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BRoWSER: Base-lining Road Works Safety on European Roads

Baseline report

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CEDR Call2012: Safety
BRoWSER: Base-lining Road Works Safety on European Roads

Baseline report

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Contents

1 Introduction

1.1 The BRoWSER project

The project Base-lining Road Works Safety on European Roads (BRoWSER) was initiated as a response to the Description of Research Need (DoRN) for the CEDR Transnational Road Research Programme Call 2012 on Safety.

The aim of the CEDR Transnational Research Programme (2012 call) seeks "to significantly reduce risks to road workers with an objective of Zero Harm". BRoWSER addresses two of the topics within the 2012 Call under the heading of "Safety of road workers and interaction with road users". These are:

- Collect data on worker injuries and near misses by country, road administration and employer
- Understand the optimum road works layouts that enable road users to approach, travel through and exit works without causing injury to workers and others

The aim of the BRoWSER project is to help National Road Authorities (NRAs) take a data-led approach to managing road worker safety. This knowledge of how road workers are exposed to risk from accidents and road user error is essential for effective safety management as it allows the real risks to be managed rather than those perceived to be the problem. The BRoWSER project focuses on the interaction between road workers and traffic and will consider road worker accidents, incidents and near misses (where available) alongside data for road works practices, network characteristics and road user accident data at road works.

1.2 This document

For each of the participating countries (the funding countries plus Slovenia) this document firstly provides a high-level overview of the network, road works management and operational arrangements for road works in each of the countries, providing general contextual information for road works management.

Secondly, this document identifies the main relevant standards and guidance that govern road works in each of the countries and illustrates some typical layouts that are used. These standards and guidance documents will be reviewed and analysed in detail in Work Package 7 of this project, which will in turn lead into later work packages looking at the possible correlation of road works layouts standards and accident data.

Thirdly, this document provides an overview of any existing data that is collected in each country that is relevant to the requirements of the EuRoWCas database. It has been identified that collecting the data required for the EuRoWCas database is not generally possible with (or without some adaptation of) the existing data collecting processes, and as such this document provides the motivation behind the three-month data collection trial to assess the feasibility of future data collection. Where available, relevant historical data are considered in order to provide a baseline.

This document builds on the interviews carried out in Work Package 1 in the trial countries. It also builds on information gathered in a project carried out under the ERAnet Road 2011 research programme (the STARs project - Scoring Traffic at Road works), in particular classification of road works and road works layout information from STARs Deliverable 1 (Defining the data requirements, April 2012).

2 Country-specific information

2.1 UK (England)

2.1.1 Network and road works management

In the United Kingdom, the Department for Transport (UK DfT) is responsible for all major strategic roads. Responsibility for operating and maintaining the strategic road network in England is devolved by the UK DfT to the Highways Agency (an executive agency of the UK DfT), with responsibility in Scotland and Wales being taken by the relevant regional Government department.

The Highways Agency (HA) divides the strategic road network in England into seven network regions which are further divided into operational Areas. The HA remains responsible for operating and maintaining their network, but engages the services of contractors to deliver day-to-day maintenance activity. These Asset Support Contractors (ASCs) undertake routine and emergency maintenance as well as winter maintenance (salting) of the network in adverse weather conditions. ASCs are usually appointed for relatively short contract periods (up to 7 years) but other some parts of the HA network are managed via Design, Build, Finance and Operate (DBFO) contracts; on these sections, DBFO Companies are engaged for much longer contracts, usually well in excess of 10 years

The following table indicates the network length and distances travelled on the network by road type in 2012.

Table 1: Road network length and distances travelled by road type (2012)

Road type	Length (miles)	Traffic (10^8 vehicle-miles)	Average daily flow
Motorway	1,856.6	555.2	81,925.4
Single carriageway A-road	943.6	54.2	15,738.1
Dual carriageway A-road	1,625.2	237.5	40,046.1
Total	4,425.4	846.9	52,432.9

Contractors maintaining the motorway and A-road network on behalf of the HA or DBFO Companies are commonly referred to as Tier 1 Service Providers. These companies or joint ventures may subcontract work to other specialist contracting organisations but remain responsible for the safety of personnel working on the section of network they are managing. Any accidents or high potential near misses that involve road works personnel that occur on the HA network must be reported to the HA via the Accident and Incident Reporting System (AIRSweb); this is a web-based system that collects data on accidents or near misses that had the potential to cause a serious accident.

Planning of road works is undertaken using a centralised booking system. All road works should be booked into this Schedule of Road Works (SRW) which manages bookings of space for road works and prevents conflicts by, in theory, containing details of all planned road works on the network. However, in practice, the information is often imprecise, for example contractors will often reserve a full week in advance for a single night's road works to allow flexibility for weather conditions and other considerations.

In theory, the SRW and/or the Highways Agency's Command and Control (C&C) database should be able to provide details of how many sets of road works there are, their duration, and the amount of network-km 'lost' to road works each year. However, SRW data is often inaccurate, as when works are be cancelled at the last minute due to unforeseen circumstances the entry in the SRW is not removed. Attempts have been made to use the SRW and C&C data to quantify the scale of road works and exposure of road workers, but it has not been possible to identify this information.

2.1.2 Standards and guidance

Applicable guidance and legislation

The main guidance document used in the UK is the Department for Transport's "Traffic Signs Manual – Chapter 8 Traffic Safety Measures and Signs for Road Works and Temporary Situations" (https://www.gov.uk/government/publications/traffic-signs-manual). This is published in two parts (Part 1 – Design and Part 2 – Operations) and provides guidance for the design, planning and managing of road works and participating in operations to install, maintain and remove temporary traffic management arrangements. It includes layout guidance and best practice for a wide range of lane closure requirements and speed restrictions on both single and dual carriageway roads.

The Traffic Signs Manual also provides the diagram below describing the five road design zones used for stationary works on dual carriageways.

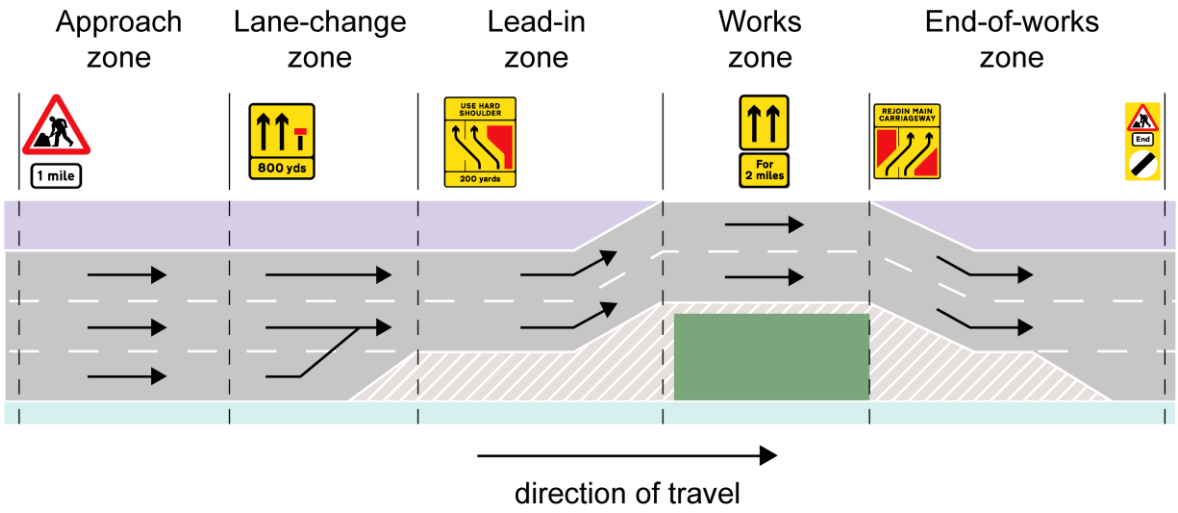


Figure 1: Road works zones as described in UK guidance

Traffic management plans are provided for each of the design zones for a number of different scenarios (varying by lane closure requirements, speed restrictions, road characteristics and management techniques).

Traffic management schemes for planned static road works are either "standard" schemes, "relaxation" schemes or "mobile lane closures" in the UK. The Traffic Signs Manual states:

- "Standard" schemes are appropriate for works carried out in all weather, visibility and traffic conditions.
- "Relaxation" schemes are appropriate for certain types of works for short-term situations with good visibility and low traffic flows.

Mobile lane closures are used where short term access is required to the carriageway at multiple locations over a long section of carriageway, for example for the maintenance of central reserve lighting). They are used only under very restricted conditions.

Interim Advice Notes (IANs) are issued by the Department for Transport and those that relate to temporary traffic management activity supplement the guidance given in Chapter 8. IANs are usually incorporated into subsequent revisions of Chapter 8, which was last subject to a major revision in 2006 though minor changes were made in 2009.

Relevant IANs that have been issued since 2009 include:

- IAN 181/14 Guidance on the use of Impact Protection Vehicles for Temporary Traffic Management
- IAN 180/14 Guidance for the selection of remote controlled temporary traffic management signs for use on the Highways Agency trunk road and motorway network
- IAN 179/14 Guidance on the Use of Vehicle Mounted High Level Variable Message Signs to provide advance warning of lane closures for Relaxation Works on Dual Carriageways with a Hard Shoulder
- IAN 163/12 Alternative Entry Taper at relaxation scheme temporary traffic management on high speed roads
- IAN 158/12 Maintenance Assessment Procedure
- IAN 150/14 Revision 2 Temporary Traffic Management Signs Simplification - guidance at road works using relaxation layout traffic management
- IAN 142/11 Temporary Barrier Decision Tool (TBDT)
- IAN 137/10 The use of stepped speed limits at roadworks

Chapter 8 is guidance only and emphasises the need for each set of road works to be assessed on a case by case basis for appropriate traffic management. In practice, it tends to be viewed as mandatory and is rarely deviated from – justification would have to be given for non-compliance in the event of an incident.

The Manual of Contract Documents for Highway Works (MCHW) is the DfT model contract for highway works. This sets as a contract condition that all works involving temporary traffic management should comply with Chapter 8 and interim advice unless directed by the client. The MCHW is used for all works on the HA strategic road network.

The Design Manual for Roads and Bridges (DMRB) was introduced in 1992 in England and Wales, and following that in Scotland and Northern Ireland. It contains information about current standards, advice notes and other published documents relating to the design, assessment and operation of trunk roads - including motorways. This includes a number of documents which are relevant in relation to road works, including GD 04/12, which specifies the Standard for Safety Risk Assessment on the Strategic Road Network and TD49/07 which sets out the standard for lorry mounted crash cushions.

Interim advice notes, the MCHW and DMRB are all available online via the UK DfT website at http://www.dft.gov.uk/ha/standards/. All Chapters of the DfT Traffic Signs manual, including both parts of Chapter 8, are also available online via the UK Government website at https://www.gov.uk/government/publications/traffic-signs-manual.

Legislation that applies in the context of road works may be separated into two areas. The first of these is highway law, which defines the responsibility of Government to act as the responsible authority for major roads (s.1, Highways Act 1980), establishes the duty to maintain roads that are maintainable at the public expense (s.41, Highways Act 1980) and requires that road works are marked and protected by appropriate signing (s.174, Highways Act 1980) to ensure risks to road users and road workers are controlled.

Signs used at road works (and anywhere else on a road) are any object or device that is used for conveying warnings, information, requirements, restrictions or prohibitions of any description (s.64(1), Road Traffic Regulation Act 1984). These signs must be of the size, colour and type prescribed by regulations (s.64(2), Road Traffic Regulation Act 1984) as it is unlawful to place any other sort of sign on a road unless it meets one of the legal exemptions (s.64(4), Road Traffic Regulation Act 1984).

The Traffic Signs Regulations and General Directions 2002 (TSRGD) and associated amendments prescribe the size, colour and type of signs that may be placed on roads. It includes all signs used on UK roads and hence includes the design and use of temporary traffic management signs. Other signs can be approved (s.64(1)(b), Road Traffic Regulation Act 1984), but only by exception where a prescribed sign does not exist or cannot be used.

The second area of relevant legislation is law relating to the safety, health and wellbeing of workers. This applies to all workers, not just road workers. The primary law is the Health and Safety at Work etc Act 1974 which places duties on all employers and employees to ensure health, safety and welfare at work and to protect against risks arising out of activities of persons at work. This applies to employers of road workers, road workers as employees and to both where their activities could affect the safety of others e.g. road users.

This primary legislation is underpinned by a large number of regulations that cover many aspects of work by road workers. Key regulations are the Management of Health and Safety Regulations 1999 that requires employers to carry out effective risk assessments for the work that their employees do (Regulation 3(1)) and to keep these up-to-date (Regulation 3(3). The Construction (Design and Management) Regulations 2007 require that all construction work (which includes road works) is carried out in such a way that so far as reasonably practicable it is carried out without risks to health and safety (Regulation 13(2)).

Other regulations cover safety of work equipment, specific activities such as lifting operations and highly specialist work such as working with asbestos. All these regulations have the same objective, which is to provide and maintain a working environment for employees that is, so far as is reasonably practicable, safe, without risks to health, and adequate as regards facilities and arrangements for their welfare at work.

When incidents or accidents happen in the workplace, there is a legal requirement to report them to the UK Health and Safety Executive (UK HSE), which is the body responsible for enforcing health and safety in the workplace. The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR) puts duties on employers to report workplace incidents and accidents. Incidents that are reportable are formally defined by UK HSE; any injury that results in absence from work for a continuous period of 7 days must be reported to HSE. Reports must be made within 10 days of the incident and records must also be kept of (as a minimum) the date, time, place of the incident, personal details of the people involved and a brief description of the event.

Typical layouts

The following diagrams show some typical layouts for road works as illustrated in Chapter 8 of the Traffic Signs Manual.

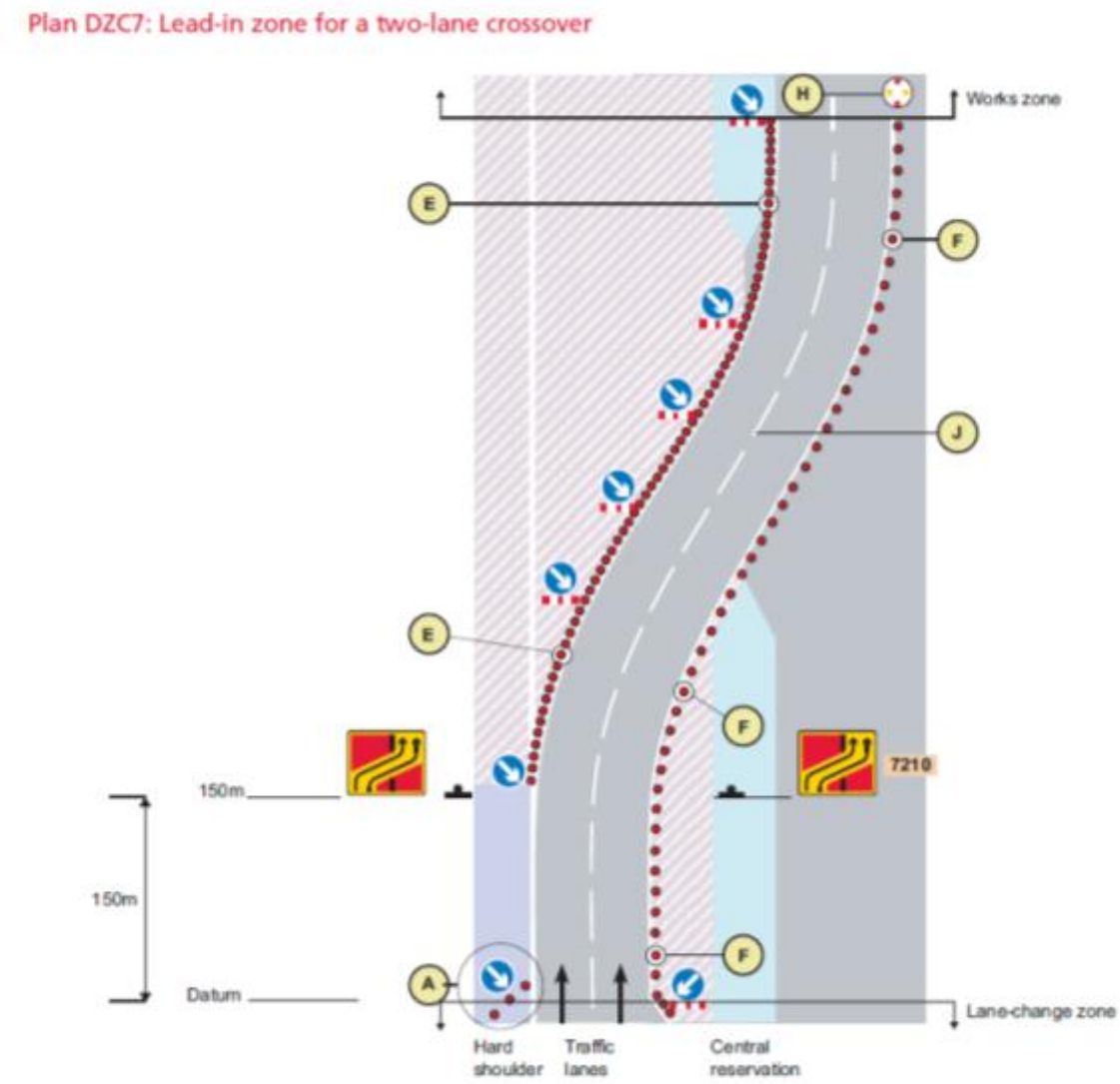


Figure 2: Layout for lead-in zone for a two-lane crossover

Plan DZB6: Lane-change zone for a single lane closure on a dual carriageway road for which the national speed limit applies

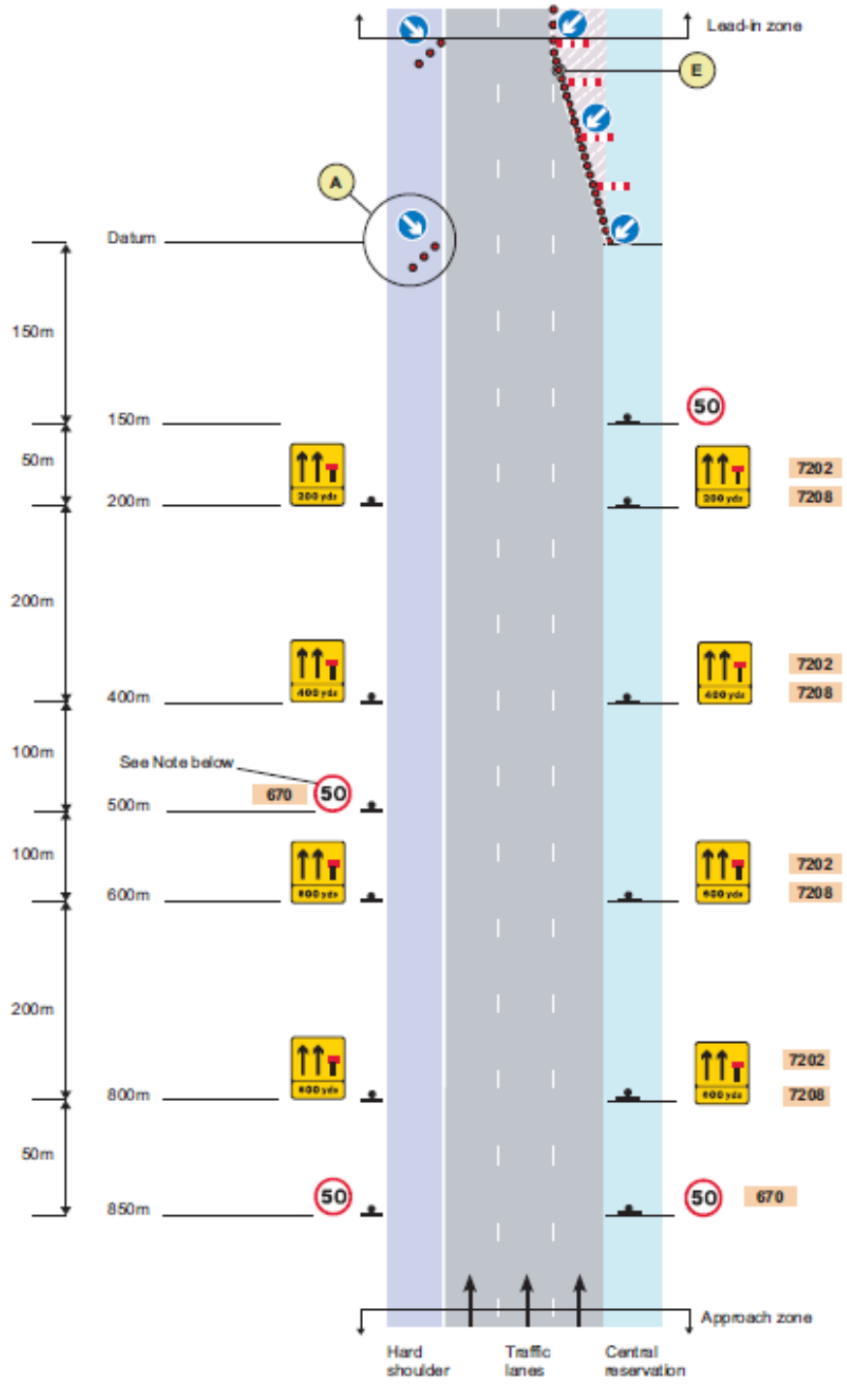


Figure 3: Layout for lane-change zone for a single lane closure on a dual carriageway

Plan DZB8 Lane-change zone for a stepped taper dosure on a dual carriageway road for which the national speed limit applies

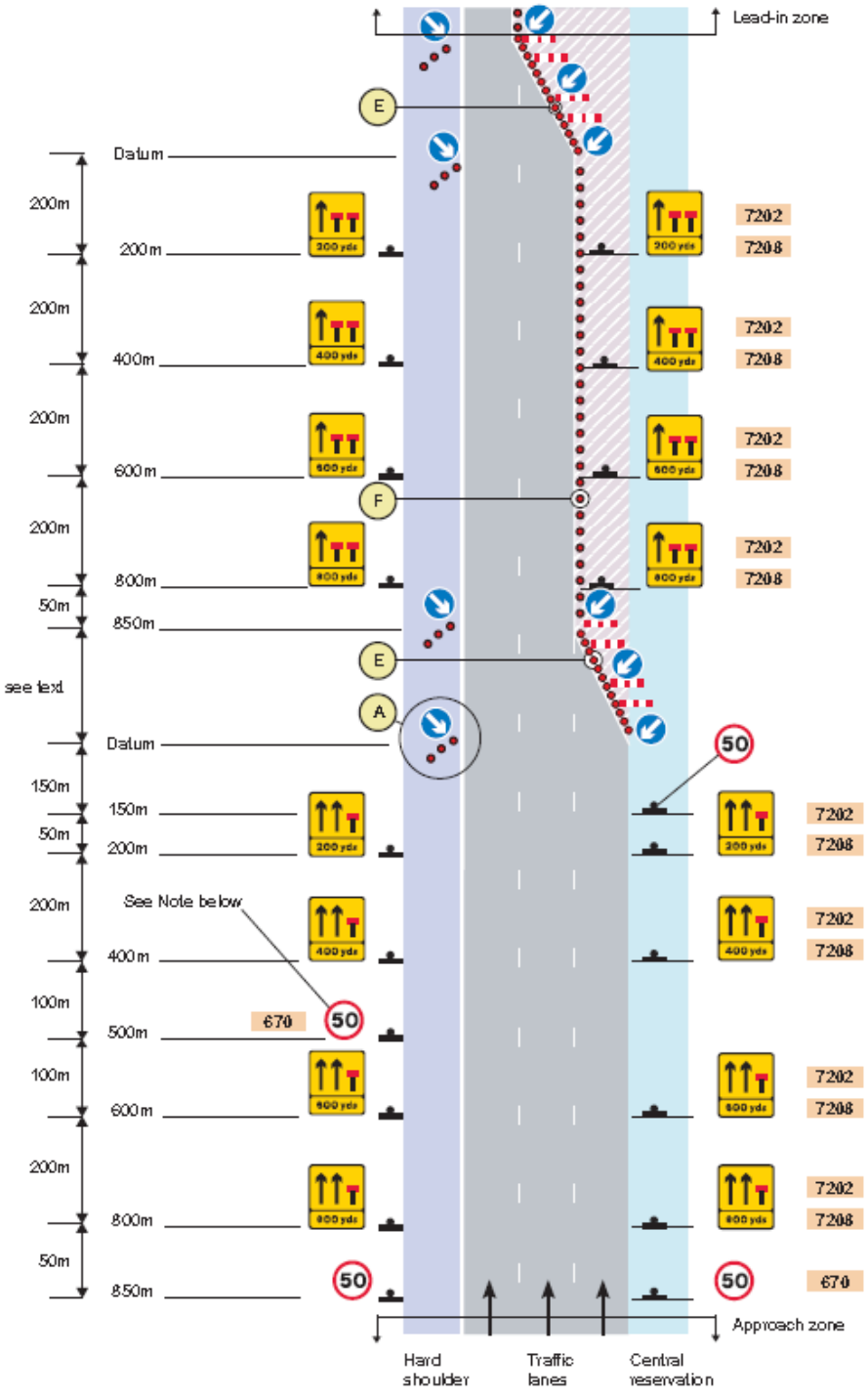


Figure 4: Layout for lane-change zone for a stepped taper closure on a dual carriageway road

2.1.3 Accident data collection

There are two main databases that collate data (relevant to EuRoWCas) in England and this section describes these in more detail.

STATS19

The 'STATS19' database is compiled by the Department for Transport from data supplied by the Police. If the Police are called to an accident then the data are collected at the scene; in some cases the accident is reported by a member of the public at a police station and the details are provided retrospectively.

The definition of an accident used in STATS19 is an incident involving personal injury occurring on a public highway in which at least one vehicle is involved, and which becomes known to the police within 30 days of its occurrence. Each accident therefore involves one or more vehicles, and each vehicle involved in an accident may have zero casualties, one casualty, or multiple casualties associated with it.

Each STATS19 data record consists of four parts:

- Accident record – which describes the circumstances of the accident, for example the date, time, road type, road number, location of the collision (the Ordnance Survey Grid Reference), speed limit, road / junction characteristics, light, weather and road surface conditions.
- Vehicle record(s) – which describe the vehicles involved (a separate form for each vehicle). This includes the vehicle type, make and model, movements before and during the incident, and some information about the driver (e.g. age or estimated age, sex, postcode, journey purpose).
- Casualty record(s) – which describe the casualty or casualties resulting from the accident (again, a separate form for each casualty). This includes the casualty age, sex, injury severity (killed, seriously or slightly injured) and type of casualty (i.e. whether they were a driver or passenger and in which vehicle, or if they were a pedestrian). Personal details such as home address, occupation and ethnic group are not recorded. Note that non-injured occupants of vehicles are not recorded.
- Contributory factors – which give an indication, in the reporting officer's opinion, of what contributed to the collision. The reporting officer can select up to six of 76 factors that may have contributed to the collision, and whether these factors were 'very likely' to have contributed or only have a 'possible' link to the accident. These factors are linked to the relevant vehicle or casualty record(s).

It is important for the purposes of this project to note that, since only accidents with casualties are included, no records are kept of 'damage only' or near misses, even if damage has occurred to vehicles or equipment. Also because only accidents that are reported to the police are included, this leads to underreporting of minor accidents.

There are several data fields in Stats19 relating to roadworks. These are:

- Special Conditions at Site (Section 1.24)

  This field includes an option for 'Road works' to indicate their presence at the site of an accident.

- Hit object in carriageway (section 2.12)

This field records the first object that a vehicle hit in the carriageway, and includes an option for roadworks. (Guidance states that if this option is selected then section 1.24 should be coded 'roadworks')

- Pedestrian road maintenance worker (Section 3.19)

  This field records whether an injured pedestrian in the accident was a road maintenance worker. The options are: Not applicable, Yes and Not known. Guidelines state that 'Yes' applies to road maintenance workers at, or within the coned area approaching (or immediately following), roadworks, whether or not they were actively engaged in road maintenance activities when the accident occurred.

- Contributory factor 'Temporary road layout (e.g. contraflow)'. (Factor 107)

  Guidelines for this factor state that 'Includes contraflow sections on dual carriageways, single alternate line working at road works on two way roads and all other locations where a temporary road layout has contributed towards an accident'

No further information is collected about any road works that may be present at the time of the incident.

Accident and Incident Reporting System (AIRS) data

AIRSweb is the official Highways Agency mechanism for recording and reporting work-related incidents that involve any part of the supply chain including their subcontractors. AIRSweb is a web-based application hosted on the Highway Agency's Information Systems which offers significant improvements, greater user functionality and ease of use compared to the previous manual version, AIRS; its development was supported and facilitated by representatives from Contractors and Service Providers.

As described in Section 2.1.2, all work-related incidents involving fatality, serious injury or absence from work for more than 7 days must be reported to the UK HSE. These accidents must also be reported to the HA. For fatal accidents, these must be reported immediately by appropriate and rapid means. All RIDDOR incidents involving fatal or major injuries must be reported via AIRSweb within 24 hours. Other incidents must also be reported within 24 hours including high potential "near miss" and "undesired circumstances" (hazards)[1].

For RIDDOR injuries that result in the employee being away from work, or unable to perform their normal duties for more than 7 days as a result of their injuries, the report must be entered onto AIRSweb within 10 days of the original injury date. Occupational diseases and dangerous occurrences must also be reported within 10 days.

Interim Advice Note 128/12 Highways Agency Supply Chain Health and Safety Incident Reporting (http://www.dft.gov.uk/ha/standards/ians/pdfs/ian128r2.pdf) provides guidance and information regarding the reporting of incidents via AIRSweb.

The AIRSweb interface has ten 'forms' for recording details:

- User details – details of the person reporting the incident
- Incident summary and location – including description of the incident, time, date and location
- Incidents – classification of the incident (shown in the screenshot below)
- Works – details of the road works type and contracting authority

[1] A "near miss" is defined as an event whilst an "undesired circumstance" is defined as a set of conditions or circumstances.

- Site and traffic – including details of the works, traffic management, speed limits, weather and visibility conditions
- Police – details of police officers in attendance
- TO – details of traffic officers in attendance
- Vehicles – details of vehicles involved (excluding those equipped with a crash cushion)
- Crash cushion – details of any crash cushion involved (including vehicle and driver)
- Investigation – details of any subsequent investigation carried out

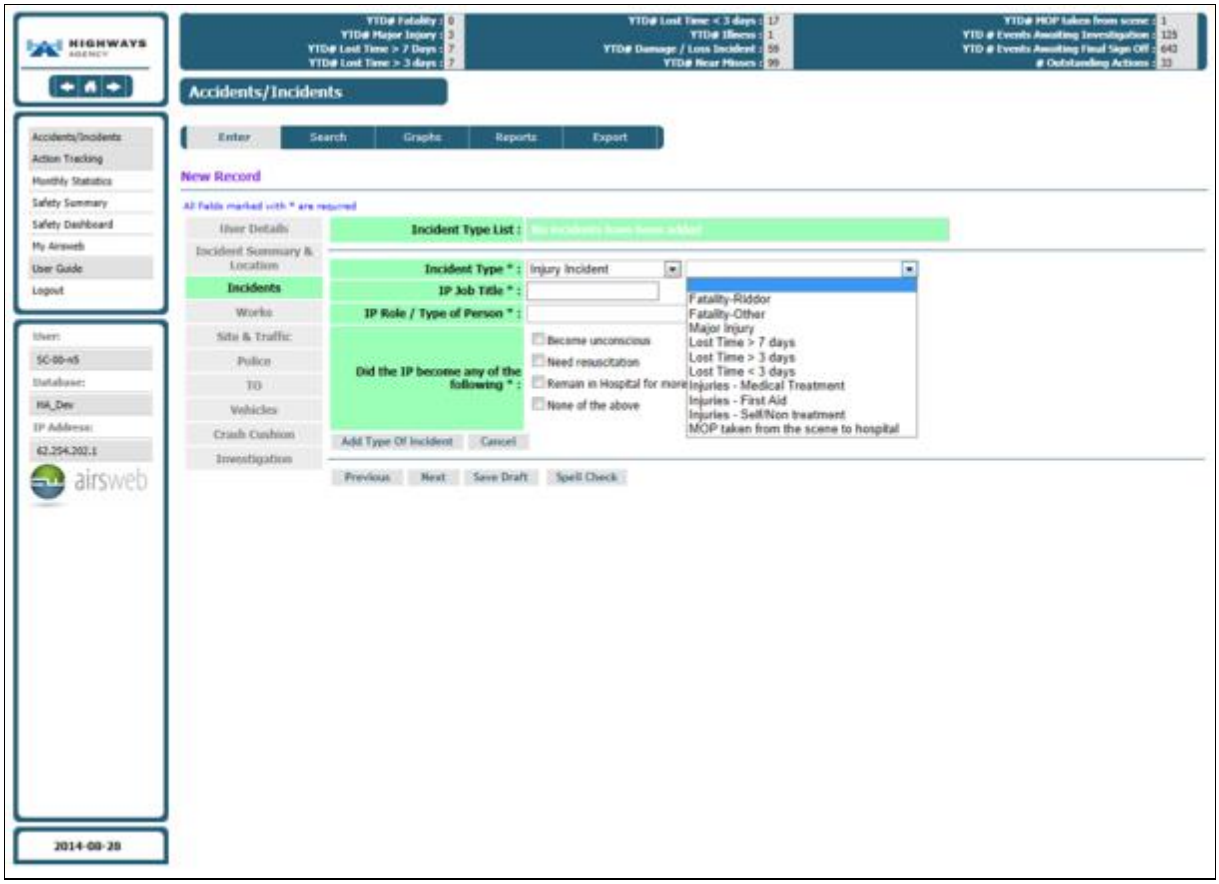


Figure 5: Screenshot of AIRSweb interface

The AIRS data provide most of the fields specified in project deliverable D2.1 (Input data definition document for EuRoWCas) for all work-related reportable incidents and some non-reportable incidents including high potential near misses. The data should be collected in a timely manner (usually within 10 days of an incident) and therefore are a suitable source for use in EuRoWCAS. Using the AIRS data avoids duplication of effort by the contractors and those reporting the incidents and therefore is the most efficient method for the UK data collection.

However, although in theory the AIRS data provides all the information required, it is known from previous projects using these data that there are issues with how the form is completed in practice. Often the forms for the site and traffic details and the vehicles details are not used, which may cause difficulties in using the data for EuRoWCas purposes. The three-month data collection trial has identified the practical problems and assessing the suitability

of this approach for continued data collection (see project deliverable CEDR BRoWSER Final Trial Report, October 2014).

AIRS data have been collected for over ten years by the Highways Agency. It is therefore possible to look at data from before the trial period; due to the numbers involved, these incidents were not processed into the BRoWSER format.

Those that would be relevant to BRoWSER and EuRoWCas were identified for the period 2013-2014 (prior to the trial).There were 3034 incidents recorded on the system between January 2013 and April 2014. Of these, 1354 fell into one of the relevant incident categories: 'Damage / loss incident', 'Injury incident' and 'Near Miss'. These incidents were further filtered by location to those that took place 'in a public place', i.e. on a road, as opposed to at the organisation's headquarters or other premises. This resulted in 570 incidents. From the information provided in the free text 'incident description' of each of these incidents, it was determined whether the incident was relevant for BRoWSER purposes.

This process resulted in 174 incidents between January 2013 and April 2014 which would be included in a EuRoWCas database. Of these, 15 were classified as 'injury incident', where one or more persons sustained an injury. The remainder were divided into 43 'damage / loss incidents' and 116 'near miss' incidents, however from the incident descriptions it can be seen that there is significant overlap between these two classifications depending on the interpretation of the contractor recording the incident – for example, a road user vehicle colliding with a safety barrier may be classified as either category, depending on the severity of the damage and the relative proximity of any road worker personnel.

2.2 Belgium (Flanders)

2.2.1 Network and road works management

The Regional Road Authority is responsible for construction and maintenance works on the network[2]. However the large majority of road works are carried out by private companies. Local districts and engineers from the road authority are responsible for the contract management as well as the road work supervision and control.

Road works execution is based on regional standard tender specifications (used as a reference document when preparing the road work contract documents). These documents include rules about how to sign the road work site depending on the category of works.

A road contractor must get a special authorisation from the road authority before starting any road work; a signing plan (for long-term road works) or at least a reference to the relevant standard signing scheme (for short-term or mobile road works) is usually established at that time.

Network length per road type

The Flemish regional Road Authority manages 6939 km of roads. The road network is composed of:

- Motorways (incl. exits and access): 1204.5 km
- Other regional roads: 5380.5 km
- Ring road: 246 km
- Ring road with Motorway status: 108 km

Vehicle-km per year per road type

Table 2: Million vehicle-kilometres driven in Flanders

	2008	2009	2010
Motorways	21,865	21,881	21,973
Province and regional roads	21,527	21,775	21,984
Municipal roads	12,522	12,651	12,790

2.2.2 Standards and guidance

Categorisation of road works & relevant documents

In Belgium, the legal basis for the categorisation of road works is determined by a federal decree from May 7th, 1999 concerning the signing of road work activities and other obstructions on public roads. The regulation describes the measures that should be applied for each category of road works and, within each category, for each zone.

The categorisation of works, from the decree of May 7th 1999, is:

- Category 1: road works on motorways and roads with a speed limit above 90 km/h
- Category 2: road works on roads with a speed limit between 50 and 90 km/h

[2] Responsibilities may differ for big projects executed through Public Private Partnerships

- Category 3: road works on road with a speed limit not above 50 km/h
- Category 4: works planned outside the traffic area but hindering pedestrians and other vulnerable road users
- Category 5: works during daylight conditions and with normal visibility (200m)
- Category 6: mobile road works hindering the traffic due to their low speed or frequent stops.

The federal regulation is complemented by regional rules which give additional details concerning the measures to apply with respect to the existing federal categorization. Regional rules provide detailed information on how road work activities should be signalized for different site characteristics (median separation, number of lanes, etc.). They sometimes give additional requirements to the decree of May 7th, 1999 (e.g. use of a truck mounted attenuator in some circumstances).

For Flanders the following documents apply:

- Standard tender specifications: “Standaardbestek 250” (Chapter X. 3 on road works signing) is used as a reference document when preparing the road work contract documents;
- Schemes for signing of the more typical road works layouts (appendix to the Standaardbestek 250) are used as a guide to build the signing plans;
- Regional Service orders (“dienstorders”) complementing the standard tender specifications.

Some road work configurations that are typical in Flanders are presented in the following sections, together with their characteristics.

Typical layouts - Major (long term) works on motorways

First are considered two typical layouts used for major road works on a 3-lane motorway with a contraflow and on a 2-lane motorway with lane deviation.

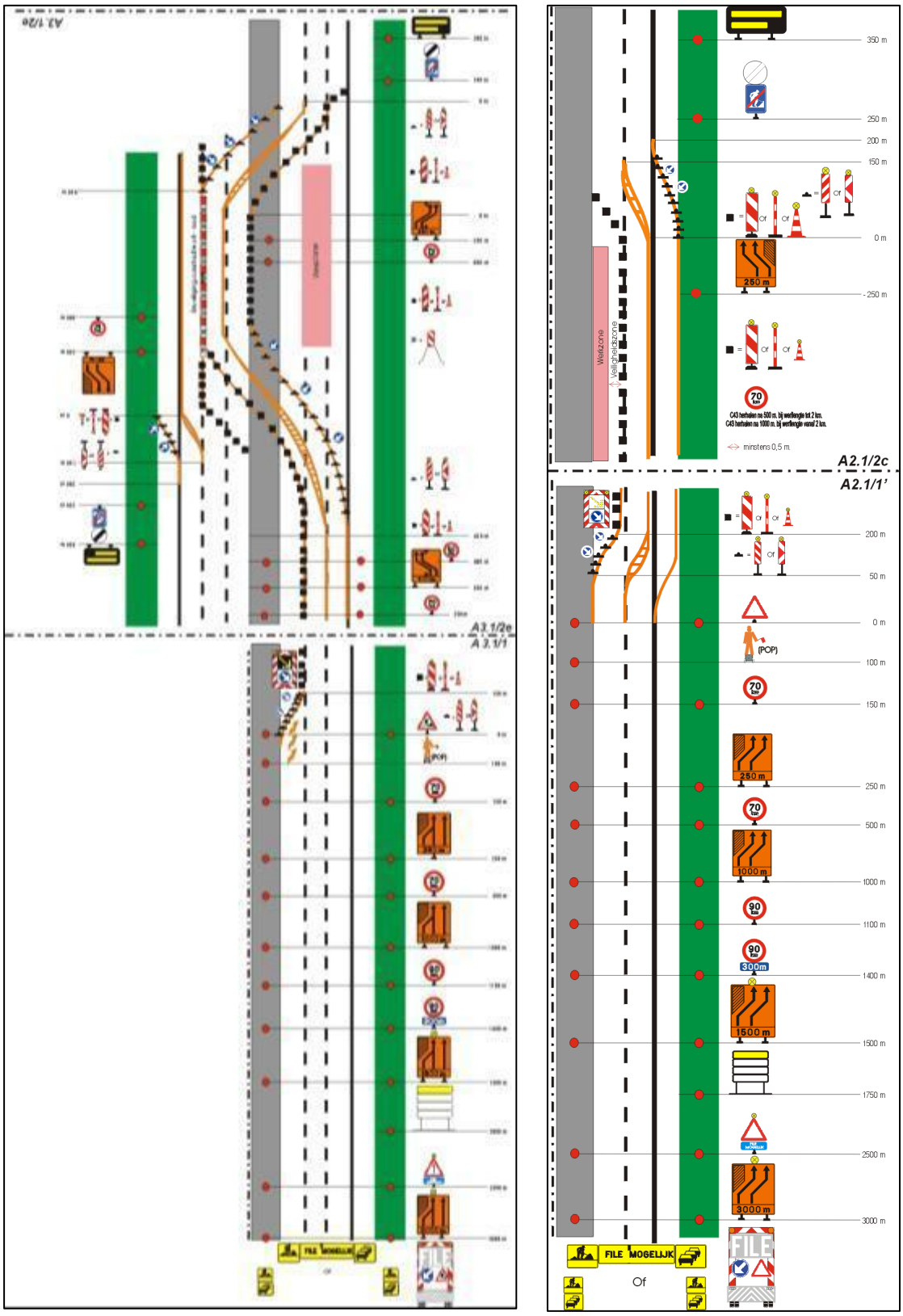


Figure 6: Standard layouts following the Flemish standard specifications (Left: major road works on a 3 lanes motorway with a contraflow; Right: major road work on a 2 lanes motorway with lane deviation)

Their main (operational) characteristics are now discussed.

- Long distance information:

For long-term road works which have a significant impact on the traffic flow, the existing fixed VMS and/or mobile trailers with VMS are typically used to inform road users and allow them to adapt their route.

Mobile trailer with VMS (here 4400m before the work zone)

- Pre-advance warning (up to -3000m):

For long-term road works which have a significant impact on the traffic flow, additional fixed signs are installed. A dynamic queue warning system is deployed in addition on the more traffic sensitive motorways.

Fixed signs warning about queue likeliness (here 4600m before the work zone)

- Far Advance warning (-1500m/-3000m):

This usually consists of the first sign about the road work layout and a standard sign for queue warning (common on all road work sites).

(3000 m) Sign about the road work layout (left) and standard sign for queue warning (right)

- Speed limits and speed control (0m/-1500m):

For layouts with a lane deviation only, the speed limit is progressively lowered from 120 km/h to 90km/h (1100 m before the transition area) and to 70km/h (500 m before the

transition area). For road work sites with a contraflow the speed limit is often locally lowered up to 50km/h; however this depends on the geometry / length of the crossing of the central reserve.

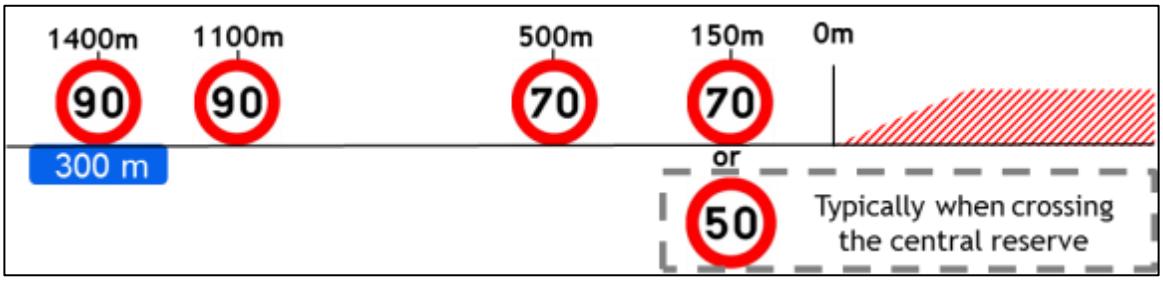


Figure 7: Speed limits scheme for long-term motorway road works having an important impact on the traffic

Traffic signs showing the road work layout are typically repeated three times in this area.

Non-compulsory traffic and speed management measures are more and more deployed along this advance warning area and up to the transition area:

- Automatic “flagging man”;
- Temporary gantry (a);
- Speed display (b);
- Transverse rumble strips (c);
- VMS trailer (c);
- Speed enforcement camera.

a.

b.

c.

- Lane closure/Transition area:

  A single lane deviation is typically 150m long and is composed of high panels with lights or temporary concrete barriers. A frame sign with flashing arrow and lights is also installed.

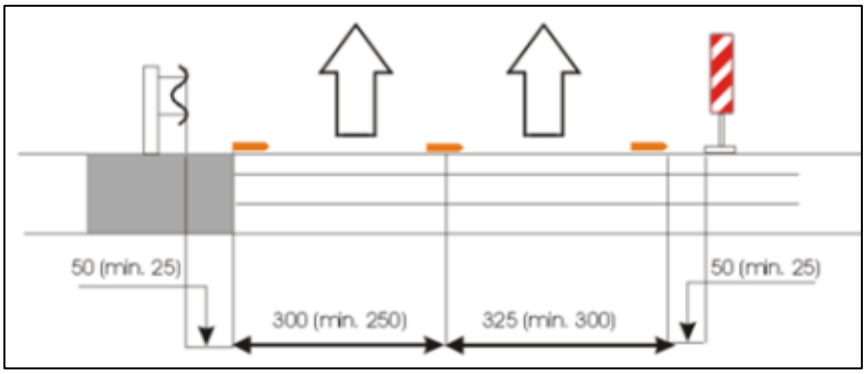
  For works layouts involving a deviation of several adjacent lanes, a temporary lane marking is laid (double lines with a 1m width neutral area).

- Lateral safety distance and work zone delineation:

  In Belgium, the minimum lateral safety distance along the work zone is about 0.50m. This distance is increased where possible.

  Following the federal decree cones or panels or safety barriers may be used to delineate the work zone. In practice, only panels and temporary safety barriers are used. The delineation type used depends on the duration of the road works, the lateral safety distance and the eventual need to enter or access the work zone at several locations.

- Temporary lane width: 3.25m/3m (HGV lanes/other lanes)



- Physical separation of the opposite traffic flows: always build with metal or concrete temporary barriers (standard containment level/Working width: T3/W5).

Typical layouts - Minor (short-term) works on a 2-lane motorway and a single carriageway road

Here are considered two typical layouts used for short-term (from dawn to dusk) road works on a 2-lane motorway with a deviation of the lane and a single carriageway road (up to 90km/h).

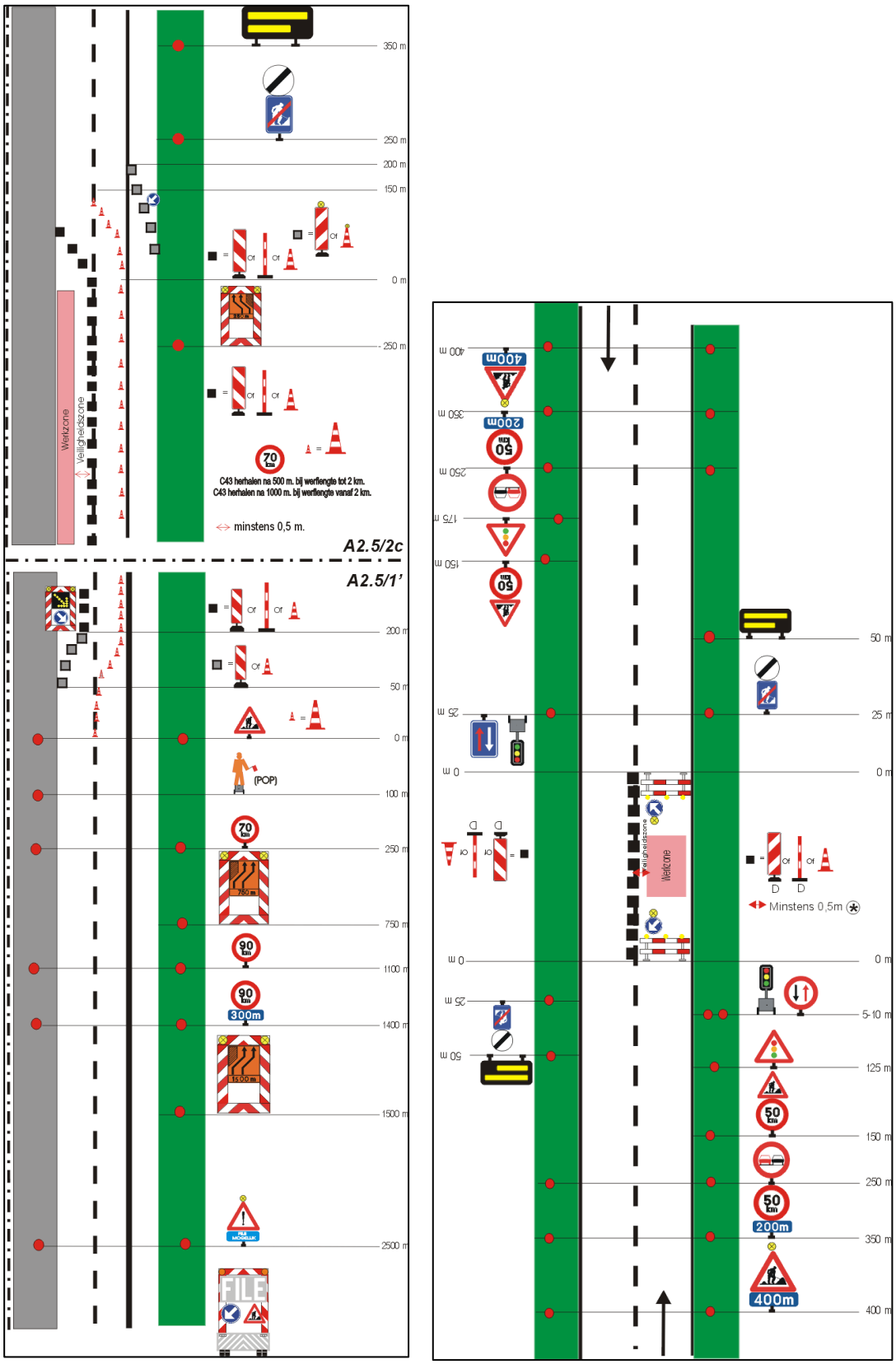


Figure 8: Standard layouts following the Flemish standard specifications (Left: minor road work on a 2 lanes motorway with a lanes deviation; Right: minor road work on a 2 lanes single carriageway with 50 km/h < Speed < 90 km/h)

Their main (operational) characteristics are now discussed.

- Long distance information:

  For road works on motorways having a significant impact on the traffic flow the existing fixed VMS and/or mobile trailers with VMS are typically used to warn road users in advance.

- Far Advance warning (-1500/-2500m):

  On motorway, this usually consists of the first sign about the road work layout and a standard sign for queue warning (common on all road work sites).

  On single carriageway roads with lower speed limits, the first warning sign is located 400m before the work zone.

- Speed limits (0m/-1500m):

  On motorways the speed limit is progressively lowered from 120 km/h to 90km/h (1100 m before the transition area) and to 70km/h (250 m before the transition area).

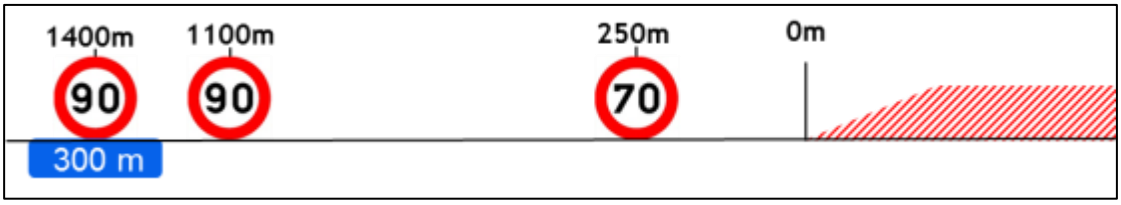


Figure 9: Speed limits scheme for short-term motorway road works having a significant impact on the traffic

The road user is informed twice about the road work layout through frame signs with lights. On single carriageway road the speed limit is lowered to 50km/h. Depending on the traffic intensity and on the length of the work zone priority signs or temporary traffic signals are used.

- Lane closure/Transition area:

  On motorway a single lane deviation is typically 150m long and is composed of high panels with lights. A trailer or a LMCC equipped with a frame sign with flashing arrow and lights is also installed. For works layouts involving a deviation of several adjacent lanes, a cone alignment is temporarily installed.

  On single carriageway roads, the lane closure is made with fixed barrier equipped with lighting and adequate road signs. A trailer or a LMCC equipped with a frame sign with flashing arrow and lights is also sometime used.

- Lateral safety distance and work zone delineation:

  As for long-term road works the minimum lateral safety distance along the work zone is about 0.50m. Given the short duration of these road works only cones or panels are generally used. The delineation type used depends on the duration of the road works and the available lateral safety distance.

- The temporary lane width: rules are similar to the ones for major works.

Typical layouts - Mobile works on a 3-lane motorway and on a high-speed dual-carriageway road

The schemes below show two typical layouts used for mobile road works on a 3-lane motorway and on a dual carriageway road with speed limit above 90km/h.

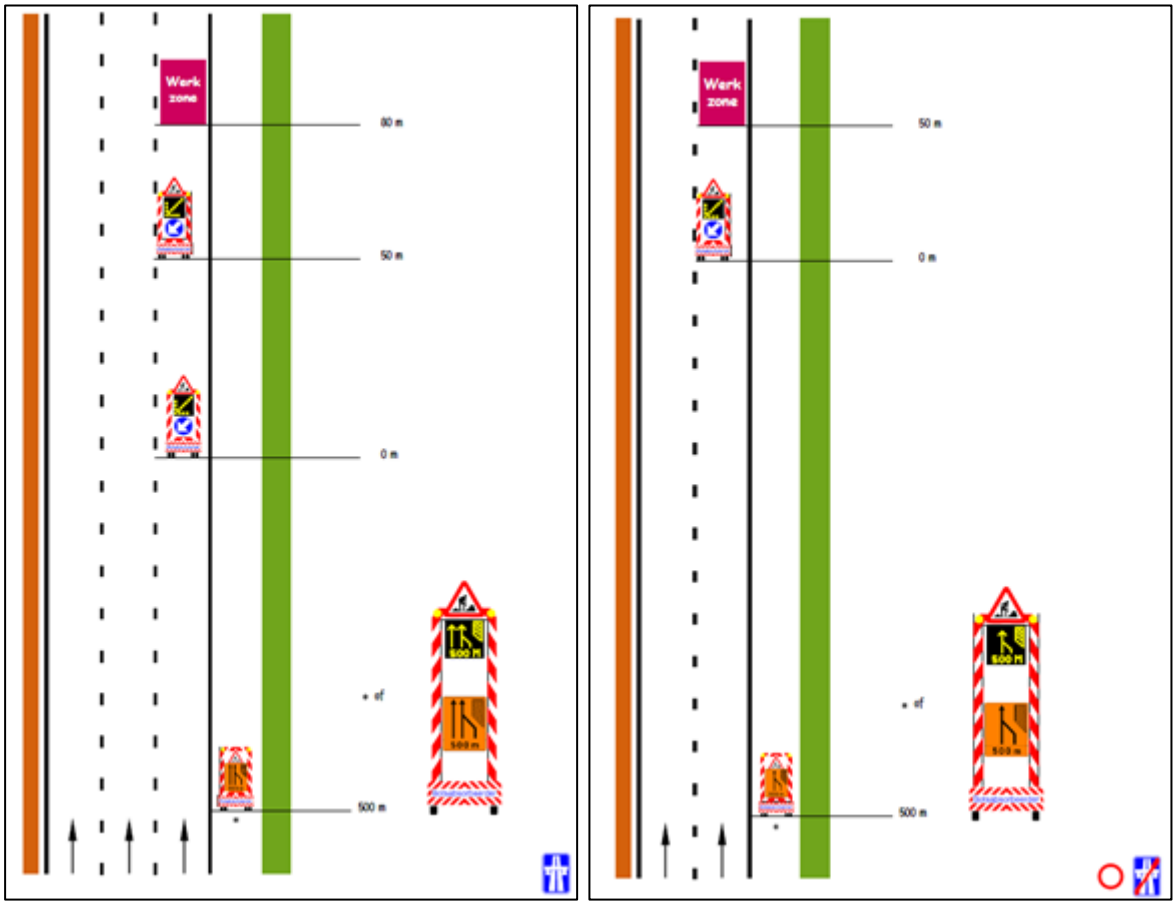


Figure 10: Some standard layouts following the Flemish standard specifications (Left: mobile road work on a 3 lanes motorway; Right: mobile road work on a dual carriageway road with speed limit above 90km/h)

Their main (operational) characteristics are now discussed.

- Long distance information:

  For road works on motorways the existing fixed VMS are typically used to warn road users in advance.

- Safety vehicles/ TMA:

On motorways in Flanders the first road works vehicle is always preceded by two dedicated safety vehicles (i.e. lorries equipped with a TMA). The first TMA vehicle is located 50m before the work vehicle and the second TMA vehicle follows 30m behind. The road works vehicles themselves are never used as warning vehicles.

On other dual carriageway roads (90 km/h speed limit) only the first safety vehicle (equipped with a TMA) is mandatory.

- Advance warning (-500m before Safety vehicle1):

On motorways and 90 km/h dual carriageway roads the advanced warning is provided through another lorry equipped with a >5m high frame sign with flashing lights and mounted with a TMA. This vehicle is located on the shoulder lane 500m upward the nearest safety vehicle. A LED matrix is used instead of fixed signs by some road contractors.

On single carriageway roads with lower speed limits, warning signs are directly mounted on the work vehicle or on a dedicated safety vehicle/trailer.

- Speed limits:

For such road works the speed limit is usually unchanged. Depending on the local conditions it may be adapted through the use of fixed or mobile VMS.

- Lateral safety distance and work zone delineation:

As for other road works the minimum lateral safety distance along the work zone is about 0.50m. In practice cones are sometimes used to delineate the work zone when the mobile road work stops for a very local intervention.

Road workers safety and well-being at work sites

Together with the regulation of road work signing and temporary traffic management mentioned above, the following pieces of legislation pertain to road worker safety and well-being.

- Act of 10 April 1971 on accidents at work; the following articles are more particularly relevant for this purpose:

    - **Art. 7.** - For the purposes of this Act, a work accident is considered as an accident occurring to an employee during and by the fact of the execution of the contract of employment and which produces an injury.
    - **Art. 8. § 1.** – an accident on the way to work is also considered as work accident.
    - From **Art. 56 & 57.** : The 'Fonds des accidents du travail / Fonds voor Arbeidsongevallen FAT/FAO' is a public agency responsible for creating a central database on accidents reported and their resolution.
    - From **Art. 62.**: The employer shall declare to the insurance company and, in some cases, to the competent inspector for safety, any accident that may result in the application of this Act. The insurance company sends the elements included in the declaration to the Fund for work accidents

- Legislation on the well-being of workers[3]

The Act of 4 August 1996 on well-being of workers in the performance of their work and its implementing decisions apply to every employer who employs workers in Belgium. This Act transposes into Belgian law the framework Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work.

2.2.3 Accident data collection

Data collection

To fulfil the requirements of the Royal decree of 25 January 2001 on temporary and mobile work sites employers must report any road worker accident to the competent authority. However the objectives of this reporting are far away from the ones of the EuRoWCas database and data collected do not appear to be detailed enough to be used within the BRoWSER project.

Traffic accident data are collected by the Police through the national crash recording form and are registered in the national road traffic accident database. However as demonstrated in the following section this database is essentially road user oriented and does not include much detailed information about the road works circumstances.

To some extent data about road works characteristics are recorded in a database dedicated to road works. However this database is mainly used to deliver the authorisation to set-up the road works.

Up to now the Belgian Traffic accident and road works dedicated databases constitute the only established source of information that may be used to (partly) feed the EuRoWCas database. Whilst data from the latter are available in a quasi-real-time, data from first one

[3] http://www.employment.belgium.be/defaultTab.aspx?id=556

are only fully available 1.5 to 2 years after the completion of the year. In the following section the possibility of using both databases to feed the EuRoWCas is analysed.

Feasibility of using existing Belgian databases for EuRoWCas

Appendix A describes a 2-step method used to analyse how far it would be possible to fill in the EuRoWCas database through the use of data typically available in the Belgian Traffic accident database (more particularly after the post-processing carried out by the Flemish RA) and the road works (RW) dedicated database (named “werf”).

This process showed that only a part of the EuRoWCas data fields can be filled-in using the existing databases (Traffic Accident data file & RW dedicated database). In particular, the data available appears unable to fill in several core fields.

Moreover an (automatic) import of the data is not possible as the drop-down lists in EuRoWCas include values that are different than the ones in the Traffic Accident data file. A time-consuming post processing would therefore be necessary. It is also important to note that the traffic Accident data file is only made fully available 1.5 to 2 years after the end of the year.

The RW dedicated database (“werf”) used by the Flemish RA can help to fill in some additional data fields in EuRoWCas. However queries in the RW dedicated database would also be time consuming and merging with events in the Traffic Accident data file not necessarily immediate.It was therefore decided that these elements justified the development of a specific data collection system, as tested in the BRoWSER 3-months trial.

2.3 Germany

2.3.1 Network and road works management

Network length per road type

The roads for non-local traffic in Germany are divided into four classes – motorways, federal highways, country roads and county roads. Motorways and Federal Highways are in the control of the Federal Republic of Germany. Planning, construction and operation of these roads is organized by the Federal States on behalf of the Federal Ministry of Transport.

Table 3 Statistics of the roads of non-local traffic (01.01.2012; Source: destatis)

Road Length (km)	Motorways	Federal Highways	Country Road	County Road	Total
Germany in total	**12,845**	**39,674**	**86,473**	**91,709**	**230,701**
Hesse	972	3030	7162	4962	16,126
Northrine-Westfalia (NRW)	2207	4767	12,837	9771	29,582

Vehicle-km per year and per day

Table 4: Statistics of Vehicle-kilometers in Germany (01.01.2012; Source: bast)

Vehicle km per year per road type (million vehicle-km)	Motorways	Federal Highways	Total
Germany in total	**222,000**	**109,600**	**719,300**

Table 5: Statistics of Average daily traffic in Germany (2005/1995); Source: "Verkehr in Zahlen")

Average daily traffic (Veh/24h)	Motorways	Federal Highways	Country Road	County Road
Germany	**47,600**	**9210**	**3789**	**1655**

2.3.2 Standards and guidance

When works affect public roads, a traffic law arrangement is required in accordance with the traffic regulations (StVO) § 45. Basically, a general plan out of the Guidelines for the Safety of workzones (RSA 1995) can be used as a traffic sign plan. Where changes due to local characteristics are necessary, the general plan serves as a basis for the traffic sign plan. The Guidelines for the Safety of workzones (RSA) is issued by the Federal Ministry of Transport in consultation with the traffic authorities of the Federal states. In addition to these nationwide guidelines, there exist additional requirements in some Federal states. For example, in Hesse there is a Workzone Management Manual, which defines for example stricter rules on

time frames for short term work zones and the number of open lanes in long term work zones. In the appendix to the Workzone Management Manual, a separate road sign plan catalogue is included, which in particular defines detailed requirements for the various stages of the installation and removal of the work zone equipment.

Categorisation of road works & relevant documents

The general categories of road works used for design of safeguards are defined in RSA 95 (Guideline for the safety of workzones):

- Long-term workzone - workzone with a duration of minimum one calendar day and fixed position with or without contraflow (example: DI/4, DII/6a)
- Short-term workzone - workzone with a duration of a limited number of hours, even if they will start again the following day; they can be stationary or mobile (example: DIII/2b)

In the general Part A of RSA the most important elements for safety in work zones are defined as ‘blocking devices’ and ‘warning devices’. Blocking devices (in accordance with § 43 StVO) are barriers, beacons or warning signs, traffic cones and mobile warning trailers. Blocking devices are used (along with red or yellow warning lights) for warning of work zones, the optical guiding of traffic and traffic control in the work zone area. Barriers and beacons are typically used in work zones of longer duration.

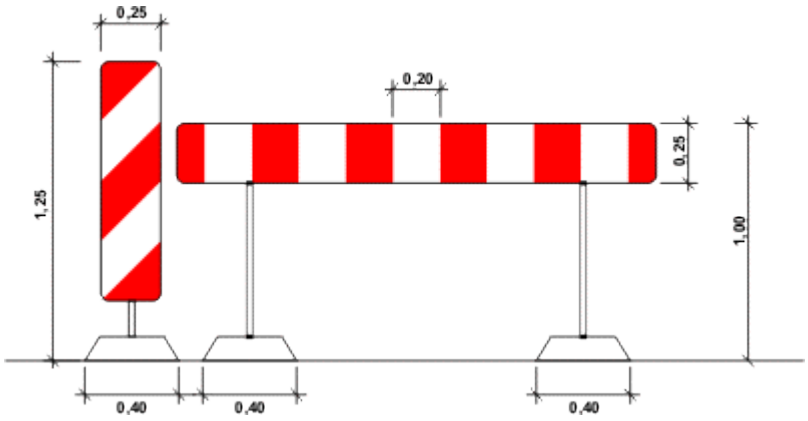


Figure 11: Example for use of barriers and beacons (RSA)

Traffic cones and mobile warning trailers are used in work zones of shorter duration.

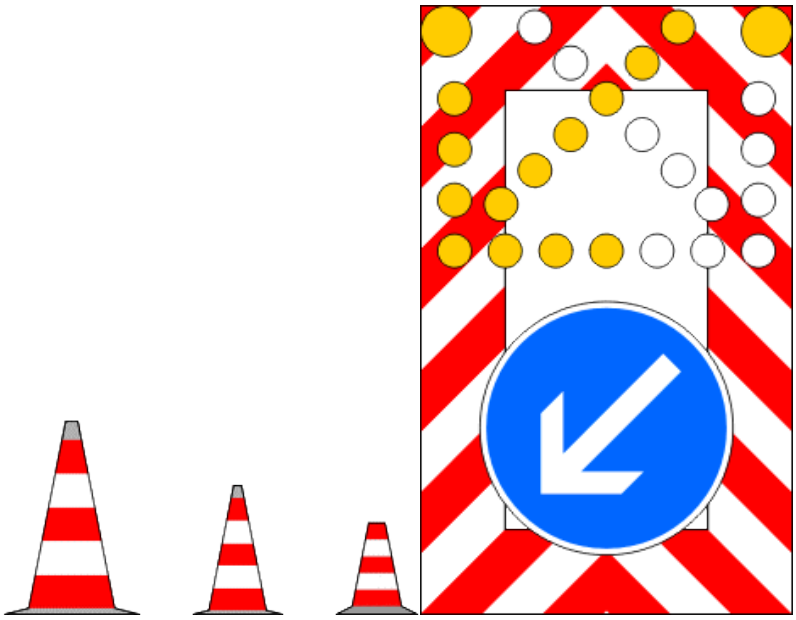


Figure 12: Traffic cones (of several heights for use on different road classes) and a design of the rear of a mobile warning trailer (RSA)

Warning devices can complement blocking devices, but they cannot replace them. They are used for early warning of abnormal or unexpected traffic restrictions. Pre-warning devices have to be used on roads with two or more lanes, especially in poor visibility conditions, depending on the visibility of warning trailers.

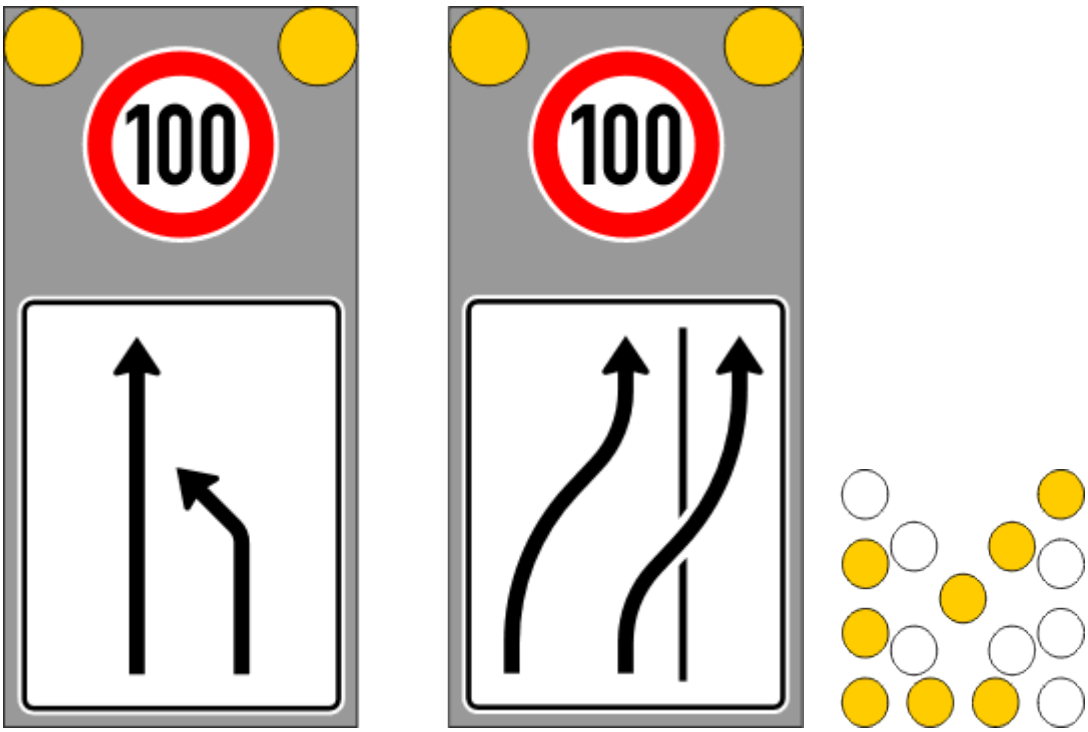


Figure 13: Examples for pre-warning devices (RSA)

The RSA only regulates the protection of traffic in work zones. Whether the protection of workers is assured by the fixed distances between traffic and work space is currently under

extensive discussion. Between the working range of the work zone (e.g. excavation edge, equipment) and the traffic flow the following minimum distances must be met, unless other measures are required by construction authorities:

- 0.3m on urban roads
- 0.5m on rural roads and motorways
- 0.15m on footpaths and cycle paths

Parts B, C and D of the RSA deal with the different road classes (urban, rural roads, motorways) and define detailed regulations for both work zones of longer and shorter duration in these road classes. In accordance with the project focus on motorways, in the following section some aspects of short and long term work zones at motorways are documented.

In the chapter “traffic management” for long term work zones on motorways options are described for maintaining the flow of traffic, through using the existing road space or through widening of the carriageway. The important issue is the number of opened lanes: basically the number of all existing lanes should be preserved. The number of lanes may exceptionally be reduced in the work zone when the expected peak traffic is less than 1500 veh/h per open lane.

Typical layouts - Long-term RW on motorways

Nearly all schemes have the same basic pattern used for warning and the reducing of lane widths. Also the longitudinal distances between the signs for speed reduction and lane deviations are fixed in general. The schemes below show two typical layouts used for major road works on a 3-lane motorway with a contraflow and on a 2-lane motorway with lane deviation.

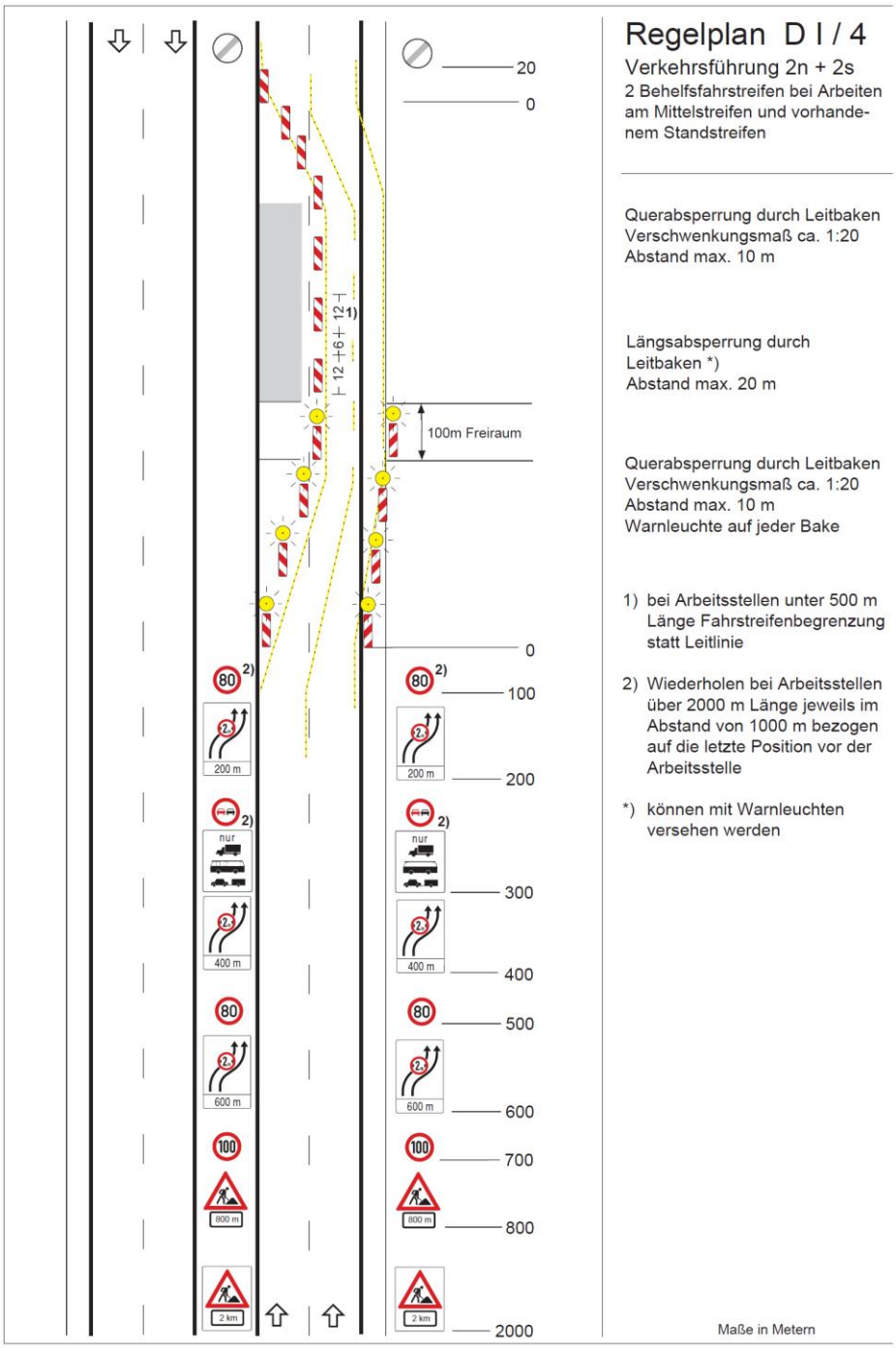


Figure 14: Standard layout (RSA): major road works on a 2 lanes motorway with lane deviation

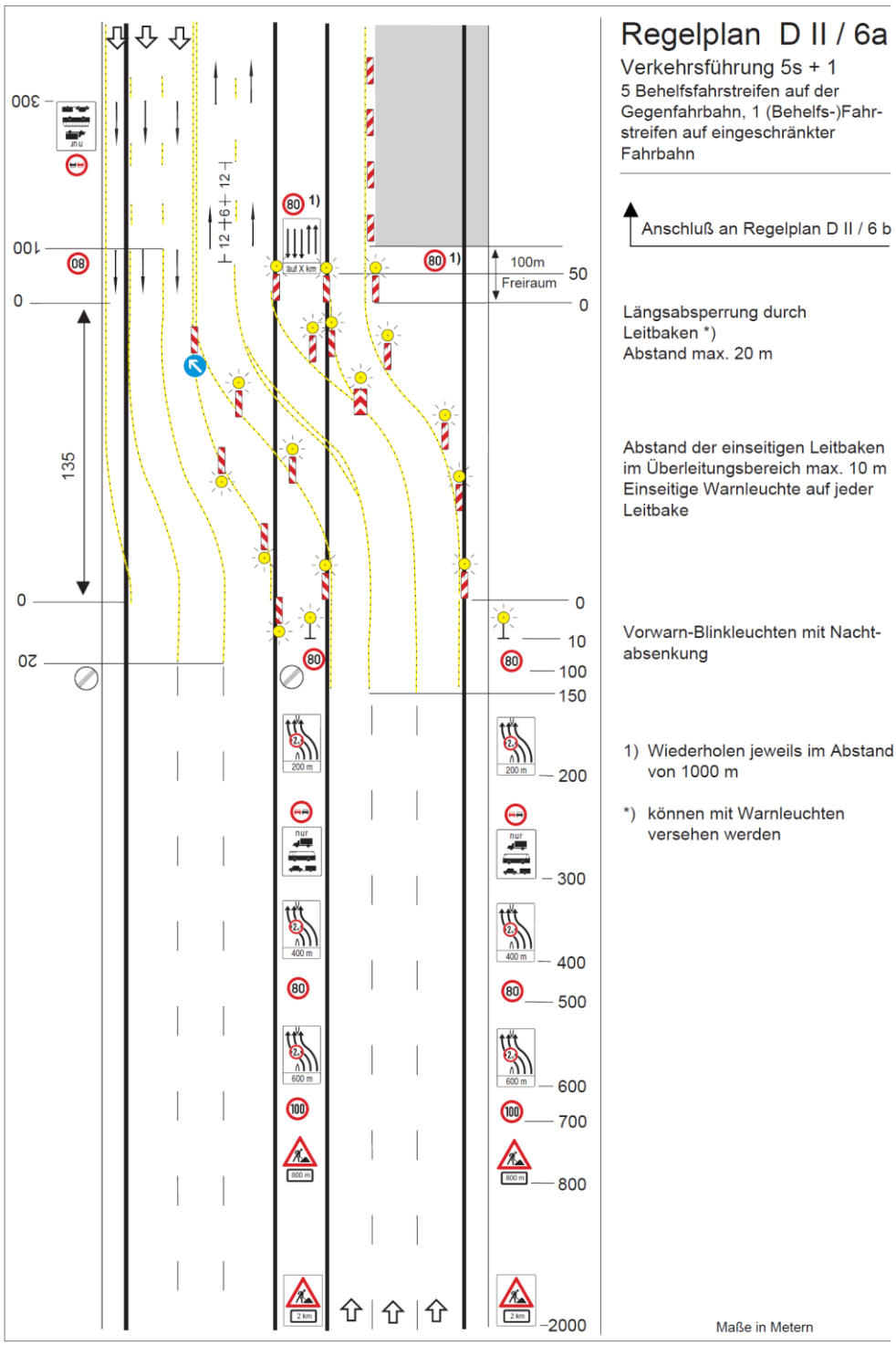


Figure 15: Standard layout (RSA): major road works on a 3 lanes motorway with a contraflow

Their main (operational) characteristics are now discussed.

- Advance warning:

  Typically for long-term road works the first information of the work zone is located 2000 m before. Only if the risk of congestions is very high are earlier advance-warnings required for the specific works.

- Speed limits and road work layout (0m/-1000m):

  Typically the first information of a change in the speed limit begins 700 m before the work zone. 100m later the first sign about the road work layout is positioned. This sign is repeated two times. The “No passing”-sign for HGVs is located 300 m before the start of the work zone. The usual speed limit is 80 km/h; only at works with specific geometric problems – for example at the crossing of the central reserve – is the speed limit is 60 km/h or less.

- Lane closure/Transition area:

  A single lane deviations has no set length; it can be calculated by using a multiplying factor of 20 on the offset distance. Contraflow length is minimum 135 m.

- Lateral safety distance and work zone delineation:

  In Germany, the minimum lateral distances are defined in several parts of the guidelines. In the RSA, part A requires that the distance between the outer lane marking and the edge of beacons should be 0.25 m. Also between blocking devices and a pit edge should be a safety distance of at least 0.5 m. The result of adding these lateral distances and the width of a beacon (0.25 m) the minimum distance between the lanes and the working area should be 1.0 m. There are currently discussions between the Occupational Safety and Health Administration and the Road and Traffic administrations about the width of safety distances and the width of working area beside machines.

  The minimum width of temporary lanes used by HGVs is 3.25m; exceptionally this can be reduced to 3.0 m. The width of temporary lanes for cars (with a maximum width of 2.0 m) depends on the length of the work zone. Up to a length of 6 km, the minimum lane width is 2.5 m, from 6 to 9 km 3.0 m and in longer work zones 3.25 m. In a revised version of RSA the minimum lane width will be 2.6 m; this already used at many work zones.

  Theoretically from RSA 95 there is no requirement for a separation between the directions of travel, but for roads with 4 or more lanes the use of physical separation is standard.

Typical layouts - short-term RW on a 2-lane motorway

The scheme below shows a typical layout used for short-term daylight road works on a 2 lanes motorway with a deviation of the lane.

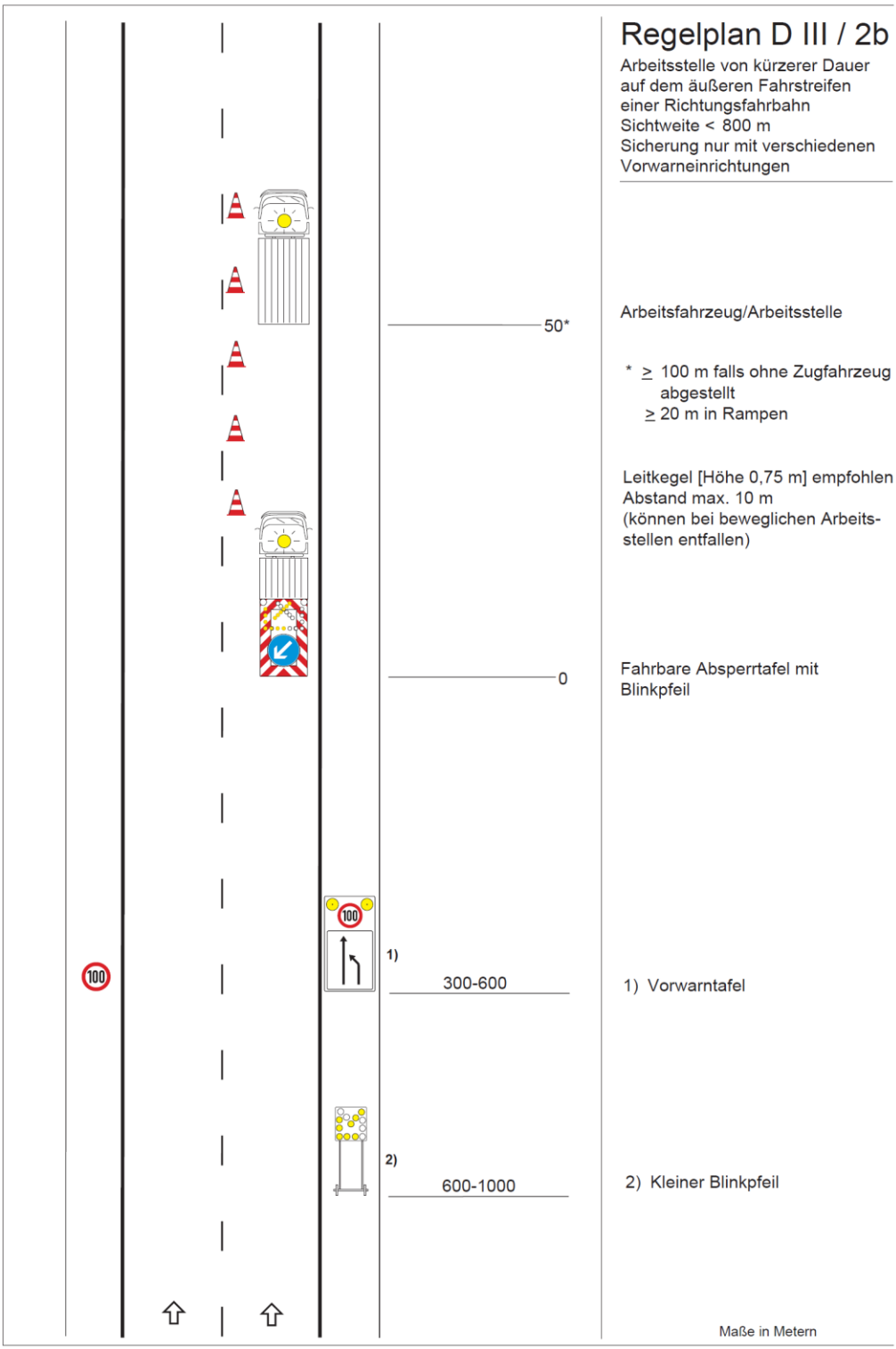


Figure 16: Standard layouts (following RSA) for a short-term road work on a 2-lane motorway with a closure of the right lane

The main (operational) characteristics are now discussed.

- Advance warning (-600/-1.000m):

  On motorways, typically two advance-warning elements are used. The layout depends on the number of deviated lanes and the sight distances. Only on motorways with speed limit of max. 120 km/h and sight distances of more than 800m can advance-warning elements be omitted.

- Speed limits (-300m/-1.000m):

  The usual speed limit for short-term work zones is 100 km/h. At sight distances of less than 400m this sign is located at the first advance-warning element (-600/-1.000m); at the second advance-warning element this speed-limit is repeated (-300/-600m). (For sight distances of more than 400m, the speed limit is displayed for the first time at the second advance-warning element.)

- Lane closure/Transition area:

  On motorways mobile warning trailers showing traffic sign 616 (StVO) are used for lane closures. Use of TMA/LMCC is not typical. Between the trailer and the work zone itself the minimum distance has to be 50m, if the trailer is positioned without a vehicle, the distance has to be 100m. A mobile warning trailer can be towed from the working vehicle itself only in exceptional cases, and when the works are mobile with a speed of more than 5 km/h (but less than 60 km/h) (even with a special safety sign corresponding to the warning trailer (Z 616)).

- Lateral safety distance and work zone delineation:

  As for long-term road works the minimum lateral safety distance along the work zone is about 0.50m. Given the short duration of these road works only cones are used. Mobile work zones have the same layout, often without cones as a lateral safety element.

2.3.3 Accident data collection

In Germany no data are collected for accidents involving workers in road work zones caused by interaction with road users. Only fatal and severe accidents are collected by the federal Occupational Health and Safety Agencies.

Accident data with road layout descriptions are available only in a few states. In Hessen these data can be used and filtered to identify accidents which happened in work zones; in many cases the description will also include whether any injured persons are road users or workers.

Experience of safety analysis of work zones has shown that only the use of police documents which include detailed layout descriptions provides sufficient information for use in detailed safety analysis. For the national accident statistics the characteristic “work zone” is not specific enough, since it is used by the police for all accidents where they suspect the influence of a work zone. Police documents can help to divide the accidents into three zones: the approach zone (with / without congestion), the interconnecting zone (with lane changes), or the work zone itself.

National statistics for the number and distribution of work zones are not available. For Hessen, analysis of the influence of the safety barrier position (left lane, right lane, hard shoulder) and the number of reduced lanes, resulted in a calculation of approximately 65,000 ‘workzone hours’ in a four year period for the 1000km motorway network; the majority of these using a reduction of one lane. One of the results of the analysis has been that a

reduction of two lanes happens rarely, but the accident rates show a much higher risk. These examples show that both detailed accident information and work zone details in combination with the relevant traffic information are important for calculating the different risks of work zone layouts.

Therefore, for the BRoWSER trial period it was decided to use the data from Hessen to assess the feasibility for the EuRoWCas database. In addition to the data obtained for the trial period (June to August 2014), the accident database for the whole of 2013 and up to the start of the trial period in 2014 was also considered in order to provide a baseline. The full dataset consisted of approximately 18,000 accidents on motorways in Hessen from the beginning of 2013 up to August 2014. (This includes all accidents, regardless of the presence of road works or road workers.) Using the methodology above, these accidents were filtered by work zone aspects and resulted in a total of 6 accidents in workzones involving injured workers during 2013. Further detail of these incidents is included below.

1. Road worker killed when disconnecting the safety trailer of his car (not truck) through being hit by a truck (In Germany this disconnection is allowed in some cases provided the longitudinal distance is very high, however during the time taken to disconnect the worker is very vulnerable.)
2. Construction worker seriously injured within in works zone by a reversing road works vehicle. This incident is not directly relevant to the EuRoWCas database since there was no interaction with road users.
3. Driver of a safety trailer was slightly injured when boarding the vehicle due to the impact of a truck. This is a major problem - it is often recommended that workers get off the safety truck in stationary short term work zones but this leaves the worker in a very vulnerable position for several seconds.
4. Driver of truck with advance warning trailer (for a mobile works zone) was slightly injured by the impact of a road user vehicle hitting the trailer and running off the carriageway.
5. Driver of mobile warning trailer in a short-term work zone was slightly injured, as a result of road user incorrectly changing lanes.
6. Driver of safety trailer was seriously injured when trailer was hit by another road worker vehicle (in this case, the safety trailer truck driver was not wearing his seat belt, because he was shortly to alight).

The data are currently being investigated to assess the feasibility of identifying those incidents where road users have collided with road works equipment or other vehicles, which will represent near misses to road workers.

The number of accidents with injured workers is very low. All accidents with injured road workers happened in short term work zones, three of them when getting on / off or working at the safety trailer (i.e. the first upstream protection vehicle). There were no traffic accidents recorded in long term work zones that involved road workers. At long term road works there are hundreds of accidents involving road users, where beacons or other work zone equipment were damaged, but no road worker was nearby.

The initial analysis shows that most of the relevant information can be delivered by the traffic accident data or derived from the accident descriptions. The main gaps are in the ID information, information about the role of the worker and information about the lateral distance between the traffic and the workers.

2.4 Slovenia

2.4.1 Network and road works management

The Ministry of Infrastructure and Spatial Planning of the Republic of Slovenia is responsible for the areas of rail, air, maritime, waterway and road transport with the exception of control over road traffic safety.

The Slovenian Traffic Safety Agency is a public legal body in the field of road safety, established in September 2010. Its mission is to reduce the number of severe road accidents (fatalities and injuries).

In Slovenia, the entire road network of 38,900 km is public. The roads are divided into national roads (državne ceste), which are owned by the Republic of Slovenia and municipal roads (občinske ceste), which are owned by local authorities (municipalities). The classification of roads is based on 'Decree on public roads classification' (Uredba o kategorizaciji državnih cest, Ur.l.RS No 102/2012).

National roads have a total length of 6,454 km and are classified into:

- motorways - avtoceste (AC),
- expressways - hitre ceste (HC),
- main roads I. Category - glavne ceste I. reda (G1),
- main roads II. Category - glavne ceste II. reda (G2),
- regional roads I. Category regionalne ceste I. reda (R1),
- regional roads II. Category regionalne ceste II. reda (R2) ter
- regional roads III. Category regionalne ceste III. reda (R3) – some of the also classified as Tourist roads (RT).

Motorways and expressways

Management, maintenance and development of motorways and expressways (total length of 539km) are under the authority of the Motorway Company in the Republic of Slovenia (DARS). DARS maintenance operations are split into nine operational areas or nine motorway maintenance bases (avtocestna baza or ACB). DARS is ultimately responsible for maintaining their network. Regular maintenance is performed by DARS employees stationed in the nine ACB. DARS head office plans and optimises the timescale of all road works on their network. The road closures are made according to standardized traffic management schemes. DARS staff are equipped to install, maintain and remove temporary traffic management arrangements.

National roads (main roads and regional roads)

Management, maintenance and development of national roads (approx 5.915km) are under the authority of Directorate of the Republic of Slovenia for Roads (DRSC). The maintenance of roads is contracted out to Construction companies. All road works must be booked into the centralised 'Schedule of road works' and approved by DRSC before the beginning of road works.

The application for permission for national roads closures is discussed in 'The road act' issued in 2010 and amendments (Zakon o cestah, Ur.l.RS No 109/10, 48/12 in 36/14). At

least 15 days before the intended road closure the applicant must deliver the necessary documents to DRSC. Application must also include the following documents:

- Description of the reason for the road closure (road works, sporting event, demonstration etc),
- Four copies of the detailed plan for temporary traffic scheme. (The 'detailed plan' must be designed by a company registered for design of roads),
- The duly completed 'Record sheet for road closure' – 'Evidenčni list zapore' (see Figure 20),
- Approved timetable for execution of works - except for short-term road closures (with duration of less than 6 days).

Information on actual traffic conditions

DARS established the 'Traffic information centre' (http://www.promet.si/portal/en/1traffic-conditions.aspx), which is a frequently visited information portal for road users. This provides information on actual traffic conditions including location of road works (see Figure 17 and Figure 18).

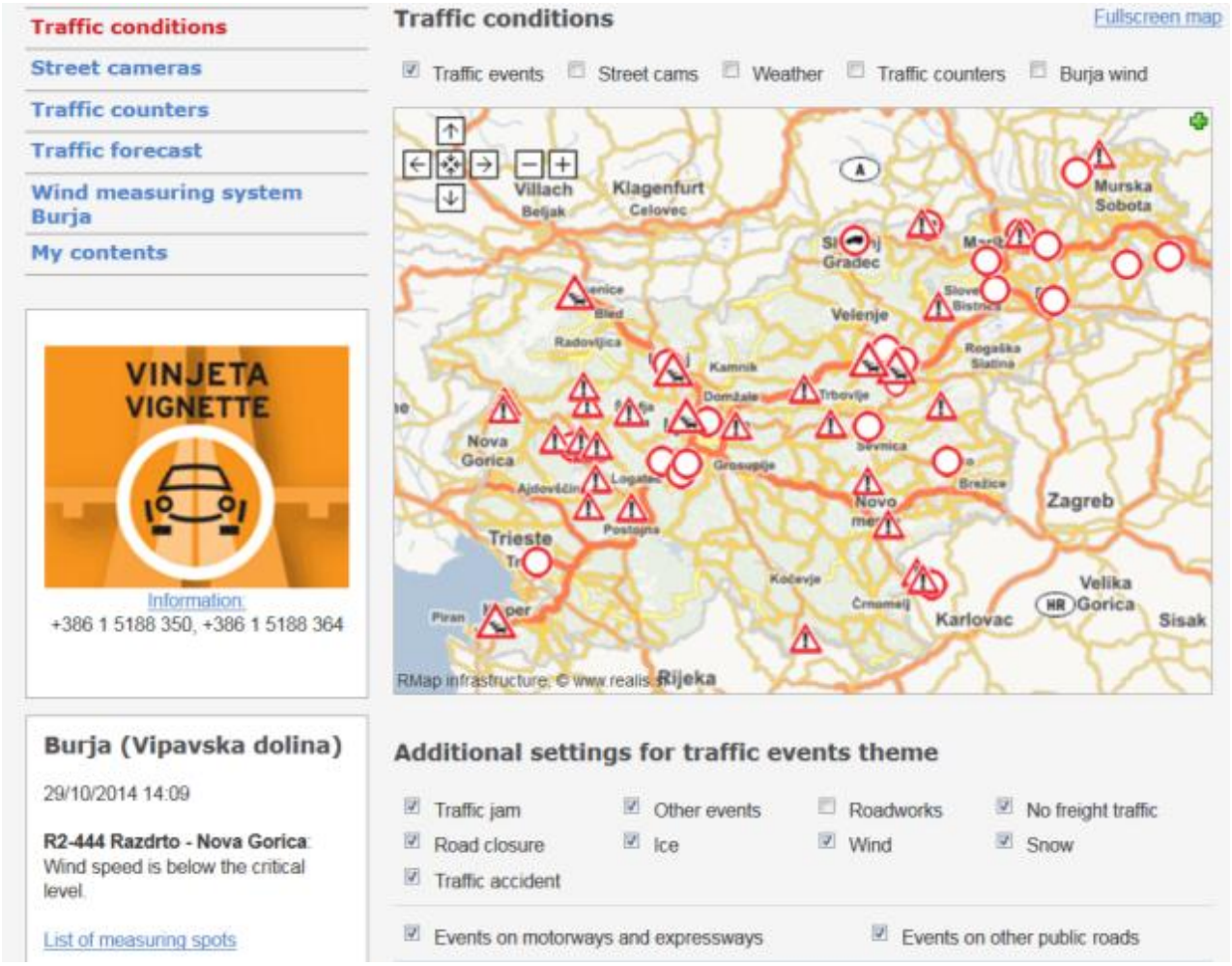


Figure 17 Actual traffic conditions on 29 October 2014

Figure 18: Actual location of road works on motorways on 29 October 2014

Municipal roads (total length of 32,450km) are operated by municipalities. In Slovenia the number of municipalities is increasing. In 1991 there were 60 municipalities in Slovenia but most of them were gradually divided into smaller communities, and since 2011 there are 212 municipalities, which are obligated to construct and maintain the public roads. This makes it very difficult to form a database of incidents or near-misses on municipal roads. The municipal roads are categorized as 'local roads' (approx 13,900km) and 'public ways' (approx 18,550km).

2.4.2 Standards and guidance

There are a number of laws and regulations that are applicable and relevant to road works. The main provisions are discussed briefly below.

General categories for design of safeguards were set in 'Regulations on the Method of Marking and Protecting Roadworks on Public Roads and Impediments in Road Traffic' and amendments, issued in 2006 ('Pravilnik o načinu označevanja in zavarovanja del na javnih cestah in ovir v cestnem prometu', Uradni list RS, št. 116/06, 88/08 in 109/10).

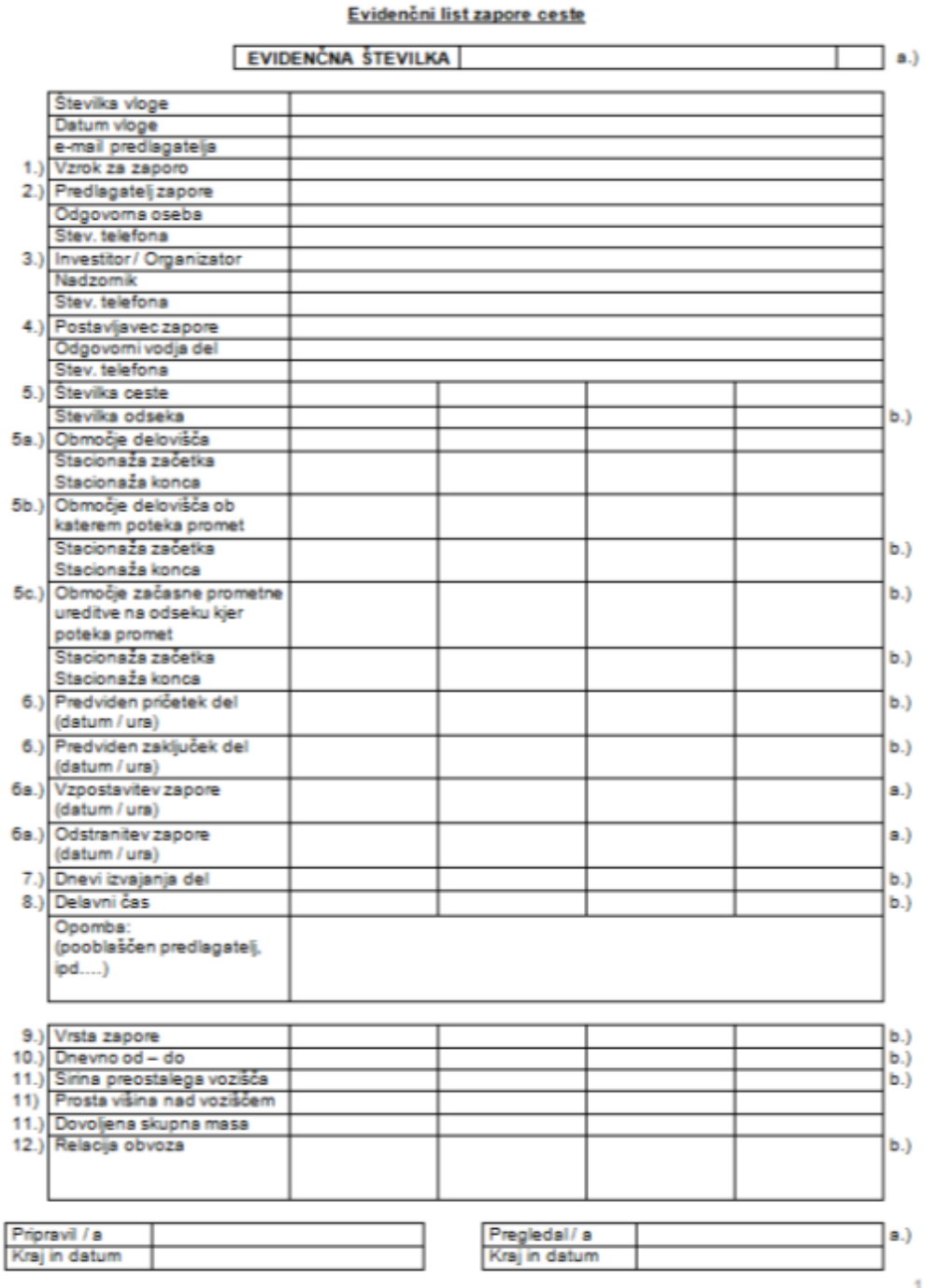
The regulations provide definitions (Table 6 'Road design zones'), rules for design of temporary traffic management arrangements and sixty standard traffic management schemes (see Table 7). Work zones comprise several sections as shown in Figure 20 and in Table 6 below.

Table 6: Road design zones

Slovene term for section	Definition	Equivalent English term
najava	Location where the first temporary traffic sign is placed	Advance warning zone, approach zone
območje opozarjanja	Section between the first temporary traffic sign and beginning of temporary change of road layout	Advance warning zone, approach zone
začetno območje,	Start of temporary change of road layout	Narrowing / lane change zone
območje umirjanja	Traffic calming section	Narrowing / lane change zone
območje preusmeritve	Lane change zone	lead-in zone
območje delovišča	Works zone	Works zone
zaključno območje	End of works zone - lane change zone continues to the last sign	End of works zone/Works end
iztek	Speed up zone (after the last sign)	End of works zone/Works end

The definitions of work zones with regard to duration are:

- "zapora ceste"- road closure
- "dolgotrajna zapora ceste"- Long-term road closure: work zone with duration of more than daylight hours (that is including at night);
- "kratkotrajna nepremična zapora ceste" Short-term stationary road closure: work zone with duration of less than daylight hours (that is excluding at night) on one location;
- "kratkotrajna premična zapora ceste" Short-term road closure: moving work zone with duration of less than daylight hours (that is excluding at night)



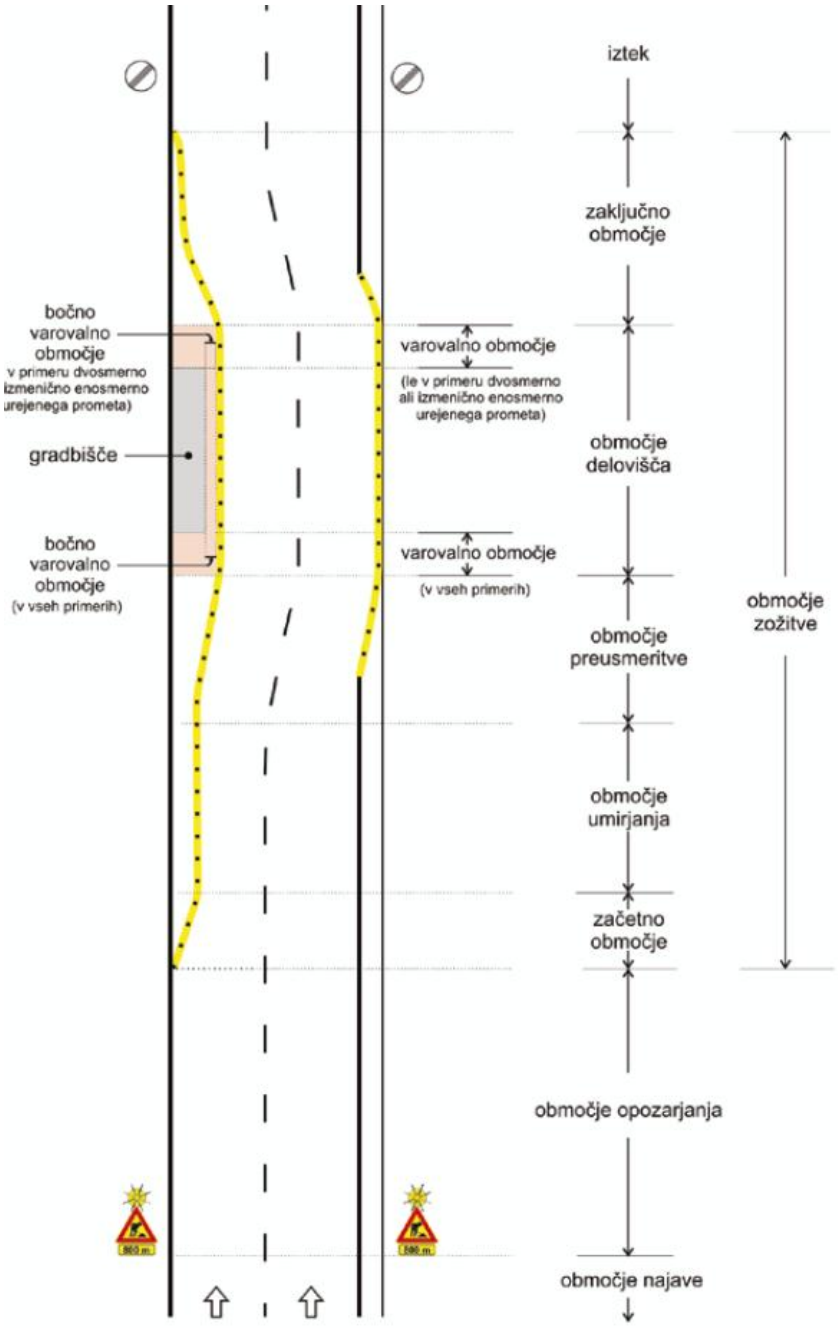
Evidenčni list zapore ceste

	EVIDENČNA ŠTEVILKA					a.)
	Številka vloge					
	Datum vloge					
	e-mail predlagatelja					
1.)	Vzrok za zaporo					
2.)	Predlagatelj zapore					
	Odgovorna oseba					
	Štev. telefona					
3.)	Investitor / Organizator					
	Nadzornik					
	Štev. telefona					
4.)	Postavljavec zapore					
	Odgovorni vodja del					
	Štev. telefona					
5.)	Številka ceste					
	Številka odseka					b.)
5a.)	Območje delovišča					
	Stacionaža začetka Stacionaža konca					
5b.)	Območje delovišča ob katerem poteka promet					
	Stacionaža začetka Stacionaža konca					b.)
5c.)	Območje začasne prometne ureditve na odseku kjer poteka promet					b.)
	Stacionaža začetka Stacionaža konca					b.)
6.)	Predviden pričetek del (datum / ura)					b.)
6.)	Predviden zaključek del (datum / ura)					b.)
6a.)	Vzpostavitev zapore (datum / ura)					a.)
6a.)	Odstranitev zapore (datum / ura)					a.)
7.)	Dnevi izvajanja del					b.)
8.)	Delavni čas					b.)
	Opomba: (pooblaščen predlagatelj, ipd....)					
9.)	Vrsta zapore					b.)
10.)	Dnevno od – do					b.)
11.)	Širina preostalega vozišča					b.)
11)	Prosta višina nad voziščem					
11.)	Dovoljena skupna masa					
12.)	Relacija obvoza					b.)

Pripravil / a		Pregledal / a	a.)
Kraj in datum		Kraj in datum	

1

Figure 19: 'Record sheet for road closure'



Slika 1: Prikaz območij označitve oziroma zavarovanja del

Figure 20 Road design zones for stationary work zone

Standardised traffic management schemes for motorways and national roads are described in the table below. The schemes were defined in 2006 and have been used since. In practice it was established that some of them need improvements and a revision of the 'Regulations on the Method of Marking and Protecting Roadworks on Public Roads and Impediments in Road Traffic' is needed.

Table 7: Standard traffic management schemes

Type of scheme	Type of road	Number of standard schemes	Lane closed	Duration
A	Motorways	5	Right driving lane or/and emergency lane	More than 1 day
B	Motorways	4	Left driving lane	More than 1 day
C	Motorways (2+2lanes)	5	All lanes in one direction	More than 1 day
D	Motorways (2+3lanes)	5	All lanes in one direction	More than 1 day
E	All roads	3	Total closure of road	
Z	National and local roads (outside populated area)	5	various	
N	National and local roads (in populated area)	18	various	
K	Motorways	5	various	Temporary (more than 2 hours), unplanned
V	Motorways	10	various	Temporary (daylight hours) planned (road works)

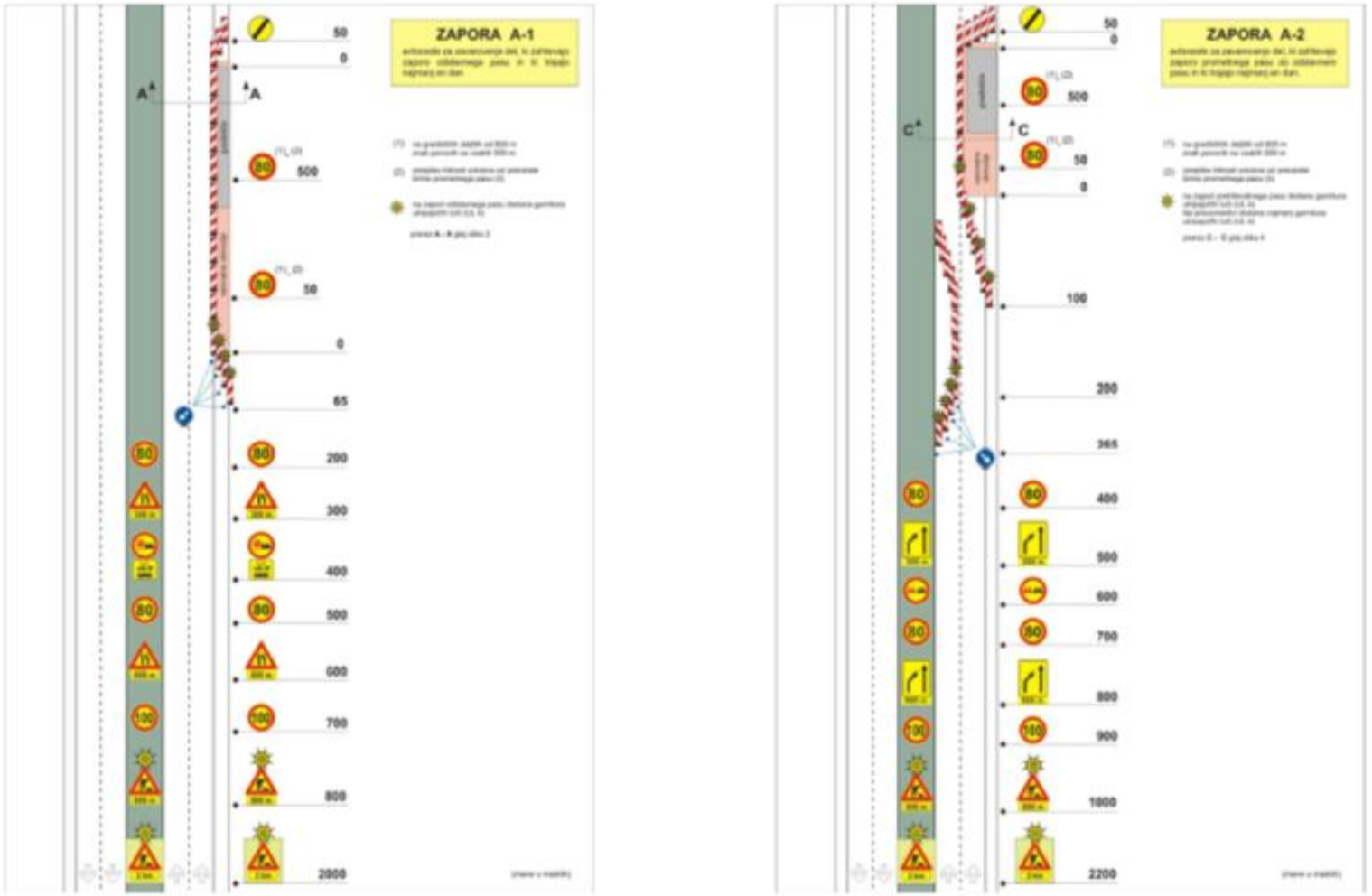


Figure 21: Standard scheme A1-1 and A-2 for motorways and expressways (long term)

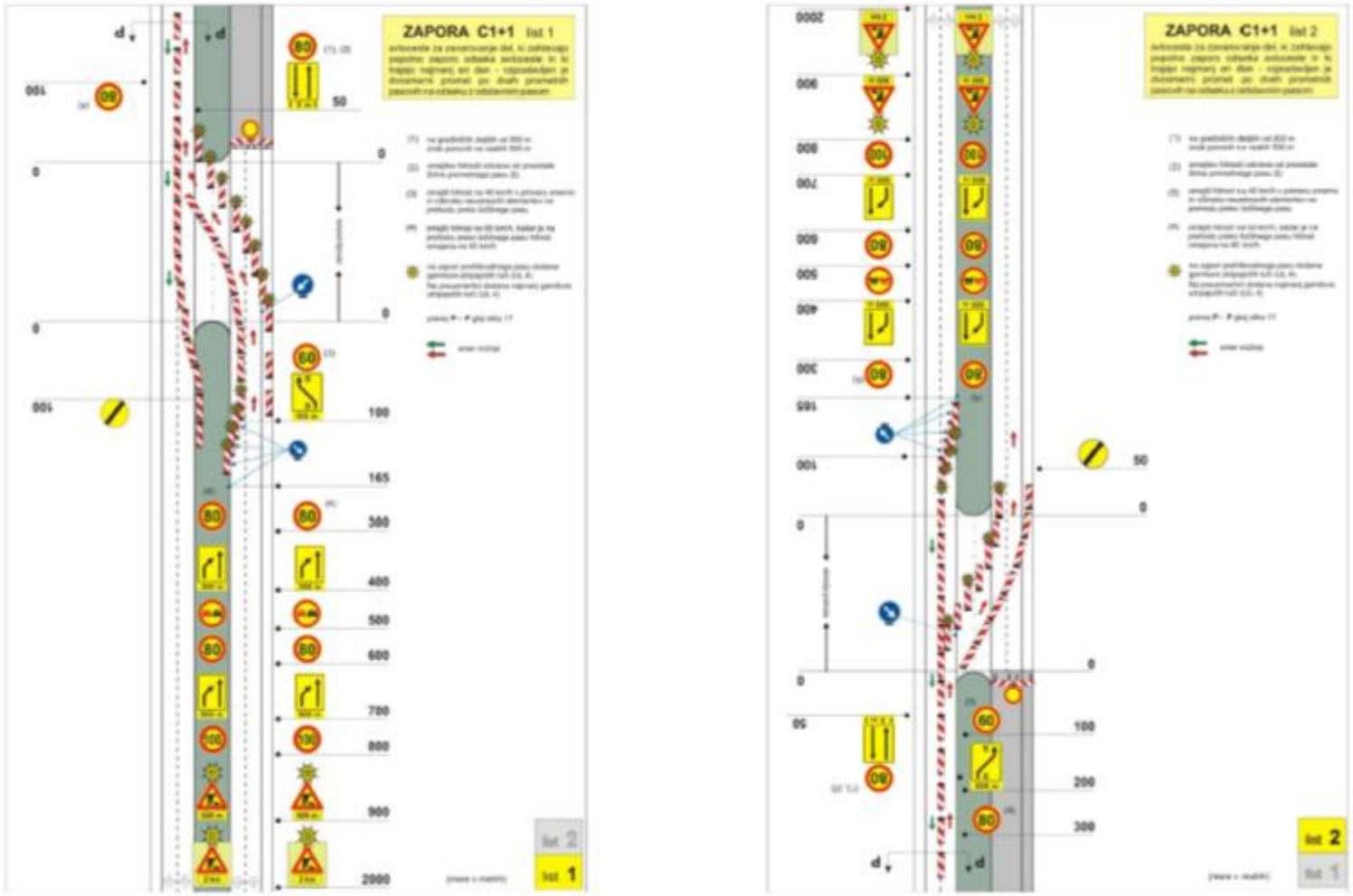


Figure 22 Standard scheme C-1 for motorways and expressways (long term)

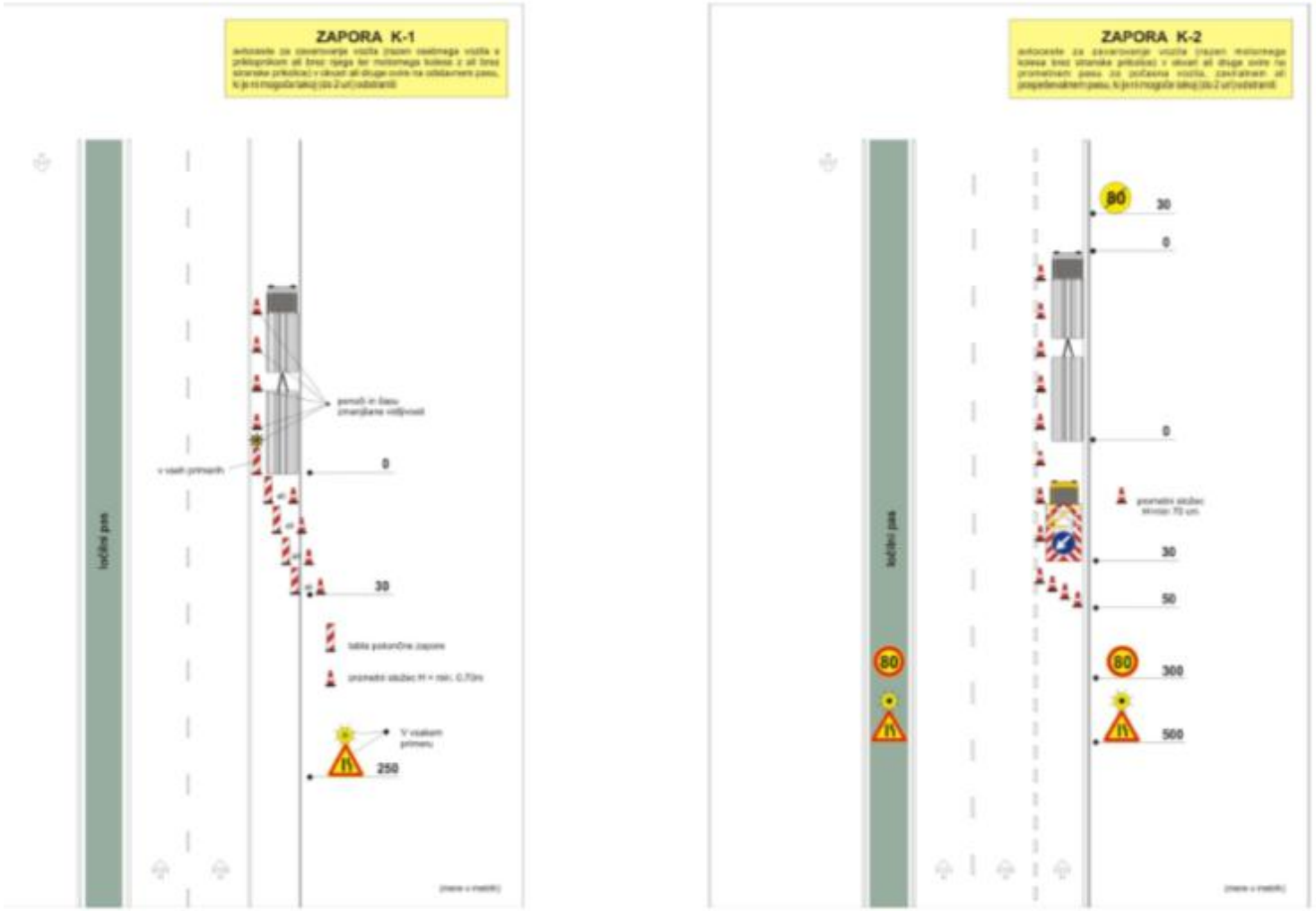


Figure 23: Standard scheme K-1 and K-2 (temporary) unplanned protection of an obstacle on hard shoulder or slow lane (longer than 2 hours)

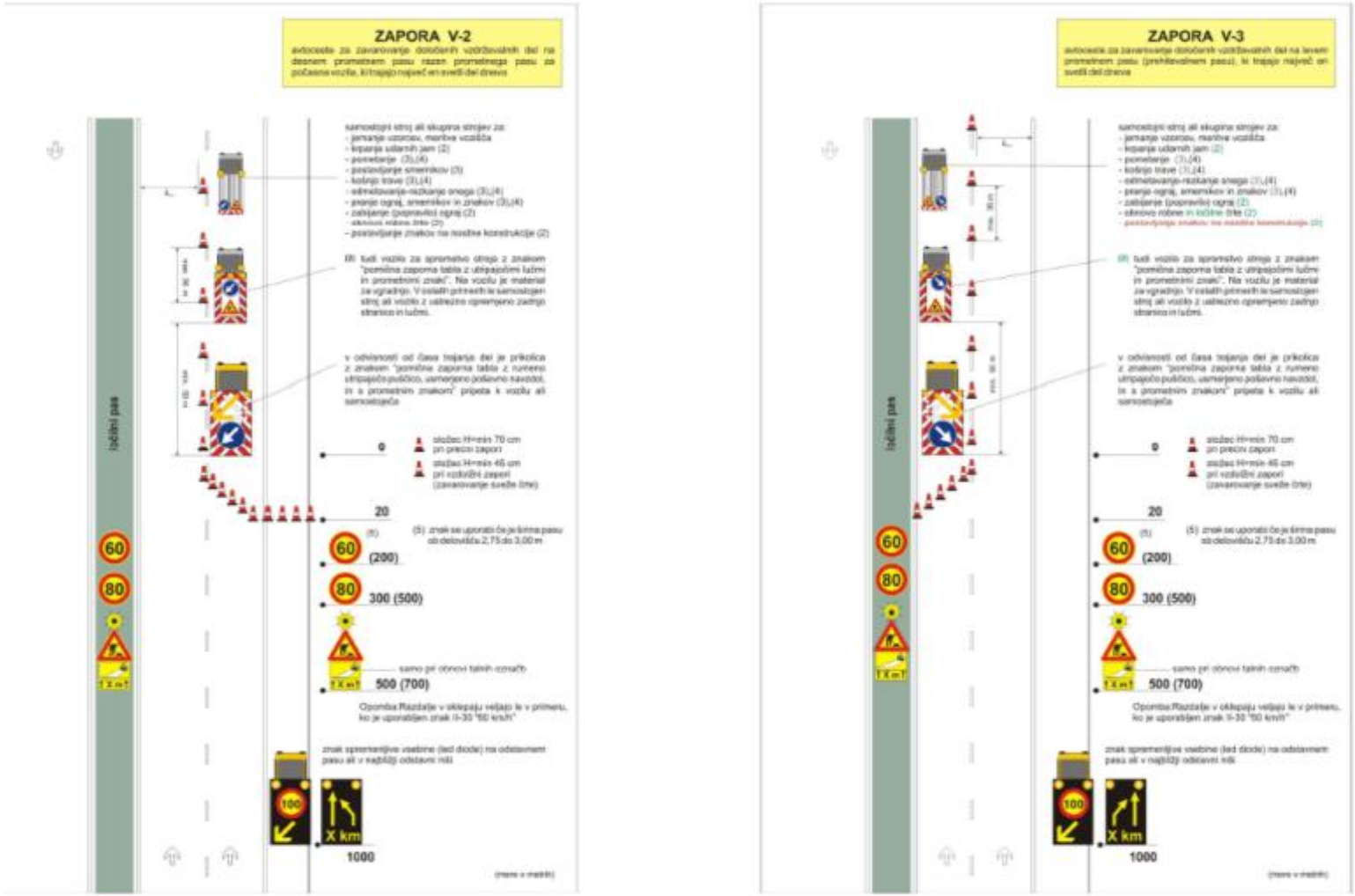


Figure 24 Standard scheme V-2 and V-3 for road works vehicles (works during daylight)

2.4.3 Accident data collection

There is one official database that collates data on traffic accidents. Slovenian Traffic Safety Agency (STSA) was established to perform regulatory, developmental, technical, and other tasks regarding drivers and vehicles, analytical and research work in the field of road safety, prevention, education, and training. Within its work the STSA also performs independent analyses of available data on road traffic accidents in Slovenia. Their investigation of the factors and causes of traffic fatalities is based on the database of registered traffic accidents and their consequences in Slovenia, annually provided by the Ministry of Internal affairs.

Since the STSA was established in 2010, their yearly reports cover statistics from the year 2011. The latest version is available for 2013 (http://www.avp-rs.si/splosno-o-varnosti/statistika). The available publication for 2013 presents statistics on personal injury accidents on public roads, which became known to the police. The publication does not reveal correlations with traffic data, weather conditions, or data on technical elements of the road including temporary changes due to road works.

DARS manages and maintains the motorway network of length 539 km. DARS is ultimately responsible for maintaining their network. Regular maintenance is performed by the 'Section for motorway maintenance' stationed in nine motorway maintenance bases (ACB). Large renewals are contracted out to Construction companies. The contract includes:

- A written agreement on shared construction site (according to 'Law on Safety and Health at Work'),
- The scope of mutual safety measures is defined,
- Nomination of the worker responsible for ensuring the safety of workers,
- Nomination of the worker responsible for coordination of safety measures.

DARS staff install, maintain and remove all temporary traffic management arrangements. The motorway closures are always done according to one of the standardized schemes A, B, C, D, K or V (see Table 'Standard traffic management schemes'). DARS is fully aware of the importance of the safety of road users and road workers, this is why the 'Health and safety department' initiated and formed a simple database of road worker accidents and near-misses in 2008. A DARS representative provided available information on the number of incidents related to road works on motorway network for 2008-2013. The data in the table below show that the number of collisions varies from 2.5 collisions per 100km of motorway in 2009 to 4.8 collisions per 100km of motorway in 2011.

Table 8: Number of collisions or near misses on motorways

	Number of incidents				approx. No of km of motorways
Year	hard shoulder	driving lane	overtaking lane	sum	
2008	5	3	2	10	386
2009	4	6	2	12	481
2010	6	8	3	17	521
2011	9	10	7	26	539
2012	8	9	2	19	539
2013	8	5	2	15	539
2014 (till September)	4	7	2	13	539
sum per lane	44	48	20		

The existing DARS database provided information for some of the fields specified in the BroWSER database. However the usual set of data had to be enlarged to fill the fields of the proposed BroWSER data collection; this was achieved through following up cases individually. Some of the information for persons involved was not available also for the three-month trial period June to September 2014. Some photos, showing the incidents in 2014, are shown below.

Figure 25: Damaged signal –on-trailer with crash cushion (18 July 2014)

A heavy goods lorry drove into DARS IPV standing on driving lane (L1). No road workers were hit. The lorry driver was injured.

Figure 26: Damaged signal –on-trailer with crash cushion (3 April 2014)

An unknown vehicle drove into a DARS IPV standing on driving lane (L2). No road workers were hit.

2.5 Ireland

2.5.1 Network and road works management

Roads in the Republic of Ireland are classified as either (a) motorways, which are shown by the letter M followed by a route number from M1 to M50; (b) National roads, which are shown by the letter N followed by a route number from N1 to N87; (c) Regional roads, which are shown by the letter R followed by a route number, e.g. R611; and (d) Local roads, which are shown by the letter L followed by a route number, e.g. L4202. Moreover, there are two types of National roads: National Primary routes and National Secondary routes.

The organisation which manages the National Road network in Ireland is the National Roads Authority (NRA). Approximately 61% of the total length of the motorways is maintained directly by the National Roads Authority through the Motorway Maintenance and Renewals Contracts (MMaRC), meanwhile the rest is maintained under existing Public Private Partnerships or through local authorities.

2.5.2 Standards and guidance

The NRA ensures the proper application of the mandatory documents and guidance to regional or local road schemes, in order that road works do not (i) compromise safety, (ii) result in poor value for money, or (iii) have an unacceptable impact on the environment. The most relevant documents and guidance used with this aim are the following:

- Guidance for the Control and Management of Traffic at Road Works (GCMTRW). This document is focused on road works on single carriageway roads.
- Traffic Signs Manual (Ireland) - Chapter 8: Temporary Traffic Measures and Signs for Roadworks. This document is recommended to address more complicated temporary traffic arrangements required for multi-lane works, mobile lane road closures, crossovers and contraflow or tidal flow operations; and to the multi-lane environment.

Other reference documents listed in Section 1.4 of GCMTRW include:

- Chapter 8 of the Traffic Signs Manual issued by UK Department for Transport
- Guidance for Safer Temporary Traffic Management issued in 2002 by the UK Highways Agency
- Safety at Street Works and Road Works. A Code of Practice published by the UK
- Department of the Environment, Transport and the Regions (1992) Guideline Document and Summary of Key Duties under the Procurement, Design and Site Management Requirements of the SHWW (Construction) Regulations 2006 issued by the Health and Safety Authority
- Roads Act 1993
- Road Traffic Act 2004
- Safety, Health and Welfare at Work Act 2005
- Safety, Health and Welfare at Work (Construction) Regulations 2006 (as amended)
- Guidelines for Working on Roads – Guide to the SHWW (Construction) (Amendment) (No. 2) Regulations 2008 (S.I. No. 423 of 2008) published by the HSA

Road Work Classification

The GCMTRW states that road works can be classified according to the type of lane closure required as (a) semi-static lane closure and/or (b) static lane closure.

A semi-static lane closure is appropriate for mobile operations or very short duration static operations that continuously progress. A reduced level of signage and temporary traffic measures (relative to static lane closures) are used to warn road users of upcoming works. Signs should be placed in the verge and moved forward as the work progresses.

The static lane closure is suitable for works that are confined to a fixed site location. The appropriate level of signing and temporary traffic measures required depends on the road classification and the type of road works. Table 9 shows the road classification according to the GCMTRW.

Table 9: Road classification according to the GCMTRW

Road Classification	Type of Road	Speed Limit	Traffic Volume
Level 1	Single Carriageway	30 km/h	All traffic volumes
Level 2		50 or 60 km/h	All traffic volumes
Level 3		80 or 100 km/h	ADT(*) ≤ 5,000 vpd
Level 4		80 or 100 km/h	ADT > 5,000 vpd
Level 5	Dual Carriageway	50, 60 or 80 km/h	All traffic volumes
Level 6		100 or 120 km/h	

(*)ADT = Average Daily Traffic – the total two-way traffic flow on a specific day (vpd = vehicles per day).

The static roads works can in turn be sub-classified depending primarily on their duration as follows:

- Type A: Full-time road works that remain in operation in all traffic flows and all visibility conditions. This type of works typically includes temporary traffic measures that will remain in position for a duration in excess of 24hrs.
- Type B: Part-time road works that remain in operation when the expected traffic flow is less than the available carriageway capacity. This type of works typically includes temporary traffic measures at off-peak times. With this type of works, the road works are such that they can be removed if necessary to minimise potential traffic delays.
- Type C: Road works that are of a short duration and involve the use of one or two vehicles, typically maintenance to utilities or street furniture, in all visibility conditions, when the expected traffic flow is less than the available carriageway capacity and the works do not reduce the carriageway width significantly.

To summarize, Figure 27 shows the classification of the road works according to the guidance GCMTRW. Note that dual carriageway and motorway roads (Level 5 and Level 6) are not addressed in the GCMTRW and so the road works classification for these roads is not shown. Dual carriageway and motorway working is governed by the Traffic Signs Manual Chapter 8 (see UK Section 2.1).

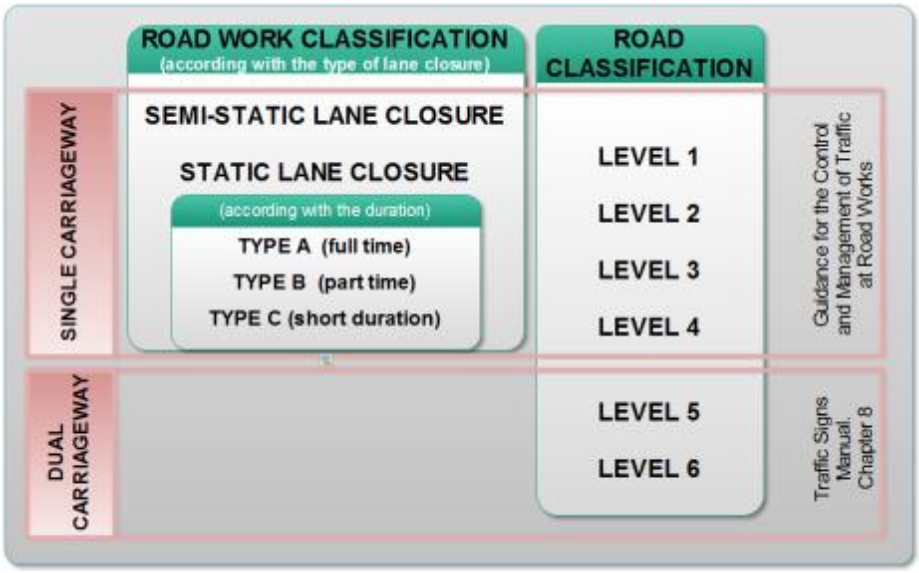


Figure 27: Classification of road works within the GCMTRW

Lane Closure Design: Layout Design Requirements

The GCMTRW defines the design parameters required for static lane closures for each combination of type of road and type of road works within the case of a single carriageway. These design parameters are presented in Tables Table **10** to Table **12**. For a better comprehension of the concepts included, Figure 28 and Figure 29 show the diagrammatic representations of the design parameters and the sign layout for two specific cases.

Table 10: Design Parameters for Level 1

Design Parameters	Road Works Type A & B (Full-Time & Part-Time)	Road Works Type C (Short duration)
Single Carriageway with Speed Limit of 30 km/hr		
Temporary Signs		
Sign Visibility (m)	50	50
Number of Signs	2	2
Cumulative Distance (m)	50	50
Dist. between advance signs (m)	25	25
Minimum Rate of Taper		
Taper at Lane (m)	1 in 10	1 in 5
Taper at Hard Shoulder (m)	1 in 5	1 in 5
Safety Zone		
Longitudinal (m)	5	5
Lateral (m)	0.5	0.5
Maximum Cone Spacing		
At Tapers (m)	3	3
Longitudinal (m)	6	6
Maximum Lamp Spacing		
At Tapers (m)	6	6
Longitudinal (m)	12	12

Table 11: Design Parameters for Level 2

Design Parameters	Road Works Type A & B (Full-Time & Part-Time)	Road Works Type C (Short duration)
Single Carriageway with Speed Limit of 50 or 60 km/hr		
Temporary Signs		
Sign Visibility (m)	50	50
Number of Signs	3	2
Cumulative Distance (m)	75	50
Dist. between advance signs (m)	25	25
Minimum Rate of Taper		
Taper at Lane (m)	1 in 15	1 in 5
Taper at Hard Shoulder (m)	1 in 10	1 in 5
Safety Zone		
Longitudinal (m)	25	5
Lateral (m)	0.5	0.5
Maximum Cone Spacing		
At Tapers (m)	3	3
Longitudinal (m)	6	6
Maximum Lamp Spacing		
At Tapers (m)	6	6
Longitudinal (m)	12	12

Table 12: Design Parameters for Level 3 and 4

Design Parameters	Road Works Type A & B (Full-Time & Part-Time)	Road Works Type C (Short duration)
Single Carriageway with Speed Limit of 80 or 100 km/hr		
Temporary Signs		
Sign Visibility (m)	120	120
Number of Signs	4	3
Cumulative Distance (m)	800	600
Dist. between advance signs (m)	200	200
Minimum Rate of Taper		
Taper at Lane (m)	1 in 55	1 in 40
Taper at Hard Shoulder (m)	1 in 30	1 in 20
Safety Zone		
Longitudinal (m)	60	45
Lateral (m)	1.2	1.2
Maximum Cone Spacing		
At Tapers (m)	3	3
Longitudinal (m)	12	12
Maximum Lamp Spacing		
At Tapers (m)	6	6
Longitudinal (m)	12	12

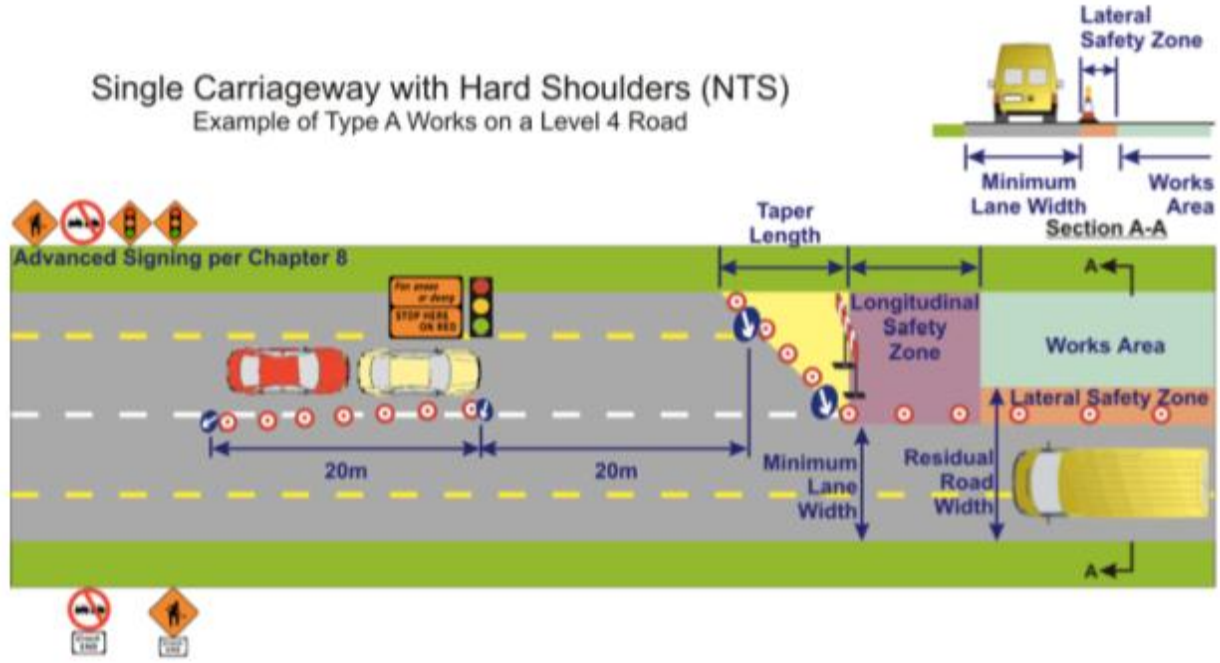


Figure 28: Representation of Static Lane Closure design parameter

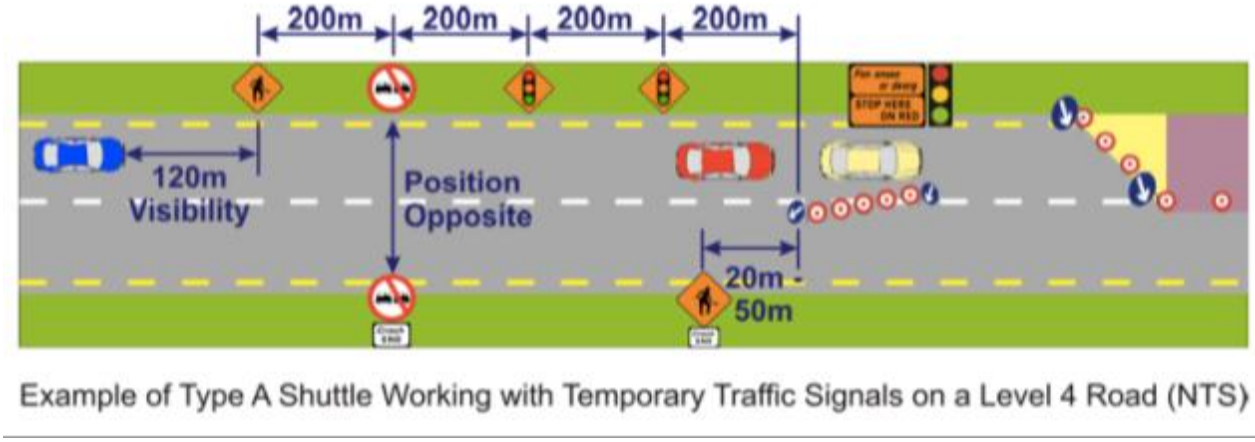


Figure 29: Representation of sign layout

In the case of works at junctions and roundabouts, a detailed description of the design parameters are dealt with in Section 5.2.1 and 5.2.2 of the GCMTRW.

Finally, the case of dual carriageway is addressed in Chapter 8 of Traffic Signs Manual, which has already been explained in section 2.1.2.

2.5.3 Accident data collection

The National Police Service in Ireland (An Garda Síochána) is the institution responsible for recording road accidents in Ireland. The Gardaí collect this information in-situ by means of a call centre, where trained operators enter the data into the PULSE (Police Using Leading Systems Effectively) database. All this information is shared via government VPN (virtual private network).

CT68s are the printed record from the PULSE database, which include detailed descriptions of aspects such as the collision location, vehicles involved, person involved, road surface, weather, injury severity, date and time of collision. After 2013 a specific field related to road work was added, to indicate whether the collision occurred within the vicinity of road works; nevertheless no specific information is recorded whether a road worker was injured. In Appendix B a CT68s form is shown. The Road Safety Authority (RSA) receives these collision data from the PULSE system, which are validated individually and georeferenced.

The existing database provided a set of 17 records of road user incidents that appeared (from the descriptions) to be related to road works in 2011 and 18 records in 2012; however, due to the lack of information regarding road work characteristics, this set of data is not adequate to know many of the most important fields of the proposed data collection.

It was therefore decided that, for the BRoWSER trial, new data would be collected by the contractors carrying out the road works, on behalf of the NRA. During the four-month period June to October 2014, the following figures were obtained:

- Number of incidents: 10
- Number of people involved: 16 (12 of them with minor injury or without injury sustained).

It was also agreed that accidents which had occurred in the months preceding the trial would be retrospectively considered. The figures of accidents related to road works obtained from March to June 2014 (i.e. 4 months) are the following:

- Number of incidents: 6
- Number of people involved: 14 (all of them without any injury sustained)

2.6 Sweden

There were no in-country members of the BRoWSER consortium from Sweden and therefore information available for this report was more limited. Data analysis assistance was provided by Eva Liljegren of the Swedish Transport Administration, with the information in the following section drawn mostly from the operational guidance developed by Vägverket/Sveriges Kommuner och Landsting, requirements set by Trafikverkert and from individual contacts in the country.

2.6.1 Network and road works management

All state-owned roads in Sweden are owned, constructed, operated and maintained by the Swedish Transport Administration (Trafikverket). Trafikverket was formed in 2010 and combined the previous Swedish Road Administration (Vägverket) and the Swedish Rail Administration. State-owned roads in Sweden have a total length of approximately 98500 km[4]. Private roads constitute approximately two-thirds of the total road network.

Trafikverket use the following classification of the state road network. Depending on this classification there are different requirements for use of road signs, safety barriers, protective equipment etc.

- Skyddsklassad väg ("Protection classified" road) – speed limit of 70 km/h, 2000 AADT or higher. Other roads can also be in this class for other specific reasons (determined by Trafikverket). Enhanced protection for road worker personnel is required for road works on these roads.
- Normalklassade vägar ("Normally classified" roads) - 250 – 2000 AADT. The basic requirements for the safety arrangements (for the protection of road workers) apply on these roads.
- Lågklassade vägar ("Low classified" roads) - Less than 250 AADT. Some relaxation of the basic requirements may be allowed provided that no unprotected personnel are on the road.

For each road works, a traffic management plan (Trafikanordningsplaner) must be submitted to Trafikverket for approval at least three weeks before the works are due to commence. A plan contains facts about the works and how it will be carried out to ensure a safe working environment for road users and road workers. The plan is examined against the relevant provisions and legislation and other governing documents adopted by Trafikverket.

Some examples of diagrams from traffic management plans are provided in the next section.

2.6.2 Standards and guidance

There are a number of laws and regulations that are applicable and relevant to road works. The main provisions are discussed briefly below.

Trafikförordningen (TrF) – Traffic Regulations

This contains the basic rules for road traffic and includes provision for exemption of these rules for the purposes of road works and maintenance. These contexts in which road works may be carried out in violation of the general rules are included in Chapter 12 – Rules for road maintenance.

[4] The Nordic State Road and Railway Infrastructure Market, Peter Molin & Emil Matintupa, 2013. Finnish Transport Agency.http://www2.liikennevirasto.fi/julkaisut/pdf3/lts_2013-19_nordic_state_web.pdf

Vägmärkesförordningen (VMF) – Traffic signs regulations

This contains the requirements for road signs and other devices. These are the general rules for traffic signs, including how they should be used in operation. VMF specifies requirements for signs at road works including installation and maintenance.

Arbetsmiljölagen (AML) and Arbetsmiljöförordningen (AMF) – Work Environment Act and workplace regulations

These regulations are the general provisions which apply to all employees to ensure a safe and secure work place. For road workers this applies to the road works site and obligates employers to ensure work is planned and conducted so that it can be performed in a safe and secure environment, with all reasonable precautions taken. This includes requirements on risk assessments, competency requirements and personal protective equipment.

There are a number of other pieces of legislation or regulations that may be relevant depending on the nature of the works – these include regulations on road construction and operation, planning and building in public places and local police and traffic regulations.

The main guidance document in Sweden is the Road Works Manual (Handbok Arbete på Väg).The handbook was developed jointly by the former National Road Administration (Vägverket) and the Swedish Association of Local Authorities (Sveriges Kommuner och Landsting), in close cooperation with the Swedish Work Environment Authority, and hence aims to provide a safe environment for both road users and road workers. This manual provides guidance for the planning and operation of road works on the network, subject to the regulations.

In Sweden road works fall into three classifications:

- *Fast arbete (Stationary work)* - “Minor stationary work” is defined as work with a duration of maximum 8 hours including installation and removal.
- *Intermittent arbete (Intermittent work)* - Work that is intermittently moved forward, occasional work of short term nature or work carried out with work vehicles at a speed that is significantly lower than the speed of the traffic.
- *Rörligt arbete (Mobile work)* - Work that is carried out with or from a work vehicle continuously moving along the road (proceeds at the same or almost the same speed as the traffic), for example snow removal. Only warning lamps are used on the vehicle, no other warning signs.

The figure below illustrates the zones (not to scale) that are defined for road works, and for which the manual defines specific requirements depending on speed limit (among other things).

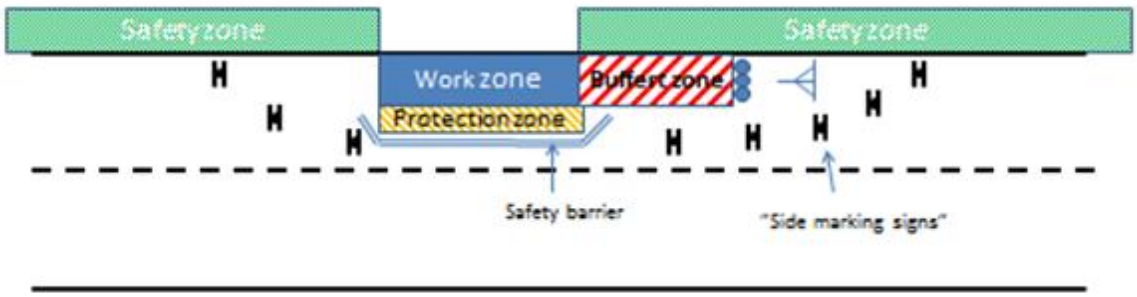


Figure 30: Zones defined for road works

For example, for stationary work where the speed is 70 km/h or higher, heavy protection (“Tungt skydd”) is required for the personnel that are within the work zone. Heavy protection is a safety arrangement (e.g. “traffic buffer” - usually tyre stacks, Truck Mounted Attenuator (TMA), Truck Attenuator (TA), safety barrier, etc). The arrangement should effectively divert or hinder the traffic from entering the work zone.

The following diagrams show some typical layouts used for road works.

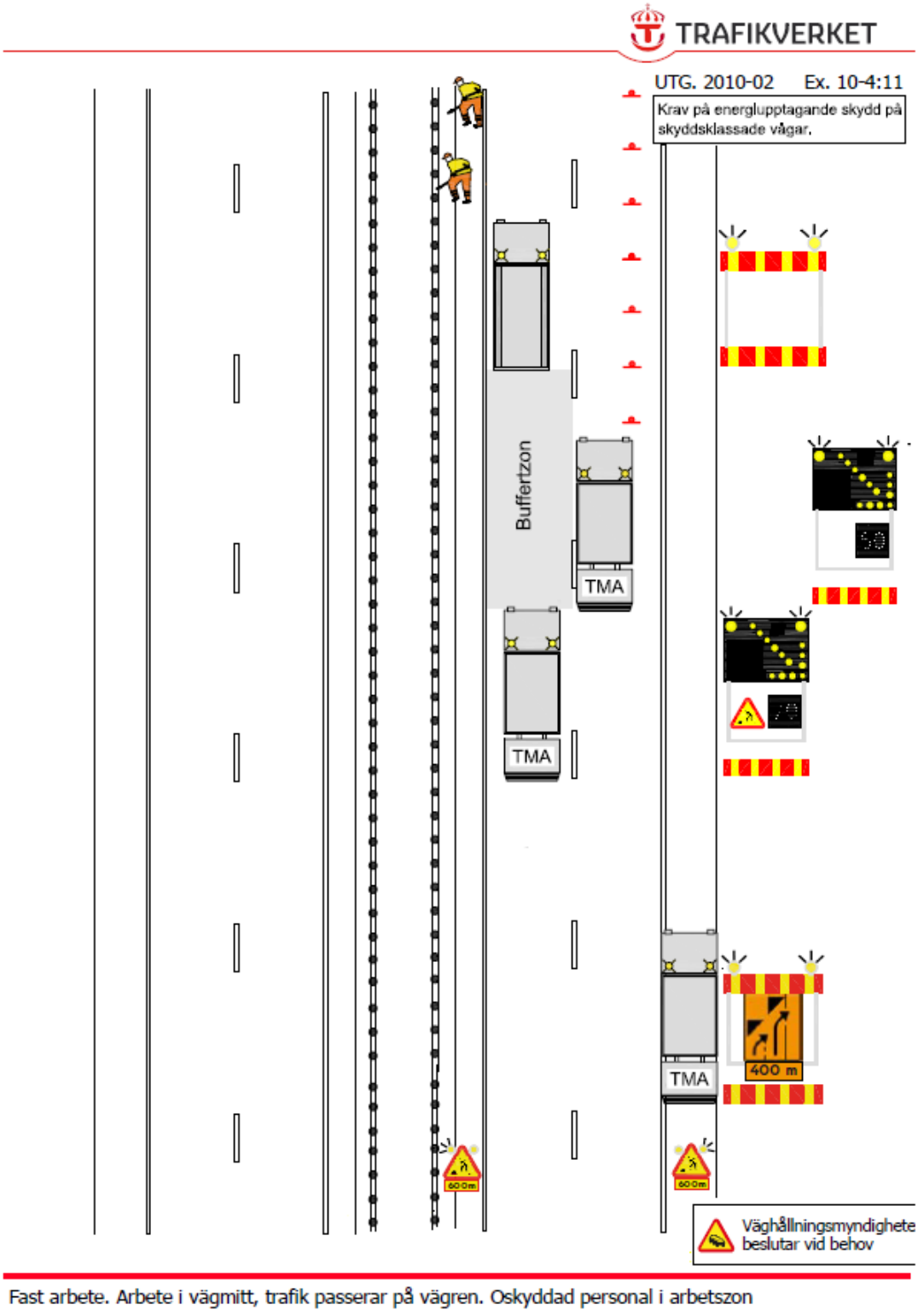


Figure 31: Stationary work. Work done in the centre of the road. Traffic passing on the verge. Unprotected personnel in the work zone.

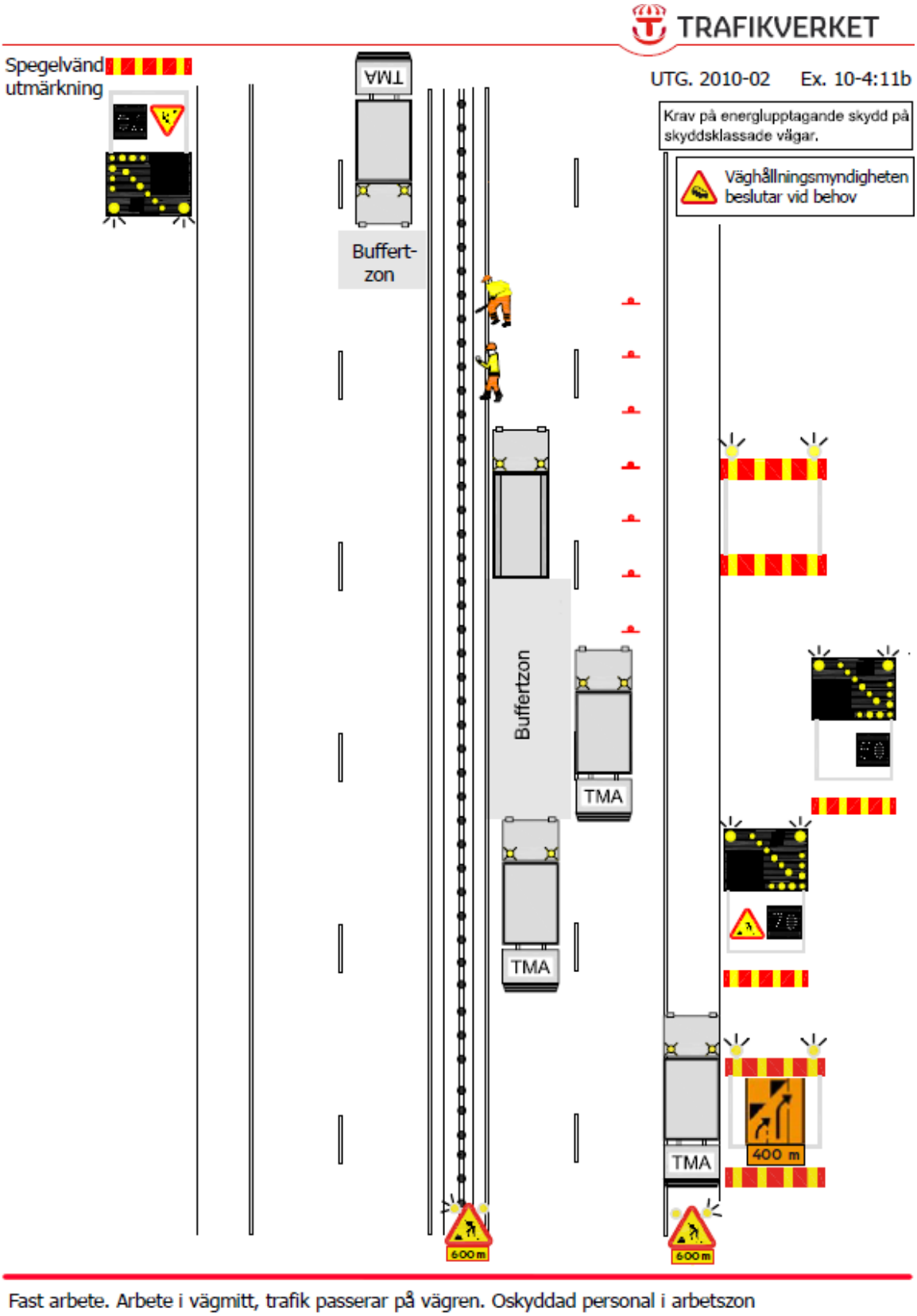


Figure 32: Stationary work. Work done in the centre of the road. Traffic passing on the verge. Unprotected personnel in the work zone.

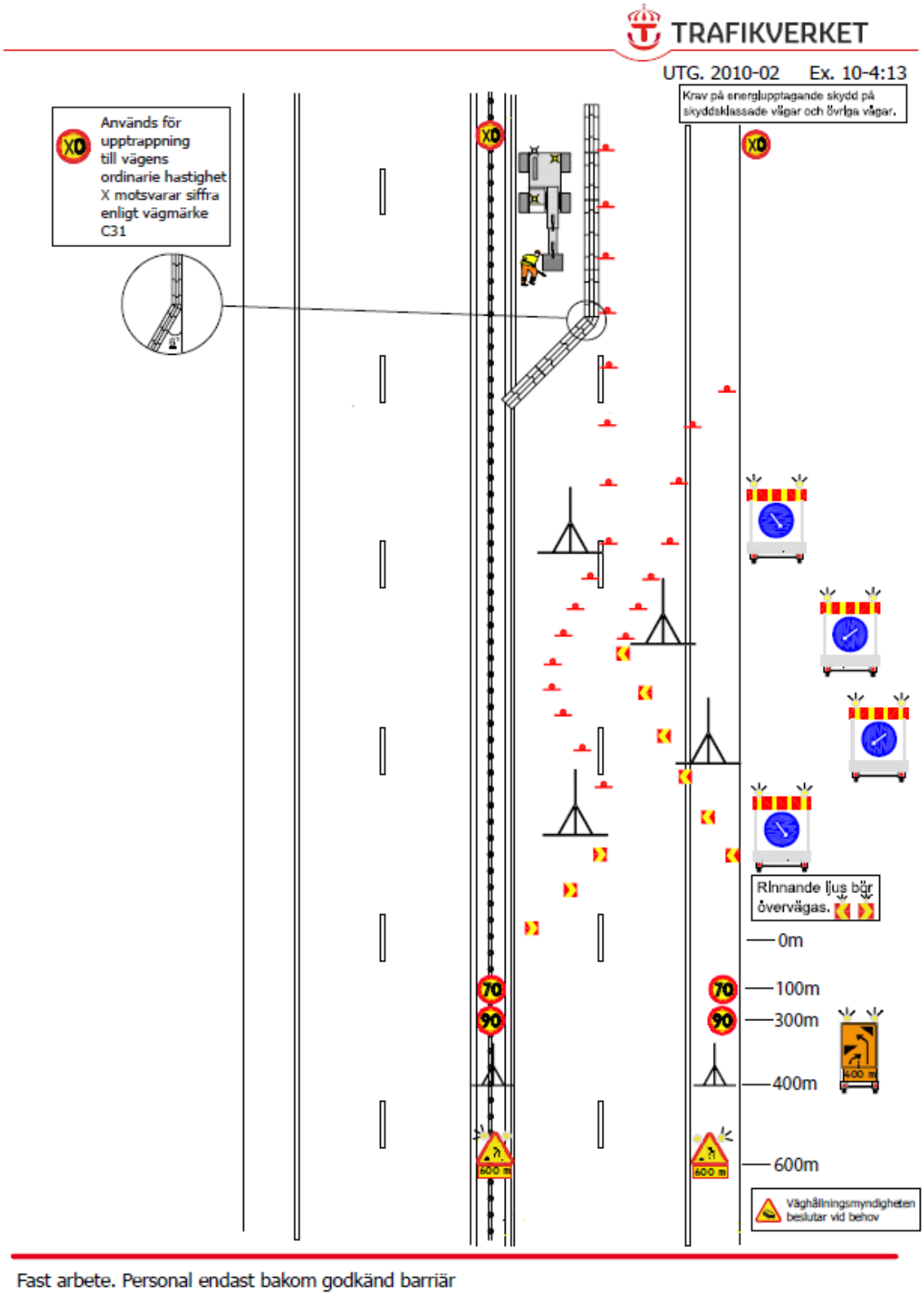


Figure 33: Stationary work. Personnel only behind approved barrier.

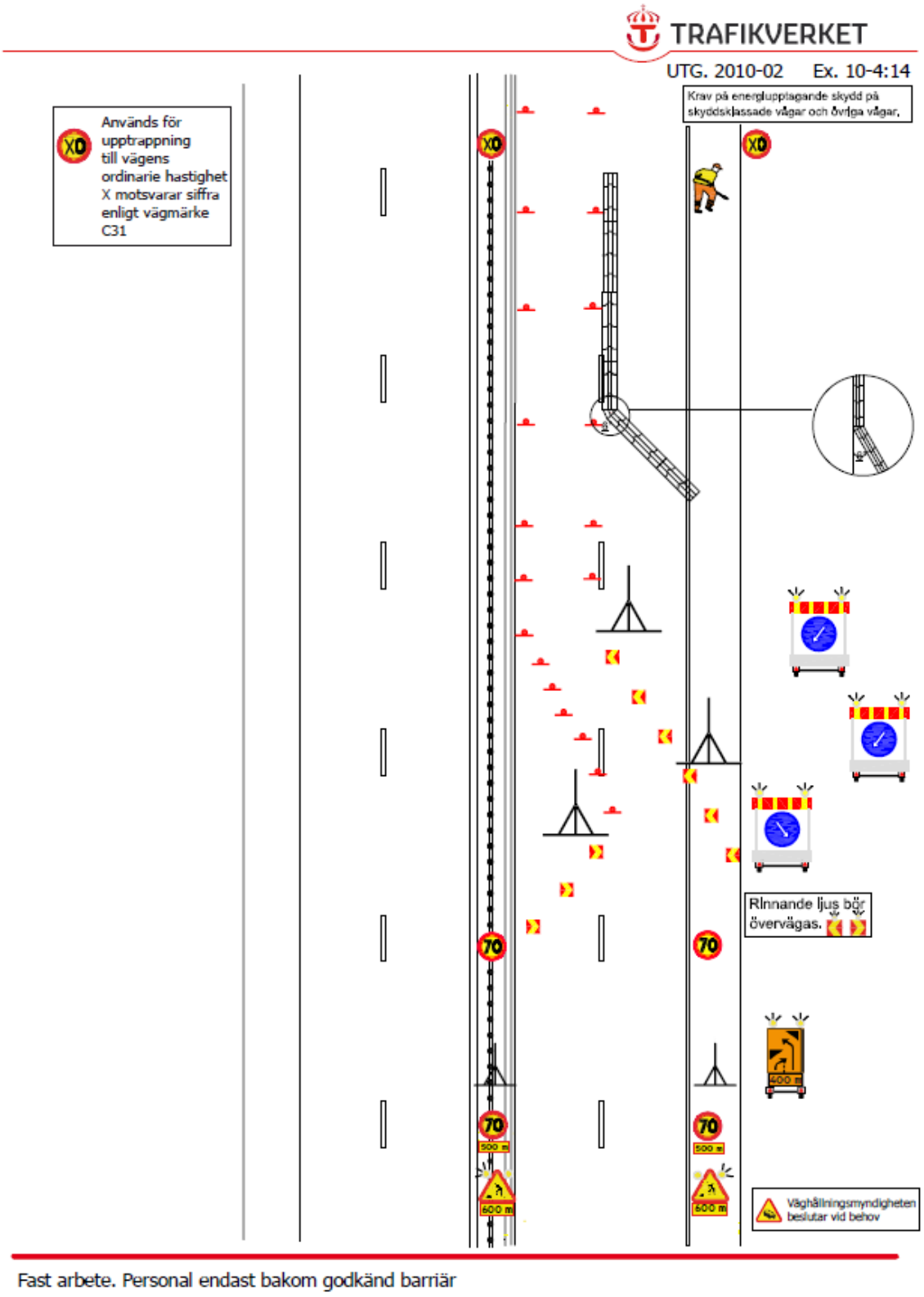


Figure 34: Stationary work. Personnel only behind approved barrier.

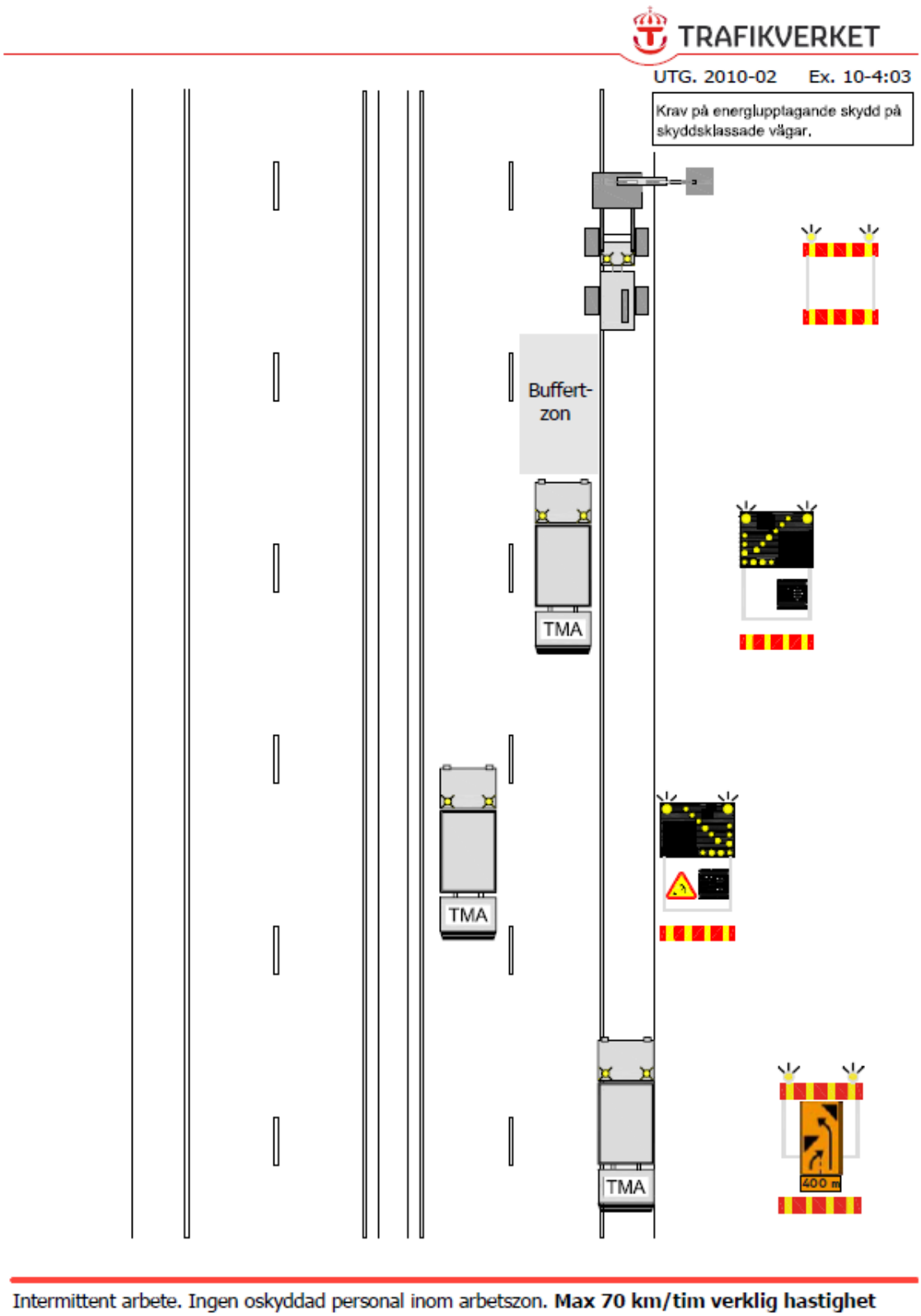


Figure 35: Intermittent work. No unprotected personnel within work zone. Max. actual speed 70 km/h

2.6.3 Accident data collection

STRADA – Swedish Traffic Accident Data Acquisition - is a national information system collecting data of injuries and accidents on the road network. STRADA is based on information from two sources - the police and hospitals. Reporting from the Police has been mandatory since 2003 at a national level; reporting from hospitals is not mandatory but is increasing.

For the BRoWSER trial, since these data are already collected and due to lack of in-country resources within the project team, it was decided that the trial would be used to ascertain if this existing data collection is suitable for the EuRoWCas database.

The data used for the trial are based on the STRADA data but have been processed and enhanced by Eva Liljegren of the Swedish Transport Administration for separate research purposes. Additional data fields have been added through this research to the original STRADA data, such as information on injured road workers and winter maintenance.

The data fields in the filtered data include:

- Time and location details – including year, month, day, time, county, municipality, road number/name, road owner
- Incident description – type of accident, description, cause, winter maintenance, presence of TMA or other protection
- Injury information – Severity rating of the accident, number of dead / severely injured / minor injuries
- Road worker involvement – whether road workers were involved, whether there were any road worker injuries (and severity)
- Road type – classification of road, speed on road, urban/rural
- Driving activity being undertaken – such as overtaking, reversing, stationary
- Other driving factors – such as drunk driving, learner driving, whether the car drove off the road
- Environmental conditions – such as the road surface condition, weather, daylight / lighting conditions.

The accidents are reported into STRADA by the police and hospitals with a maximum delay of two months. However these data are classified and owned by the Swedish Transport Agency.

Unfortunately the information from the accidents is quite limited. It is, for example, seldom possible to tell what type of road work that was going on at the time of the accident. These accidents are not investigated by experts (unless they are fatal accidents) so it is quite difficult to obtain any details about the road works, signage, speed limits in place etc. For fatal accidents the situation is different, as all fatal accidents are investigated in depth.

2.7 Norway

There were no in-country members of the BRoWSER consortium from Norway and therefore information available for this report was more limited. Information in the following section drawn mostly from Manual no. 51 published by Statens vegvesen and from individual contacts in the country.

2.7.1 Network and road works management

The total length of the road network in Norway is approximately 206,000 km, which comprises national, municipal and private roads. As of 2010, when 17,200 km of national roads were transferred to the counties, there are 10,451 km of national roads and approximately 44,000 km of county roads. The Norwegian Public Roads Administration (Statens vegvesen) still administers the roads on behalf of both the state and the regional authority and so are responsible for a total of approximately 54,734 km (national and regional/county)[5], including planning, construction and operation. The NPRA comprises the Directorate of Public Roads and five regional units - Northern Region, Central Region, Western Region, Southern Region and Eastern Region.

The NPRA is therefore responsible for road works on state and county roads in Norway. For each road works, the contractor must prepare a roadwork safety plan based on a risk assessment. This must highlight the safety of both road workers and road users, whilst maintaining network performance for all road users as far as possible. For national and county roads, this plan must be sent to the NPRA for approval.

2.7.2 Standards and guidance

The main guidance document for road works in Norway is Manual no. 051 – Work on and along roads, Requirements and guidelines regarding warning and protection (Directorate of Public Roads, Roads and Transport Department, 2012). The manual provides guidance for how to warn, direct and regulate traffic safely and efficiently past road works sites on or along public roads, including planning and execution of works. Manual 051 contains special rules concerning works on roads, and these are binding for all sign authorities, including municipalities and the police.

The manual has a basis in the legislation and regulations relevant to road works, of which the main ones are briefly discussed below.

- The Road Traffic Act, specifically the Traffic Rules and the Road Sign Regulations - Chapter 14 of the Sign Regulation covers ‘Temporary signing etc in connection with warnings of roadworks and arrangements on public roads’. The Road Sign Regulations provide the legal basis for the Directorate to issue technical rules.
- The Public Roads Act – which covers the permissions and authority for maintaining and carrying out work on public roads.
- The Working Environment Act – as in other countries, these are the general provisions which applicable to all employees to ensure a safe and secure work place and hence this applies to the road workers on site and during installation and removal of works.

[5] The Nordic State Road and Railway Infrastructure Market, Peter Molin & Emil Matintupa, 2013. Finnish Transport Agency.
http://www2.liikennevirasto.fi/julkaisut/pdf3/lts_2013-19_nordic_state_web.pdf

In addition there are other manuals and specifications that may be of relevance, for example Manual 062 - Traffic Safety Equipment, Manual 231 - Guardrails, Manual 271 - Risk assessments in road traffic.

Manual 051 includes both specifications and guidelines. For the specifications, there are requirements (which are mandatory, although the Directorate can approve departures) and recommendations (where departures are allowed based on only a technical assessment).

In the manual a distinction is made between 'permanent' works (Fast arbeid), 'short-term' works (Kortvarig arbeid) and mobile works (Bevegelig arbeid). Example layouts are provided for various scenarios, e.g. for multi-lane roads with speed level above 50 km/h, the layouts described are:

- Installation and removal of signs and equipment
- Permanent work in right lane on 4 lane road
- Permanent work in right lane on 4 lane road, with one lane contraflow
- Permanent work in left lane on 4 lane road
- Permanent work in both lanes on 4 lane road
- Permanent work in right lane on 6 lane road
- Permanent work in right and middle lane on 6 lane road
- Short-term works in right lane on 4 lane road
- Short-term works in left lane on 4 lane road
- Short-term works in right lane on 6 lane road
- Short-term works in right and middle lane on 6 lane road
- Short-term works in one lane on 4 lane road without shoulder
- Short-term works on exit ramp
- Mobile works in right lane on 4 lane road
- Mobile works in left lane on 4 lane road
- Closure of exit ramp
- Carriageway closure, detour via exit ramp
- Carriageway closure, two-way traffic by exit ramp

The manual also covers layouts for: streets and roads with speed limits under 60 km/h, two-lane roads with speed limits between 60-90 km/h, works for applying road markings and special working (mostly reactive incident management, breakdowns and working in tunnels). Some typical layouts are illustrated below.

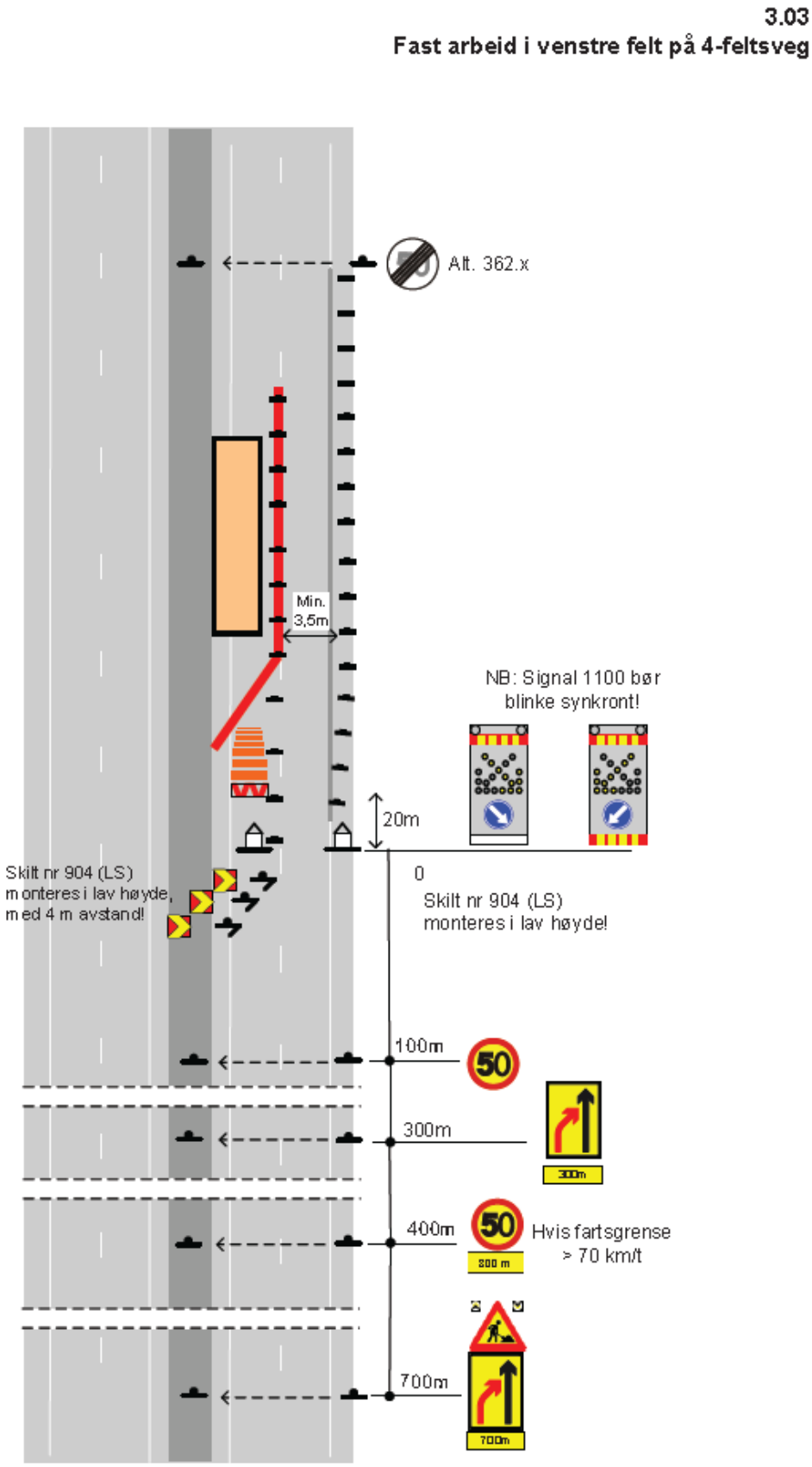


Figure 36: 'Permanent' work in left lane of 4-lane motorway

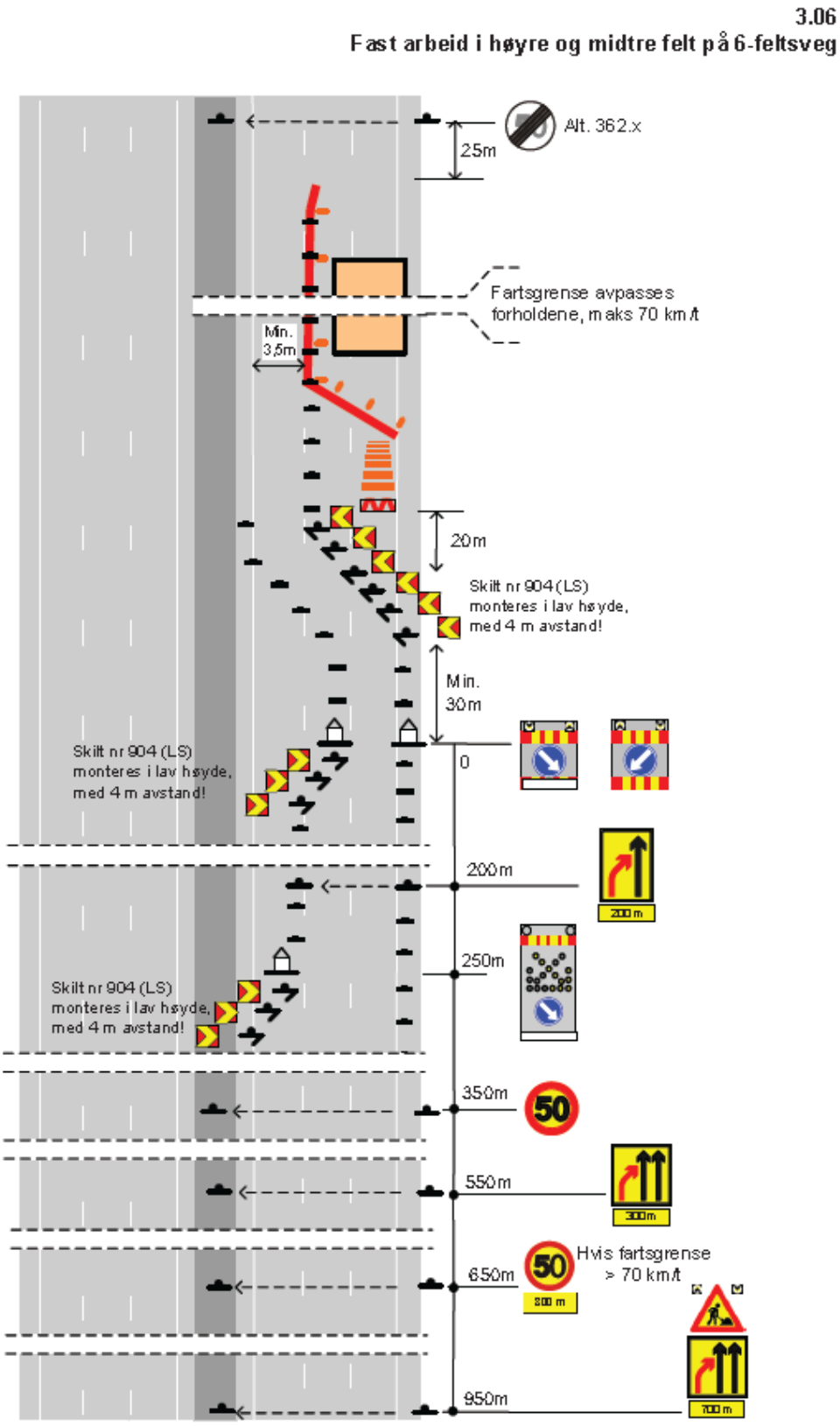


Figure 37: 'Permanent' work in middle and right lane of 6-lane motorway

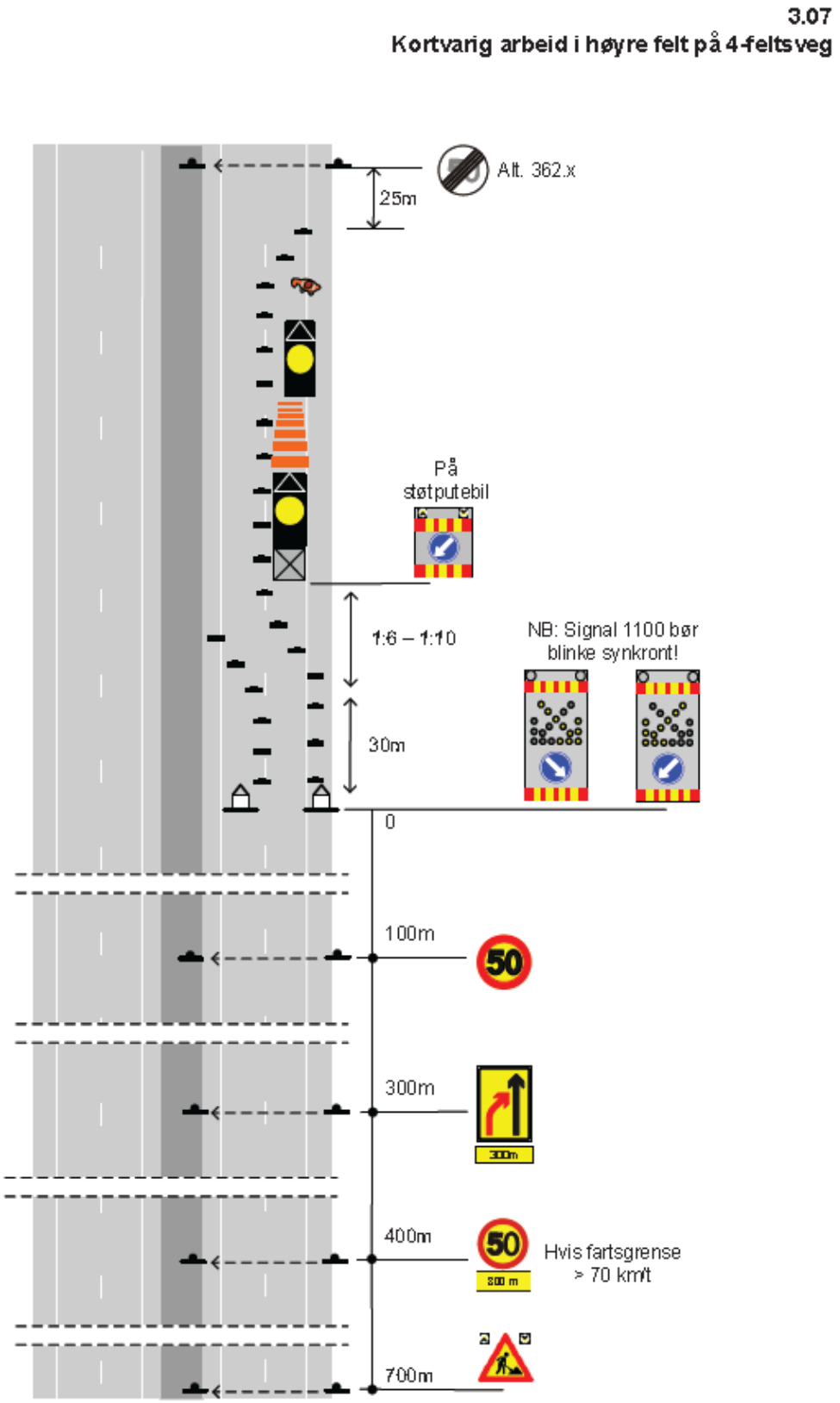


Figure 38: Short-term works in right lane of a 4-lane motorway

3.11
Kortvarig arbeid i ett felt på 4-feltsveg uten skulder

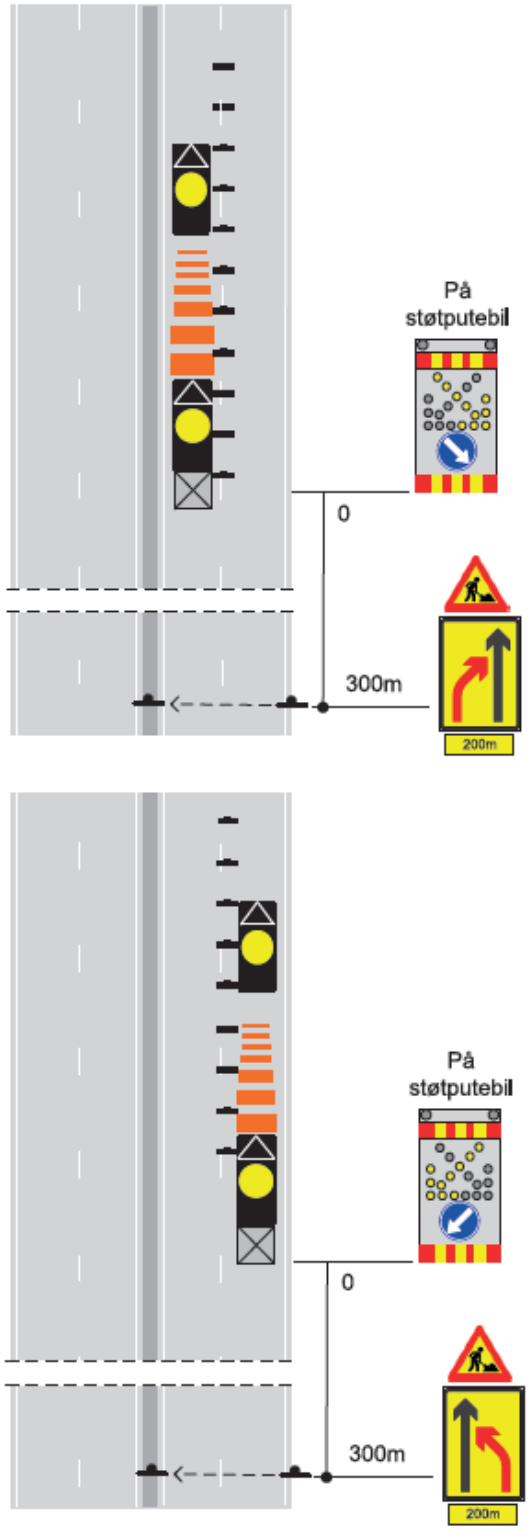


Figure 39: • Short-term works in one lane on 4 lane road without shoulder

2.7.3 Accident data collection

In Norway, data on all personal injury accidents on the roads are collected by the Police. The data fields collected fall into three sections – accident details, vehicles involved and people involved. There are no fields in the database that specifically identify whether road works were present at the scene of the accident, and hence there is no way of extracting those accidents that occurred in work zones or in the presence of works unless this is mentioned in the free text description. The fields collected are listed in the table below.

Table 13: Data fields collected in accident database

Accident details	ID County Road Marker Post HP Department Municipality Severity of most serious injury Accident Date Accident Time Day of week Date of registration (of accident) Accidents category Accidents Code Number of vehicles involved Number killed in accident The number of very seriously injured The number of seriously injured Number of slight injuries Given number of casualties Type of road Location Conditions Central reserve present Surface type Surface Conditions Weather Light conditions Lane type Number of lanes Urban/rural Road width Speed limit Temperature Municipality no Historical road status Historical road category Historical road number Historical HP Historical kilometres value Road name Location accuracy Number of vehicles involved in accident Vehicle types
For each vehicle involved in accident	ID County Road

	HP Marker post Department Municipality Vehicle Type Number of people per vehicle in accident Crossroads / junction Driving Direction A cway / B cway Purpose of journey Regulation at junction Country of registration Year of vehicle Obstacle type Road distance from obstacle Tyre type Number of people involved in accident
For each person involved in accident	ID County Road HP Marker post Department Municipality Person's sex Person's age Person's location in vehicle Scheme 2 SSB Damage / injury

In Norway most accidents in work zones involving road workers are categorized as work-related accidents only and are therefore collected by a different government department to Statens Vegvesen.

For fatal accidents however, in-depth analysis is carried out. A report produced by Statens Vegvesen in 2011[6] looked at accidents connected with road works, based on data from the in-depth expert analysis of road traffic fatalities 2005 – 2009.

The report analyses 23 fatalities associated with the roadworks or construction work near the road with the definition being "accidents that have occurred in areas where there is planned work on or near the road, and where the analysis group found a connection between this work and the accident. The roadwork may be directly or indirectly the cause of the accident."

The reason for doing this analysis was because there is very little information available on the subject of accidents connected with road works. The extent of such accidents are not known since the presence of road works are not systematically recorded by the police when recording accidents and are not therefore included in the data. In the more detailed analysis

[6] Temaanalyse av trafikkulykker i tilknytning til vegarbeid (Basert på data fra dybdeanalyser av dødsulykker i vegtrafikken 2005-2009), Veg- og transportavdelingen, Region sør, Februar 2011 - Theme analysis of traffic accidents in connection with roadworks (Based on data from in-depth analysis of fatalities in road traffic 2005-2009) Roads and Transport Department Southern Region, February 2011
http://www.vegvesen.no/_attachment/263341/binary/467271?fast_title=Temaanalyse+av+trafikkulykker+i+tilknytning+til+vegarbeid+2005%E2%80%932009.pdf

of fatal road accidents, there is additional data available that is not found in the police reports, therefore the report aimed to investigate whether these data could provide a greater insight into these accidents. It is believed that this is the first analysis of traffic accidents in connection with roadworks in Norway and it helps to form a picture of the extent of such traffic accidents and the safety issues associated with them.

The Norwegian Public Road Administration (NPRA) is currently developing a new National Road DataBase (NRDB). The database will store information about all state, municipal and private roads in Norway. The NRDB will store both basic data and calculated data like traffic accidents and average annual daily traffic. Amongst other things, the intention is to use NRDB for road maintenance and operation, traffic safety work and statistics about traffic accidents.

Data on all personal injury accidents on roads are collected, i.e. road user accidents, but no information is included within these to indicate whether road works are present or not. If this additional information were collected it would theoretically be possible to identify potential near misses, since road user accidents in work zones constitute a risk to road workers. However, in order to collect all the data required by EuRoWCas it would be necessary to extend the existing data collection significantly or collect bespoke data specifically for this purpose.

3 Conclusion

This report has firstly provided a high-level overview of the network and road works management and operational arrangements for road works in each of the participating countries (the funding countries plus Slovenia).

The benefits of a EuRoWCas database were identified in the project deliverable D1.1 (BRoWSER Benefits Case). In order to realise these benefits, and by extension to achieve the overall objectives of the research programme, road worker incident data must be collected as specified in project deliverable D2.1 (Input data definition document for EuRoWCas). It has been identified that collecting the data required for the EuRoWCas database is not generally possible with (or without some adaptation of) the existing data collecting processes, and as such this document has provided the motivation behind the three-month data collection trial to assess the feasibility of future data collection. Where available, relevant historical data have been considered for each country in order to provide a baseline.

This report has also identified the main relevant standards and guidance that govern road works in each of the countries and illustrated some typical layouts that are used. These standards and guidance documents will be reviewed and analysed in detail in Work Package 7 of this project, which will in turn lead into later work packages looking at the possible correlation of road works layouts standards and accident data.

Appendix A: Feasibility of using existing Belgian databases for EuRoWCas

This section describes a 2-step method used to analyse how far it would be possible to fill in the EuRoWCas database through the use of data typically available in the Belgian Traffic accident database (more particularly after the post-processing carried out by the Flemish RA) and the road works (RW) dedicated database (named "werf").

The raw data used were mainly the 2010 – 2011 traffic accident data on Flemish Motorways (exits & access not included), as delivered by the Flemish RA (Agentschap Wegen en Verkeer – Expertise Verkeer en Telematica) on the 31/03/2014. This comprised 7634 rows corresponding to 3412 accidents.

For the purpose of this discussion, the RW dedicated database has not yet been queried; however it is hereafter considered that this database, being managed by the Flemish RA, would provide relevant information about RW location, time and characteristics.

Step 1: Screening of the DB to identify accidents likely to be associated with RWs

Criteria used:

Criteria 1:

- ID in the official Police traffic accident recording form: Box 13 "Other local characteristics": a topic "Road work having an impact on the carriageway" can be ticked, if relevant;
- Corresponding ID in the NRA database (as received): Column "Plaatselijke karakteristieken 1", value "werken met invloed op het wegdek"

Criteria 2a:

- ID in the official Police traffic accident recording form: Box 18 "Accident factors"; part "Road/Traffic conditions": a topic "Road work" can be ticked, if relevant;
- Corresponding ID in the NRA database: Column P "Wegomstandigheden 1", value "werken"

Criteria 2b:

- ID in the official Police traffic accident recording form: Box 18 "Accident factors"; part "Road/Traffic conditions": a topic "Road work" can be ticked, if relevant;
- Corresponding ID in the NRA database: column Q "Wegomstandigheden 2", value "werken"

Criteria 3:

- ID in the official Police traffic accident recording form: Box 8 B) "Users and Obstacles involved": code 54 if the obstacle is a container; code 55 if the obstacle is composed of road work signing or related equipment;
- Corresponding ID in the NRA database: Column AH "Hindernis", values "container" or "werken, signalisatie werken";

Results:

- Criteria 1: 124 accidents identified; 45 not identified through other Criteria (52 not identified through Criteria 2a, 121 not identified through Criteria 2b, 109 not identified through Criteria 3);

- Criteria 2a: 143 accidents identified; 65 not identified through other Criteria (71 not identified through Criteria 1, 143 not identified through criteria 2b, 127 not identified through Criteria 3);
- Criteria 2b: 4 accidents identified; 1 not identified through other criteria
- Criteria 3: 26 accidents identified; 5 not identified through other criteria

Conclusion:

- As a consequence, Criteria 1, 2a and 3 must be considered together when screening the DB;
- In total, 201 accidents seem to be associated to road works between the 1st of January 2010 and the 31st of December 2011. 8 fatally injured, 63 severely injured and 268 lightly injured persons where recorded. In total it concerned 565 persons;
- With the information available at this stage it is neither possible to determine if any road workers were concerned by some of these accidents (in the available data set all the 565 persons concerned by the accidents are being identified as road users), nor to confirm these accidents strictly concern RW sites;
- For the first point, a cross-check with any information concerning road worker accident would be helpful (following the Royal decree of 25 January 2001 on Temporary and mobile work sites the safety coordinator must report about accidents happening on the work site);
- For the latter point, a cross-check (even a merge) with the RW dedicated database (named "werf") used by the Flemish RA would be desirable;
- Additionally it will remain difficult to determine where the accidents exactly happened; i.e. in vicinity of the work zone or somewhere in the queue far from the work zone (e.g. rear-end collision). The only possibility would be to compare the posted speed limit (recorded in column BM "Snelheidsregime 1") with the ones mentioned in the signing plans stored in the RW dedicated database;
- Some other data fields from the Traffic Accident data file received from the Flemish RA may be used to feed EuRoWCas (i.e. on the accident circumstances, environment, etc.), as described in the following section (step2).

Step 2: Data necessary for EuRoWCas (based on the spreadsheet used for the 3-months trial)

Preliminary remark: the existing Traffic Accident database is very unlikely to include near misses, incidents or accidents with light material damages only because in such circumstances the Police are usually not called to go on-site.

Sheet "Circumstances":

Data fields (EuRoWCas) **Core data fields in bold characters**	**Traffic Accident data file**	**RW dedicated database ("werf")**
Country	Yes	Not relevant
Road authority	Yes	Not relevant

Date & Time	Yes ("Datum + uur")	Merging Criteria
Incident description	Yes ("Type aanrijding"; "Hindernis"; "Beweging"; "Dynamica"; "Factoren weggebruiker"; "Factoren voertuig")	Not relevant
Location and direction identifier	Yes ("Gemeente"; "Gewestweg x"; "Km-punt 1") – Direction not given	Merging Criteria
Coordinates	Yes ("X"; "Y")	No
Carriageway type	Yes ("Type weg x")	Likely to be available
Incident type	Yes ("Type aanrijding") but the values mentioned are quite different than in the drop-down list EuRoWCas	No
Hard shoulder usage	No	Likely to be available
Standard Lanes	No	Likely to be available
Junction detail	Yes ("Plaatselijke karakteristieken", "Kruispunt"; "Kruispuntregeling")	More detailed information likely to be available
Permanent speed limit	No	Likely to be available
Temporary speed limit type	No	Likely to be available
Temporary speed limit	Yes ("Snelheidsregime")	Likely to be available
HS; L1; L2; L3; L4	No	Likely to be available
Type of roadworks	No	Likely to be available
Works activity	No	No
Advanced signing present	No	Likely to be available
Length of works zone	No	Likely to be available
Traffic control measures (at works)	No	Likely to be available
Contraflow type	No	Likely to be available
Incident location in road works	No	No
Incident location adjacent to	No	Maybe (if crossing KP with detailed signing plan)
Day/night	Yes ("Lichtgesteldheid")	Not relevant
Lighting	Yes ("Lichtgesteldheid")	No
Weather	Yes ("Weer")	Not relevant
Visibility	No	No

Road surface condition	Yes (“Staat weg”)	No

Sheet “Vehicles”:

Data fields (EuRoWCas) **Core data fields in bold characters**	**Traffic Accident data file**	**RW dedicated database (“werf”)**
Vehicle class	No	Not relevant
Vehicle type	Yes (“Aard”)	Not relevant
Driver/operator role	No	Not relevant
Driver/operator sex	No	Not relevant
Driver/operator age	No	Not relevant
Intended manoeuvre	Yes (“Beweging”; “Dynamica”)	Not relevant
Object hit	Yes (“Type aanrijding“; “Hindernis”)	Not relevant
First point of impact on vehicle	No	Not relevant

Sheet “People”:

Data fields (EuRoWCas) **Core data fields in bold characters**	**Traffic Accident data file**	**RW dedicated database (“werf”)**
Person Class	No	Not relevant
Role	No	Not relevant
Activity (road workers only)	No	Not relevant
Person location	No	Not relevant
Impact type	No	Not relevant
Person's sex	No	Not relevant
Person's age	No	Not relevant
Injury level	Yes (“Aantal doden”; “Aantal zwaar gewonden”; “Aantal licht gewonden”; “Gevolgen”) but the information is provided globally for the accident)	Not relevant
Object hit	Yes (“Type aanrijding“; “Hindernis”)	Not relevant

In conclusion, the three tables above show that only a part of the EuRoWCas data fields can be filled-in using the existing databases (Traffic Accident data file & RW dedicated database). In particular, the available data appears not available to fill in several core fields.

Moreover an (automatic) import of the data is not possible as the drop-down lists in EuRoWCas include values that are different than the ones in the Traffic Accident data file. A time-consuming post processing would therefore be necessary. It is also important to note that the traffic Accident data file is only made fully available 1.5 to 2 years after the end of the year.

The RW dedicated database ("werf") used by the Flemish RA can help to fill in some additional data fields in EuRoWCas. However queries in the RW dedicated database would also be time consuming and merging with events in the Traffic Accident data file not necessarily immediate.It was therefore decided that these elements justified the development of a specific data collection system, as tested in the BRoWSER 3-months trial.

Appendix B: CT68s form (National Police Service in Ireland, accident report form)

station: **garda:** **incident no:**

garda siochana road traffic accident report

station name:
accident involved:
date:
day:
time:

speed limit:
investigated at scene:
number of vehicles involved:
number of pedestrians involved:

GPS Coordinates
Coordinate Type:

county:
local authority:
city/town/townland:
name street/road:

at intersection with:
or if not at intersection:

if national/regional route/route no.:
and if national route, metres/feet:
direction:
of post no.:

metres/yards:
direction:
of:

light conditions:
weather conditions:
surface conditions:
junction/crossing control:
road character:
other road character:

skidding occurred:
road works:
road width:
junction type:
road type:

road markings

1. broken centre line		5. lane markings	
2. continuous centre line		6. no markings	
3. double continuous centre line		7. centre line reflectors	
4. edge markings		8. edge line reflectors	

vehicle details vehicle 1
registration no.:
make:
model:
type.:

vehicle details vehicle 2
registration no.:
make:
model:
type.:

vehicle 1 occupants	age	sex	severity	Taken to Hospital	Seatbelts/ Helmets Worn	Vehicle 2 Occupants	age	sex	severity	Taken to Hospital	Seatbelts/ Helmets Worn
Driver / Cyclist						Driver / Cyclist					
Passenger Front						Passenger Front					
Passenger Rear						Passenger Rear					
Passenger Rear						Passenger Rear					
Passenger Rear						Passenger Rear					

pedestrian casualties

	age	sex	severity	Taken to Hospital		age	sex	severity	Taken to Hospital
pedestrian 1					pedestrian 2				

Name of Hospital to which Casualties were taken:

1 of 4

station: **garda:** **incident no:**

primary collision type:
other primary collision:

single vehicle collision with:
other single vehicle collision:

pedestrian 1 action:
if other action, specify:

pedestrian 2 action:
if other action, specify:

driver 1 action:
if other action, specify:

driver 2 action:
if other action, specify:

driver 1 exiting/entering:
if other exiting/entering, specify:

driver 2 exiting/entering:
if other exiting/entering, specify:

contributory action driver 1:
if other action, specify:

contributory action driver 2:
if other action, specify:

driver/cyclist details

	driver/cyclist 1	driver/cyclist 2
driver resident:		
driver learner:		
driver/cyclist familiar w/location:		
walkman/hand held phone in use:		

road factor contribution

1. layout		4. lighting		7. sight distance	
2. skid resistance:		5. surface resistance		8. crossfall/camber	
3. road signs		6. road markings		9. traffic signals	
10. other:					

Driver/Cyclist 1 Trip Purpose:
Driver/Cyclist 2 Trip Purpose:

pedestrians visibility at night

	pedestrian 1	pedestrian 2
light:		
armbands:		
walkman/handheld phone in use:		

Pedestrian 1 Trip Purpose:
Pedestrian 2 Trip Purpose:

station: **garda:** **incident no:**

vehicle 1 description:
if goods, loaded:

vehicle 2 description:
if goods, loaded:

vehicle defects

	vehicle 1	vehicle 2
1. tyres:		
2. brakes:		
3. lights:		
4. markings:		
5. steering:		
6. suspension		
7. couplings:		
8. other defects:		

are the following in order?

	vehicle 1	vehicle 2
road tax:		
insurance:		
cert of road worthiness		
driving licence:		
full licence:		
provisional license:		

alcohol testing

	driver 1	driver 2
breath screening specimen at scene:		
if yes:		
reason test not taken:		
blood/urine breath specimen at station:		
if yes:		
blood/urine specimen at hospital:		
if yes:		
bureau red seal no.:		

contributory factors:

was there a single principal cause which precipitated this accident:
if yes, specify:

factors	extent	specify

station: garda: incident no:

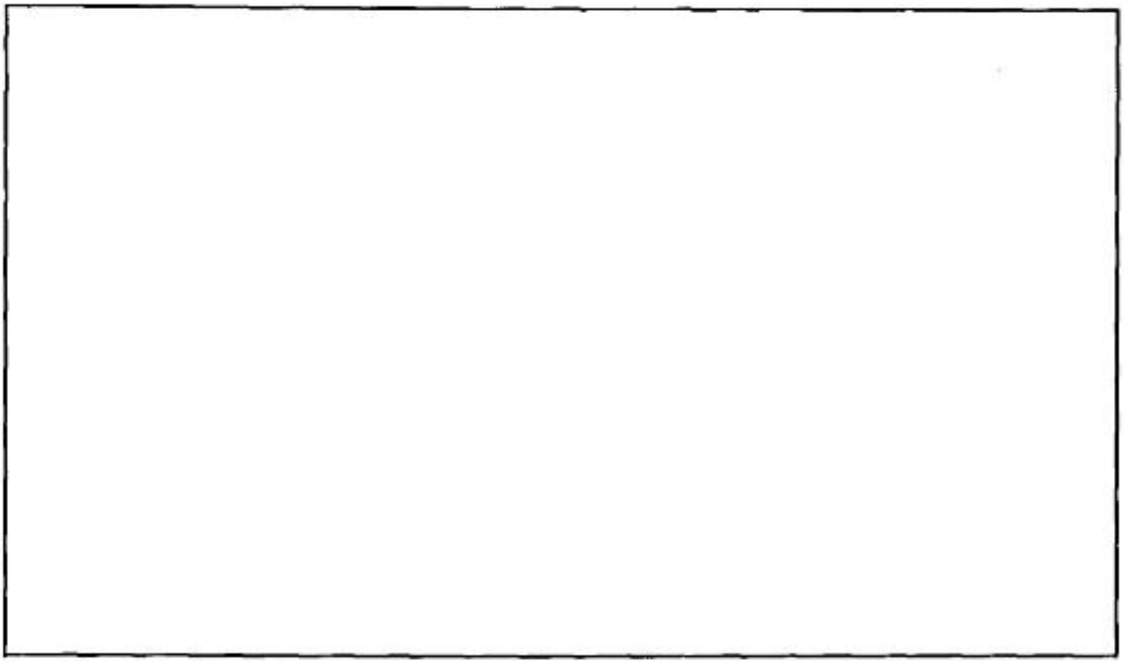
GPS Coordinates

Coordinate Type: N/A

**mark and record grid line number

map title:

diagram (specify markings, widths, signs, etc.)



description:

**mark and record grid line number to be recorded on top right hand corner of page