



**KERAJAAN MALAYSIA
JABATAN KERJA RAYA MALAYSIA
STANDARD SPECIFICATION
FOR ROAD WORKS**

**Section 19:
TRAFFIC MANAGEMENT AT WORK ZONES**



ISBN 978-967-5957-63-5



9 789675 957635



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FOREWORD

As practices in road construction change over time, it is imperative for Jabatan Kerja Raya (JKR) to continuously update and improve their Standard Specifications. These new specifications are not only aimed at keeping abreast with current technologies but also to help improve the quality of construction works and its final product. Consequently, these new specifications will ultimately have a significant positive impact on the construction industry especially with the incorporation of new products and technologies.

The JKR Standard Specification for Road Works is an essential component in the road infrastructure construction industry. This Specification provides an improved guidance in the material selection and quality control of workmanship and products, based on current best practices. The purpose of the JKR Standard Specification is to establish uniformity in road construction practices to be used by road designers, road authorities, manufacturers and suppliers of road related products.

This particular document, the “**Standard Specification for Road Works – Section 19: Traffic Management at Work Zones**”, is part of a series of improved specifications in the JKR Standard Specification for Road Works. The compilation of this document was carried out through many discussions that had been held by the technical committee. The draft had also been presented and discussed at length in a specially held workshop to get feedback and comments from relevant parties involved, which were then carefully considered and incorporated into the Specification wherever appropriate or necessary.

The Specification has also gone through the different phases of vetting and approval before the production of its final draft and printed copy. It will be reviewed and updated from time to time to cater for any changes in policies and the inclusion of current requirements, if necessary. Any feedback or improvement to be considered for future revisions should be forwarded to *Bahagian Pembangunan Inovasi & Standard, Cawangan Jalan, JKR Malaysia*.

Published by: -

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Ibu Pejabat Jabatan Kerja Raya Malaysia
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September 2017

ACKNOWLEDGEMENT

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Finally, the publisher would like to express its gratitude to the above committee members for their substantial contribution towards the successful completion of this document.

A special thanks to Dato' Dr. Meor Aziz Osman, Deputy Director General of Works (Infra Sector), Dato' Ir. Hj. Che Noor Azeman bin Yusoff, Director of Road and Bridge Design, Ir. Dr. Lim Char Ching, Director of Forensics Engineering and Technical Support Division, *Cawangan Jalan, Jabatan Kerja Raya Malaysia* for their support and contribution towards the successful completion of this specification.

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SECTION 19 – TRAFFIC MANAGEMENT AT WORK ZONES

19.1 GENERAL

Latest version of ARAHAN TEKNIK (JALAN) ATJ 2C/85 Manual on Traffic Control Devices : Temporary Signs and Work Zones Control, published by Ibu Pejabat JKR, Kuala Lumpur shall be used as main reference to be read together with this specification.

19.1.1 Purpose

This specification shall consist details of Traffic Management at Work Zones including planning and installation of traffic control devices, traffic management equipment and traffic management procedures. An effective traffic management must have the following elements:

- Planning and design aspects of traffic management works during construction.
- A comprehensive inspection and maintenance program.
- Ability to prewarn motorists and pedestrians of hazard ahead.
- Able to advise motorists of the proper travel path through the area, at all times (day or night) and in all weather conditions.
- Delineate areas where traffic should not operate.
- Separate and protect motorists, pedestrians and the work force.

19.1.2 Work Zones

The Work Zone is the distance between the first advance warning sign and the point beyond the termination area where traffic is no longer affected. A typical Work Zone should have the following areas:

- Advance Warning Area
- Transition Area
- Buffer Area
- Work Area
- Termination Area

The work zone length shall be limited to a maximum of 5km in rural condition and 2km in urban condition. On single carriageway, the work zone may not be carried out in opposite location simultaneously.

If no lane or shoulder closure is involved, the transition area will not be used. In this chapter, each of the above areas will be examined for one direction of travel. If the work activity affects more than one direction of travel, the same principles apply to traffic in all directions.

The details and illustration of the five (5) areas of traffic control zones have been covered in the latest ARAHAN TEKNIK (JALAN) ATJ 2C/85, published by Ibu Pejabat JKR, Kuala Lumpur.

19.1.3 Traffic Management Implementation Team

The Contractor shall establish dedicated teams to implement, inspect and maintain all traffic management related works. All employees involved within the construction area should be qualified and properly trained, consisting of engineers, inspectors, superintendents, foremen and other related personnel.

The Contractor shall design and provide all traffic management resources as stated in the Bill of Quantity for Traffic Management and Control. He shall also comply with the specifications of all the resources as stated in this Specification and detailed drawings.

19.2 THE EFFECTIVE IMPLEMENTATION OF TRAFFIC MANAGEMENT AT WORK ZONES

The Traffic Management at Work Zones requires thorough planning and design so as to ensure that a high and satisfactory level of safety is provided for all road users. A well thought out Traffic Management Plan (TMP) will reduce the number and severity of accidents, slow down traffic and minimize public complaints. Therefore, strategies are necessary for the effective implementation of traffic management at construction area.

The strategies shall outline the procedures for planning, designing, implementing and maintenance of the traffic management at work zones. It also outlines the roles and responsibilities of the people and authorities involved in the implementation of the above. The procedures and steps to be taken are as follows:

19.2.1 Implementation Strategies

19.2.1.1 Design Activities, should consider the following:

- (a) Execute appropriate planning and design including Traffic Study, if required such as when there are lane closures.
- (b) Carry out full field checks and inventory of existing facilities.
- (c) Preparation of Traffic Management Plan (TMP) based on the Plans and Bill of Quantities provided in the Contract prior to site activities. Traffic control plans (TCP) to be provided as stipulated in the Contract or as directed by Superintending Officers/Project Director.
- (d) Traffic Control Plan (TCP) must be endorsed by a qualified Professional Civil Engineer (P.E.) prior to submission to the local authority(s) for approval.
- (e) Traffic Study report must be endorsed by qualified traffic consultant with Professional Civil Engineer (P.E.) status prior to submission to local authority(s) for approval.
- (f) The TMP needs to be made available for Road Safety Auditing upon receiving of Construction Drawings.

- (g) Design of TMPs must be endorsed by Professional Engineer (P.E.) and approved by the S.O./P.D prior to commencement of work.

19.2.1.2 During the Pre Implementation of TMP, due consideration should be given to the following:

(a) Contractor shall appoint a qualified Traffic Management Officer (TMO).

(b) TMPs must be made known to:

- Local Authorities
- Local communities
- Road users
- JKR District and JKR State.

Note: Local Authorities, Local communities, JKR District and JKR State to take whatever action deemed necessary, particularly if it may involve road/lane closure or major road diversion.

19.2.1.3 During the construction activities, the Contractor shall carry out the following:

(a) Set up Traffic Management Team (TMT), inclusive of supervisors, flagmen, placement and removal crews and maintenance personnel.

(b) Set up an Emergency Response Team (ERT) if required in the contract.

(c) Maintenance of the traffic management works.

(d) Ensure timely placement and removal of devices.

(e) Inspection and reporting of traffic management at work zone shall be carried out minimum twice daily.

(f) Inform the relevant JKR District Engineer of any road/lane closure and/or diversion well in advance as specified, at least one week, before commencement of works.

19.2.1.4 Reporting

The Contractor shall carry out the following:

(a) Preparation of Traffic Management Safety Reports (TMSRs) by the TMO as stipulated in the Contract or as required by S.O./P.D.

(b) The Contractor needs to prepare the TMSRs every 3 months or at interval required by S.O/P.D.

(c) The TMSRs need to be made readily available for Road Safety Auditing.

19.2.2 Prior Pre-Construction Activities

19.2.2.1 Proper Planning and Design

Before any planning on Traffic Management Plan (TMP) commences, the Contractor must visit the site for field check and to collect inventory of the existing facilities including existing structure, services and public facilities such as street lighting, traffic light, bus and taxi stop and road furniture that may require removal or relocation during the construction stage.

In addition, the Contractor should assess the existing road capacity, determine the existing travel and distribution patterns and identify potential problems that might arise due to temporary road diversions. The Contractor should also carry out discussions with the Local Authorities on the effect of the construction works on the existing traffic patterns and the occurrence of any local festivities, activities or upgrading programs, which might further aggravate the traffic condition and to take the necessary mitigation measures in reducing the traffic woes.

19.2.3 During Construction Activities

19.2.3.1 Dissemination of Information to Road Users

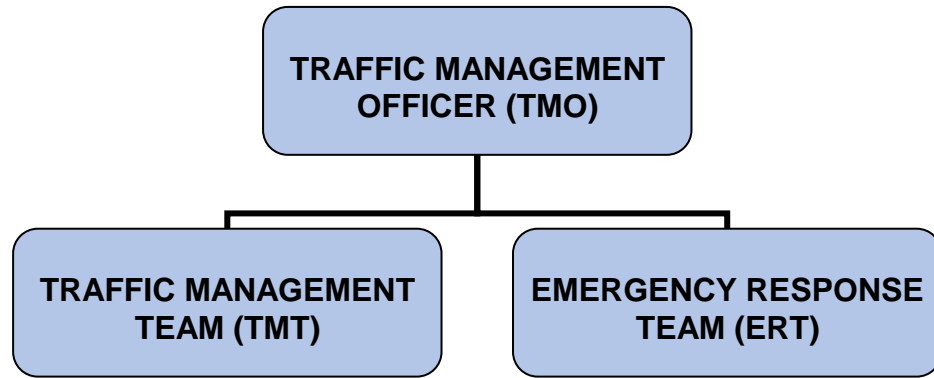
Dissemination of information to the road users by Contractor through mass media, when necessary. The public needs to be informed early in the process in order to assist them to plan for this change. Information should be channeled a week before the implementation of traffic management scheme. This is done through public announcements in newspapers, radio and television and approach signboards well before work zones, or any other method as deemed fit by the Contractor.

19.2.3.2 Obtaining Approval of Local Authorities

The Contractor shall obtain all necessary approvals from the Local Authorities prior to any construction activities, where required.

19.2.3.3 Supervision and Execution of Traffic Management Plan.

To ensure a smooth construction sequence without compromising public road safety for pedestrians and other road users, the Contractor shall set up two distinct teams, each with their unique roles and responsibilities. They are the **Traffic Management Team (TMT)** and the **Emergency Response Team (ERT)** as illustrated below:

**Note:**

1. TMT is required for all traffic management works.
2. ERT is only required, where applicable.

19.2.3.4 Traffic Management Team (TMT)

The role of the Traffic Management Team is to ensure that the traffic management plan is implemented in accordance with the approved drawings. Their duties include proper installation, maintenance and cleaning of road safety equipments such as plastic barriers, safety cones, plastic hoardings, temporary warnings and directional signboards, arrow flashers, flashing ambers and etc. In addition, they will ensure that all lane closures and traffic diversions are implemented in compliance with all traffic management procedures as per the Authority requirement.

The team (TMT) is also responsible to ensure the safety and smooth traffic flow through the period of road closure or diversion. The person-in-charge of the traffic management team must regularly inspect the situation of traffic flow and update the Road Authorities on the prevailing traffic conditions. The team must be able to establish an effective line of communication for emergencies and changes in circumstances. There are occasions when it would be necessary to re-route the traffic to opposite traffic lanes in contra flow for activities such as the launching of bridge beams, the construction of a bridge pier and at interchanges in the middle of existing roadways. Traffic management personnel should always be present at site during construction including weekends, public holidays, and under any weather conditions.

19.2.3.5 Emergency Response Team (ERT) – Where Applicable

The role of the Emergency Response Team is to provide a 24-hour patrol for the full domain of the construction zone. They will liaise with the main Contractor, tow-truck operators, traffic police in the event of a road accident, stalled vehicles, landslides, ground failures and flash floods that may occur at any time within the construction zone.

In addition, the ERT will report to the traffic management officer on any incidence of poor housekeeping by sub-contractors. They shall be on the lookout for inappropriate or poor condition signboards. They must ensure that all signages are strategically and properly re-installed and that all unattended open excavations by roadsides to be clearly made known to the road users of their existence through high visibility signs and road markings as well as blinkers and lights during the night and made good where necessary. Particular attention must be given to public safety in areas of open excavations.

The Emergency Response Team are responsible for preparing an Emergency Response Plan (ERP) that will include all likely events that may cause disruptions to the smooth flow of traffic at the approach to and at the construction site. An orderly chain of command needs to be established by the ERT to inform all parties of any emergencies and enable the S.O./P.D and/or his representative to make well-informed decisions, including informing the Police and the media, to overcome/mitigate the effects of the emergencies and minimize inconveniences to road users. A copy of ERT set up and its ERP are to be submitted each to the State JKR Director and JKR District Engineer for their information and record.

19.2.4 Responsibilities

19.2.4.1 Responsibilities of the Traffic Management Officer (TMO)

The Traffic Management Officer is the Contractor's representative responsible for all matters related to the traffic management, safety of the travelling public and construction workers within the limits of the construction works / Contract. He supervises both the Traffic Management Team and Emergency Response Team.

The TMO must ensure the following:

- (a) The Contractor's responsibilities in providing safe and convenient travelling conditions for road users and safe working environment for personnel and plants under their control.
- (b) The personnel under their control are employees of the Contractor and should at all times be courteous to the travelling public. Personnel should not allow themselves to be provoked by members of the public and, by exercising restraint; this will strengthen their position both then and at any subsequent enquiry or legal proceedings if ever it arises.
- (c) The traffic controllers assigned to direct traffic or personnel employed to place, maintain and remove signs and

devices, are well-trained and fully aware of their duties and responsibilities.

- (d) To act in accordance with the provisions and directives of, this guideline and all the relevant acts.

The Traffic Management Officer is to provide evidence to the S.O. that he has the necessary skills and qualification as stipulated in the Contract.

The duties of the Traffic Management Officer to include and not limited to:

- (i) Designing the TCPs for Overall and Localized Traffic Management Plan during construction.
- (ii) Monitoring the placements and removals of the Traffic Control devices.
- (iii) Monitoring the operations of the Traffic Control devices equipment.
- (iv) Maintain the effectiveness of the Traffic Control Plans.
- (v) Analyzing the occurrences of road accidents within the work zones.
- (vi) Preparing and displaying up-to-date TMP for inspection and audit.
- (vii) Preparing the tri-monthly Traffic Management Safety Report (TMSR).
- (viii) Prepare Emergency Response Plan (ERP) that shall include all contingencies that can affect the smooth flow of traffic at the approach to and within the construction site (e.g. floods, landslides, stalled vehicles, major sporting events, etc.).
- (ix) Oversee the performance and effectiveness of the Emergency Response Team (ERT). This includes 24-hour patrol, liaison with PDRM, and local authorities.
- (x) Give special attention to abnormal traffic operations such as contra flow, bridge diversion, etc.
- (xi) To ensure all permits given by the Local Authority(s) is valid.
- (xii) Developing Standard Operating Procedures (S.O.P.).
- (xiii) Prepare and maintaining daily records.

19.3 TEMPORARY SIGNAGE

Temporary signage refers to the different types of signage used during construction which includes temporary warning signs, temporary informative signs and temporary directional signs. All temporary signs shall be in accordance with the requirements of the **latest ARAHAN TEKNIK (JALAN) ATJ 2C/85 Manual on Traffic Control Devices: Temporary Signs and Work Zones Control**, published by Ibu Pejabat JKR, Kuala Lumpur.

19.3.1 Temporary Signage for Work Areas

19.3.1.1 Description

Temporary warning signs are used to warn the road users about any changes or danger before and during travelling through the work zone.

Temporary informative signs are used to inform road users about road closure information or diversion ahead.

Temporary directional signs are used to direct traffic to designated alternative road during road closure or diversion to guide the traffic back to the intended destination.

19.3.1.2 Material

(a) Sign Plate

Sign plate shall be made of aluminium composite material with total minimum thickness of 4mm with aluminium thickness of 0.2mm for both sides.

(b) Sign Face

The sign face shall comply with the Malaysian Standard Specification for Reflective Sign Faces Materials (MS 1216 or ASTM D4956).

The background of the temporary sign shall be of the "Wide Angle Prismatic" Fluorescent Orange colour. The background for any inserts/symbols within the temporary sign shall be of the "High Intensity Prismatic" non-fluorescent colours.

(c) Backing Frame

Backing frame for temporary signs shall be as shown in the drawing for A-shape type and pole type using 25mm x 25mm x 1.2mm Thickness Square Hollow Mild Steel painted in black color. This kind of backing frame is only meant for short time signaging (less than one week).

(d) Post

Post for temporary signs shall be as shown in the drawing using 75mm Ø x 1.2mm thickness Hollow Mild Steel painted in black.

For any temporary sign with width more than 1500mm, it is advisable to use two posts for added stability.

The temporary sign that needs to be embedded, the post concrete footing shall be of 450mm depth with minimum 150mm width.

In areas, where it is not feasible to embed the sign, it is recommended to use a steel post mounted on a circular steel plate with a counter weight of 50kg (minimum) to ensure the signage is in place.

19.3.2 Warranty & Certification for Retroreflective Sheeting

19.3.2.1 Warranty for Retroreflective Sheeting

The retroreflective sheeting used for the temporary warning sign shall have a warranty period provided to the relevant authority by the sheeting manufacturer. The minimum warranty period shall be 3 years from the date of installation of the temporary warning sign. For temporary warning sign that are reuse over time; the retroreflective performance shall be tested using a retroreflector meter to ensure its effectiveness.

19.3.2.2 Certification for Retroreflective Sheeting

The retroreflective sheeting used must comply to either the Malaysian Standard MS 1216 or the ASTM D4956. The sheeting manufacturer shall provide the relevant authority with current certificate of testing from the above mentioned standards.

If the need arises for the sheeting to be tested at site due to various reasons, the sheeting shall comply to the following tables for the different types of prismatic sheeting types when new. However, for signs that have been in service within the minimum 3 years warranty period, the tested reading shall not be less than 80% of the values in the two (2) tables below.

TABLE 1 : RETROREFLECTIVE PERFORMANCE FOR “WIDE ANGLE PRISMATIC” SHEETING

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange
*0.1 ^o B	-4°	830	620	290	83	125	37	25	660	500	250
*0.1 ^o B	+30°	325	245	115	33	50	15	10	260	200	100
0.2°	-4°	580	435	200	58	87	26	17	460	350	175
0.2°	+30°	220	165	77	22	33	10	7.0	180	130	66
0.5°	-4°	420	315	150	42	63	19	13	340	250	125
0.5°	+30°	150	110	53	15	23	7.0	5.0	120	90	45
1.0°	-4°	120	90	42	12	18	5.0	4.0	96	72	36
1.0°	+30°	45	34	16	5.0	7.0	2.0	1.0	36	27	14

Source : ASTM D4956 - Standard Specification for Retroreflective Sheeting for Traffic Control

TABLE 2 : RETROREFLECTIVE PERFORMANCE FOR “HIGH INTENSITY PRISMATIC” SHEETING

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown
*0.1 ^o B	-4°	500	380	200	70	90	42	25
*0.1 ^o B	+30°	240	175	94	32	42	20	12
0.2°	-4°	360	270	145	50	65	30	18
0.2°	+30°	170	135	68	25	30	14	8.5
0.5°	-4°	150	110	60	21	27	13	7.5
0.5°	+30°	72	54	28	10	13	6	3.5

Source : ASTM D4956 - Standard Specification for Retroreflective Sheeting for Traffic Control

19.3.3 Method of Installation

19.3.3.1 Preparation of Site

Preparation of site must be done before the installation of the temporary signage. This includes determining the location of each sign to be installed (i.e: road side, median, type of surface such as gravel, premix, or soil). Once the location has been determined, the Contractor must then determine the method of installation, either by digging, or coring the surface.

19.3.3.2 Spacing Interval

Temporary warning signs shall be installed starting at Advance Warning Area subject to category of traffic at the required spacing as per approved TMP unless otherwise instructed by the S.O. to suit the site condition.

19.3.3.3 Type of Temporary Signage to be Installed

For temporary road closure or diversion of less than one week, it is recommended to use the portable A-shape signage. For road closure or diversion of more than one week, it is recommended to use 1500mm to 2000mm high post signage (embedded into the ground or supported by a portable weighted base).

19.3.3.4 Installation

If the installation requires a lane closure, a flagman shall be placed in advance of the installation area to warn the traffic.

19.3.3.5 Maintenance

All displaced, worn out or damaged signage must be rectified/replaced immediately. The sign face shall be free from dirt or unwanted marks (e.g. sticker).

19.4 TEMPORARY ROAD MARKING

19.4.1 Description

This work shall consist of the supply and installation of temporary road marking material to form continuous or intermittent lines, letters, arrows, symbols or figures. The markings shall be yellow in colour laid to the dimensions and at the locations shown in the TMP and as specified herein or as directed by the S.O. The work includes the supply of all labour equipment, materials, warning signs and traffic control devices as necessary for the safe and efficient completion of the entire work.

19.4.2 Road Marking Materials

The requirements specified hereafter emphasizes on the performance of temporary road markings during their functional life. The requirements are expressed by several parameters representing different aspects of the performance of road markings.

The temporary road marking shall either be of paint or thermoplastic material depending on the duration of the temporary works.

19.4.2.1 Paint

The road marking paint shall be used for temporary road markings for traffic diversion at temporary work zone of less than 30 days construction period and shall comply with the requirements of MS 164.

19.4.2.2 Thermoplastic

The thermoplastic material used shall be of the hot-applied thermoplastics and set on laying for temporary work zone of more than 30 days construction period. It is also recommended to be used in road with high traffic density.

The road marking materials shall be of thermoplastic type and shall comply with the requirements of BS EN 1424 (Road Marking Materials – Premix Glass Beads), and shall demonstrate compliance with the relevant performance of BS EN 1436 (Road Marking Performance for Road Users).

19.4.3 Colours

All temporary road markings shall be yellow in colour. The standard colour definition for the yellow paint marking shall be No. 356 B.S 381C or equivalent when tested to the latest version of MS 133: Part D.

For yellow thermoplastic marking, the “X,Y chromaticity co-ordinates” for dry road markings shall be within the regions defined by the corner points given in **Table 3** below:

TABLE 3 : CORNER POINTS OF CHROMATICITY REGIONS FOR WHITE AND YELLOW ROAD MARKING

CORNER POINT NO.		1	2	3	4
White road markings	X	0.355	0.305	0.285	0.335
	y	0.355	0.305	0.325	0.375
Yellow road markings class Y1	X	0.443	0.545	0.465	0.389
	y	0.399	0.455	0.535	0.431
Yellow road markings class Y2	X	0.494	0.545	0.465	0.427
	y	0.427	0.455	0.535	0.483
The classes Y1 and Y2 for yellow road markings are intended for permanent and temporary road markings respectively					

Source :BS EN 1436: Road Marking Materials. Road Marking Performance for Road Users

19.4.4 Thickness of Temporary Road Marking

The following is the recommended thickness for temporary road marking using the two types of road marking material;

19.4.4.1 Paint

Road marking paint shall be laid to give a wet film thickness of not less than 315 microns and not more than 400 microns.

19.4.4.2 Thermoplastic

Road marking thermoplastic for screed lines is not less than 2 mm. The thickness shall be measured by using a suitable device such as micrometer gauge, calipers or reflectometer machine.

19.4.5 Preparation and Removal

The preparation of site and removal of road markings shall be in accordance and complies with the requirements of Section 6: Road Furniture of this Specification.

19.5 TRAFFIC MANAGEMENT EQUIPMENT

19.5.1 Traffic Guidance Cone

19.5.1.1 Specifications

- (a) Traffic guidance cone shall follow specifications as shown on the Drawings or as approved by the S.O.
- (b) Traffic guidance cone shall be from LDPE material and shall only come in red or orange colour. The minimum weight for the cone shall be 3.0kg with 440mm x 440mm rubber base and 750mm height as shown in the drawing. It shall also come with reflective strips which shall be white high intensity prismatic retro reflective sheeting.
- (c) Traffic guidance cone shall be weighted down using rubber base to prevent it from being displaced by strong winds or surface runoff.

19.5.1.2 Application Requirements

- (a) Contractor shall ensure cones are installed at the required position and visible to the traffic. All displaced or damaged cones must be rectified or replaced immediately.

- (b) Traffic guidance cones shall be used at Buffer Area, Work Area and Termination Area during temporary lane closure or road diversion of less than 24 hours. Blinkers must be installed on traffic guidance cones at the required spacing during lane closure or road diversion at night.
- (c) Traffic guidance cones shall be at 5m spacing throughout Traffic Control Zones or as indicated on the approved Traffic Management Plan (TMP).
- (d) After every storm, the Contractor shall conduct a complete 'sweep' of the whole site to determine that all cones are back in order. This shall be done immediately after storm is over.
- (e) Cones may be placed either by a Traffic Controller on foot or from a moving vehicle. When working from a vehicle, the truck shall be equipped with a suitable worker platform and railing.
- (f) On high-speed roadways, a shadow vehicle with suitable warning device shall be used to protect the workers who are working from the back of truck.

19.5.2 Traffic Super Cone

19.5.2.1 Specifications

- (a) Traffic super cone shall follow specifications as shown on the Drawings or as approved by the S.O.
- (b) Traffic super cone shall be from LDPE material and shall only come in red or orange colour. The minimum weight for the cone shall be 5.0kg with 530mm x 530mm rubber base and 1000mm height as shown in the drawing. It shall also come with reflective strips which shall be white high intensity prismatic retro reflective sheeting.
- (c) Traffic super cone shall be weighted down using rubber base to prevent it from being displaced by strong winds or surface runoff.

19.5.2.2 Application Requirements

- (a) Contractor shall ensure cones are installed at the required position and visible to the traffic. All displaced or damaged cones must be rectified or replaced immediately.
- (b) Traffic super cones shall be at 5m spacing or as indicated on the approved Traffic Management Plan (TMP).

- (c) After every storm, the Contractor shall conduct a complete 'sweep' of the whole site to determine that all cones are back in order. This shall be done immediately after storm is over.
- (d) Cones may be placed either by a Traffic Controller on foot or from a moving vehicle. When working from a vehicle, the truck shall be equipped with a suitable worker platform and railing.
- (e) On high-speed roadways, a shadow vehicle with suitable warning device shall be used to protect the workers who are working from the back of truck.

19.5.3 Plastic Barrier

19.5.3.1 Specifications

- (a) The base material shall be of Ultra-violet (UV) light stabilized linear high density polyethylene.
- (b) Plastic barriers shall have holes complete with caps. Once the barriers are aligned, they shall be filled with water to a minimum of half the barrier height for weight. Water must be treated with insecticide to prevent mosquitoes breeding. Routine inspection and maintenance shall be carried out to ensure plastic barriers are filled up with water up to the required level at all times during construction.
- (c) Every plastic barrier shall have a minimum dry weight of 10.0kg.
- (d) Dimension of Plastic Barrier shall be 1000mm (L) x 800mm (H) x 500 (W).

19.5.3.2 Method of Installation

- (a) Preparation of site must be done before the installation of plastic barrier. This includes removing any debris or large objects from the ground level and stabilizing the earth so that the barrier can easily be placed vertically and in the proper alignment.
- (b) With the exception of work area, other areas must be provided with plastic barriers and equipped with reflector disks.
- (c) Prior to the installation of plastic barrier, the TMP must be approved by the S.O. If the installation requires lane closure, a flagman shall be placed before the installation area to warn the traffic. Plastic barrier may be placed either by a Traffic Controller on foot or from a moving vehicle.

When working from a vehicle, the lorry shall be equipped with a suitable worker platform and railing.

- (d) Plastic barrier must be cleaned at least once in three months, or earlier if necessary, to ensure its visibility.

19.5.3.3 Application Requirements

- (a) Serve as channelizing and guiding device to road users rather than as a safety barrier that can contain vehicle when hit.
- (b) The barrier shall be used at excavation work area if depth is less than 1m. Minimum 1m lateral clearance to be provided from edge of barrier to the excavated area and concrete barrier to be used if otherwise.
- (c) Plastic barriers shall be arranged in alternate colours of red and white and must be interlocked.
- (d) The Contractor shall inspect barriers daily (day and night time) to ensure alignment, position and condition is in order and according to approved plans and stage of diversion and take necessary action should there be any changes.
- (e) The Contractor shall ensure that barriers do not reduce the lane width as approved on plans. Immediate action is required when barriers are found to protrude out and obstruct traffic. Unused barriers shall be collected and stored away to prevent confusion.
- (f) The Contractor shall carry out routine inspections and determine whether plastic barriers shall be replaced with concrete barriers at locations which are prone to accidents or displacement by others. Deployment of these shall be approved by the S.O.
- (g) In all cases, the plastic barrier shall be used with proper assessment based on site condition and engineering judgement.

19.5.4 Concrete Barrier

19.5.4.1 Specifications

- (a) The concrete shall be of grade min G25 with minimum F2 Grade Finishes. It shall be carried out with necessary tests to confirm the concrete strength approved by the S.O. and shall conform to the requirements of Section 9: Concrete of this Specification.
- (b) Barriers shall come in 1.0m segment with the dimension of 1000mm (L) x 800mm (H) x 500mm (W).

19.5.4.2 Method of Installation

- (a) Preparation of site must be done before the installation of concrete barrier. This includes removing any debris or large objects from the ground level and stabilizing the earth so that the barrier can easily be placed vertically and in the proper alignment.
- (b) With the exception of work area, other areas must be provided with concrete barriers and equipped with reflector disks.
- (c) Concrete barrier must be cleaned at least once in three months, or earlier if necessary, to ensure its visibility.

19.5.4.3 Application Requirements

- (a) Serves as safety barrier to road users and shall be used at excavation work with depth of 1m or more and a minimum 0.6m lateral clearance to be provided from edge of barrier to the excavated area.
- (b) Concrete barriers also shall be placed at the following critical locations:
 - (i) Replacing an existing permanent safety feature that has been removed such as guardrails, bridge railings, median barrier etc.
 - (ii) Located close to rigid objects such as sheet piling, bridge structures, stockpiles etc.
 - (iii) Sharp and dangerous corners.
 - (iv) flood prone areas.
 - (v) slope failure or sinkhole and if there are any visible hazards that can cause dangers to the public such as heavy machineries.

- (c) Concrete barriers shall be arranged in alternate colours of black and yellow and must be interlocked.
- (d) Contractor shall immediately adjust, remove or align any barriers which are out of position, to prevent accidents from happening.
- (e) All major displacements of barriers shall be reported to the TMO. TMO shall ensure that appropriate action is taken immediately.
- (f) In all cases, the concrete barrier shall be used with proper assessment based on site condition and engineering judgement.

19.5.5 Plastic Hoarding

19.5.5.1 Specifications

- (a) The base material shall be of Ultra-violet (UV) light stabilized linear high density polyethylene.
- (b) Material for plastic hoardings shall be the same as the plastic barrier as specified in 19.5.3 of this specification with minimum weight 7kg.
- (c) Plastic hoardings shall be arranged in alternating colours of red and white and interlocked when installed on Concrete Barrier and Plastic Barrier.
- (d) Bottom part of the plastic hoarding shall be slotted at least 150mm into the plastic barrier or concrete barrier.
- (e) Dimension of Plastic Hoarding shall be minimum 1200mm (L) x 1140mm (H) x 60mm (W).

19.5.5.2 Method of Installation

- (a) The installation of plastic hoarding is only necessary if there are any heavy machineries or activities within the construction area. The use of plastic hoarding shall follow the approved TMP. Plastic hoarding shall be installed (if necessary) after the installation of plastic barrier has been done.
- (b) Plastic hoarding must be slotted properly into the plastic barrier or concrete barrier to avoid slanting or fall. If the installation requires lane closure, a flagman shall be placed before the installation area to warn the traffic.
- (c) Plastic Hoarding must be cleaned at least once every three months, or earlier if necessary.

19.5.5.3 Application Requirements

- (a) Plastic hoardings shall be installed properly on plastic barriers and concrete barriers.
- (b) Plastic hoardings shall be maintained by the Contractor to prevent them from falling, leaning or being damaged. They shall always be in good condition.
- (c) Plastic hoardings on barriers shall be placed at work area where the view of activities is to be blocked. This is to prevent distraction to the traffic.
- (d) Plastic hoardings shall be tied down away from traffic to prevent overturning during storms, at every 10m interval or as directed by S.O. Reinforcement at the back of plastic hoardings shall be provided to prevent misalignment. Contractors shall ensure that in all critical areas these hoardings are properly tied down to prevent any mishaps.
- (e) The Contractor shall inspect and ensure that hoardings are always secured to the base and properly fastened. The Contractor shall also ensure that hoardings are safe and not protruding out dangerously to the traffic at all times.

19.5.6 Delineator string

19.5.6.1 Specifications

- (a) The materials for the delineator string shall be approved by the S.O.
- (b) The delineator string shall have square double sided reflective plates (75mm x 75mm fluorescent orange retro-reflective sheeting) tied to the string at 1000mm c/c. The length of the string shall be 50m long.

19.5.6.2 Application Requirements

- (a) Delineator string shall be installed along Work Area next to a road.
- (b) Delineator string shall be maintained by the Contractor to prevent it from falling, or being damaged throughout the duration of the works. Delineator string with missing reflective plate (s) shall be removed and immediately replaced with a new delineator string.
- (c) Delineator string shall be installed with minimum height 1m from the ground level and mounted to wooden post (25mm x 25mm) with 3m spacing interval.

19.5.7 Flashing Light (Blinker)

19.5.7.1 Specifications

- (a) The type and make for the blinker shall be approved by the S.O.
- (b) Blinkers shall have a minimum lens diameter of 200mm and shall emit amber coloured light.
- (c) Blinkers shall be visible from a minimum distance of 900m to warn the road users.

19.5.7.2 Application Requirements

- (a) Blinkers shall be installed on traffic guidance cones, barriers or hoardings every 30m c/c at straight and 10m c/c at taper or curve to allow drivers enough time to alter their driving patterns.
- (b) Contractor shall ensure that all blinkers are installed at the required interval and shall be visible to the traffic at all times. All displaced or damaged blinkers shall be rectified or replaced immediately.

19.5.8 Beacon Light

19.5.8.1 Material

- (a) 4 pcs super bright LED.
- (b) 1.2V 1500mAH Ni-MH rechargeable battery.
- (c) 0.4W solar panel (optional).
- (d) Post for beacon light shall be 48mm Ø Mild Steel Pipe.
- (e) Base of Beacon Light shall use Square Hollow Mild Steel with the size of 100mm x 50mm x 4mm thickness.

19.5.8.2 Specifications

- (a) Beacon Light shall be of amber colour and able to work for a minimum of 12 hours or throughout the night. The type and make for the beacon light shall be approved by the S.O.
- (b) Beacon Light is used at points of special hazards as a means of calling the driver's attention to these locations.
- (c) Beacon Light shall be visible from a minimum distance of not less than 1 km to warn the road users.
- (d) Minimum height of adjustable beacon light shall be 1meter from the existing ground level and shall be visible to the traffic.

19.5.8.3 Method of Installation

- (a) Preparation of site must be done before the placement of beacon light. This includes determining the location of beacon light to be placed.
- (b) Beacon light may be installed or placed at any location that requires extra attention from the road user.
- (c) The beacon light must not be obstructed by any object. Any damaged beacon light must be rectified or replaced immediately.

19.5.8.4 Application Requirements

- (a) During normal daytime maintenance operations, the functions of flashing beacons are adequately provided for by the lighting equipment on maintenance vehicles, either emergency flasher, the rotating dome light, or both. However, at locations where the daytime maintenance activity requires an obstruction to remain in the roadway at night, flashing beacons may be installed at the point of hazard.
- (b) Beacon Light may be operated singly or in groups containing more than one unit and they are brighter than blinker lights.

19.5.9 Flashing Arrow**19.5.9.1 Material**

- (a) LED Strip light with dimension of 8mm (W) x 2mm (H) that consists of 60 LEDs per meter or 3 LED per inch.
- (b) 1.2V 1500mAH Ni-MH rechargeable battery.
- (c) 0.4W solar panel.
- (d) Post for Flashing Arrow shall be 62.5mm Ø Mild Steel Pipe for bottom part and 50.8mm Ø Mild Steel Pipe for top (retractable) part.
- (e) Base of Flashing Arrow shall use Square Hollow Mild Steel with the size of 100mm x 50mm x 4mm thickness.

19.5.9.2 Specifications

- (a) Flashing arrow shall be able to work for a minimum of 12 hours or throughout the night. The type and make for the flashing arrow shall be approved by the S.O.
- (b) Each flashing arrow shall use LED strip.

- (c) Flashing arrows shall be visible from a minimum distance of not less than 1000m to warn the road users. Flashing arrow panels are valuable to assist the Traffic Controllers during placement or removal of channelizing devices for lane closures.
- (d) Maximum height of adjustable flashing arrow shall be 2500mm from the existing ground level and shall be visible to the traffic at all times.

19.5.9.3 Method of Installation

- (a) Preparation of site must be done before the placement of arrow flasher. This includes determining the location of arrow flasher to be placed.
- (b) Arrangement of flashing arrow at Transition Area shall follow the typical drawing for lane closure.
- (c) The arrow flasher light must not be obstructed by any object. Any damaged beacon light must be rectified or replaced immediately.

19.5.9.4 Application Requirements

- (a) Flashing arrow shall be installed at Transition Area for tapering (with 3 nos. of Left/Right Signs and can be combined with chevron light when necessary) during night lane closure or other locations as required by the S.O.
- (b) Traffic Management Team shall ensure that flashing arrows installed are at the required position and visible to the traffic. All displaced, malfunctioning or damaged flashing arrows shall be rectified or replaced immediately.

19.5.10 Chevron Light

19.5.10.1 Material

- (a) LED bulb with 50 pcs High Efficiency Super Flux with dimension of 105mm (inner) and 140mm (outer).
- (b) Post for Chevron shall be Square Hollow Mild Steel with the size of 100mm x 50mm x 4mm thickness. Additional support may use 25mm x 25mm x 2mm thickness square hollow welded to the base.
- (c) Base of Chevron shall use Square Hollow Mild Steel with the size of 100mm x 50mm x 4mm thickness.

19.5.10.2 Specifications

- (a) Chevron lights shall be able to work for a minimum of 12 hours or throughout the night. The type and make for the chevron light shall be approved by the S.O.
- (b) Dimensions of the chevron light board shall be 1820mm (L) x 1220mm (H). The chevron light shall be able to show the following indicators:
 - (i) Arrow left
 - (ii) Arrow right
 - (iii) Double arrow
 - (iv) Sequential double arrow
 - (v) Chevron left
 - (vi) Chevron right
 - (vii) Sequential arrow
 - (viii) Sequential chevron
- (c) Chevron light panel shall be installed at the appropriate location, height and visible to the traffic.

19.5.10.3 Method of Installation

- (a) Preparation of site must be done before the placement of chevron light. This includes determining the location of chevron light to be placed.
- (b) Arrangement of chevron lights (combined with flashing arrow) at taper shall follow the typical drawing for lane closure.
- (c) The chevron light must not be obstructed by any object. Any damaged beacon light must be rectified or replaced immediately.

19.5.10.4 Application Requirements

- (a) Chevron lights (if required) shall be installed at Transition Area for tapering and can be combined with flashing arrow during night lane closure or at other locations as required by the S.O.
- (b) Contractor shall ensure that chevron lights are installed at the required position and visible to the traffic. Displaced, malfunctioning or damaged chevron light shall be rectified or replaced immediately.

19.5.11 Variable Messaging System (VMS)

19.5.11.1 Material

- (a) Screen resolution of 1024 pixel dots.
- (b) 64 (L) x 40 (H) / Pixel Dots.
- (c) 6500 cd/m² Brightness.
- (d) Post for VMS shall be Square Hollow Mild Steel with the size of 100mm x 50mm x 4mm thickness. Additional support may use 25mm x 25mm x 2mm thickness square hollow welded to the base.
- (e) Base of VMS shall use Square Hollow Mild Steel with the size of 100mm x 50mm x 4mm thickness.
- (f) If frequent mobility or shifting of VMS is required, the Contractor may opt for the wheel-based type.

19.5.11.2 Specifications

- (a) VMS shall be able to operate 24 hours. The type and make for the VMS shall be approved by the S.O.
- (b) VMS board shall have a black background with amber colored LEDs. There shall be at least 4 pcs of LED bulbs per pixel of the board. VMS board shall be able to display graphics and letters.
- (c) VMS board shall have a minimum display dimension of 1800mm(W) x 1200mm(H).

19.5.11.3 Method of Installation

- (a) Preparation of site must be done before the placement of VMS. This includes removing any debris or large objects from the ground level and determining the location of VMS to be placed.
- (b) The VMS shall be installed at a max. distance of 500m before any work area which involves frequent change of information to the road user.
- (c) The VMS must not be obstructed by any object or posed as a hazard to road users. Any malfunction or damaged VMS must be rectified or replaced immediately.

19.5.11.4 Application Requirements

- (a) Wordings to be displayed on the VMS shall be approved by the S.O.
- (b) Contractor shall ensure that the VMS board is installed at the appropriate position and visible to the traffic at all times. Displaced or damaged VMS board shall be rectified immediately.
- (c) VMS to be fully operational at all times and necessary backup power supply to be provided to ensure its continuous operation.

19.5.12 Delineators on Barrier

19.5.12.1 Specifications

- (a) The delineators on barrier shall be from HDPE material.
- (b) Size of the delineators on barrier shall be 115mm (H) x 50mm (W) with fluorescent orange on both sides of the delineator.

19.5.12.2 Method of Installation

- (a) Delineators shall be installed at every interlocked plastic and concrete barrier. Fluorescent Orange reflective sheeting shall be visible to the traffic.
- (b) To be installed at the front centre of barrier at minimum 750mm height from ground level.

19.5.12.3 Application Requirements

- (a) To be used with interlocked plastic or concrete barriers.
- (b) Delineators on barrier shall be maintained by the Contractor. All faded, twisted, damaged or lost delineators shall be immediately replaced.
- (c) Routine inspection, maintenance and cleaning shall be carried out by the Contractor to ensure that delineators on barrier are in good working condition.

19.5.13 Robotic Flagman

19.5.13.1 Specifications

- (a) Robotic flagman shall be able to work for a duration of 24 hours operation. The type and make of the robotic flagman shall be approved by the S.O.
- (b) Robotic flagman shall be visible and equipped complete with flagman uniform, a safety helmet and a reflective flag during daytime or baton light during night time.

19.5.13.2 Method of Installation

- (a) Preparation of site must be done before the placement of Robotic Flagman. This includes removing any debris or large objects from the ground and determining the location of Robotic Flagman to be placed.
- (c) The location to be installed is immediately within the Transition Area.
- (d) The Robotic Flagman must not be obstructed by any object. Any malfunction or damaged Robotic Flagman must be rectified or replaced immediately.

19.5.13.3 Application Requirements

- (a) Robotic flagman shall be maintained by the Contractor to ensure it is in good working condition.
- (b) Robotic flagman shall be deployed for both the short term and long term at work area unless otherwise instructed by the S.O.

19.5.14 Traffic Control Paddle

19.5.14.1 Specifications

- (a) Material and design of the traffic control paddle shall be approved by the S.O.
- (b) Traffic control paddle shall be round in shape and 350mm diameter. Red fluorescent prismatic retro-reflective sheet shall be used on both sides of the paddle.

19.5.14.2 Application Requirements

- (a) Traffic control paddle shall be used by flagman to control traffic during daytime operations.
- (b) Method of using traffic control paddle to be the same as flagging method.
- (c) Flagger Guidelines
 - (i) For short work areas where both ends can be seen at the same time, only one flagger is needed. Both directions of traffic must be able to see the flagger and to recognize the person as a flagger. If this is not possible with one flagger, use two.
 - (ii) Flaggers should be visible, always face traffic and be prepared to warn workers to get out of the way if necessary. Do not allow other workers to gather near the flagger. During lunch or other breaks, flaggers should leave their station so that drivers will know that the flaggers are not on duty and not think they are shirking their duties whilst having their lunch or break if flaggers act otherwise.
 - (iii) Whenever a flagger is on duty, the advance flagger sign should be displayed to traffic. When a flagger is not on duty, remove or cover the sign.
 - (iv) Flaggers may use either a red, 600mm square flag or 600mm diameter circular Stop-Go paddle.
 - (v) Flagger for flagging has to be an experienced/trained person so as not to cause any inconvenience to the traffic flow. It is advisable that flagger be given proper courses on flagging procedures.

(d) Flagging Procedures

(i) To Stop Traffic

The flagger shall face traffic and extend the flag horizontally across the traffic lane in a stationary position so that the full area of the flag is visible hanging below the staff. For greater emphasis, the free arm may be raised with the palm towards the approaching traffic.

(ii) Traffic to Proceed.

The flagger shall stand parallel to the traffic movement and with flag and arm lowered from view of the driver, then motion traffic ahead with his free arm. Flags shall not be used to signal traffic to proceed.

(iii) To Slow Traffic

Where it is desired to alert or slow down traffic by means of flagging, the flagger shall face traffic and slowly wave the flag in a sweeping motion of the extended arm from the shoulder level to straight down without raising the arm above a horizontal position.

19.5.15 Traffic Baton Light

19.5.15.1 Specifications

- (a) Material and design of the traffic baton light shall be approved by the S.O.
- (b) Traffic baton light shall be minimum 40mm diameter and 260mm in length. It shall be of red colour and able to work for a minimum of 12 hours or throughout the night.
- (c) Traffic baton light shall be visible from a minimum distance of not less than 200m to warn the road users.

19.5.15.2 Application Requirements

- (a) Traffic baton light shall be used by flagman to control traffic during night time operations.
- (b) Method of using traffic baton light to be the same as flagging method of 19.5.14 in this specification.

19.5.16 Traffic Management Deployment Team (TMDT) Lorry

19.5.16.1 Specifications

- (a) Lorry shall be provided by the Contractor for setting up and maintaining traffic control devices for day and night operations.
- (b) The lorry shall be a minimum 1 tonne lorry with cargo hood and grill. The lorry shall be white in colour.
- (c) Each lorry shall be equipped with the following accessories:
 - (i) Arrow light mounted on lorry rooftop with collapsible holder.
 - (ii) Reflective yellow and red stripes with 150mm width on both sides and rear of the lorry.
 - (iii) Project sticker with package location, hotline number and contractor logo.
 - (iv) Digital video camera (DVR) to be fixed in the lorry.
 - (v) 1 unit of strobe light (amber-coloured) fixed on the lorry rooftop.

19.5.16.2 Application Requirements

- (a) TMDT lorry shall be used to ferry workers and/or traffic management devices.
- (b) The lorry and accessories shall be maintained by the Contractor at all times to ensure that the lorry and accessories are in good working condition.

19.5.17 Roof Mounted LED Arrow Light (Accessories for TMDT Lorry)

19.5.17.1 Specifications

- (a) Support frame for Roof Mounted Arrow shall be a minimum of 40mm x 40mm x 3mm thick angle iron.
- (b) LED arrow light shall be able to work even when vehicle's engine is turned off.
- (c) LED arrow lights shall have a flashing frequency of 40 - 55 times per minute. Roof mounted LED arrow lights shall be visible from a minimum distance of not less than 1000m to warn the road users.

- (d) Dimensions of the roof mounted LED arrow light board shall be 1280mm (L) x 750mm (H). The LED arrow light shall be able to show the following indicators:
 - (i) Arrow left
 - (ii) Arrow right
 - (iii) Double arrow

19.5.17.2 Application Requirements

- (a) During operations, the LED arrow light shall be mounted on TMDT lorry rooftop with collapsible holder to secure the arrow light board.
- (b) LED arrow light shall be used when the TMDT lorry carries out its duty at work area.
- (c) Displaced, malfunctioning or damaged arrow light boards shall be rectified immediately.

19.5.18 Emergency Response Team (ERT) Lorry

19.5.18.1 Specifications

- (a) The lorry shall be a minimum 1 tonne lorry with cargo hood. The lorry shall be white in colour.
- (b) Each lorry shall be equipped with the following accessories:
 - (i) 1 unit of amber coloured light bar fixed on the rooftop.
 - (ii) Reflective yellow and red stripes with 150mm width on both sides and rear of the lorry.
 - (iii) Project sticker with package location, hotline number and Contractor logo.
 - (iv) Digital video recorder (DVR) to be fixed in the lorry.
 - (v) Built-in rack at the back of the lorry for storage of ERT equipment.

19.5.18.2 Application Requirements

- (a) ERT lorry shall be provided by the Contractor to the Traffic ERT for patrolling and attending to emergency needs and situations for day and night operations.
- (b) The response time to reach affected area and initiate necessary action shall not be more than 30 minutes.

- (c) Each ERT lorry shall be equipped with a complete set of ERT equipment.
- (d) The lorry and accessories shall be properly maintained at all times to ensure that they are in good working condition.
- (e) ERT lorry vehicle is strictly for the use of ERT personnel only and its use to ferry workers is strictly prohibited.

19.5.19 Emergency Response Team (ERT) Equipment

19.5.19.1 Specifications

- (a) Contractor shall provide the following ERT equipment which shall either be in the ERT lorry at all times or properly stored away and ready to be used at any time, as and when required:
- (b) ERT equipment that shall be in the ERT lorry at all times are as follows:
 - (i) Two (2) walkie-talkies
 - (ii) Two (2) baton lights
 - (iii) Two (2) battery powered torch lights
 - (iv) Two (2) traffic control paddles
 - (v) Ten (10) traffic super cones
 - (vi) Three (3) A-shape signboards
 - (vii) One (1) first-aid kit
 - (viii) One (1) car battery jumper
 - (ix) One (1) toolbox
 - (x) One (1) set towing cable
 - (xi) One (1) 9kg ABC fire extinguisher
 - (xii) Oil absorbent
 - (xiii) Two (2) flat head scoops
 - (xiv) Two (2) brooms
 - (xv) Two (2) bags of 25kg cold mix asphalt
 - (xvi) One (1) water pump with accessories
 - (xvii) Ten (10) blinkers
 - (xviii) One (1) 24" chainsaw

19.5.19.2 Application Requirements

- (a) Equipment inside the ERT lorry shall be stored properly at all times to ease the handling and installation process when attending to emergency needs and situations.
- (b) All ERT equipment shall be well maintained throughout the project duration to ensure that they are in good working condition.

19.6 PLACEMENT AND REMOVAL OF TRAFFIC CONTROL DEVICES

This Chapter discusses the important aspects of the process of placing and removal of traffic control devices in work zones including its preparation, the order of device placement, the treatment of existing signs, and the use of “shadow” or protection vehicles.

19.6.1 Preparation for Placement Process

The placement, modification, and removal of traffic control devices for road construction and maintenance operations can be enhanced by adequate preparations. This is particularly important because of the hazard associated with these activities. The installation and removal of work zone traffic control devices create situations that are often far more hazardous than the operation of the completed zone. These hazards are often greater than those during the work activity because:

- (a) Workers placing advanced warning and channelizing devices must be in the roadway at points of high conflict without the full protection of the devices being placed.
- (b) The placement operation constitutes an unexpected situation for the motorists as they are confronted with a roadway partially closed and with partial traffic control devices.

The inherent danger of these operations can be lessened by using techniques that emphasize safety. Also, to reduce exposure to such hazards, the installation should be done as quickly as possible. To this end, several elements must be considered before the setting up of the traffic control zone.

19.6.1.2 Coordination with Affected Groups

Advance time coordination should be done with all affected organizations and groups (but not limited to) such as:

- (a) Police
- (b) Traffic Department of affected Local Council
- (c) Emergency services such as the fire dept, hospitals, etc.
- (d) Media platform (news, social, etc.)
- (e) Businesses and industries
- (f) Public transportation,
- (g) Residents and Residents' Representatives

Coordination prior to the placement of the traffic controls at a site greatly improves the safety and efficiency of the installation. The coordination includes the following (but not limited to) considerations:

- (a) Advance publicity
- (b) Selection of the day and time-of-day for the setting up
- (c) Analysis of traffic volumes

- (d) Selection of crew work hours
- (e) Consideration of emergency requirements in case of utility breakdown, road accidents, etc.

19.6.1.3 Inventory and Storage

All traffic control devices required for the placement and maintenance of the zone should be on-hand and in good condition. Also, special equipment, trailers, and trucks should all be operating properly and safely.

Devices maintained in inventory need to be formally organized to assure that all items are actually in stock and can be rapidly retrieved. Traffic control devices need to be stored properly to avoid marring, and all devices need to be kept clean.

All mechanical and electrical elements and equipment require routine maintenance to assure that they will function properly. Devices should be inspected carefully when they are returned to inventory. All devices found to be non-standard or in poor condition should be replaced, modified, or repaired. Equipment for the roadway work zone must be in good operating condition, otherwise there will be occurrences of breakdowns, delays, and increased site occupancy time.

Good practice suggests that devices be marked to identify ownership. The name and phone number of the owner may be shown on the non-reflective surface of the barricades. This procedure pinpoints responsibility and minimizes "borrowing." Standard inventory packages of organized traffic control devices can be established for activities by pre-packaging and ensuring checklists for each activity and location.

19.6.1.4 Training and Instruction

All Traffic Management Personnel should be trained for their tasks, with particular emphasis on safety. In addition, to ensure that all Traffic Management Personnel know their installation assignments, and to assure an efficient and speedy operation, the supervisor should review the installation process with his crew before going into the field. If either a new or different procedure is to be used, or if new people are in the team, these instructions are essential. In some cases, a rehearsal on an abandoned segment of roadway may be desirable.

19.6.2 Placement

19.6.2.1 Placement Sequence

Devices are installed in the direction that traffic moves that is, moving “downstream”. The first device placed is the first advance warning sign. The installation then proceeds with the:-

- (a) Advance warning area
- (b) Transition area
- (c) Buffer area
- (d) Work area
- (e) Termination area

If traffic in both directions will be affected, such as with work in the centre lanes, the devices can be placed in both directions at the same time, starting at each end farthest from the work area. Alternately one direction can be installed before the other.

When one direction of traffic will be directed into opposing traffic lanes, the signs, devices, and pavement markings for the opposing traffic should be placed first. It is essential to channelize opposing traffic out of its lane before moving the oncoming traffic into the lane. When all signs and devices are placed for opposing traffic, the devices for the oncoming direction can then be set up.

When signs or channelizing devices are to be installed and removed several times during the work operation, a spot should be painted where each device is located. This way the installation can be repeated quickly and properly. The devices should either be stored off the roadway, out of sight, or transported to another location. Channelizing devices should not be stored on the shoulder of the roadway, as this would appear to be a shoulder closure.

High-level warning devices, flagmen, or flashing vehicle lights should be used to warn the road users of the presence of workers. Flashing arrow panels are valuable to assist the workers during placement or removal of channelizing devices for lane closures.

19.6.2.2 Placement Procedure

Work vehicles should park in a safe location to unload teams and devices. Locations such as these should be the priority;

- (a) At kerbs
- (b) On shoulder
- (c) On side street

The work vehicle may serve as the advance warning device by using its flashing/rotating lights while the first warning signs are being placed. To protect the teams, the device truck should be

located upstream of the teams. This can be awkward, however, if the signs are unloaded from the rear of the truck.

On high-speed roads, a “backup,” “shadow,” or “protection,” vehicle should be used. This vehicle should first be positioned on the shoulder some 30 meters or more behind the device truck when the first signs are placed. The shadow vehicle uses special lights or a flashing arrow panel to warn traffic. When the team needs to work on the roadway, the shadow vehicle is moved into the travelled lane. Truck mounted attenuators are desirable for these vehicles.

19.6.2.3 Placing Channelizing Devices

When closing a lane, tapers are laid out in a straight line starting at the shoulder. Each channelizing device is then placed in sequence moving downstream. When placed by hand, the devices should be moved out from the shoulder with the worker looking towards traffic as he moves into the lane to place the device. When channelizing tapers are installed, each device is placed 30cm further into the lane that is being closed.

19.6.2.4 Lateral Position

For some closures, traffic doesn't have to be excluded from the entire width of the lane to establish a safe workspace. Under these circumstances, the work area channelizing devices should be placed a few meters back from the lane line as to:

- (a) Reduce the chances of the devices being hit
- (b) Provide increased lateral clearance, thereby increasing capacity

19.6.2.5 Cone Placement

Cones may be placed either by workers on foot or from a moving vehicle. When working from a vehicle, the truck should be equipped with a suitable worker platform and railing. On high-speed roadways, a shadow vehicle should be used to protect the team which is working from the back of the truck.

19.6.2.6 Expressway Lane Closures

Expressway lane closures should be more carefully carried out and are categorised into two types. “Exterior” lanes are those with a shoulder along one edge. “Interior” lanes, such as the centre lane of a three lane roadway, are bordered by lanes on both sides.

19.6.2.7 Exterior Lane Closures

The protection vehicle travels along the shoulder or exterior lane if no shoulder is available. It is equipped with a warning light and a flashing arrow panel. The protection vehicle then stops in a blocking position at least 30m upstream while the first warning sign is located. This operation is repeated for all warning signs -- first for one side, then the other side of the roadway.

When all signs are in place, channelization devices are then placed. The protection vehicle gradually encroaches upon the exterior lane as the workers install the taper in front of the protection vehicle. Finally, the protection vehicle is positioned in the closed lane while the work area channelization is installed.

19.6.2.8 Interior or Center Lane Closures

When work is necessary on an interior or center lane, the recommended procedure is to also close the adjacent exterior lane to avoid an "island" closure. In locations where, due to traffic volume or road geometrics, it must be carried around both sides of an interior lane work space, the preferred procedure is to first close an exterior lane upstream from the work space, particularly for high-speed conditions. Next, the interior lane traffic is channelized into the previously closed exterior lane.

Warning signs are placed on both sides of the approach warning area. The exterior lane is then closed as described above to create an "empty" work space.

To continue the setup, the protection vehicle moves carefully into the closed exterior lane and workers complete the exterior lane channelization and closing taper. The shadow vehicle then moves to the downstream end of the closed exterior lane and blocks the adjacent center lane. The taper which moves traffic from the interior lane to the previously closed exterior lane is placed, and work area channelization is established on both sides of the closed center lane.

In the final configuration, the shadow vehicle can be moved into the work area behind the taper. Traffic may now flow around either side of the work area.

19.6.3 Modification and Removal

Where possible, traffic control area should be removed by picking up the devices in a reverse sequence to that used for installation. This requires moving backwards or upstream through the zone.

With no shoulders, the removal of advance warning signs is made in the downstream direction.

Where extensive modifications to the traffic control area are required, as when switching a closure from one side of the roadway to the other, it may be necessary to remove the entire zone and then re-install it in the new configuration.

Portable concrete barriers require special care and planning to place and remove. Normally the lane next to the barrier must be closed while the barriers are placed or moved. This operation should be scheduled to cause as little disruption as possible.

19.6.4 Special Equipment and Techniques

Some Maintenance Agencies may have special equipment to facilitate and expedite the placement process, such as, trucks with racks in which signs are loaded in the reverse sequence to that needed; that is, the last sign put on is the first one to be taken off.

Special traffic control vehicles should be available for placement, maintenance and removal of traffic control zone devices and signs.

These vehicles should be employed to:

- (a) Carry devices to worksites.
- (b) Facilitate handling.
- (c) Help to organize and protect signs and devices.
- (d) Cater for emergency situations.

Special features of these traffic control vehicles may include;

- (a) Appropriate colour (orange)
- (b) Flashing/rotating lights or beacons
- (c) Flashing arrow panels
- (d) Sign racks
- (e) Cone chutes
- (f) Power lift tailgates
- (g) Worker platform and protective railing
- (h) Variable Message Signs
- (i) Crash cushions on shadow vehicles

19.7 MAINTENANCE OF TRAFFIC CONTROL ZONES

Traffic control zones should be maintained so that they remain as effective as when first established. Documentation of maintenance and inspections is vital in the event of lawsuits resulting from accidents or other grievances suffered by an injured citizen. This chapter will explain the types of inspections and maintenance required and methods to document them (record of inspections and actions taken).

19.7.1 Inspection and Maintenance Program

Once the traffic control zone is established and enforced, it is important that it continues to function effectively. The traffic control devices must be maintained as it was first installed or modified to ensure that the motorists are not misled with unnecessary changes to the work zone shape and sizes.

Regular maintenance is needed to service the traffic control devices and necessary corrections to be made due to a combination of any of the following factors:

- (a) Traffic accidents
- (b) Device displacement by;
 - (i) vehicular contact
 - (ii) slip stream from trucks
 - (iii) workers
 - (iv) wind
- (c) Damage caused by construction activities
- (d) Damage caused by adverse weather
- (e) Malfunctions and burn outs
- (f) Physical deterioration over time
- (g) Dust, dirt, grime and bitumen over spray.
 - (i) on sign faces
 - (ii) on barriers or cones
 - (iii) on reflectorized rails or string delineators
- (h) Dirt and debris on roadway.
- (i) Vandalism and theft.

19.7.1.1 Elements of an Inspection Program

A comprehensive inspection and maintenance program should include the following elements :

- i) A formalized plan
- ii) Defined inspection procedures
- iii) A form to record the findings of the field inspection
- iv) A repair program
- v) An adequate inventory of devices for emergency replacements or repairs
- vi) Day and night review of the marking and traffic control devices along the travel path through the work zones
- vii) Procedures to assure that specified repairs are made

- viii) Formal documentation of inspections and repairs
- ix) Identification of possible causes of accidents and skid marks

The inspector will need to make decisions during the inspection. He must exercise judgement in establishing appropriate practices. As deficiencies are observed, the following choices are available:

- (a) Make on-the-spot corrections
- (b) Call for emergency repairs (by radio or phone)
- (c) Instruct the work crew to make routine repairs during the next work day
- (d) Schedule deferrable corrective actions, such as sign cleaning

A key element of the program is the procedure that ensures that the required maintenance is performed. Corrective action should be fully documented with date, time and action taken.

19.7.2 Inspection Procedures

19.7.2.1 Responsibility

On construction projects, the Contractor should designate a Traffic Management Officer (TMO) who should be responsible for traffic control design, installation, maintenance and routine inspections.

Less frequent but additional periodic inspections should be performed by the senior staff of the Contractor (typically his superintendent), the Superintending Engineer and the Road Authority (the resident engineer and/or the traffic engineer).

Lines of communication and responsibility must be clearly established between the person conducting routine inspections and senior contractor or agency personnel. This communication is especially important between those in control of routine maintenance activities and those in authority. Effective communication ensures that urgent problems can promptly be brought to the attention of officials who can then respond immediately.

19.7.2.2 Frequency

Factors that must be considered :

- (a) Project size and duration

To determine the frequency of inspections, the following needs to be considered :

- (a) Severity of hazards
- (b) Frequency at which damage is occurring

- (c) Number of deficiencies observed during previous inspections.
- (d) Traffic volumes and speed.

Traffic controls left in place overnight should be inspected during hours of darkness at the same frequency as during the daylight hours. Inspections should also be carried out during adverse weather conditions to ensure safety requirements are met and adequate road drainage is maintained during the construction period.

19.7.2.3 Documentation

Documentation is an essential part of the traffic control maintenance function. It is necessary for good planning and for project accounting. Documentation serves to:

- (a) Ensure the integrity of the project traffic control; and
- (b) Provide a means of
 - (i) identifying the maintenance needed
 - (ii) providing a tool for getting maintenance started
 - (iii) checking to see that maintenance is done
 - (iv) documenting that maintenance was done

Well maintained traffic control maintenance records provide substantial support for the project in the following ways :

- (a) The records aid in the evaluation of the effectiveness of the planned and modified traffic control installation.
- (b) Traffic control maintenance records provide evidence of a proper traffic control installation in the event of a lawsuit arising from an accident at the worksite.

19.7.2.4 Record Keeping

Record keeping begins with an inventory of traffic control devices located in both the shop and field. With this information, future material needs can be estimated based on planned projects and anticipated damages and thefts. Costs can be budgeted, and needed material can be purchased (or fabricated) prior to commencement of work.

Good record keeping procedures suggest that the time and location of the installation and removal of traffic control devices should be noted. Although this record keeping can be time consuming for a moving maintenance operation, significant traffic control actions taken by the field crew should be recorded. These records should include:

- (a) Starting and ending time of work
- (b) Location of work
- (c) Names of personnel
- (d) Type of equipment used, and
- (e) Any changes in temporary or permanent regulatory devices

Major projects will require more detailed record keeping since they may involve greater amount of funds available from the contract BQ, and longer distances and times of physical exposure with resulting potential danger to the worksite employees and the motoring public.

Several methods of recording traffic controls are available. These include:

- (a) Photographs either keyed to a diary or containing a brief description of
 - (i) Date
 - (ii) Time
 - (iii) Location with GPS co-ordinates if possible.
 - (iv) Direction, and
 - (v) Photographer's name.
- (b) Videotaping of work zone drive-through can also be used to document the placement and condition of traffic control devices.
- (c) Special notes on construction plans (preferably the traffic control plan sheet); and
- (d) Diary entries of times, location and names of individuals (if known) involved in the :
 - (i) installation
 - (ii) change, and
 - (iii) removal of traffic control devices.

Work orders also serve as a reference, and should be keyed into the diary when used. When the maintenance inspection process reveals a condition that requires correction, the documentation should include:

- (a) Description of the correction needed, when it was noted, and by whom;
- (b) Corrections made or deferred and why;
- (c) Replacements made or deferred and why; and
- (d) Any other necessary actions.

Each agency should have general checklists for the different types of operations and conditions. These can be modified to meet the requirements of an individual worksite. Inspection sheets for major projects should be developed from the general checklists and schedule guidelines. For typical worksites, standard inspection sheets can be

prepared and used. A guideline for the inspection checklist may be referred to in Appendix 19A (JKR/BORANG PEMERIKSAAN RUTIN/2017)

19.7.3 Training and Equipment Needs

19.6.3.1 Training

Several elements should be considered in preparing for and performing traffic control zone inspections and maintenance. Personnel designated to perform these tasks must understand the general traffic control process, have a deep appreciation for safety, and be trained in device maintenance procedures. Training should include:

- (a) Proper cleaning methods for the various types of equipment and reflective materials
- (b) Maintenance techniques for mechanical and electrical equipment
- (c) Proper placement and ballasting of traffic control devices
- (d) Methods to check sign reflectivity,
- (e) Knowledge of the hazard potential of various types of situations
- (f) Solutions that may be used to solve various problems
- (g) Situations requiring special technical assistance (such as handling of hazardous materials) and procedure to be followed in securing such assistance, and
- (h) Documentation techniques.

19.7.3.2 Personnel, Equipment and Materials

Sufficient equipment and materials should be readily available to perform the required tasks. Usually, a dedicated vehicle will be needed to keep all the required materials on-hand. The following items may be needed.

- (a) Communications equipment
 - (i) Two-way radio
- (b) Safety equipment for personnel safety and emergency situations
 - (i) flashing warning lights or beacons
 - (ii) spot/flood lights
 - (iii) flares
 - (iv) first aid kit
 - (v) safety helmet
 - (vi) high visibility / reflective vests

- (b) Tools and hardware for on the spot repairs
 - (i) hammers
 - (ii) screwdrivers
 - (iii) pliers and wrenches (crescent)
 - (iv) wrecking bar
 - (v) shovel
 - (vi) saw
 - (vii) nails, nuts, bolts and washers
 - (viii) tape measure
 - (ix) knife

- (c) Spare parts and materials
 - (i) batteries
 - (ii) bulbs
 - (iii) fuel
 - (iv) sandbags
 - (v) posts
 - (vi) hardware :
 - wire and rope
 - pavement marking tape
 - reflective tape
 - washing materials

- (d) Spare devices
 - (i) plastic barriers
 - (ii) cones
 - (iii) temporary signs (A-Shape)
 - (iv) flashing light (blinkers)

- (e) Reference materials
 - (i) traffic control plan
 - (ii) inspection forms and checklists
 - (iii) logbook
 - (iv) pencils
 - (v) accident guidelines and report forms
 - (vi) emergency procedures and telephone numbers

APPENDIX

For JKR Internal Use Only

BORANG PEMERIKSAAN RUTIN ZON KERJA

Projek :
 Kontraktor :
 Lokasi Tapak :
 Nama TMO :

Tarikh : _____

Masa : _____

1 ZON A - KAWASAN AMARAN AWAL (ADVANCE WARNING AREA)								CATATAN	C.A.R. 1/ 2
i. Papan Tanda Pemberitahuan	A1	A2	A3	A4	A5	A6	A7		
ii. Papan Tanda Amaran Awal (AWAS)	A1	A2	A3	A4	A5	A6	A7		
iii. Papan Tanda Orang Bekerja	A1	A2	A3	A4	A5	A6	A7		
iv. Papan Tanda Lorong Sempit	A1	A2	A3	A4	A5	A6	A7		
v. Papan Tanda Had Laju	A1	A2	A3	A4	A5	A6	A7		
vi. Papan Tanda Anak panah	A1	A2	A3	A4	A5	A6	A7		
vii. Penanda Garisan Jalan Sementara	G1	G2							
viii. Keadaan Jalan	J1	J2	J3	J4					
2 ZON B - KAWASAN PERALIHAN (TRANSITION AREA)								CATATAN	C.A.R. 1/ 2
i. Papan Tanda Anak panah (3 Bilangan)	A1	A2	A3	A4	A5	A6	A7		
ii. Arrow Flasher / Chevron light	K1	K2	K3						
iii. Blinkers (Selang 10m)	B1	B2	B3	B4					
iv. Reflective Disc / Delineator String	C1	C2							
v. Plastic Barrier	D1	D2	D3	D4	D5	D6			
vi. Concrete Barrier	E1	E2	E3	E4	E5	E6			
vii. Kon Keselamatan	F1	F2	F3						
viii. Pengawal Bendera	H1	H2	H3						
ix. Robotic Flagman	I1								
x. Penanda Garisan Jalan Sementara	G1	G2							
xi. Keadaan Jalan	J1	J2	J3	J4					
3 ZON C - KAWASAN KELEGAAN (BUFFER AREA)								CATATAN	C.A.R. 1/ 2
i. Papan Tanda (Orang Bekerja / Had Laju)	A1	A2	A3	A4	A5	A6	A7		
ii. Blinkers	B1	B2	B3	B4					
iii. Reflective Disc / Delineator String	C1	C2							
iv. Plastic Barrier	D1	D2	D3	D4	D5	D6			
v. Concrete Barrier	E1	E2	E3	E4	E5	E6			
vi. Kon Keselamatan	F1	F2	F3						
vii. Penanda Garisan Jalan Sementara	G1	G2							
viii. Pengawal Bendera	H1	H2	H3						
ix. Keadaan Jalan	J1	J2	J3	J4					
x. Shadow Vehicle	L1	L2	L3						

4	ZON D - KAWASAN KERJA (WORK AREA)	CATATAN							C.A.R. 1/ 2
i.	Papan Tanda (Orang Bekerja / Had Laju)	A1	A2	A3	A4	A5	A6	A7	
ii.	Blinkers	B1	B2	B3	B4				
iii.	Reflective Disc / Delineator String	C1	C2						
iv.	Plastic Barrier	D1	D2	D3	D4	D5	D6		
v.	Concrete Barrier	E1	E2	E3	E4	E5	E6		
vi.	Penanda Garisan Jalan Sementara	G1	G2						
vii.	Keadaan Jalan	J1	J2	J3	J4				
5	ZON E - KAWASAN TAMAT (TERMINATION AREA)	CATATAN							C.A.R. 1/ 2
i.	Papan Tanda Mohon Maaf	A1	A2	A3	A4	A5	A6	A7	

Nota : C.A.R. = Permintaan Tindakan Pembetulan (*Corrective Action Request*)
 C.A.R. 1 = Tindakan pembetulan diambil dalam masa 24 jam.
 C.A.R. 2 = Tindakan pembetulan diambil dalam masa 2-5 hari.

Cc : Pasukan Projek (JKR)
 Resident Engineer (RE)
 Jurutera Projek

Maklumat tambahan / gambar dilampirkan : Ya Tidak

Disediakan Oleh Pegawai Pengurusan Trafik (TMO) :

 Nama :
 Tarikh :

Disemak oleh Pengurus Projek (PM) :

 Nama :
 Tarikh :

Diambil Tindakan Oleh TMO :

 Nama :
 Tarikh :

BUTIRAN KETIDAKPATUHAN PENGURUSAN TRAFIK

PERALATAN TRAFIK	KOD	NO	KETIDAKPATUHAN PENGURUSAN TRAFIK
Papan Tanda	A	1	Rosak
		2	Pudar / Tidak jelas
		3	Tidak mencukupi
		4	Jatuh / Bengkok
		5	Tidak dapat dilihat / Tersembunyi
		6	Tidak mengikut spesifikasi
		7	Lokasi tidak betul
Blinkers	B	1	Rosak
		2	Tidak berfungsi
		3	Tidak beroperasi dengan betul
		4	Tidak dipasang dengan jarak yang betul
Reflector Disc	C	1	Tidak dipasang dengan jarak yang betul
		2	Tidak memantul cahaya
Plastic Barrier	D	1	Pemasangan tidak berselang-seli (warna putih & merah)
		2	Rosak
		3	Sampah / habuk di antara <i>barrier</i> / kotor
		4	<i>Reflective plate</i> tiada / tidak mencukupi
		5	Tidak diisi dengan air / Air tidak mencukupi
		6	Tidak disusun dengan betul
Concrete Barrier	E	1	Pemasangan tidak berselang-seli (warna kuning & hitam)
		2	Rosak
		3	Sampah / habuk di antara <i>barrier</i> / kotor
		4	<i>Reflective plate</i> tiada / tidak mencukupi
		5	Tidak disusun dengan betul
		6	Tiada <i>concrete barrier</i> di lokasi kritikal (pengorekan dalam di sebelah jalan selekoh tajam, pengasingan kerja <i>falsework</i> / <i>scaffold</i> , kawasan berisiko banjir dan <i>rigid structure</i>)
Kon Keselamatan	F	1	Sampah / habuk di antara kon keselamatan / kotor
		2	<i>Reflective strip</i> tiada / tidak mencukupi dan/atau berat tidak mencukupi dan/atau rosak
		3	Tidak disusun dengan betul
Penanda Garisan Jalan Sementara	G	1	Pudar / mengelirukan
		2	penanda garisan jalan sedia ada yang tidak digunakan tidak dipadam
Pengawal Bendera	H	1	Pengawal Bendera tidak dilengkapi dengan pakaian seragam
		2	Tiada Pengawal Bendera di laluan masuk tapak / penutupan jalan / lencongan jalan
		3	Pengawal Bendera tidak dilengkapi dengan wisel dan bendera / <i>baton light</i>
Robotic Flagman	I	1	Tidak berfungsi
Kedaaan Jalan	J	1	Jalan berlubang / permukaan jalan tidak rata
		2	Kotor disebabkan oleh lumpur / tanah dari tapak projek
		3	Jalan sempit / lebar jalan tidak mencukupi
		4	Lampu jalan tidak berfungsi / kawasan gelap
Arrow Flasher	K	1	Tidak berfungsi
		2	Rosak
		3	Tidak mengikut spesifikasi
Shadow Vehicle	L	1	Tidak disediakan
		2	Tidak diletakkan dengan betul
		3	Kenderaan tidak dilengkapi / tidak berfungsi mengikut keperluan