SWOV-Contributions to the Annual Report concerning WP 31.2, WP 31.3 and WP 31.4

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TABLE OF CONTENTS

1. WP 31.2 ACCIDENT REVIEW

The accident review is meant to detect specific types of problems that resulted in accidents, which could possibly have been prevented if the drivers had been warned in time by a telematic warning system. This accident review was planned for all three Incident Warning Systems that are part of the HOPES Evaluation study: PORTICO, EURO-TRIANGLE and MELYSSA.
In the EURO-TRIANGLE project the experimental section is part of the Antwerp ring road system just before the Kennedy tunnel, going in the direction of the centre of Antwerp.
The PORTICO system is or will be implemented on a mountain road and a motorway. The last one is located before a toll-station just outside Lisbon.
The MELYSSA location is situated on the north-south motorway A6 in the neighbourhood of Lyon. Two parallel roads, the RN6 and the D933, are relevant as re-routing alternatives.

The accident review focusses attention to the causes of those accidents that could have been prevented if correct information about the situation at hand had been given in time.
Outcomes of the review were supposed to give information about the causes of the accidents that could be used to focus the attention in the behavioural study at particular problems. Furthermore, to compare relative frequencies of accident types with corresponding types of critical behaviour and conflicts.

1.1. EUROTRIANGLE

1.1.1. Introduction

Accidents registered in automated data files on the experimental section (E17) as well as additional automated accident data (surrounding motorways: ringroad of Antwerp and motorways that give access to that ringroad) from 1993 were send by the "Rijkswacht" at the beginning of 1994.

On the bases of the description of these accidents, relevant accidents were selected.
However, the amount of information about the cause or chain of events is in general rather restricted and differs from accident to accident. Classifications of types of accidents as well as categories of causes are therefore rather subjective and not very systematic.

Most of the detailed descriptions of the relevant accidents give some information about the chain of events, allowing selection of causes, such as:

- head/tail accident, caused by high speed;
- head/tail accident, caused by incident;
- head/tail accident, caused by an obstacle on the road;
- lane change, caused by an overtaking manoeuvre;
- lane change, caused by diffuse behaviour in front.

1.1.2. Results

The total number of accidents on the experimental section was ca. 200 and more than 2,000 accidents on the surrounding motorways. All accidents are analysed by hand.

- First step: selection of relevant accidents. Criterion for determining: place of the accident. For instance, not relevant accidents are: accidents on crossings along side the motorway, at fuel stations etc.
- Second step: categorisation of types of accidents.
- Third step: categorisation of relevant causes.

Table 1 gives an overview of the types of accidents, both on the E17 (experimental section) and on the surrounding motorways.
Table 2 gives an overview of categories of relevant causes.

Table 1. Classification of accident types

1993	accident types	E17 (experimental)	Surrounding Motorways
-	head/tail	37	222
-	lane change	28	285
-	flat tyre/fire	14	22
-	rain/aquaplaining	14	54
-	lost freight/obstacles	11	60
-	entering/exiting	11	43
-	other/unknown	23	121
-	Total	138	807

Table 2. Selected relevant categories for the accident review.

1993	categories	E17 (experimental)	Surroundings Motorways
-	late notice of queue	10	102
-	high speed, relative to vehicle in front inattentive, incident	22	120
-	overtaking	28	118
-	entering/exiting	11	43
-	Total	71	383

1.2. PORTICO

1.2.1. Introduction

We received accidents of the experimental section in Portugal (A1) on paper, including a codebook. Recording an accident, the Portugal police selects one accident type out of seven. Per accident type, the police selects one cause out of four main causes (with each a number of sub-causes):

- Driver related causes.
- Vehicle related causes.
- Infrastructure related causes.
- Other causes.

1.2.2. Results

Fifty percent of all the selected causes are of the excessive speed type (see Tabel 3). But, it is not kown what cause will be selected in case of a driver who is under the influence of alcohol and was driving too fast.
Differences between the accident type "chain" - and "rear-end" accidents are not clear either. To compare relevant accident types and causes (between EUROTRIANGLE, PORTICO and MELYSSA) more information is needed from the PORTICO police reports. Therefore some of the accident reports will be studied in more detail.

Table 3: types of accidents and causes on the A1 in Portugal.

Accident type	Number	Road wet	accident causes	
- Roll over	(3)		excessive speed	1
			driver distracted/unattend.	1
		(1)	mechanical problem	1
- skidding/running	(60)	(21)	excessive speed	31
		(1)	driver distracted/unattend.	5
			sleep	1
		(1)	driving in wrong direction	2
		(2)	problem with brakes	9
			alcohol	1
		(4)	other causes	11
- Rear-end collision	(28)	(6)	excessive speed	15
		(3)	driver distracted/unattend.	5
		(1)	sleep	2
		(1)	driving in wrong direction	2
			gravel/sand on the road	1
		(1)	other causes	3
- Lateral, sideways	(5)	(1)	excessive speed	1
		(1)	driving in wrong direction	2
		(1)	mechanical problems	1
		(1)	other causes	1
- Frontal collision	(1)	(1)	driver distracted	1
- Chain accident	(7)	(2)	excessive speed	4
			driving in wrong direction	1
			obstacle on lane	1
			other causes	1
- Guardrail/other obj.	(17)	(4)	excessive speed	10
		(1)	driver distracted	4
			problems with brakes	3
Total	121	(54)		

1.3. MELYSSA

The data analysis for the MELYSSA project has just started. Some formal problems concerning the contract and permission for the delivery of detailed accident data by the authorities had to be dealt with. The analysis will be finished before the end of September 1994.

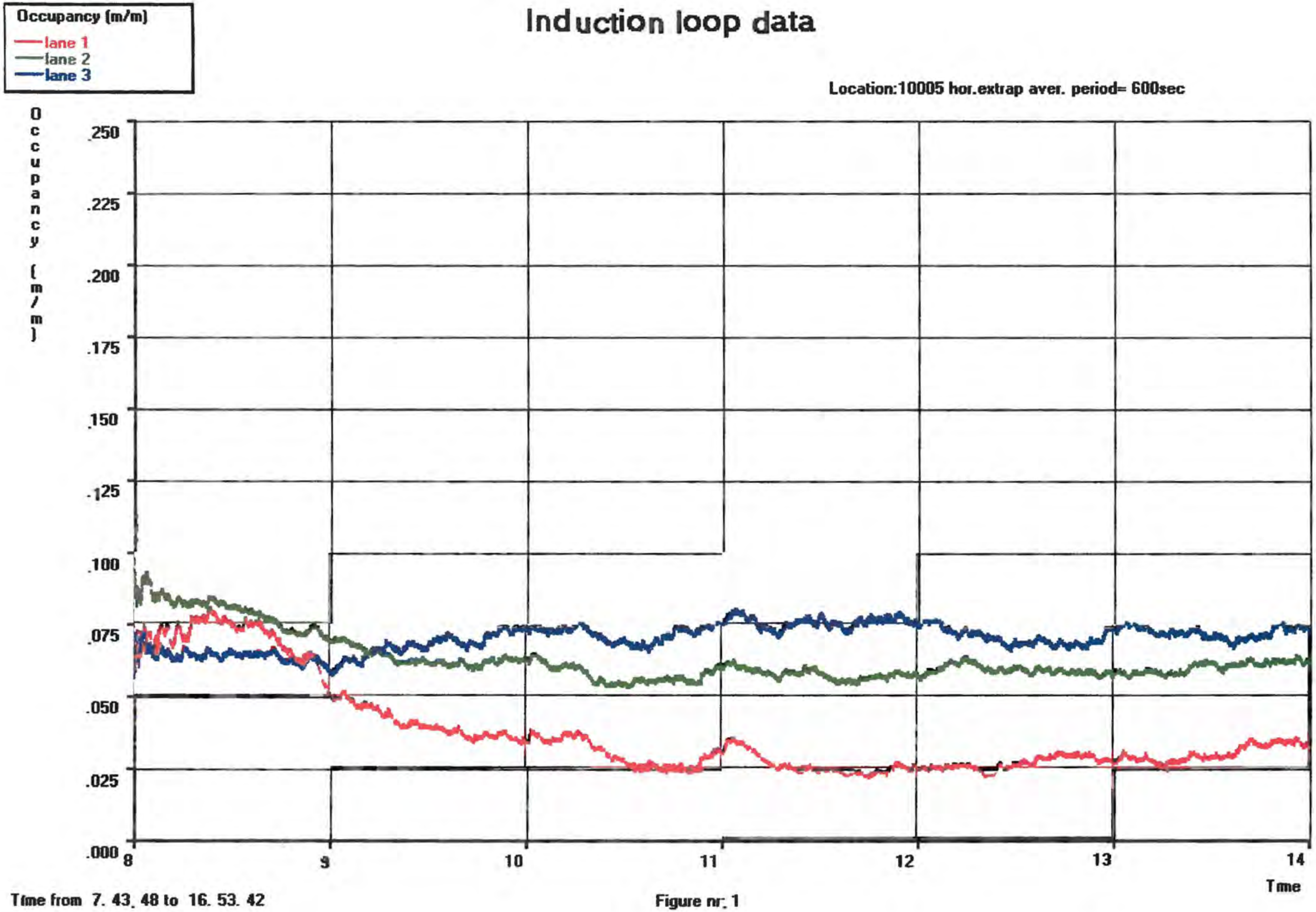
The accident data are collected over the period from 1988 through 1992. In this period 228 accidents have been registered at the A6 motorway itself, 348 at the parallel road RN6 and 278 at the parallel road D933.

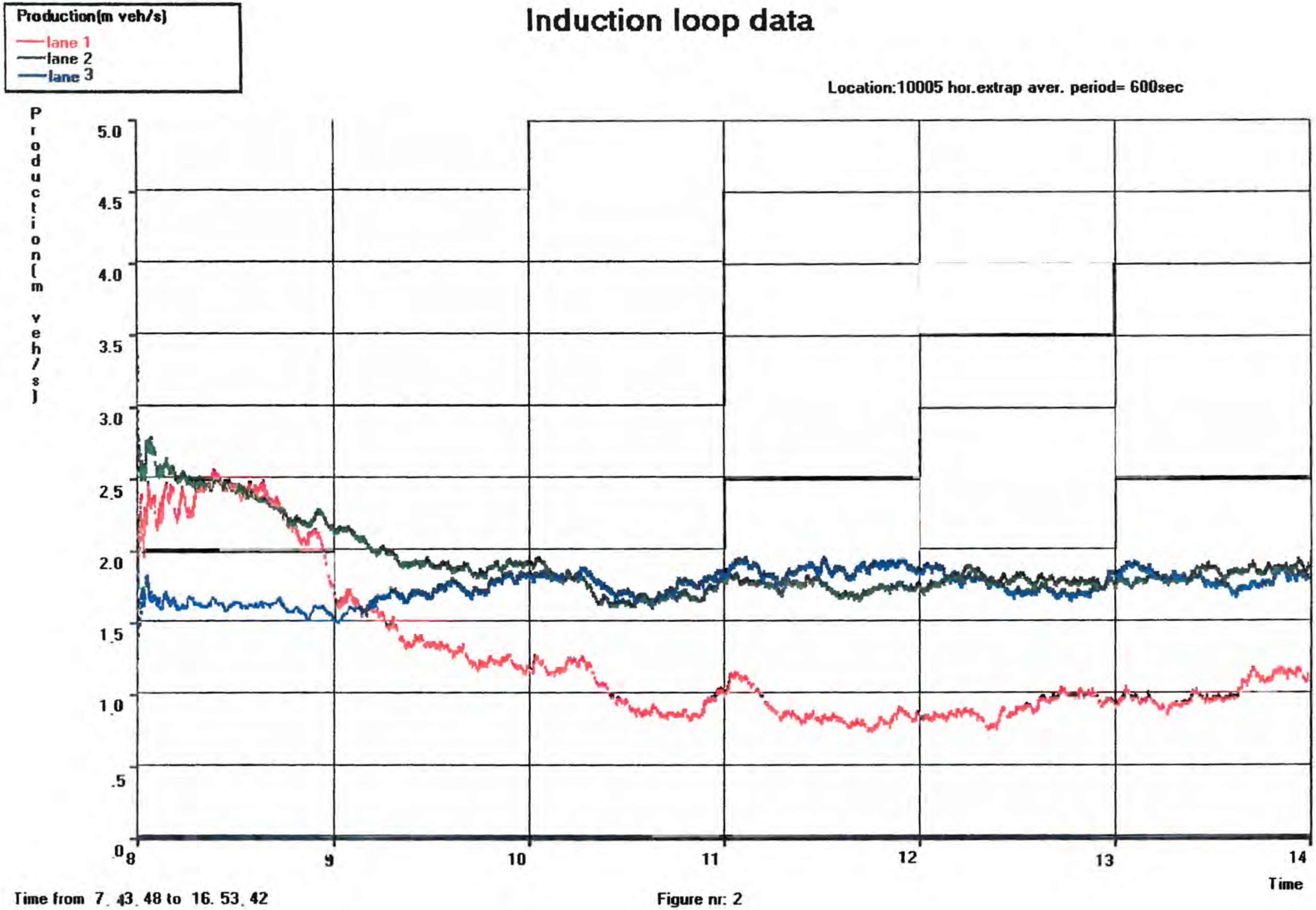
Table 4 gives an overview of the main accident categories, their supposed causes and relevant manoeuvres. In this table a number of provisional headings are used, that need reordering or renaming.

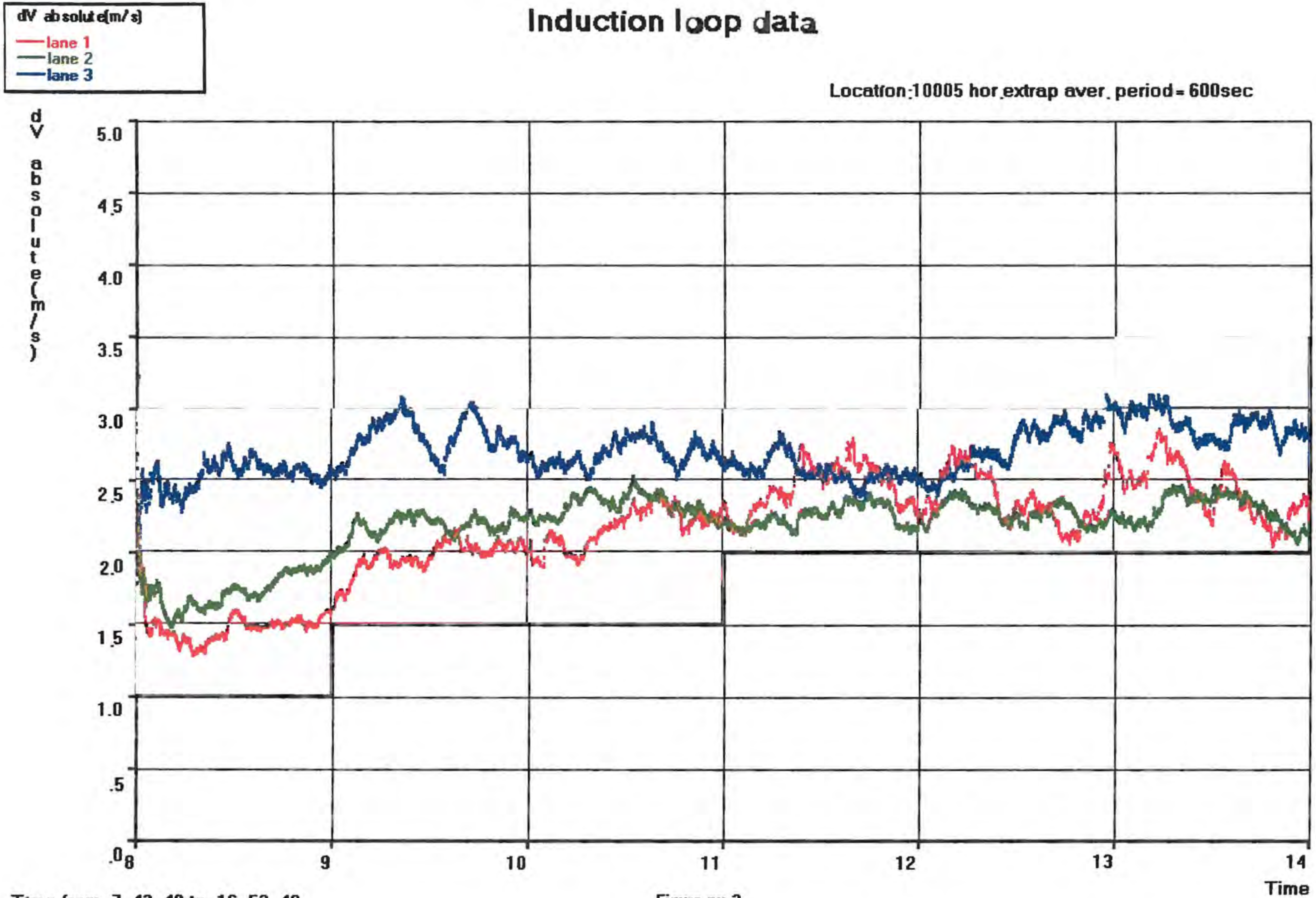
Table 4: Accident types, causes and manoeuvre for MELYSSA

Accident review lyon-maçon						
	A6		RN6		D933	
Supposed causes						
offence	102	44,7	63	18,1		
weariness, indisposition, drug	27	11,8	8	2,2	6	2,1
disability	1	0,43			1	0,3
drunk driving	5	2,2	40	11,4	35	12,5
parking			3	0,8		
speed	16	7	49	14	68	24,4
other causes driver	24	10,5	87	25	133	47,8
engine	3	1,3	4	1,1	2	0,7
blow out of tyre	7	3				
bad weather	2	0,8	6	1,7	3	1
wandering animal	2	0,8				
other cause road	3	1,3	4	1,1		
unknown cause	36	15,7	84	24	30	10
Total	228	100	348	100	278	100
Type of collision						
frontal	10	4,3	36	10,3	63	22,6
rear	78	34	45	12,9	28	10
in line	47	20,6	35	10	13	4,6
sideways	15	6,5	113	32,4	91	32,7
moved out roadways	18	7,8	32	9,1	35	12,5
stayed on roadways	43	18,8	13	3,7	3	1
no collision	5	2,2	1	0,2	12	4,3
other	12	5,2	73	20,9	33	11,8
total	228	100	348	100	278	100

Manoeuvre before accident						
no changing direction	148	65	223	64	183	65,8
same direction, same file	33	14,4	7	2	7	2,5
parking		0,8	3	0,8		
backing	2	3,9	1	0,2	2	0,7
stopped	9	0,8	1	0,2	1	0,3
entering	2	8,3	9	2,5	7	2,5
overtaking by the left	19		17	4,8		
changing file			3	0,8		
turning right			4	1,1		
turning left			31	8,9		
crossing the road			15	4,3	25	8,9
half turn			11	3,1	3	1
cutting in on the right	5	2,2	3	0,8	6	2,1
turning left					31	11,1
turning right					2	0,7
other	10	4,3	20	5,7	11	3,9
total	228	100	348	100	278	100

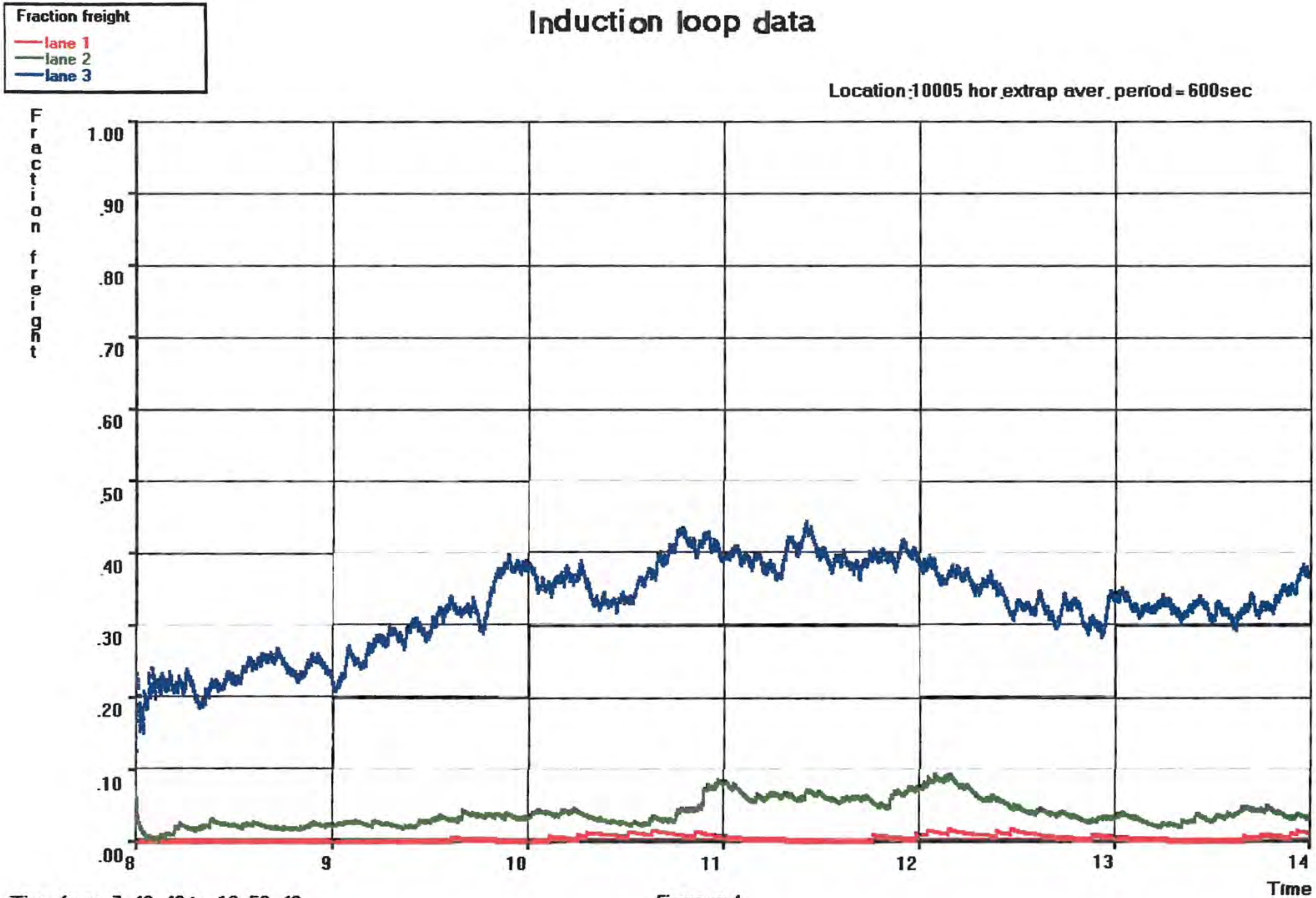

Occupancy (m/m)
lane 1
lane 2
lane 3
Induction loop data
Location:10005 hor.extrap aver. period= 600sec
Occupancy (m/m)
.250
.225
.200
.175
.150
.125
.100
.075
.050
.025
.000
8
9
10
11
12
13
14
Time
Time from 7. 43. 48 to 16. 53. 42
Figure nr: 1


Production(m veh/s)
lane 1
lane 2
lane 3
Induction loop data
Location:10005 hor.extrap aver. period= 600sec
Production(m veh/s)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0
8
9
10
11
12
13
14
Time
Time from 7. 43. 48 to 16. 53. 42
Figure nr: 2



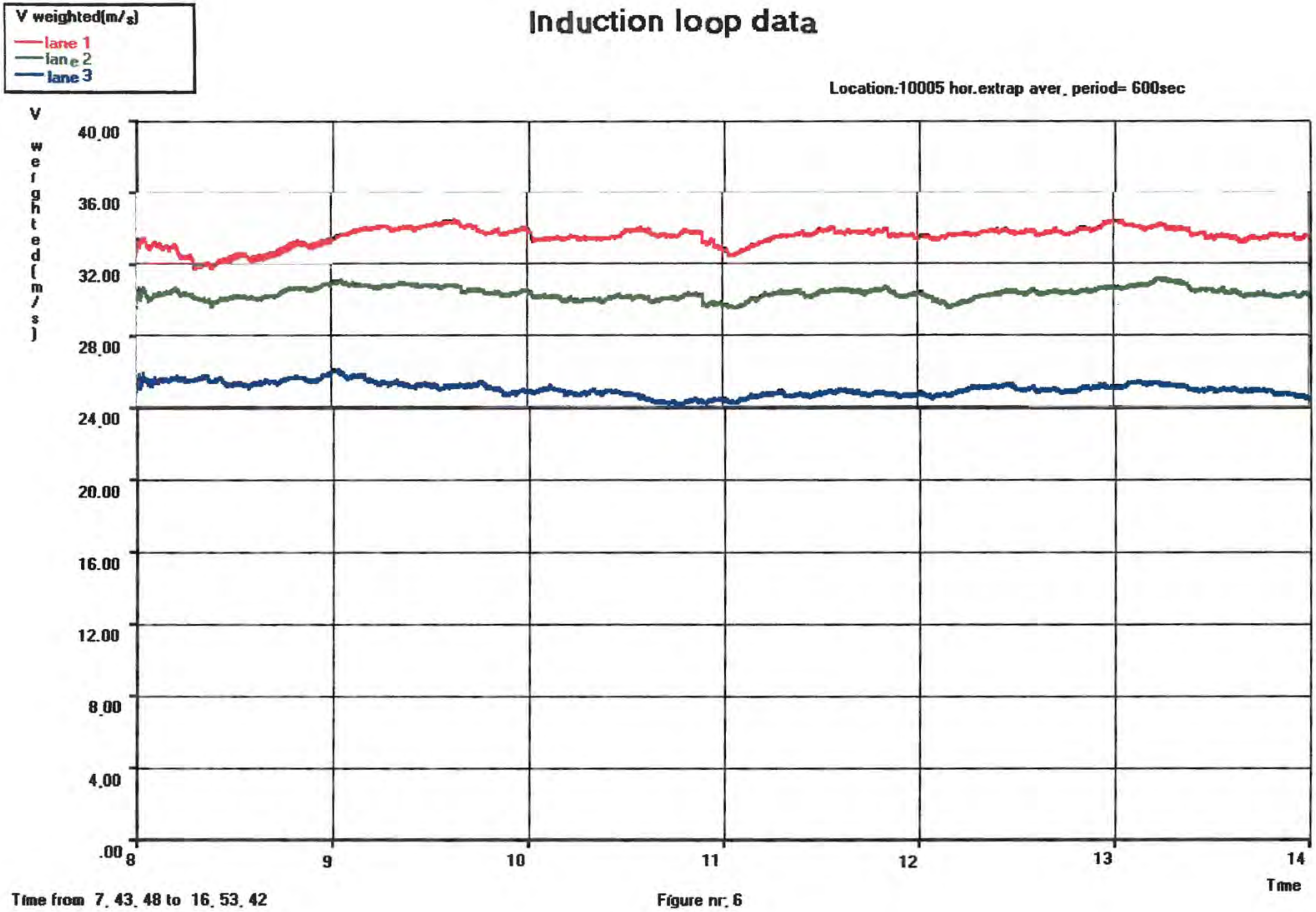
Time from 7. 43. 48 to 16. 53. 42

Figure nr: 3

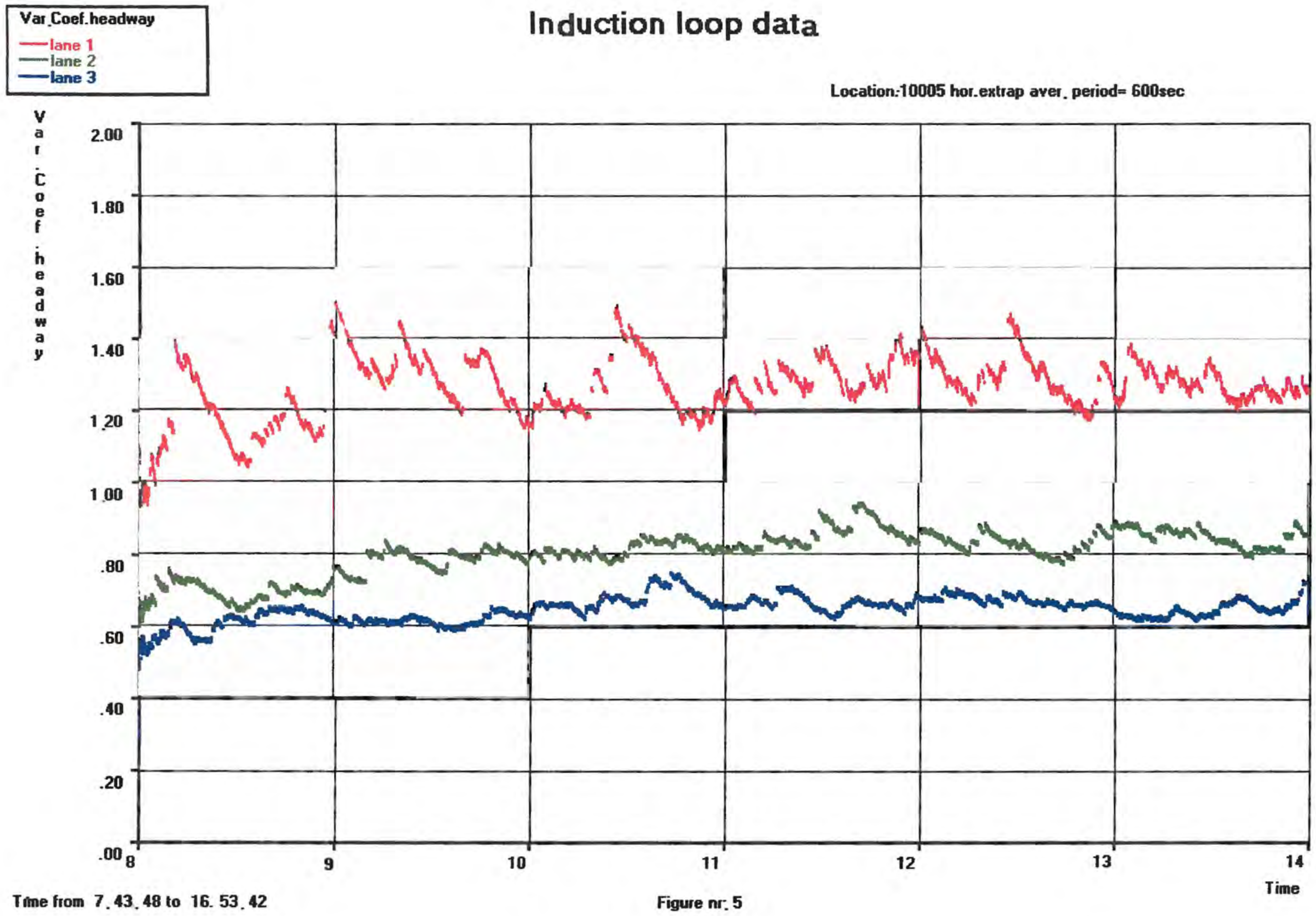


Time from 7. 43. 48 to 16. 53. 42

Figure nr: 4



Induction loop data
V weighted(m/s)
lane 1
lane 2
lane 3
Location:10005 hor.extrap aver. period= 600sec
V weighted(m/s)
40.00
36.00
32.00
28.00
24.00
20.00
16.00
12.00
8.00
4.00
.00
8
9
10
11
12
13
14
Time
Time from 7. 43. 48 to 16. 53. 42
Figure nr: 6


Var.Coef.headway
lane 1
lane 2
lane 3
Induction loop data
Location:10005 hor.extrap aver. period= 600sec
Var.Coef.headway
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
.20
.00
8
9
10
11
12
13
14
Time
Time from 7.43.48 to 16.53.42
Figure nr: 5

Induction loop data

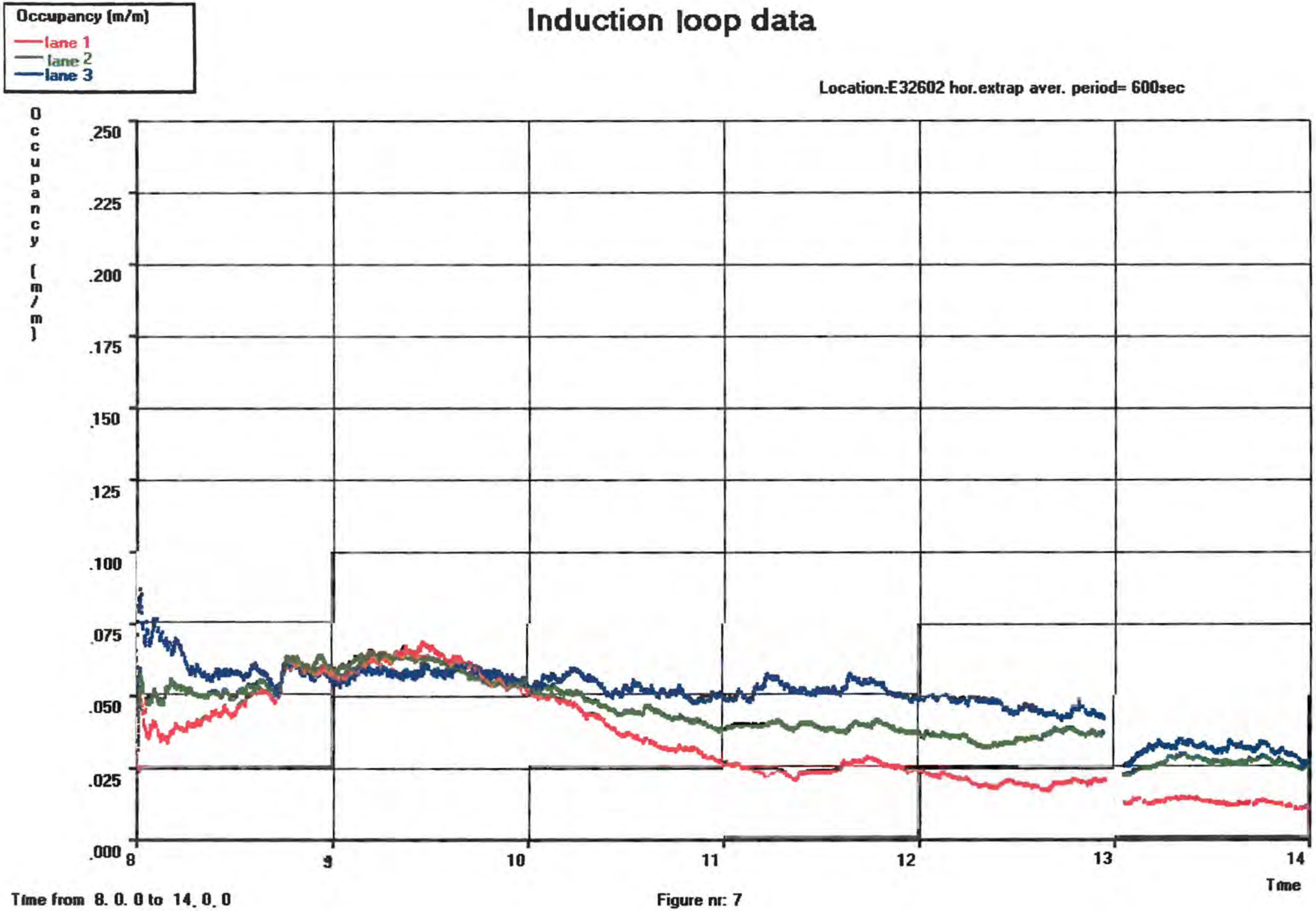
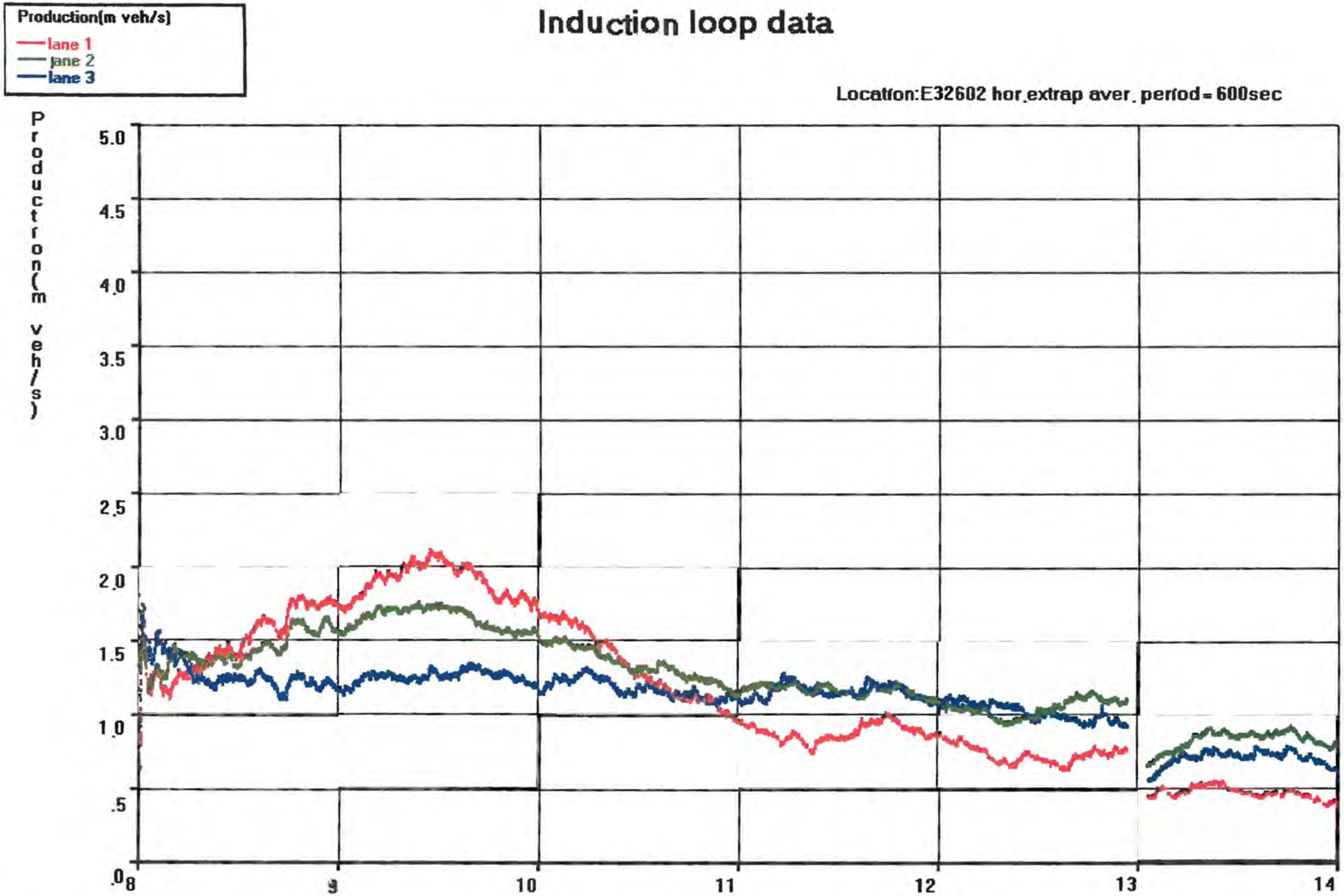
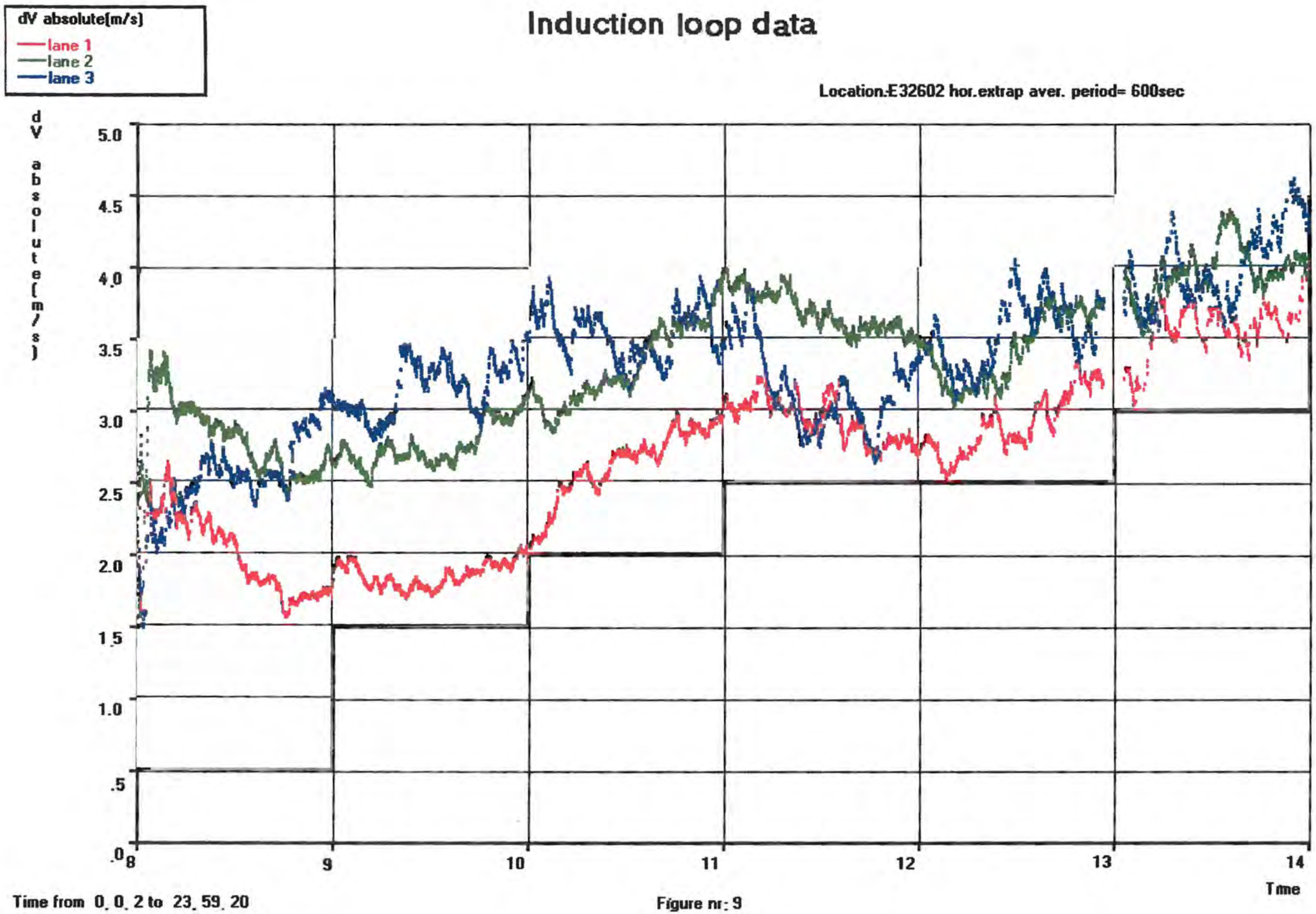


Figure nr: 7



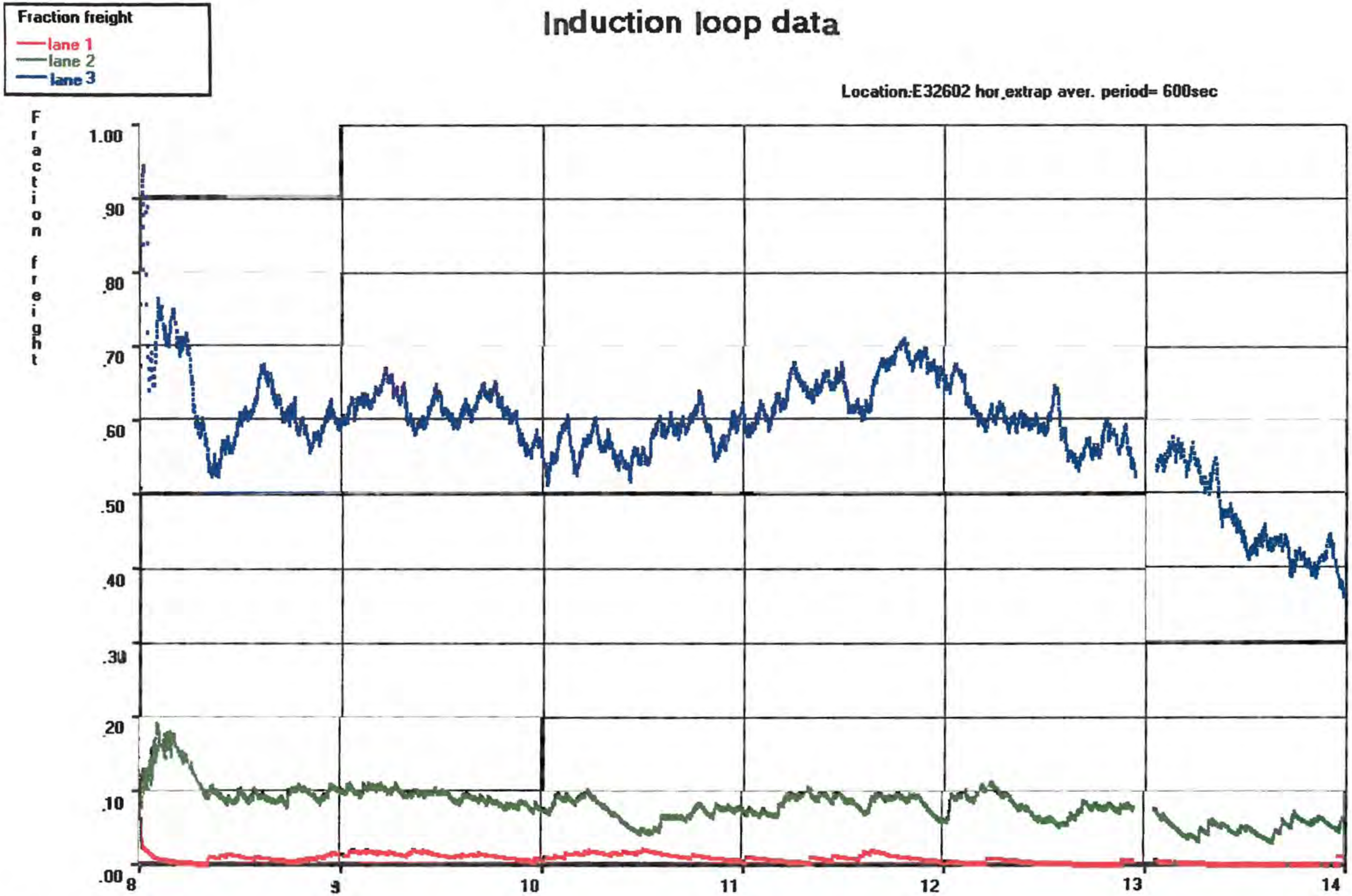
Time from 0. 0. 2 to 23. 59. 20

Figure nr: 8



dV absolute(m/s)
lane 1
lane 2
lane 3
Induction loop data
Location:E32602 hor.extrap aver. period= 600sec
dV absolute(m/s)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
.0
8
9
10
11
12
13
14
Time
Time from 0. 0. 2 to 23. 59. 20

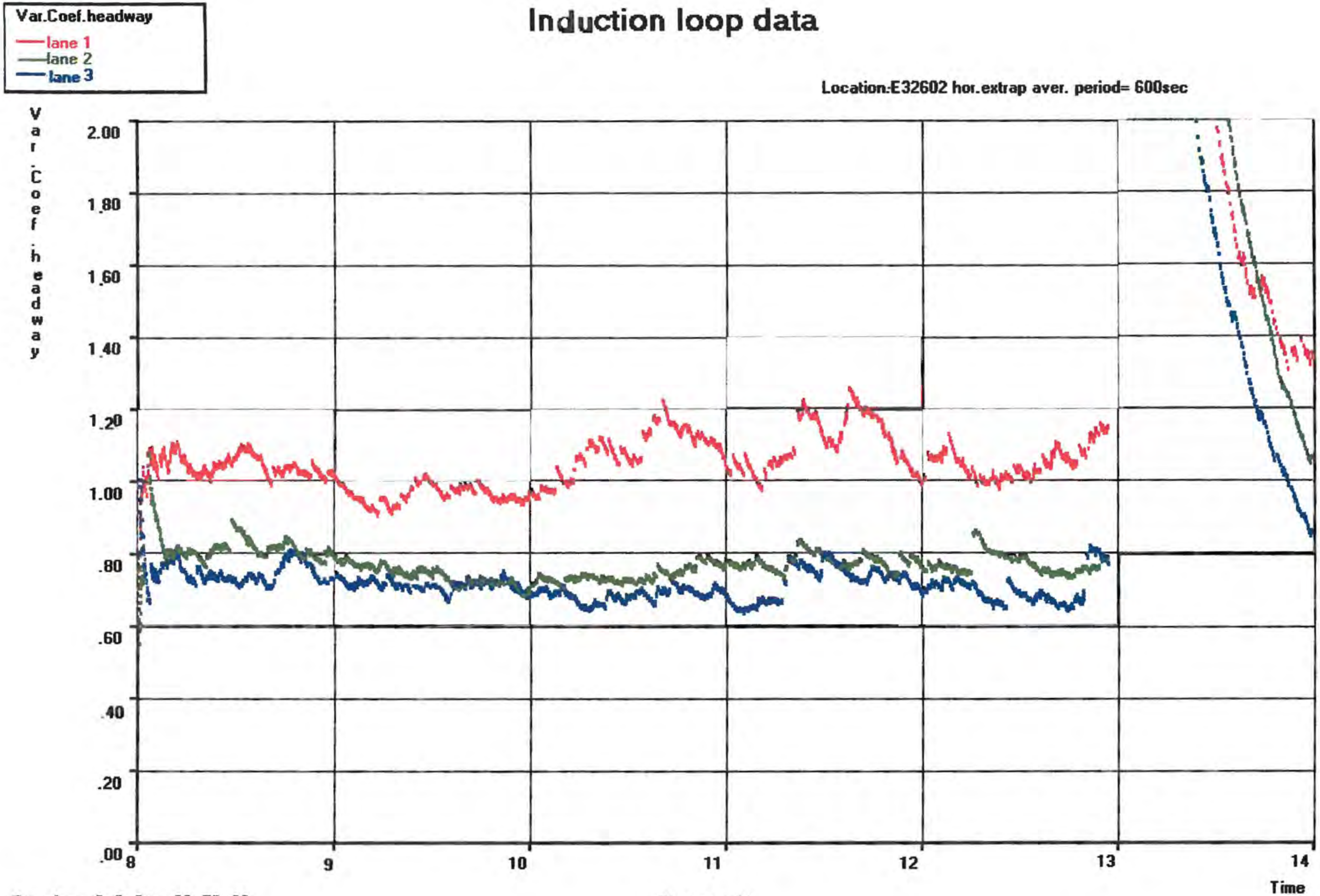
Figure nr: 9



Time from 0. 0. 2 to 23. 59. 20

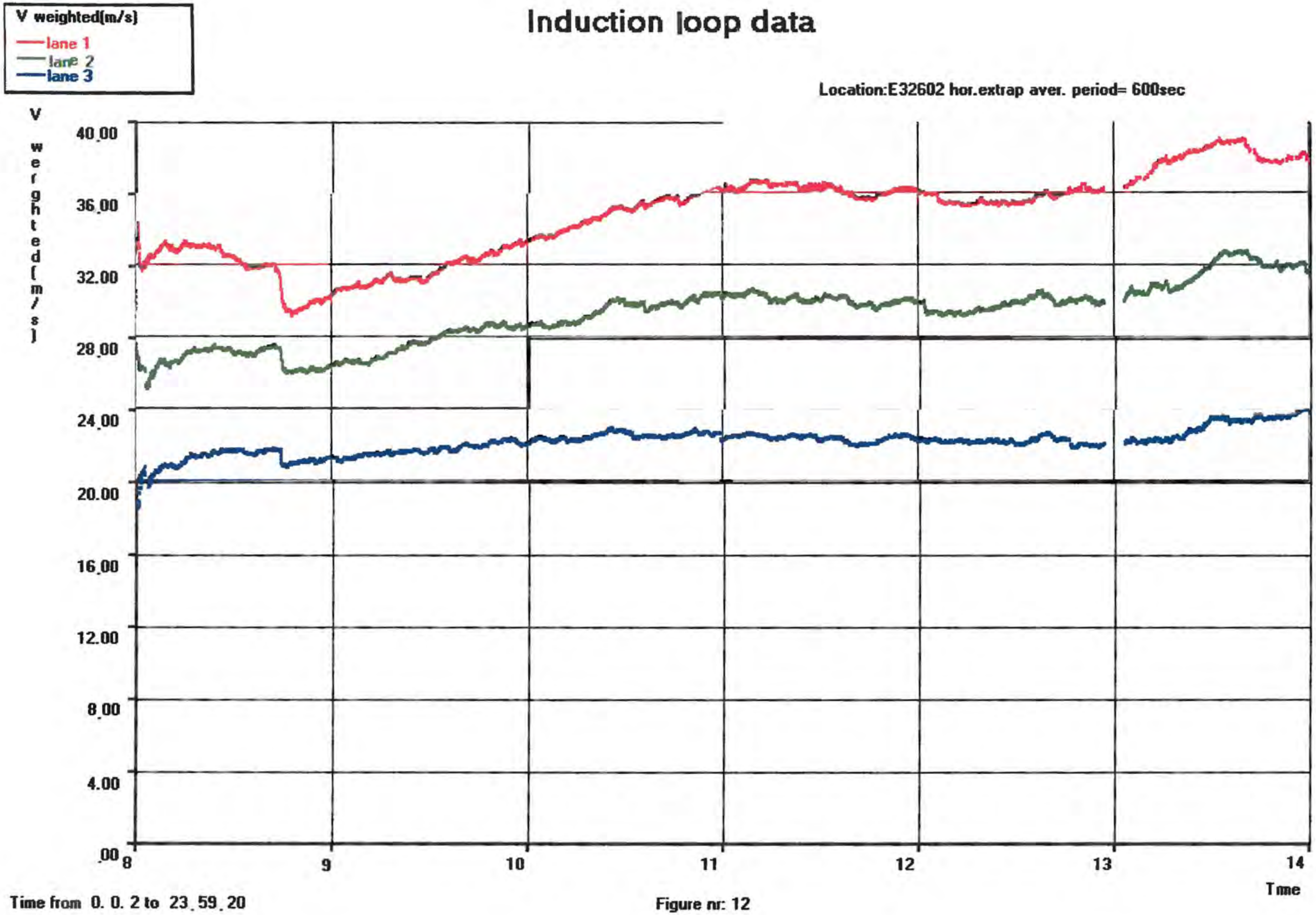
Figure nr: 10

Induction loop data



Time from 0. 0. 2 to 23. 59. 20

Figure nr: 11



V weighted(m/s)
lane 1
lane 2
lane 3
Induction loop data
Location:E32602 hor.extrap aver. period= 600sec
V weighted(m/s)
40.00
36.00
32.00
28.00
24.00
20.00
16.00
12.00
8.00
4.00
.00
8
9
10
11
12
13
14
Time
Time from 0. 0. 2 to 23. 59. 20

Figure nr: 12

2. WP 31.3/31.4 BEHAVIOURAL DATA AND SPEED AND TRAFFIC FLOWS

Sub-section: The interaction between behavioural observations and loop-detector data in the PORTICO before study.

2.1. INTRODUCTION

The aim of these activities was twofold:

- to provide a general analysis of traffic conditions on the basis of loop data;
- to process induction loop data in a way that makes it possible to supplement video observations with quantitative data of selected events.

Moreover, an attempt has been made to derive indicators of unsafe traffic situations purely from loop data which can be verified against video observations.

The general analysis was performed using computer programs already available at SWOV. For the other aims, separate software had to be developed. In order to be able to develop these, we had to take the following steps:

- joining and converting the original ASCII datafiles to a more manageable format;
- develop a program with the following functions:
  - searching the loop data for patterns derived from video data in order to obtain synchronicity;
  - enable selection of "time slices" and produce a graphical rendition of the measurements in that slice to facilitate the analysis of traffic patterns;
  - generate several diagnostics in such a way that situations that are identified as potentially dangerous can easily be found and compared in the video registrations.

2.2. DATA CONVERSION

As stated before, the original data from the DRIVE-II project PORTICO have an ASCII format which is readable by humans but otherwise for computer processing rather cumbersome because of the relatively low information density.
Since we already disposed of several programs to extract a number of general characteristics from loop data, programs that employ a compact data format so that large amounts of data can be accomodated, it was decided to convert the Portico data to this same compact format.
This required two steps:

- combining some PORTICO data files that represented data of separate lanes over the same time period;
- translating the completed files into our compact format.

2.3. PROGRAM FOR DATA ANALYSIS

An extensive computer program for IBM-PC has been developed which implements all three functions mentioned in the introduction. This program, called VERSIM, has been written in an advanced version of BASIC for a Windows environment (CA-Realizer). The Windows environment enables the use of large amounts of internal memory and therefore the fast processing of large files of loop data.
At the same time, the graphics user interface facilitates the operation, making the rather complex program relatively user-friendly.
The three main functions will now be discussed briefly:

A. *Pattern search facility*

- Loop data and video observations, each have separate and unsychronized time registration.
- Although data has been provided to reference both clocks against "real time", still some differences have been found that sometimes makes it difficult to achieve sychronization quickly. Therefore, a facility has been developed that allows the user to specify search patterns in a way that is conveniently derived from video registration. The pattern consists of an arbitrary number of vehicle data, each vehicle needing a sequence of three parameters in the

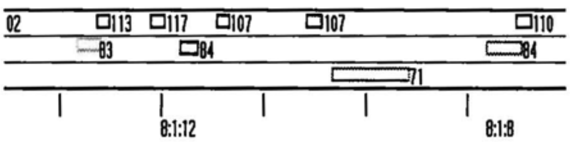
pattern: passing time, passing lane and vehicle type (2 classes: passenger- or freight vehicle). Since video observation can never be very accurate with regard to time and the loop detectors are also endowed with a certain variablity, the user can specify a time interval of tolerance wich will be applied to each vehicle: usually a 2 second interval is needed.

- An other problem is, that loop detectors may miss a vehicle altogether when it happens to cover too small a portion of the loop. Therefore, the user may also specify a number of possibly missing vehicles in the pattern (just a number, no specification of position or type is needed since the program checks all permutations).

In practice, this pattern search facility works very well with patterns of 8 to 10 vehicles, which turn out to be sufficiently unique patterns to be found only in the proper file.

B. *Graphical representations*

- The user may also specify a certain point in time to center the time window on and proceed moving the window in either direction. To facilitate the concurrent use of video fragments, there is provision to temporarily change the program's base time, so that the displayed time coincides with the video registration.
- All vehicles that passed within the time window will be pictured on the screen, together with a specification of their speed. In this way, a graphical representation is provided of the distances *in time* between those vehicles in the window and also of their length *in time*.
- This picture may differ considerably from the *spatial* distances and lengths we are used to observe and therefore an optional second picture can be generated in addition depicting an estimate of the spatial distances and lengths in the same time-window. These distances are estimated on the assumption that all vehicles in the window maintained or already had the speed that was measured when they passed the loops.



Example I

Since the window generally has a time-length of 8 seconds this assumption may not be entirely correct (for the PORTICO project we could assess the correctness of this assumption by using the data of the second pair of loops 20 meters downstream, but this has not been done yet). The windows shown on the screen can also be printed for documenting purposes (see Example I).

During the development of this part of the program we discovered an important difference between the system used in HOPES and Dutch systems of loop-measurements: where the PORTICO systems seems to log the passing time of vehicles with the onset of the measurement, the Dutch systems logs them at the end. Depending on the length and speed of the vehicle, the difference between the two may be up to 1 second.
Although this poses no real problem, to avoid difficulties the program has been fitted with an option to specify the type of registration.

C. *Diagnostic facilities*

- As stated before, SWOV already possesses some programs to derive various characteristics from loop data. These programs however, operate on the basis of averaged parameters and so provide insight into the change of a diversity of safety-related parameters of the traffic flow.

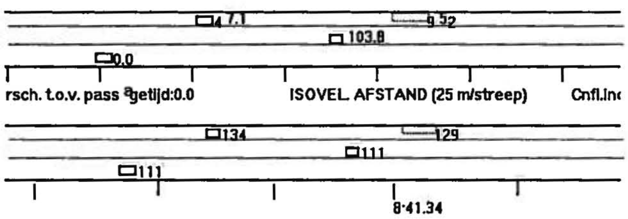
Although these characterisations may also be of some interest to the PORTICO programme, we primarily needed to diagnose single events in the traffic stream that may be considered potentially dangerous.

- The program VERSIM is therefore equipped with a facility to scan the whole data file or a specific portion thereof for such specific events on a vehicle by vehicle basis and log them in a separate file.
- This log-file is formatted such, that the data may easily be used to retrieve the corresponding video fragments for further analysis.

2.4. LOOP DATA ANALYSIS

This part of the program is largely based upon the results of video analysis. This analysis has resulted in the definition of a number of potentially dangerous events, part of which can also be inferred from loop data. So far, six types of event are recognized by the program. Four of these events regard subsequent vehicles in a single lane, the other two events regard vehicles interfering in adjoining lanes. We stress the fact that the numerical criteria for each event do not have a very solid basis yet; in fact we expect this project to provide a more firm basis later on.
The four single-lane events are:

- TTC warning: this is scored when the hindmost of two vehicles is the faster and without any action collision is imminent within a specifiable time interval which is by default set to 2 seconds. This criterion accounts for *relative speed and proximity* and is only active when a speed difference exists.
- Emergency braking: this criterion considers *proximity and reaction time* and works also when two vehicles have the same speed. Here, we suppose that the leading vehicle of a pair suddenly executes an emergency breaking manoeuvre with an average retardation of 6 m/s2. We then calculate whether or not the second vehicle will collide with the first, in case there is a certain (specifiable) reaction timelag (default 1 second).
- Pushing: this criterion actually weighs the same phenomena as the TTC criterion but in a simpler way: it reports an event when two vehicles are closer to each other than a specifiable distance (default 4 m) and some positive speed difference exists. Other than TTC, which may report an incident with far larger distances but greater speed difference, this criterion signals mainly very close proximity.
  We discovered however that, where the Dutch system seems to be able to discern vehicles that pass the loops with a distance shorter than the length of the pair of loops, the PORTICO system cannot. Instead, a single, long vehicle is reported. Therefore, a fourth criterion was introduced:
- The "false freight vehicle": if a vehicle longer than 8 meters is reported on any lane, having a speed in excess of 30 m/s, it is assumed to be falsely reported as a freight vehicle, but instead must be interpreted as a close pair of passenger cars (see Example II).



Example II : False freight vehicle

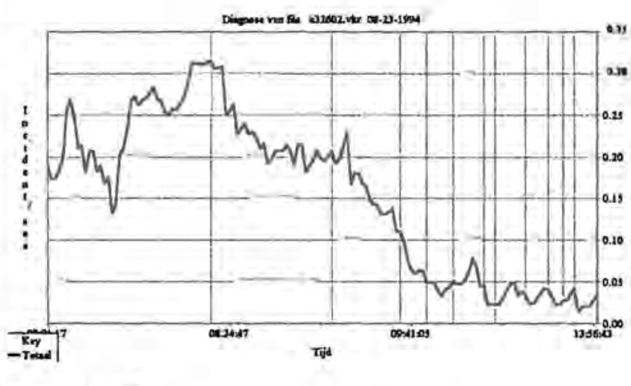
The two other events are:

- Overtaking on the wrong side: this criterion is activated if a vehicle in a certain lane has a significantly greater speed (>4 m/s) than a vehicle in an adjacent left lane, while at the same time the distance between the vehicles (before or after the leftmost) is less than 15 meters.
- Simultaneous encroachment: this is an interaction between 3 vehicles and occurs when two vehicles in adjacent lanes encroach upon a third (in the rightmost lane of the two) that, if no action is taken, the three vehicles will eventually end up trying to occupy a space suited for only two of them.

Since this criterion is based upon the assumption of unchanged speeds and as this assumption becomes progressively weaker with elapsed time, we have limited the extrapolation period to 10 seconds.

Lastly, the program provides some statistics regarding the reported incidents: the number of incidents is averaged over time as well as the traffic flow and these data are incorporated in the diagnostic outputfile.

With the aid of a separate program, called INCIDEX, we can display graphs of the average frequency of incidents (the "incident density" in incidents per second; see Example III).

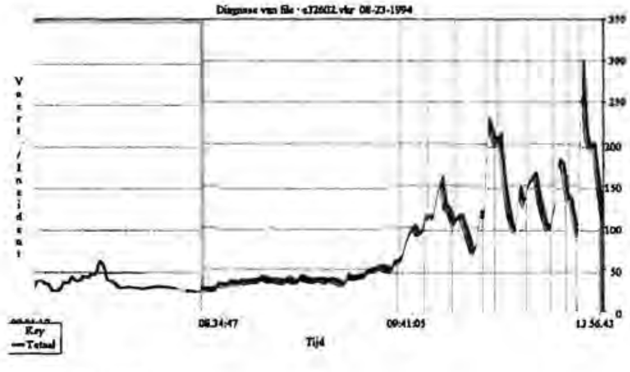


Example III

Since this indicator is rather strongly correlated with the traffic flow, a second indicator is produced, weighing the incident density with flow, so providing a *flow-independant characteristic*: the number of incidents per vehicle. As this is usually a small number, the inverse is presented: the number of passing vehicles per incident which is low in unstable traffic (e.g. 1 incident per 10 passing vehicles) and high when the traffic is more stable (e.g. 1 incident per 300 vehicles: see Example IV).

It is also possible to produce graphs depicting the relative contribution of all types of conflict, thus diagnosing the predominant conflict at a certain time or a certain location.

The incident density is calculated while taking into account that a single vehicle can be part of more than 1 conflict; if these are conflicts of the same nature (TTC, pushing etc) we count its contribution to the tally of conflicts for only one.



Example IV

For the calculation of the moving averages we have employed a scheme that was developed for previous diagnostic programs: a modified discounted least squares scheme that can accomodate non-equidistant data (since incidents do not occur at regular time intervals).

2.5. RESULTS

A. General typification

In this typification we try to uncover some basic, normally slowly changing characteristics and hence we employ filtered signals; the filter used here has a time constant of approximately 600 seconds.

The figures 1-29 of the full report show several characteristic parameters derived from the PORTICO loopdata. There are 6 graphs for each day of observation and the time intervals more or less coincide with the hours of video observation. All parameters are defined *per lane* and identified as follows:

1: leftmost lane, green, 2: middle lane, red and 3: rightmost lane, blue. It should be pointed out that instead of the "classical" parameters: flow and density, SWOV prefers to use parameters that account for the length of the passing vehicles as well. Thus we substitute density (veh/m) with occupancy (m-veh/m) and flow (veh/s) with "production" (m-veh/s).

If we now consider the graphs we find, that the average speed increases slightly over the day (ca. 1 m/s) and that there is a rather large speed difference between lanes 3 and 2 of 5 m to 7 m/s and

between lanes 1 and 2 of ca. 5 m/s. The maximum production is 1.5 m-veh/s, round 8 o'clock, and decreases gradually.
The same is true for the lane occupancy, which is highest at ca. 6%. The percentage of freight vehicles, that is vehicles over 6 m in length, per lane is relatively high on the rightmost lane: always higher than 40% but often 60%. Although freight vehicles are often considered an obstacle to passenger cars, the total of characteristics indicates no serious traffic conditions: capacity is never reached. There are, however, some remarkable features shown by the graphs of the absolute speed differences (dV absolute) between successive vehicles in one lane: the average speed difference in all lanes is at least 2.5 m/s and increases toward noon to 4-5 m/s. The higher speed differences are apt to induce frequent speed adjustments, making the traffic pattern less predictable and therefore theoretically less safe, so we could infer that there is a tendency towards increasing risk over the observation period. This tendency however, is offset by a gradually decreasing intensity (here: production) and occupancy which influences the frequency, making the conclusions less "straightforward" (see "event analysis").
Another characteristic, the variation coëfficient of gaps, which varies around the value of 1, indicates that over most of the observation period the traffic is more or less Poisson distributed and not strongly clustered (which would result in a much higher variation coefficient). There is a remarkable "gap" in the period between 11h and 13h in which the traffic density suddenly seems to decrease drastically for about 10 minutes. Such a sudden change is probably caused by an artifact in data collection (e.g. a change of recording media, interrupting the measurements) wich the video observations seem to corroborate.

B. Event analysis
Figure 37 to 50 in the full report represent the results of the INCIDEX program described in the previous paragraph. These show a general tendency towards a decreasing average number of "critical events" over the observation period. The incidence of these events is highest in the period between 8h and 9h30 and considerably lower in the later period. Contrary to the general speed difference characteristic, this suggests that the earlier period must be considered as having the highest risk. Since the general speed difference does not account for distance between vehicles and the event analysis does, we are inclined to have higher confidence in the latter.
There remains the problem, however, of determining which frequency of events must be considered grounds for corrective actions. So far, we have no reference in "real accidents" to establish such a limit (or area of unacceptable risk). However, in previous research carried out by SWOV and the Technical University of Delft, we have obtained video- and induction loop registrations of a comparable 3 lane motorway where an accident occurred during the observation period. From figures 30 to 36 we may conclude that this motorway shows largely comparable general characteristics to those of the PORTICO road, albeit that the dutch motorway has a consistently higher production (ca 20%) on all lanes.
The accident took place at 16h, during the evening rush hours, at a distance of ca. 50m from a loop station. In figures 49 and 50 the change in event frequency at that loop station is shown in the 15 minutes prior to the accident: we find a change from 0.15 to 0.5, which maximum is twice as high as the maximum frequency during the morning rush hours. This one result is no real basis for firm conclusions, at most an indication that at frequencies of around 0.5 or higher an accident seems somewhat more likely. In the PORTICO measurements we generally find maximum values well below 0.5 except for one day where a value of 1.5 occurred for a few minutes (but no accident took place!). To establish a better insight into the practical value of the event-frequency indicator more and longer term observations and correlations with accident data are needed; in the meantime, this indicator seems intuitively promising.

3. WP 31.4 TRAFFIC BEHAVIOUR

3.1. INTRODUCTION

It is not easy to define safe road user behaviour. In different countries, differences in life styles are reflected in traffic behaviour.
To our Western eyes, traffic behaviour of the massive amounts of bicyclists as well as cars, trucks and buses in Bejing look rather chaotic. Still, the amount of road fatalities per year is rather low. Also in Europe there are large differences in driving styles and road use, that makes a comparison of risk difficult.

One of the ambitions of the application of telematics in traffic, is to prevent traffic from getting into a state that is potential dangerous. If this can be achieved, then we may speak of a sustainable traffic system.
Till now, the characteristics of traffic streams are hardly ever studied in detail to describe the aspects of risk. Incident detection systems as developed, e.g. within the DRIVE project, concentrate on situations that already ran out of hand. Such systems detect accidents that took place or traffic streams that come to a stop. These situations are rather easy to detect, because they can be measured directly, which is not the case with *potential danger.*
In general, traffic flow research is not aiming at incidents. It describes traffic flows in general stream characteristics (average speed or headways, speed distributions etc.).

One of the fundamental characteristics of traffic flows that is ignored in classic traffic flow theory, is the interaction between individual road users. Conflict techniques on the other hand detect interactions between road users with imminent danger, but for isolated events, not related to the characteristics of the traffic stream.

3.2. AIM OF THE STUDY

It is the aim of this study to bridge the gap between traffic flow theory and risk detection.
In order to do this, one should first find out what characteristics of the traffic flows are potentially dangerous. One conjecture to this approach is, that danger is the result of human error and cannot be measured from the traffic characteristics.
This position is hardly tenable.
Although the human error may be in the end the final cause for a particular accident, the characteristics of the traffic flows are the major conditions for human errors to be evoked. Especially, in traffic flows that are highly unstable, the probability of incidents and accidents are also high.

A first step in this procedure is trying to understand which traffic conditions are important. As said before, although this knowledge is essential for guiding traffic streams, such studies are hardly ever carried out. The reason for this is that it is not easy to carry out this complicated type of research. Furthermore, these studies are traditionally made by human observers, which makes the research expensive. New methods should be developed for this purpose. Therefore, the aim of this study is:

- to develop and apply a method that is well defined, easily used and with minimal human judgement;
- to carry this study out as part of an evaluation study with a well defined aim;
- to do this for a relevant, but not too complicated situation.

3.3. WORKING PROCEDURE

The following procedure will be used:

- video and loop detector data will be used as a basis;

- interactive traffic flow characteristics will be selected to define categories of potential danger;
- human observers will be used to select, categorize and score events in the traffic stream with a certain degree of potential risk;
- traffic stream characteristics will be related to the risk scores;
- loop detector data will be analyzed automatically, to detect all situations with the same characteristics (related to the risk scores);
- human observers will score these situations on a risk scale;
- a discriminant analysis will be carried out at these scores, on the basis of the traffic characteristics, in order to refine the automatic detection procedure.
- accident types and causes will be categorized. Relevant causes will be related to the potential risky situations in order to estimate the safety impact of the refine automatic detection procedure.

This procedure is supposed to result in an automatic detection procedure, based on traffic flow characteristics. This part of the study will be carried out in the period before a certain RTI-system is installed.

The procedure will be repeated in the after period. The human observations method will be used to evaluate the RTI-measure, as well as to check for the applicability of the automatic detection method in the new situation.

The study will be done for two different RTI-incident detection and warning systems, one in Portugal in the PORTICO project and one in Belgium in the EURO-TRIANGLE project.

3.4. METHODOLOGY OF THE ADAPTIVE BEHAVIOURAL STUDY

3.4.1. Definitions of interactive traffic flow characteristics with potential risk

The following concepts are distinguished:

- disturbance:
  - traffic situation in which one of the drivers deviate from the norm, with or without interrupting normal traffic flow and/or:
  - events in traffic stream with a certain degree of potential risk.
- potential risk:
  - if something (unexpected) in front of a given disturbance should have happened, an accident could not or hardly be avoided by traffic participants involved.
- reaction:
  - to neutralize a disturbance at least one of the drivers involved takes action (noticeable to an observer, e.g. braking, overtaking).
- risky disturbance:
  - judging a disturbance risky or not, the following issues are taken into account:
    1. short headways;
    2. number of manoeuvres to neutralize the disturbance;
    3. complexity; occupancy per lane of participants involved.

3.4.2. Categories of disturbance for potential risk

After examining several video tapes the following disturbances in traffic flow could be distinguished with a certain degree of potential risk:

- Overtaking to the right.
- Overtaking to the right in "keeping your lane" situation. Exception: exiting a motorway on the left side (this situation occurs on the motorway near Antwerp).
- Pushing: high speed and headway between two cars is kept deliberately too short.
- Cutting off to the left/right.
- Not giving way; this situation occurs only on the motorway in Antwerp where two motorways converge.
- Diffuse behaviour: for instance, if a driver drives in the middle of two lanes, indicates to carry

out a specific manoeuvre, but does not carry it out or even carries out an opposite manoeuvre (e.g., indicates lane change to the right and overtakes to the left). Such an action can confuse drivers behind.

Also correct behaviour (according to traffic rules) can create situations with a certain degree of potential risk (for the driver himself or others), for instance:
- Cut in by overtaking to the left.
- Cut in (shoulder or acceleration lane).
- Approaching a car in front with high speed although it is clear that an overtaking manoeuvre is not possible (all lanes are fully occupied) and therefore an abrupt braking manoeuvre is needed.

3.4.3. Scoring background on the video screen
- Scoring of a disturbance (with/without reaction(s)) is restricted to the first 150 meters on the video screen (interpretation of the different reactions/manoeuvres is not a problem).
- Reactions further on (like braking or overtaking) are only used for judging the risk of a disturbance that is scored within the range of 150 metres.

In case of uncertainty (screening and/or scoring), the observer puts a question mark on the coding formula. Afterwards another observer will screen and score the same situation. In case of different interpretations screening and scoring are discussed to reach an agreement.

3.4.4. Screening the number of disturbances
A disturbance can be caused by:
- **Incorrect traffic behaviour**, brake down in the following categories:
  - overtaking to the right (moving to the right or keeping lane);
  - pushing (following a car at a distance of approximately 3 to 5 meters);
  - diffuse behaviour (driving in the middle of two lanes, indicating direction to the right but overtaking to the left, etc.);
  - cutting off to the left/right;
  - not giving way.
- **Correct behaviour (at the wrong moment)**:
  - cut in by overtaking to the left from shoulder or acceleration lane;
  -cut in by exiting to the left;
  - driving up close to a car in front with high speed in situations where it is clear that overtaking is not possible.

3.4.5. Scoring the complexity of a disturbance
When a disturbance is screened the following items are scored:
- Classification of each disturbance as risky or not. This depends on the feeling of the observer (subjective judgement).
- Number of reactions/manoeuvres by other traffic (each manoeuvre connected to its lane) to neutralize the disturbance (including the manoeuvre which causes the disturbance), such as:
  - braking;
  - overtaking to the left/right;
  - cutting off to the right/left (subjective judgement; free passage is blocked by this manoeuvre).

Standard behaviour (e.g., weaving behaviour according to the rules) is supposed not to cause a disturbance. However, if carried out at a time that all lanes are occupied and/or another road-user is (slightly) hindered, this could cause potential risk because of the complexity of the situation. Therefore, we decided to score these situations as well and judged them risky or not, to get an indication of the frequency of this kind of disturbances. If other participants had to take action to neutralize the potential risk, such an action is scored as well as the (as such correct) standard manoeuvre.
- number of vehicles involved (each vehicle addressed to its lane), distinguished into two classes:

- motorcycle/car/van;
- lorry.

3.4.6. Reliability
Screening and scoring are subjective interpretations. To reach consensus three observers screened and scored the same video tape. Afterwards the results are compared. Differences are discussed to reach consensus as much as possible.
The reliability of screening and scoring during the whole period is controlled by taking samples (one tape per location is screened and scored twice).

3.5. PORTICO PROJECT

3.5.1. Aim of the study
Evaluation of the safety effects on traffic behaviour of a flashing light warning system given the system as it is operating and to compare the results to other systems.
The warning system used in PORTICO restricts itself to just warning the driver. It does not tell him what he is warned about (e.g. road blocking) and also not what he has to do (e.g. speed advice: 50 km/h).

3.5.2. Preliminary fieldwork
The evaluation study will be a before and after study, using video and loop detector data of one week during the before and one week during the after period.

In November 1993 a meeting was held at JAE headquarters in Lisabon to discuss in detail preparation of and cooperation within the evaluation plan.
The experimental section is chosen on the A1 motorway (apr. 3 km/h long).

According to the plan the first loop detector is placed 200 metres before the start of the experimental site, in order to measure the traffic parameters before the experimental area.
The position of the first camera was chosen at the beginning of the trajectory (at location 6.510). It is installed at a 5 metre pole, just inside the beginning of a guard rail, as close as possible to the road. The video camera is partly masked by trees at the background.

The second measuring camera position is at the upwards slope of the hill at point 5.390. There are trees again that hide the camera.
Two pairs of loop detectors are implemented here, to measure speed as well as changes in speed, headway etc. e.g. at 20 and 40 metres from the video camera.
The automatic incident detection would be based on a simple loop detector data, such as speeds and stopping cars. The system could also be triggered on the basis of control ventre interference; e.g. at warnings from road users or the police about incidents and bad weather conditions, such as fog.

3.5.3. Experimental design
On a macro level (adaptive behaviour): mean speed and head way, speed and head way distributions at the experimental zone will be described as a function of the installation and onset of the warning system, using loop detector data.

On a micro level (adaptive and conflict behaviour): speed differences and differences in headway, lane changing and breaking at the experimental zone and between the incident/congestion zone (if possible) will be described as a function of the installation and onset of the warning system. Video and loop detector data will be used to describe changes in behaviour at and between the location of the warning system and the incident location.

3.5.4. Relevance of the study

The outcomes will be relevant to answer the following questions:

1. Does driver behaviour change where a warning system is displayed, and if it does, how does it change?
2. Does driver behaviour change between the location of displayed warning and the location of the incident warned about, and if it does, how does it change?
3. Does driver behaviour change at the location of the location of the incident warned about, and if it does, how does it change?
4. Does the existence of the warning system change driver behaviour at times of no warnings, and if it does, how does it change?

3.5.5. Results

In November 1993 video and loop-detector data are gathered (before implementation of the system).
All video data (camera nr. 1 and 2: 84 hours) are screened and scored except a dark period of approximately 10 minutes each day (interpretation was too difficult).
During sunny hours it was difficult to read the video time and sometimes even impossible. In those cases the exact time was estimated. The detection of braking behaviour is sometimes hindered by the location of the sun.

Reliability score
The following reliability on screening and scoring disturbances has been reached:

- After analysing two video tapes (separately), consensus has been reached of 90% on screening a disturbance. Exception concerns situations in which the manoeuvre was scored as "pushing" (approximately 50% consensus). Therefore, pushing situations are reanalysed and are restricted to headway of less than five metres.
- Consensus of approximately 90% was reached on screening a disturbance.
- Screening of really risky disturbances were nearly 100%.
- Consensus of approximately 75% was reached on scoring the number of vehicles and on the number and types of manoeuvres.

Screening/scoring results
After screening all video data (camera 1 and 2), the results were loaded in a computer file.
The file has not been screened yet. Given the complexity of the task of the observers, it is noticed that some combinations are scored incorrectly or inconsistently.
For instance:

- An incorrect combination can be: a disturbance is scored as "pushing", but pushing is not scored as one of the manoeuvre types.
- Another incorrect combination or inconsistency can be when entering the video screen a car is driving on the right lane and the manoeuvre is scored as "overtaking to the right".
- An inconsistency can be: a disturbance is scored as overtaking to the left. But, this manoeuvre can not be carried out if a car entering the video screen drives already on the left lane. However, there is an exception. If two cars are driving on the left lane and there is enough room on the middle lane to give free passage, only "pushing" behaviour will be scored. This, contrary to the situation where the middle lane is occupied. In that case, besides "pushing" also overtaking to the left will be scored.

Corrections will be carried out. Therefore, we only have information on an indicative level.

Table 5.1: Number of disturbances, subdivided in: correct/incorrect behaviour, with/without reaction of others to neutralize the disturbance and judged risky/not risky (PORTICO: camera 1 and 2).

type of behaviour	reaction others with	without	risky behaviour		not risky behaviour	disturbances
correct behaviour	-	-	28	41	69	
incorrect behaviour						
- overtaking to the right	14	114	25	103	128	
- pushing		66	116	50	132	182
- other	19	27	18	28	46	
Total	99	257	121	304	425	

- 425 disturbances are screened. As expected, incorrect behaviour is the main cause for screening a disturbance (84% or 356 out of 425). Only 69 times (16%) correct-behaviour-at-the-wrong-time was involved (see Table 5.1.).
- Most of the disturbances, scored as incorrect behaviour, are caused either by overtaking to the right (36%) or by pushing behaviour (51%).
- Although correct behaviour is only a fraction of the scores, 41% of those situations were judged "risky".
- Approximately a fourth of all pushing scores and a fifth of overtakings-to-the-right were judged "risky". Probably short headways are the main reason to judge "pushing" more often in the category "risky" than overtaking-to-the-right. Within the risk scores the proportion of pushing scores is 56% and overtaking-to-the-right 29%.

- Most of the disturbances (caused by incorrect behaviour) **no reactions** of other participants to neutralize the disturbance were scored (83%), subdivided in risky (19%) and not risky situations (81%). Nearly the same proportions are found in case of the overtaking as well as the pushing disturbances (see Table 5.2):
  - overtaking (89%): risky (13%) and not risky (87%).
  - pushing (64%): risky (28%) and not risky (72%).

  Contrary, proportion of **reaction** scores differ from those presented above, subdivided in type of disturbance (see Table 5.2):
  - overtaking: risky (71%) and not risky (29%).
  - pushing: risky (27%) and not risky (73%).

Table 5.2: proportion of risky and not risky disturbances (caused by incorrect behaviour), subdivided in with and without reaction of other participants.

type of incorrect behaviour	risky react.	not risky no-react.	react.	no-react.	total
overtaking	10	15	4	99	128
pushing	18	32	48	84	182
other	8	10	11	17	46
total	36	57	63	240	356

Occupancy of a road is expected to determine the degree of complexity of a certain type of disturbance. Therefore, presence of all relevant participants involved in a disturbance are scored, each addressed to its lane. Determining the occupancy per lane depends on the presence of one or more cars per lane during the disturbance, not the number of cars per lane.

Relation between occupancy (per lane) and types and/or potential risk of disturbances are shown in

Table 5.3.

- As shown in table 5.3. most of the risky disturbances are happening when the left and middle lane are occupied (31%) and when all lanes are occupied (56%), comparable with the not risky scores, e.g. left and middle lane: 23%, all lanes occupied (55%).
- Contrary to risky pushing situations (44%), 68% of risky overtakings to the right are scored when all lanes are occupied. This could be an explanation why overtakings to the right more often are scored together with reactions of other participants than pushing (see Table 5.2.). This confirms also the statement that judging pushing as risky could be more related to short headways than judging overtaking-to-the-right as risky (see Table 5.1.). Therefore, judging the latter as being "risky", is probably more related to occupancy.

Table 5.3: distribution of type of disturbance and risk score, subdivided in occupancy per lane.

occupancy per lane	risky behaviour corr.	incorrect behaviour overt.	push.	other	not risky corr.	incorrect behaviour overt.	push.	other	total
left lane only	-	-	2	-	1	4	15	-	22
middle lane only	-	-	2	-	-	-	2	1	5
right lane only	-	-	-	-	-	-	-	3	3
left + middle	8	8	17	5	11	15	38	6	108
left + right	1	-	7	-	3	1	9	-	21
middle + right	2	-	-	1	6	15	4	4	32
all lanes occ.	17	17	22	12	20	68	64	14	234
total	28	25	50	18	41	103	132	28	425

Given a certain occupancy (per lane), the number of manoeuvres carried out by participants to neutralize the disturbance will be related to the degree of potential risk of a (certain type) of disturbance.

3.6. TRAFFIC CONFLICTS

Comparison of the adaptive study (SWOV) and the conflict study of LUND shows the following results (camera 2 + 1):

- LUND scored 76 times a conflict; SWOV scored 425 times a disturbance of which 121 were judged "risky".
- Two times LUND scored a conflict and SWOV did not. After reanalysing SWOV considered the situation as a disturbance too.
- One conflict scored by LUND could not be found on the video tape (wrong time coding?).
- LUND and SWOV scored 32 times the same situation (SWOV as a disturbance and LUND as a conflict).
- So, LUND scored 43 times a conflict, where SWOV did not. Eight times it regards a situation in the early morning (too dark to make a proper interpretation).
  The other situations were analyzed by SWOV as normal adaptive behaviour. For instance, a car approaches another car on the middle lane. Awaiting a safe opportunity to overtake to the left, the driver brakes.

It is expected that most of the LUND scores (also scored by SWOV) will be judged risky by SWOV. Actually, comparable scores were found in risky as well as in not risky disturbances (Table 6.1).
Different from the proportion of SWOV scores for disturbances (of which 20% was scored as correct and risky and 12% as correct and not risky), 88% of all the LUND scores (respectively 50% correct-but-risky and 38% correct-not-risky) are scored in those situations (see Table 6.1).

Further investigation will be carried out by relating traffic stream characteristics to the SWOV and LUND scores.

Table 6.1: comparable LUND and SWOV scores, subdivided in types of disturbances and risk score.

type of behaviour		risky beh.			not risky beh.	total
	SWOV only	SWOV+ LUND	SWOV only	SWOV+ LUND	disturbances	
correct	21	7	35	6	69	
incorrect						
- overtaking to the right	23	2	101	2	128	
- pushing		48	2	127	5	182
- other	14	4	25	3	46	
Total	106	15	288	16	425	

3.7. RISK SCORES AND TRAFFIC STREAM CHARACTERISTICS

Description of the activities, carried out on loop detector data and developing computer programs are reported elsewhere (WP 31.3/WP 31.4).
This chapter will describe the results of relating risk scores to loop detector data.

3.7.1. Working procedure (using VERSIM program)
First, the following question will be answered:

- using loop detector characteristics, can the same pattern of a certain disturbance (scored by observers form a video picture) be found?

We decided to use only "risky" disturbances (judged by observers) to start with to answer the question.
Therefore, patterns of risky disturbances are synchronized with computer simulated patterns of the same event in the traffic stream as found from the loop detector data.

The following steps are carried out:

1. Using video date and time the comparable loop detector data was loaded.
2. After synchronising video and loop detector time, the crossing-time of the vehicle that started the disturbance (start-up time of the disturbance) was loaded.
3. Next, the VERSIM program searches for the synchronic time and shows a traffic pattern on the computer screen.
4. To be sure the same situation was presented the computer pattern (number and type of vehicles, each connected to its lane) was compared with the disturbance pattern (relevant vehicles involved). Much of the time it was necessary to start the video tape some seconds before or after the start-up time of the disturbance until a few seconds after the incident or the other way round (searching in the computer file).
5. Finding the correct pattern, the computer pattern was printed.

Although, video and loop detector time were synchronized, two times a difference of one minute was found in two files between the video and the loop detector time. In those cases it was initially difficult to find the correct pattern.
Finally, every pattern of a risky disturbance could be connected to a corresponding computer pattern.

The second question is:
- can a disturbance be recognized and/or interpreted as a disturbance with a certain degree of potential risk directly from the computer pattern?

On the experimental section two pair of loop detectors were implemented (approximately 20 to 40 metres difference between the two pair).
Data of both loop detectors allows producing two pair of computer patterns.
Speed and head way per passing vehicle can differ between both computer patterns.
Differences (or none) will be interpreted as accelerations or decelerations.

The following problems are noticed:
- The computer can not recognize two cars on the same lane with short headway and high speed and presents both cars as if it was a lorry.
- Speed difference between the first and second passing-through-time of a vehicle was often one to three km/h. Not clear if such a difference must be interpreted as an unreliability within the data or as a start of an action. Some margin must be selected.
- On the right lane sometimes the first passing-through-time shows a certain speed and the second time that speed was approximately 10 km/h less. But, on the same lane in front of that vehicle no other vehicle was shown in the pattern. That makes an interpretation also difficult.
- For a few disturbances scored by the observers and compared with the traffic stream characteristics, it could not be explained why the disturbance was scored in the first place. This will be reanalyzed.

For a proper interpretation of these findings about the traffic stream characteristics, it is necessary to go back to the video data and/or the other way round.

3.8. EUROTRIANGLE PROJECT

3.8.1. Aim of the study
The original objective of the EUROTRIANGLE project was to evaluate a VMS-system of several gantries (pictogram), to be installed at the end of 1993 or the beginning of 1994 of a before and after study.
Only one alphanumeric gantry is available. Therefore, only the effect of one message for rerouting on traffic behaviour can be investigated.

3.8.2. Preliminary fieldwork
Contrary to the PORTICO project, gathering data in the EUROTRIANGLE project (video and loop detector) depends on the available measurements of the project itself (CCAT cameras (oncoming traffic, loop detector data are directly generated on a one minute basis from the video camera) and/or police cameras (drive off traffic)).
Before a final integrated measurement scene could be made, information was needed about the extent of assistance (by whom, with or without extra costs etc.) that can be given by EUROTRIANGLE.
To get all the answers we needed, four working visits to Antwerp were made.

The first meeting concerned the Flemish Community (mr. Cypers), the Rijkswacht (control room) and TRAFICON (owner of the CCAT cameras) to discuss in general:
- Possible date of installation of the gantries.
  We heard that the decision to implement the system was postponed. A new confirmation on a political level was necessary. The outcome of this decision is still not known. As an alternative, the (small scale) already existing warning system was subject to further discussion. At the same location on the E17 (Antwerp) the influence of two kinds of warning systems on driver behaviour can be investigated. Both systems are already in use. The pictogram gantries over more than two years (controlled automatically), the alphanumeric gantry from the first of

september 1993 (controlled manually). The study will be a "system-on vs. system-off" one instead of a before/after study.

- Kind of cameras (police and/or CCAT) could be used:
  - possibilities to wiretap video data from the police and/or CCAT cameras;
  - do the police keep a log file when and why the gantries are activated/stopped, what kind of messages are used, etc.

The second meeting concerned:

- Demonstration (given by TRAFICON) of their analysis software for loop detector data on a vehicle-by-vehicle basis (headway, intensity, speed and three categories of vehicle length):
  - possibilities to record video data directly from the CCAT cameras;
  - what are the costs.

At the third meeting technical possibilities were discussed with representatives of VIGITEC, such as:

- The most efficient way to wiretap video data from the police cameras.
- Who can/will deliver the technical equipment (recorders, time-indicators etc.)?
- Who will be responsible to carry out the arrangements on the field?
- What are the costs?
- Data from the police camera nr. 11 was needed to evaluate rerouting. At this meeting we heard that this camera was not operational. The Flemish Community promised to do their utmost to repair the camera before the fieldwork would start. If camera 11 could not be operational in time, no video data will be available to investigate rerouting.
- Loop detector data (storing data of ten days) were analyzed to know what time the morning peak normally started/ended. On working days congestion started in the Kennedy tunnel around seven o'clock in the morning and ended around 8.30. Within approximately a quarter of an hour congestion was built up from the entrance of the tunnel until camera 14. On weekend days very busy traffic or even congestion could be expected between 16.00 and 18.00 hours.

At the last meeting (two days before the fieldwork started) definitive arrangements were made:

- The Rijkswacht: instruction was given about what kind of messages we are interested in, how to fill in the working documents, during what period, what to do with the working documents and log files after finishing the fieldwork;
- TRAFICON (contracted): delivering loop data of all the CCAT cameras (nr. 1 to 15) on the E17 (in the direction of the Kennedy tunnel) on floppy on a one minute basis;
- VIGITEC (contracted): four police cameras were selected (nr. 2, 4, 7 and 14), VIGITEC fixed the four cameras (could not be moved from the control room during the fieldwork), a test tape was made (15 minutes per camera). Arrangements were made when to start/end the video tapes; what kind of video recordings would be used, how many copies we need and what must be administrated.
- Police camera nr. 11 was not operational. Therefore, rerouting will not be analyzed. Alternatively, traffic will be counted on the exiting lane (camera 14) to give an indication about rerouting.

During the preparation period of the fieldwork on the E17 near the Kennedy tunnel (14th of May until 20th of May 1994) and after that period we met the following practical problems:

- VIGITEC did not receive our contract in time, although we sent them the contract on the 9th of May. When we were notified at May 16 about the situation, we faxed a new contract. VIGITEC started the fieldwork on Tuesday morning (17th of May) and went on until the 22th of May. That means we lost one working day.
- Until now we did not receive the working documents and/or log file(s).

3.8.3. Fieldwork

The fieldwork took place from the 16th of May until the 22th of May. As already mentioned, video recording on Monday the 16th was lost.

On working days, video data was gathered per camera:

- From 6.15 until 7.15 in the morning (before congestion time) and from 11.00 until 12.00 a.m. (free flow traffic situation).
- On Saturday and Sunday video data was gathered from 16.00 until 18.00 p.m. (busy traffic).

At the beginning of June we received loop detector data from TRAFICON on floppy and send it to München.
VIGITEC send us tapes and copies of the video data. A complete set of tapes were send to LUND.

3.8.4. Results

Testing video data (screening/scoring a quarter of an hour per camera) the following problems and/or adaptations (according to the scoring form used for the PORTICO data) were needed:

- Four lanes instead of three (camera 14 and 4).
- Correct behaviour: exiting to the left.
- Incorrect behaviour:
  - not giving way;
  - using exiting lane for lane changing;
  - crossing uninterrupted line.
- Contrary to the PORTICO video data, a lot of lorries uses the right and middle lane. This means, that we miss a lot of traffic situations on the left lane and/or exiting lane (camera nr. 14). Furthermore, "pushing" behaviour is difficult to interprete.
- Interpretation of a disturbance is difficult according to false (sun)light (camera 14 during the early morning hour) and/or presence of lorries on the right and middle lane (all cameras).
- Before entering the Kennedy tunnel nearly all traffic brakes (not because of a disturbance); this was interpreted as normal adaptive behaviour by entering the tunnel (camera 2).
- During congestion time average speed slows down. A lot of cars are braking (all cameras). Judging those situations as risky or not is difficult. Information on TTC and/or estimation of headway is needed. When everybody keeps his/her lane these situations are also interpreted as normal adaptive behaviour (not scored).

As far as we understand, no loop detector data is available of traffic on the exiting lane (camera 14). Therefore, we decided to count traffic on that lane (two categories: cars/motorcycles and lorries).

Screening and scoring disturbances
Examining the possibility of using the PORTICO working documents and definitions to screen disturbances, a test case was carried out, using one video tape for each camera. The following problems are noticed:

- bad (sun)light interferes with screening for disturbances;
- when average speed or traffic flow goes down, braking behaviour (nearly by all traffic) is interpreted as normal adaptive behaviour;
- approaching the Kennedy tunnel nearly all traffic brakes; this is also interpreted as normal adaptive behaviour;
- unlike PORTICO on the E17 a lot of heavy traffic often blinds off traffic on the left lane or in front on the same lane; this interferes with estimating headways (for instance: when screening pushing behaviour) and the interpretation of a disturbance as risky or not.

The screening and scoring activity has been started.
After analysing one tape from camera 14 a new kind of manoeuvre was detected: using the exiting lane for overtaking to the left. If such a manoeuvre is against traffic rules (not yet clear) this manoeuvre will be scored as incorrect behaviour. Until then, as an indication of the frequency of this phenomenon, we will only score the number of times this manoeuvre occurs.