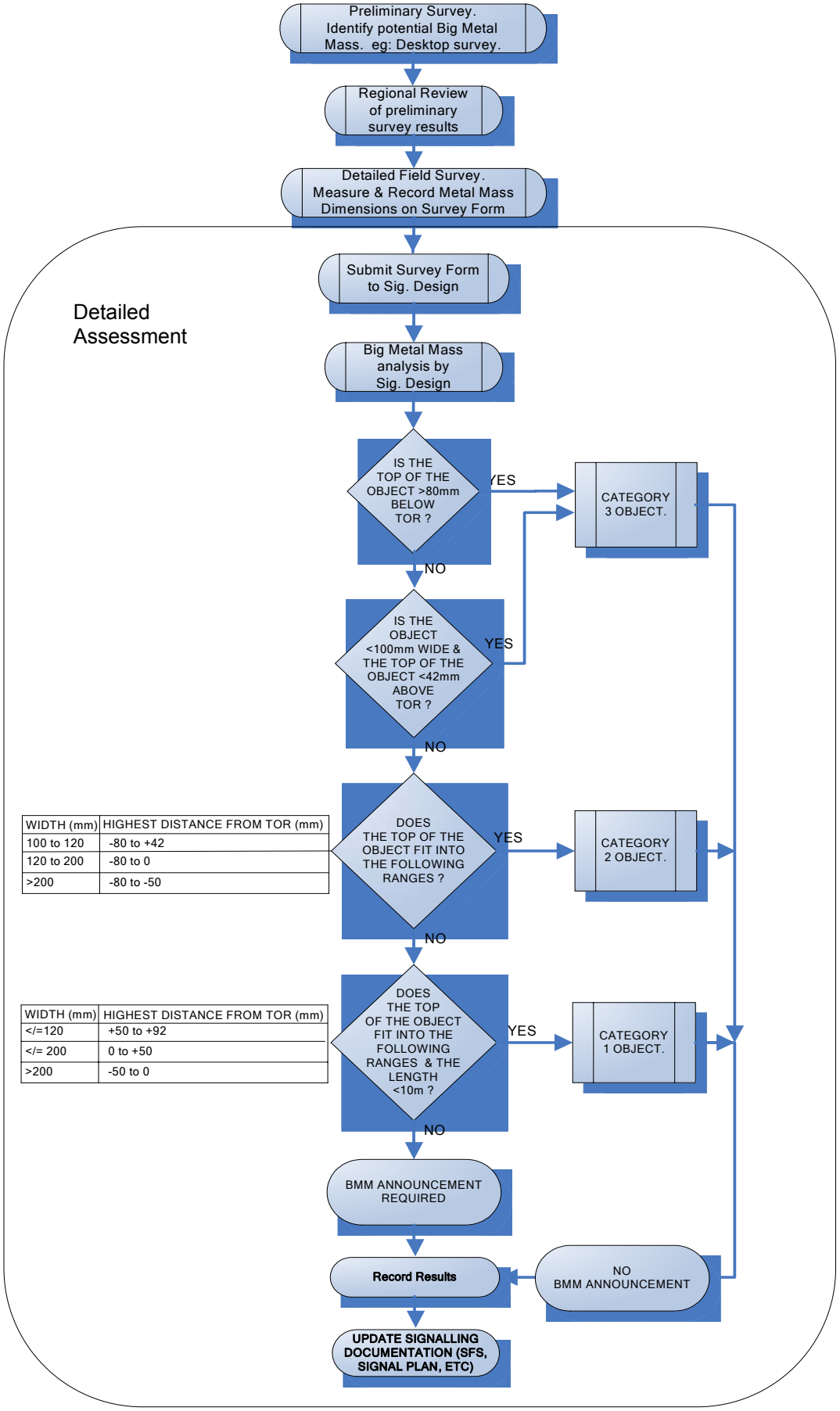
10 List of Typical Items Not Considered BMM

- Check-rails
- Guard-rails
- Point Blades
- Crossovers
- Impedance Bonds
- Mesh Walkways directly on top of sleepers/transoms
- Channel Iron and Mechanical Linkages
- Steel In-bearer Points

- Steel Sleeper Track
- Steel under Bridges with timber sleepers/transoms
- Dragging Equipment Detectors

11 Appendix

11.1 Appendix 1 - Metal Mass Assessment Flow Chart



WIDTH (mm)	HIGHEST DISTANCE FROM TOR (mm)
100 to 120	-80 to +42
120 to 200	-80 to 0
>200	-80 to -50

WIDTH (mm)	HIGHEST DISTANCE FROM TOR (mm)
</=120	+50 to +92
</= 200	0 to +50
>200	-50 to 0

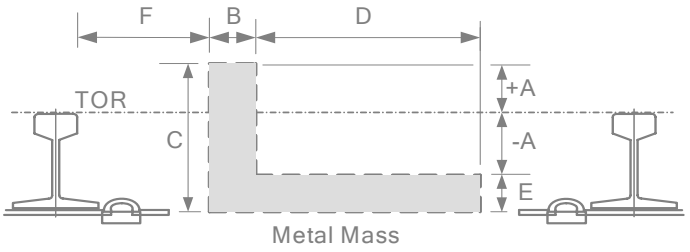
11.2 Appendix 2 - Metal Mass Details Recording Form

ETCS METAL MASS RECORDING FORM

PROJECT: Automatic Train Protection	
LOCATION:	**JOB No:**

LINE DESCRIPTION:			
START LOCATION:	km	**ACTUAL START LOCATION:**	km

Sketch Mass Profile below (shape shown is example):



LOCATION PLAN

← SYDNEY COUNTRY →

A (Distance above or below TOR) mm	**B** (Width of Mass at high point) mm
C (Depth of Mass) mm	**D** mm
E mm	**F** (Distance to closest rail) mm

LOCATION DESCRIPTION

Distance from signal to metal object
Kilometre post No ……..
…… metres Sydney Side* / Country Side*
(*Delete whichever is not applicable)

Reference Drawing No:

Note: Where the top of the object is below top of rail, use negative sign

Remarks – Provide: photos, names of photos, description of the object eg: concrete derailment plinth, details of concrete reinforcing depth details if known, etc**.**

Assessment:
Date:

Representative	Name	Signature	Division / Region	Position
Regional Signal Representative:				
Signal Design Representative:				
Contractor:			**Company:**	
Other:				