



Centrico

**Ramp metering
synthesis**

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Centrico – Ramp metering synthesis

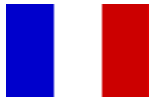
A Euro-Regional Deployment Plan for Road ITS between Belgium, France, Germany, Luxemburg, The Netherlands and the United Kingdom.

Partners involved:



Belgium:

- Brussels
- Flanders
- Wallonia



France:

- METL/DSCR
- SANEF
- SAPN



Germany:

- NRW
- Hessen
- RP
- SL
- Federal Ministry



Luxembourg



The Netherlands



United Kingdom



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Ramp Metering Synthesis

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1. Introduction

1.1. Background

Ramp metering is a new activity within CENTRICO. All CENTRICO partners were invited to delegate an expert on the expert group meeting. A first meeting was organised in June 2000, the 5th meeting took place on June 25, 2001 in Paris.

As a starting point, a questionnaire was used to gain an understanding of the needs and expectations of the participants.

The goal of the workshops was to encourage the exchange of experiences and to investigate opportunities for harmonisation. Therefore on-site visits were organised in England, France, Germany and The Netherlands.

From the questionnaire and the on-site visits, it became clear that there is no need for harmonisation for pure technical aspects (algorithms, detection). Harmonisation should concern end-user aspects.

1.2. Ramp metering?

Metropolitan areas throughout the world all are confronted by the same type of traffic-related problems : an increasing demand which cannot be accommodated by existing capacity, funding difficulties or political pressure preventing the creation of additional road infrastructure. This observation is all the more true for urban motorway networks that have to cope with especially high volumes of traffic during peak periods.

The general concept of ramp metering consists in controlling the flow of traffic entering motorway access ramps. Ramps are used to stock vehicles temporarily, in order to optimise the flow on the motorway itself, and maintain it below the critical level, over which congestion is likely to appear. Ramp metering can answer to different sets of sub-objectives. First and foremost it is used to solve a problem of congestion created by a bottleneck that can originate from a physical feature of the roadway, an excess of demand on one or more ramps, etc. Ramp metering can be implemented in different ways, to optimise various traffic parameters: minimise average travels times, maximise entering flows with a throughput constraint, or maximise the rate of use of the motorway. Several projects put forth voluntary objectives regarding safety that should be enhanced by ramp metering. Finally ramp metering can be used to give priority to certain types of trips or users: priority to through traffic vs. local traffic, long distance vs. short distance trips, or specific cases such as summer peak periods, emergency-related traffic plans, etc.



1.3. Future?

The present synthesis document highlights goals and operational issues concerning ramp-metering installations in different Member States and explains differences in national approaches.

Each country/region is presented in using the same structure. The information given in this document mainly concerns CENTRICO and schemes in Paris and Bordeaux.

In the chapter 'conclusions' guidelines for harmonisation accepted by the CENTRICO Steering Committee are presented.

2. Development

2.1. Belgium

2.1.1 Flanders

Current situation

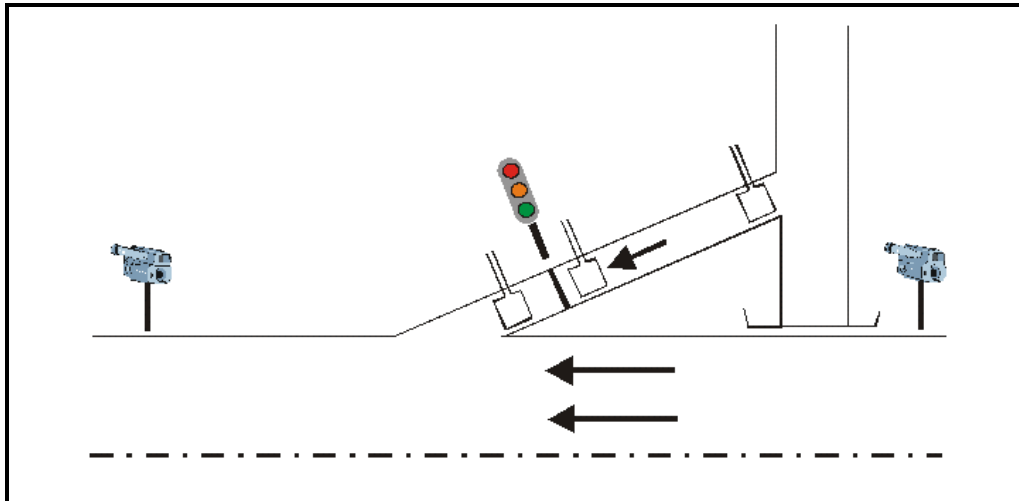
Actually only one (single lane ramp metering) installation is in operation at Leuven, focusing on the improvement of the traffic flow on the E314 motorway (=increasing capacity). Leuven is situated at the crossing of the E40 (Calais-Brussels-Köln) and E314 (Leuven-Aachen).

Project-Planning

Several other potential sites are being studied (near Brussels and Antwerp). Regarding their particular traffic situation, for some of them double lane metering installations are required.

Detection methods

Operation modus is based on video-monitoring of downstream traffic flow on the motorway, and loops on the ramp (at the entry and just before the traffic lights).



Algorithms

The algorithm is based on the ALINEA (based on occupancy-monitoring) specification. Upstream occupancy is monitored as well for evaluation purposes.

Cycle time

The green-amber-red cycle time is chosen (minimum 4 sec) regarding the actual monitoring and the one-per-green principle is honoured.

Signal sequence for ramp metering:

Green time => 1 - 3 sec

Amber time => 1 - 2 sec

Red time => 2 sec minimum

Traffic lights

'Traditional' traffic lights are situated at the end of the ramp, only at the right hand side of the road. Green, amber and red colours are used.

On/off switching is based on (minimum) numbers of vehicles and have both different thresholds. In case of a too high demand on the ramp (loop at the entry of the ramp occupied), the installation is automatically switched off and turns into flashing amber, in order to avoid congestion on the underlying network.

The ramp metering is only operational on weekdays between 06:00 and 10:00 and when the occupancy is more than 18%.

Pre-signing

To explain to the people how the system work, several information boards were implemented on the ramp itself.





Enforcement

There is no automatic vehicle identification or enforcement in case of red violation.

Harmonisation

Actually, Belgian regulation concerning 'traditional' traffic lights does not really match with the requirements of an independent two lanes metering. Belgian Traffic Law allows only lane allocation signs (red cross- green arrow) for installations with different status or cycle time above/beside the pavement. Flanders would prefer to apply a kind of traffic lights (using bulbs) for dynamic steering of free passage.

Therefore Flemish and Federal authorities are keen on obtaining a (European) consensus on a common layout of the installation and if possible on the one-per-green principle before introducing a request for adaptation of the traffic regulation.

2.1.2 Wallonia

Current situation

No ramp metering project is foreseen in Wallonia.

2.2. England

Current situation

The Highways Agency (HA) is currently running a Ramp Metering Pilot Scheme (RMPS) on the M3/M27 motorways in the Southampton area, on the south coast of England. Although it is primarily a HA initiative, aimed at making best use of existing roads, the HA is also working in partnership with Hampshire County Council, Southampton City Council and the Hampshire Police.

The scheme includes operational sites at M3 junction 11 southbound, M27 junction 3 eastbound, M27 junctions 5 & 7 westbound and M27 junctions 10 & 11 eastbound, plus 2 control sites at M3 Junction 12 northbound and M27 Junction 5 eastbound.

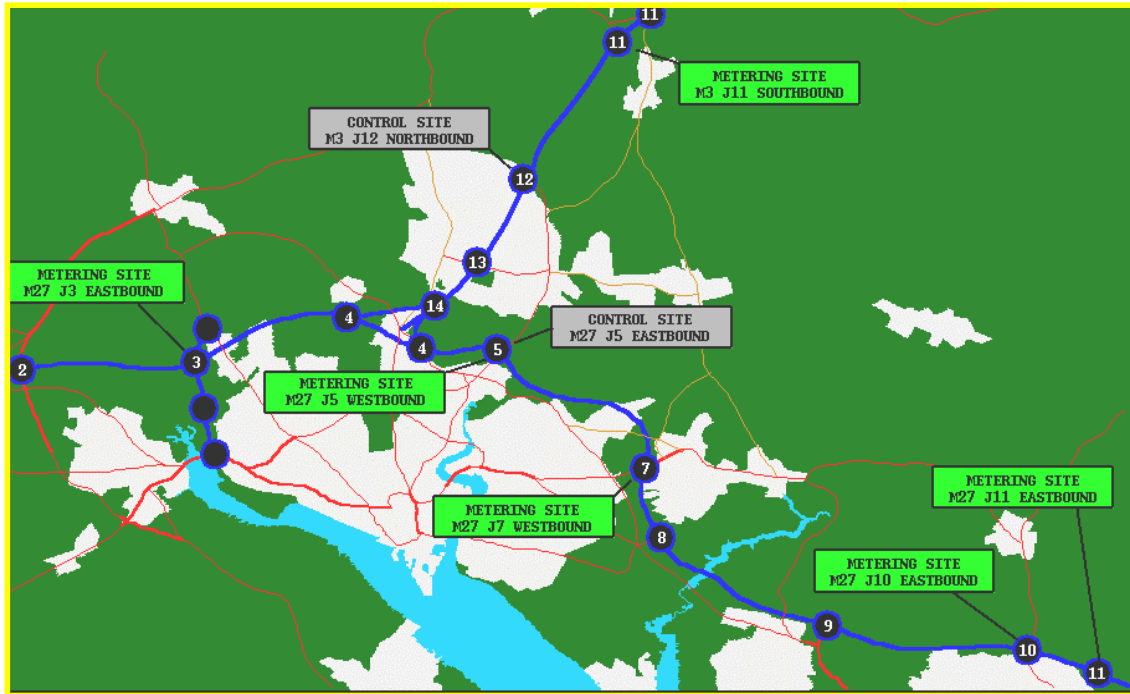
A control site does not have traffic lights and is just used to collect data, as a means of verifying if there are any changes to traffic flows not attributable to ramp metering.

All sites are thoroughly monitored, including traffic flow data, journey time data from vehicle number plate recognition systems and video recording of CCTV information. Additional data on weather conditions and traffic incidents is also collected and collated.

The first site went operational in autumn 2000 and all sites were in use by the end of 2000.

Work is underway at present producing a report on the first 12 months of operation.





Overview map of M3/M27 RMPS

Project Planning

The project aims to produce a business case, guidance and specifications for the roll out of the ramp metering technique elsewhere in England.

Additionally, the equipment under trial on the M3/M27 scheme has recently been incorporated into the Birmingham, West Midlands area. Here a previous trial of ramp metering on the M6 motorway took place in the mid 1980's and the equipment installed for that is now life expired and in need of a maintenance upgrade.

The opportunity to evaluate the new generation equipment and techniques under a different set of characteristics will provide valuable support the Ramp Metering Pilot Scheme.

In the near future there is also the significant possibility of using ramp metering as a component of the HA Active Traffic Management (ATM) Pilot Scheme, which, as part of the recent HA Ten Year Plan announcements from Central Government, is in the planning stage and should be implemented over the next three to five years.



Detection methods

After consideration of other methods, it was decided to use readily available loop detection equipment as the basis of ramp metering. This has the advantage of being well understood, supported and maintained by several UK manufacturers.

It was also much quicker to base the ramp metering infra-structure on existing HA specifications used for the Motorway Incident Detection & Automatic Signalling (MIDAS) project. The communications and protocols were adapted to form the basis of traffic data collection for ramp metering.

Algorithms

Several algorithms were researched during the planning stage of the ramp metering pilot scheme. The most promising were ALINEA and Demand/Capacity. Both are being evaluated in operation and the ramp metering equipment is capable of accepting other algorithms if required.

Analysis to date has mainly been of ALINEA usage, and early indications are that this is producing quantifiable benefits.

Cycle time

Cycle times for the traffic lights used with ramp metering are variable depending upon the prevailing traffic conditions and the number of vehicles the system wishes to meter. At present we are using a minimum amber time of half a second in the release phase and two seconds in the stopping phase. The red and green times are adjusted to achieve the desired metering rate.

Traffic lights

In order to comply with current UK legislation, the traffic signals need to be type approved. Rather than develop new signals for ramp metering, the decision was made to use modern, incandescent lamp, anti-phantom approved signals of 200mm diameter for both primary and repeater purposes. A special blue diamond backing board is fitted to the signals that highlight their difference from all-purpose road signals. These work well, and have not been a problem.

As the trial progresses there may be the opportunity to try LED based signals, which should reduce maintenance overheads and to investigate the use of 100mm diameter signals for repeater operation.

Pre-signing

As part of the approval process for each ramp metering site, additional fixed signing is specified along the entry slip road before a driver meets the traffic lights. These are standard agreed signs, which warn of "possible queues ahead" and "part time traffic signals", and use both text and images.

Prior to each site becoming operational, supplementary temporary signs were also erected to give drivers advanced warning of the new signal operation. These were removed after the sites began operational metering.



Typical advanced fixed signs

Enforcement

The ramp metering system was designed such that a standard red light running camera could be integrated into the system for enforcement purposes. To reduce overall costs and reduce the complexity of system operation it was decided to initially try the system without automatic enforcement.

To date this has been a prudent move, as the level of compliance with the red stop light is quite high and occasional enforcement by Police Officers has been sufficient to maintain it.



Harmonisation

The HA is in continuous liaison with CENTRICO regarding several projects, including ramp metering. As part of this process, the HA is aware of the desire to harmonise the use of ramp metering throughout Europe.

The first step will be the incorporation of a common design for the backing board used with ramp metering signals. Currently the HA has approval for a blue diamond shape with white border. However, in common with other ramp metering in Europe this will be changed to a yellow lozenge shape. Approval has been given for use of the new backing board and it is hoped to have it installed on existing sites early in the New Year.

The present signal timings result in a minimum of three vehicles /lane being released on each green, however, it is the HA's intention to move, over time, to one vehicle / lane / green, in line with CENTRICO harmonisation ambitions.

Any feedback that is received on these changes will be reported back to CENTRICO at the regular meetings.

2.3. France

Although ramp metering is not widely deployed in France, the first trials paradoxically began rather early: in 1970, 35 ramps on the Paris motorway network were equipped with traffic lights running on fixed time cycles that were set for morning peak periods during the week, and for the week-end returning periods. Another system was installed in Lyon, around the Fourvière Tunnel, consisting of barriers that can be closed by the operators in the traffic management centre, in cases of congestion or incidents around the tunnel.

During the 1980s and the early 1990s, several experiments were conducted and reported on : INRETS published several studies showing the benefits provided by ramp metering based on real-life experiments and traffic simulations.

In December 1997, CERTU (French ministry of Transport) published a state of the art report, analysing and synthesising the different technical, regulatory and organisational issues raised by ramp metering in view of deploying it in France.

The report concluded that further experiments were needed, using state of the art technologies and strategies to acquire a deeper understanding on ramp metering and to analyse the feasibility and the conditions of a wide deployment. Several test sites were selected including Paris and Bordeaux.

2.3.1 Paris

Current situation

Some 15 ramp metering installations are already operational in Paris.



Project Planning

Some 100 more ramps will be controlled within the next 4 years in the near suburb area of Paris.

Traffic lights

Three lights signals: red, amber and flashing amber. At the moment, there is no contrast shield to complete the apparatus: this point should be defined for the ramps under equipment.

On/off switching: the ramp metering is now only operational on weekdays between 06 and 10 AM and on Sundays afternoon (returns from week-end). In the future the on/off switching might be based on the motorway's flow all day long. In case of a too high demand on the ramp (loop at the entry of the ramp occupied), the installation is automatically switched off and turns into flashing amber, in order to avoid congestion on the secondary network.

Pre-signing

Today each ramp is equipped with fixed signs with a flashing amber light that is activated when the metering installation is on. The 2 next installations that will be operational within 2 months will test double VMS as an experiment.



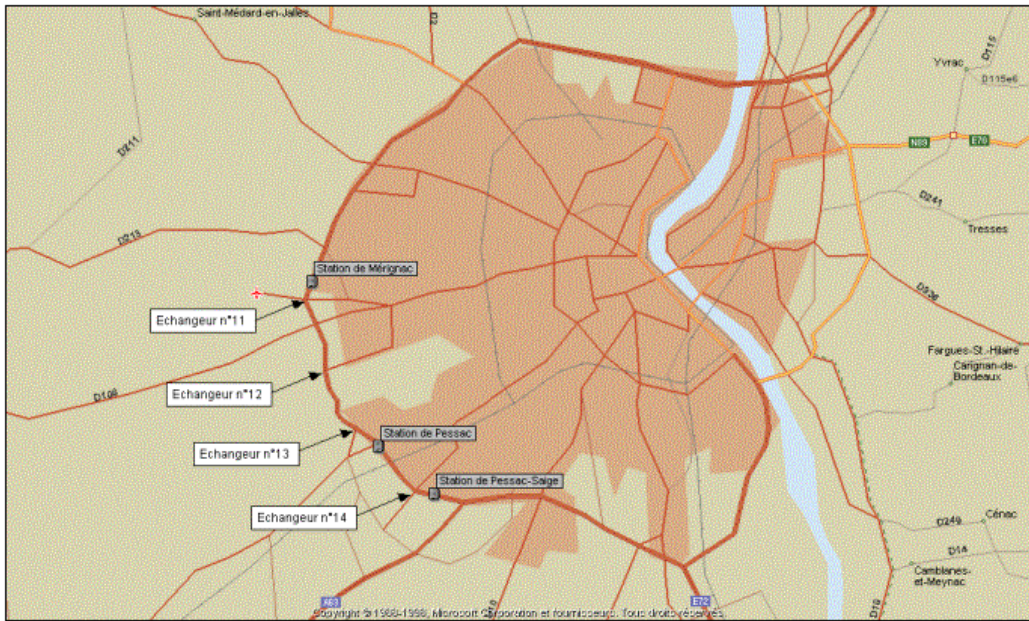
Enforcement

French regulation

2.3.2 Bordeaux

Current situation

No installation for the time being. The evaluation plan is almost finished, and the reference situation will be measured in June. The calls for tender for the equipment have already been launched



Project Planning

Two or three ramps will be controlled after September/October 2001

Detection methods

Inductive loops will be installed soon. Please note that the slip roads only have a single lane.



Algorithms

Alinea. No co-ordination planned

Cycle time

1 to 2 seconds flashing amber (=green), and the cycle time will depend on the flow to be sent on the motorway (probably 12s maxi).

One of the questions is the minimum duration of the flashing amber. The site tests will allow help-refine the settings.

The sequence will be: red, flashing amber, amber, red, etc. The sequence for the start up phase needs to be precisely defined.

Traffic lights

Three signal colours: red, amber and flashing amber. The backing shield will be yellow.

The ramp installations will be in operation during morning peak periods and returns from week-ends. The on/off logic remains to be better defined.

Pre-signing

At least one slip road will be equipped with a double VMS. Fixed signs will be used on the other slip road, in order to evaluate the real advantage provided by a VMS (which is rather expensive). No photograph available for the time being.

Enforcement

Concerning red violation, there is no automatic enforcement planned up to now. However, the police could play a role, especially at the beginning.

Harmonisation

After this experiment in Bordeaux, and if it is successful, a revision of the French regulations (the so-called "Livre I, 6th. Part") could be launched



2.4 Germany

2.3.3 Hessen

Current situation

There is no ramp metering in operation in the State of Hessen. A Paramics-simulation has been done for a site on the A 5 near Friedberg and final results were obtained in February 2001.

Project Planning

For the next five years, 5 more sites are planned in the Federal Traffic Control Program.

Detection methods

Detection is done by loops.

Algorithms

ALINEA will be used.

Cycle time

The cycle time is still not decided.

Traffic lights

The on-off logic depends not only on loads and traffic quality on the motorway but also on the subordinate roads (waiting time restriction). The question of using amber light will not be answered before the test phase of the Friedberg-site. The use of a contrast shield and its colour will depend on the agreement that we expect from CENTRICO.

Pre-signing

As we will have a real testing period, we will not have a pre-signing from the beginning. If the installation proves to be successful on this site, a pre-signing might be added.



Enforcement

N.A. yet

Harmonisation

The State of Hessen is highly interested in an agreement on the one-per-green principle and a common layout of the ramp metering installation.

2.3.4 Nordrhein-Westfalen

Current situation

For the time being 5 ramp metering installations are in operation. They are located on the highly loaded motorway A 40 between the access points of Gelsenkirchen and Bochum-Stahlhausen in the direction of Dortmund. All installations are single lane ramp meterings, which are not connected with each other. The first evaluation showed that the number of accidents and congestions on the carriageway have been reduced significantly.

Project-Planning

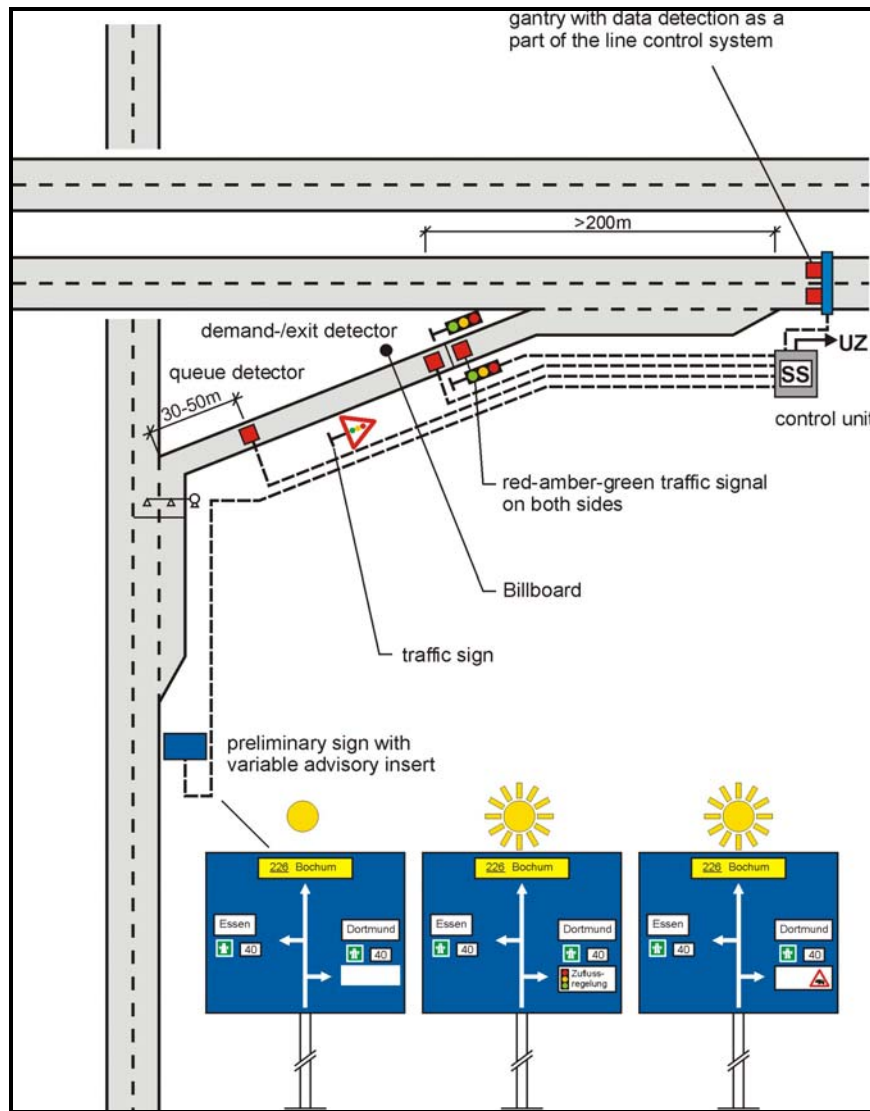
Probably 15 ramp metering systems will be implemented on several entries of the A 40 in the area of Bochum and Essen, the motorway network around Cologne (A 3) and the A 59 Duisburg-Ruhrort till the end of 2002.

Furthermore about 50 other sites are under study (A 1, A 3, A 40, A 43, A 46 and A 57).

Detection methods

As a rule, all detections for ramp metering (both for operational systems and for those under study) are made through induction loops.

The ramp metering operation modus is based on traffic data detection (traffic volume, speed and occupancy) of downstream traffic flow on the continuous carriageway and demand-, exit- and queue-detection on the access ramps at the entry and just before the traffic lights (see figure below).



Algorithms

The ramp metering control strategy is based on ALINEA. This strategy regulates the on-ramp flow to keep the downstream carriageway occupancy below a pre-set optimal level.

Cycle time

Green-amber-red cycle, but red-green is possible too.

One vehicle per green.

Signal sequence for ramp metering:

Red time => 2 sec

Red/Amber time => 1 sec

Green time => 0 – 16 sec

Amber time => 1 sec

Under these conditions the cycle time differs from 4 – 20 seconds.

Traffic lights

Traffic signals are located on both sides of the lane towards the end of the slip road at the transition to the acceleration/filtering in- lane, just before the start of the merge with the main carriageway. The traffic lights have red, amber and green lights, which have the same meaning as signals used on crossroads, with the same penalties if they are not obeyed. The police will enforce the signals.

The traffic signals are automatically switched on by changing from dark over 5 seconds amber to red, when the occupancy on the motorway has reached a certain level and when the merging traffic would probably cause problems. This happens mainly during peak hours. Each cycle of the signals allows only one car to access the motorway.

The signal sequence with red-red/amber-green-amber time is related to an usual traffic light. Nevertheless the green and amber signal time is shortened. The minimum actual green amounts to a tenth of a second; the actual green period could be extended to 16 seconds. But in any case the traffic light is set to red if one vehicle has passed.

Ramp metering will only operate when needed. Otherwise the signals are automatically switched off by changing from red over red/amber to dark.

Pre-signing

The preliminary signs on the access road are additionally equipped with added variable advisory signs (see figures below). These signs should inform the road user about the actual status of the ramp metering.

1. Neutral – no announcement
2. "Zuflussregelung" - regulated access
3. Congestion sign



A dedicated information panel placed near the traffic light installation clarifying the "one car per green" principle (see figure). This panel will be removed, when the road user are accustomed to ramp metering.



Enforcement

By police on site.

Harmonisation

European consensus on one-per-green principle.



2.3.5 Rheinland-Pfalz

Current situation

For the time being, there is no ramp metering installation but Rheinland-Pfalz is looking to use it at some motorways entries.

2.4. The Netherlands



Typical two lane ramp meter near Zoetermeer

Current situation

Since 1989 a total of 33 ramp metering installations (TDI's) have been installed. The average rate in recent years was 5 new installations per annum. In only one situation the controller never was put in operation and removed after political discussions. Another one has been removed thanks to the changing circumstances in which it was no longer effective. A full set of functional and technical design guides have been developed. There also exists an operation practice handbook. For maintenance reasons and for the deployment of co-ordinated strategies, a Central Traffic Management Systems (CTMS) was specified and put in operation. All Regional Directorates in The Netherlands adhere to these guides and handbooks. These guides give some figures on slip road layout like minimum distance for stop line to merging area. Length of merging area in relation to acceleration distance. There are no figures for minimum slip road distances or typical slip road geometry. Ramp metering has extensively assessed. See the paper by: H. Taale and F. Middelham (2000). "Ten Years of Ramp Metering in The Netherlands", 10th International Conference on Road Transport Information and Control, IEE, London, April 2000. Due to several reasons, the co-ordinated strategies have never been put in operation and assessed.

The implementation costs are 150.000 EURO for a one lane controller and 175.000 EURO for a two lane controller. Red light camera's add another 45.000 EURO. The maintenance costs are 10.000 EURO per annum. All these figures are exclusive the costs for infrastructural additions like extra queuing capacity.

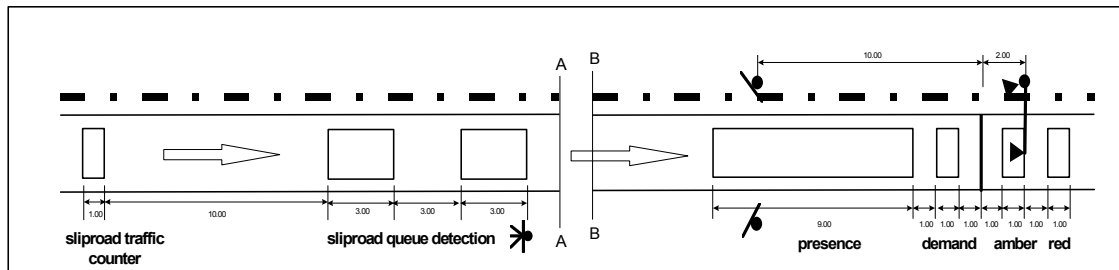


Project Planning

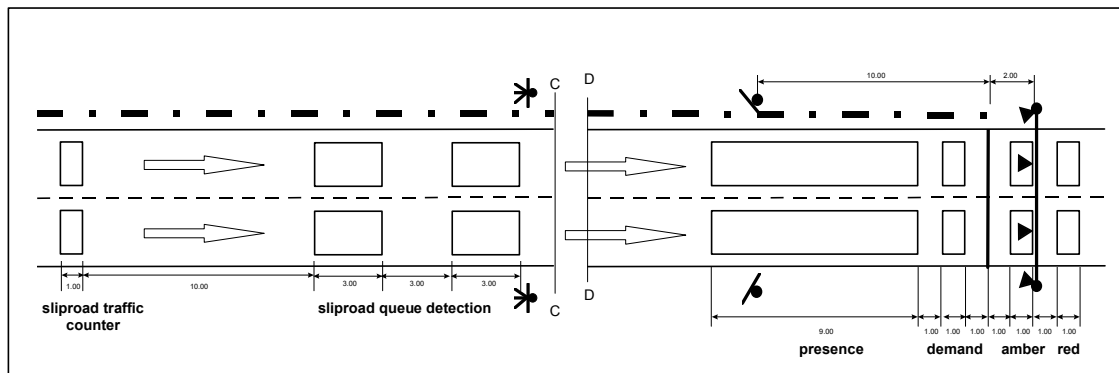
For the next five years another 37 ramp meters are planned for installation.

Detection methods

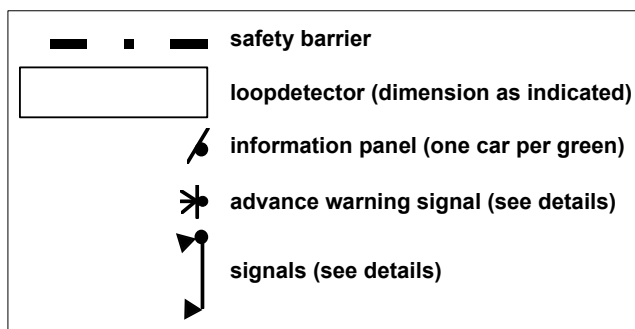
On the motorway there are detector stations 500 meter upstream and 500 meter downstream the on-ramp. They measure speed, flow and density per lane. On the slip road, there is a queue detector close to the surface streets. Near the stop line there is a demand detector, a start amber detector and a start red detector.



typical detector lay-out for a one-lane ramp meter



Typical detector lay-out for a two-lane ramp meter



Legends for detector lay-out

If public transport is in operation via the slip road, a bus lane is introduced adjacent to the lanes for normal traffic. In one occasion in The Netherlands a truck lane exists adjacent to the lanes for normal traffic. Busses and trucks have priority over an existing queue on the slip road, i.e. as soon as they

are detected they get green in the next cycle. Busses and trucks are detected by covering two small detectors, 15 meter apart.



Typical one-lane ramp meter with adjacent bus lane



Birds eye view of two-lane ramp meter

Algorithms

The algorithm is based on the RWS-strategy, which is a demand capacity strategy. The number of cars being allowed to enter the motorway is the difference between upstream demand and (an assumed) downstream capacity. When speed drops on the motorway either upstream or downstream, the

access from the slip road is limited to a minimum. When a queue develops on the slip road, the access from the slip road may be set to a maximum. The choice between minimum and maximum is a political decision and can be configured by setting a software switch.

Several other strategies like FUZZY and ALINEA have been tested, In general they gave some better results, but for practical reasons, like complexity of tuning and maintenance, the RWS-strategy was chosen as the standard.

The controller is always in operation, with the signals being dead. But the signals are put in effect when the demand on the motorway exceeds a certain threshold or the speed on the motorway (either upstream or downstream) lowers a certain threshold. The signals are switched off when the demand on the motorway lowers a certain threshold and the speed on the motorway (both upstream and downstream) exceeds a certain threshold. All thresholds have some hysteresis. The initiation procedure is 15 seconds amber flashing, 5 seconds fixed amber and 5 seconds fixed red.

The Netherlands is facing a simplification of the controller, as tuning is still quite difficult and the controller quite expensive. It has been proposed to test a V-ALINEA strategy based upon a speed detector close to the cabinet of the controller, which is close to the stop line on the slip road. Metering will then be based on the traditional ALINEA principles, however instead of occupancy, speed is the typical parameter. Above a certain speed on the motorway, the metering rate will be increased. Under a certain speed on the motorway, the metering rate will be decreased, finishing at a minimum rate. Switching on/off also will depend on speed.

Cycle time

The cycle time is calculated from the difference of upstream (motorway) demand and downstream (motorway) capacity and number of lanes on the slip road. Capacity is not on line calculated (like in the earlier Birmingham trials). The cycle time is limited to a maximum value (normally 12 - 15 seconds). Green time is dynamic and depends upon the reaction time of the driver and its acceleration. Typically the green time is 2 seconds. The amber time is dynamic and depends upon the speed behind the stop line. Typically the amber time is 0.5 seconds. The red time is the rest of the cycle time minus the green time minus the amber time. The minimum red time is 2 seconds. Given these figures the minimum cycle time is typically $2.0+0.5+2.0=4.5$ seconds.

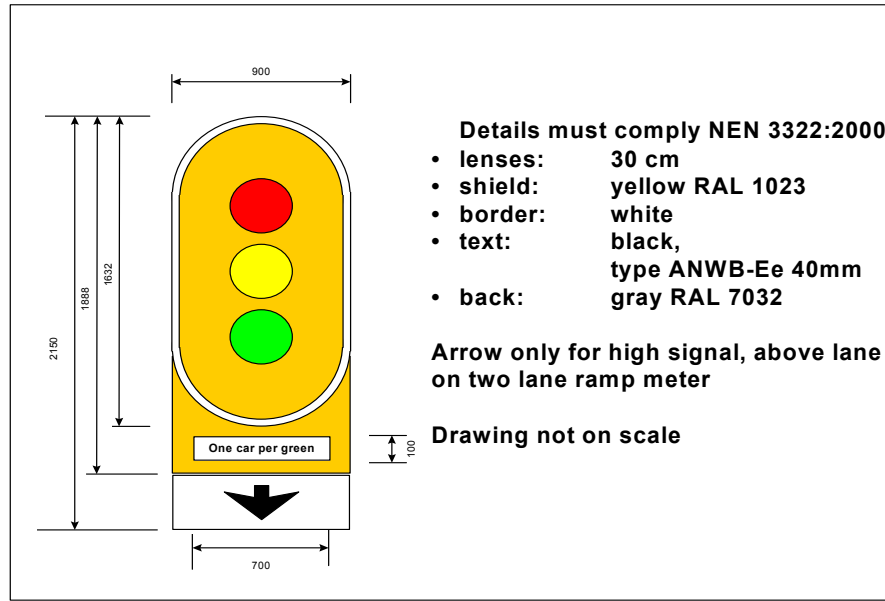
Other aspects are:

In case of a two lane ramp meter, start of green is synchronized. The so called non-staggered start. End of green per lane depends upon reaction time and acceleration speed of the first vehicle.

When a long truck slowly accelerates, the start of green in a new cycle is postponed as long as the truck occupies a 'start amber' and/or a 'start red' detector.

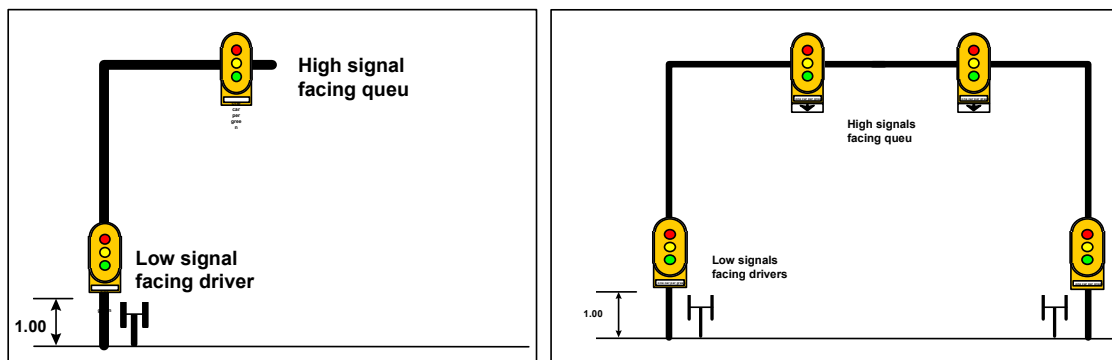
Traffic lights

Traffic lights have to conform the standards of normal signal heads. In The Netherlands this standard is known as the NEN 3322:2000. In the next figure the dimensions are given.

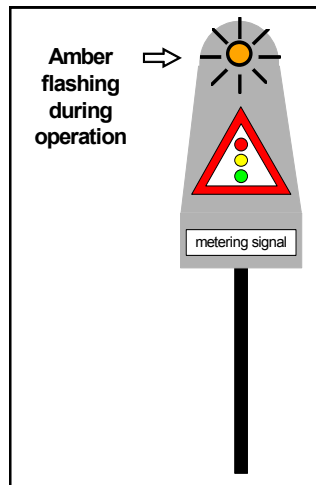


Details and dimensions of signal heads

Every signal head is mounted on a standard pole and/or gantry. In case of a one-lane ramp meter, the gantry can be replaced by a pole on the right side of the lane. See the following figures for more details.



Typical one lane and two-lane signal head lay-out



Pre warning sign

Pre signing

A normal 'you are approaching a traffic signal' sign is used to warn for the on-coming signals. An additional text panel states: 'metering signal'. When the signals are in effect an amber flashing signal has to draw extra attention.

Enforcement

Standard equipment includes red-light cameras. Red violation is minor when congestion can be observed on the motorway. The fine is 50 EURO per violation. Not all situations a red light camera is applied.

Harmonisation

The signals applied in ramp metering are traditional traffic lights. But the legislation with respect to traffic signals mentions:

1. an exception for the yellow background shield in case of 'doseerlichten'
2. the possibility to apply a 'full lens signal' to only one lane by adding 'falling arrows' on the background shield



3. Conclusions

3.1. General

Ramp metering as new activity within CENTRICO will certainly progress in the future. For the next five years, a lot of implementations are planned (see comparison table inserted in annex).

In using ramp metering, the partners follow the same objectives: increase traffic flow, decrease congestion, reduce journey time and improve traffic safety. Especially when the flow on the continuous carriageway is saturated and the merging process would cause problems ramp metering has a positive effect on safety.

When we look at the technical aspects like type of detection, algorithms, a certain coherence appears. The "Alinea" algorithm is mostly used and detection on the ramp is done by loops. However users needs aspects show more divergence: use of green, amber or flashing amber in order to inform the drivers they can pass through, one car per 'green' or platoon? This synthesis confirms the fact that it will not be evident to reach a standard. However, almost each member states have chosen for a yellow contrast shield. On this point, UK, which is now using a blue diamond, is looking to use a yellow contrast shield.

CENTRICO already agreed that in case of harmonisation it should be for the road users. Legal aspects seem also to be an object of preoccupation (place of the traffic light,...). Some countries are looking to introduce ramp metering in the national road legislation.

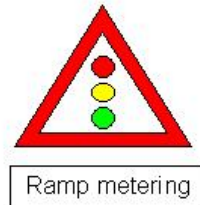
Because ramp metering is a promising but sensitive matter to harmonise, the CENTRICO partners decided to write guidelines which have been accepted by the CENTRICO Steering Committee.

3.2. Guidelines

The Steering Committee endorsed the following guidelines in September 2001:

- Pre-signing on the slip-road

A ramp metering traffic light on a slip-road might not be usual, therefore it is advised to pre-sign the ramp metering signal. It is also advised to use the normal warning sign (red triangle) with traffic lights within the triangle and an additional sign mentioning "ramp metering (in the official language)". See figure below as illustration.



- The ramp metering traffic light

It is advised that the outlook of the ramp metering traffic light differs from urban traffic lights. There is common sense to use a yellow contrast shield. This shield has the normal shape (so no rectangular shield).

- The control strategy

It is advised that a ramp metering sign uses a 3 aspect light with green, amber and red. This sign is combined with a one vehicle per green strategy. The one vehicle per green strategy offers a maximum capacity of 800 vehicles / hour per lane.

- Lay-out of the ramp metering system

There is no advice on detection neither on positioning of the traffic lights except that it is advised to put a low level (left or right) and a high level sign.

This synthesis is a good working base for a future 'common understanding' of ramp metering within CENTRICO.

Annex: Comparison table

	Flanders	England	Hessen	Nordrhein-Westfalen	Paris	Bordeaux	The Netherlands
Number of site operational	1 – E313 (Leuven)	6 operational, 2 control	0 - simulation	5 – A40 (Bochum)	15	0 – evaluation plan	33
Project-planning	yes	yes	5 sites	15 + some 50 under study	some 100 more	2 or 3 (end 2001)	37
Detection (ramp)	loops	loops	loops	loops	loops	loops	loops
Algorithms	Alinea	Alinea & Demand/ Capacity	Alinea	Alinea	Alinea	Alinea	RWS-strategy
Cycle time	green-amber-red – min. 4 sec	variable depending on conditions.	not decided	green-amber-red/amber – 4 to 20 sec	flashing amber-amber-red – 15 to 40 sec.	Flashing amber-amber-red	green-amber-red – 4.5 to 15 sec.
Traffic lights	traditional	traditional, (blue diamond backing board)	not decided	traditional	traditional (yellow shield)	yellow shield	yellow shield
Pre-signing	billboard	fixed signs, text and images	if needed	Dedicated information panel	fixed signs	fixed signs	yes
Enforcement	no automatic	not automatic	n.a.	police on site		police on site	automatic
Harmonisation	traffic light layout and one –per-green	yellow shield and one per green	traffic light layout and one – per-green	one-per-green		French regulations	